

Computer versus Paper-based Reading: Comprehension of Moroccan EFL First-Year University Students

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Abstract

Our research study investigated the effect of the computer-based text versus the paper-based text on the reading comprehension of 60 Moroccan EFL first-year university students. To achieve this objective, a reading comprehension test and a follow-up semi-structural interview were the research instruments employed to obtain data for this study. A between-subjects design, wherein participants were randomly assigned to either the paper condition or computer-screen condition, was adopted to meet the study's objective. Independent samples t-test and Content analysis of the participants' transcripts were conducted to examine the computer-based reading vis-à-vis the paper-based reading and their attitudes toward each of the two conditions. Although the interview results revealed that the participants expressed more positive attitudes toward their computer-screen reading experience, descriptive and inferential statistical analyses of the reading comprehension scores demonstrated no significant difference in the reading comprehension performance. Some pedagogical implications of the findings are suggested for consideration by teachers, educators, and stakeholders.

Keywords: computer-based reading, paper-based reading, reading comprehension, attitudes, EFL

1. Introduction

Technology today plays a fundamental role in almost every aspect of life, and people depend on it for entertainment, work, and study. People nowadays spend more time on their computers, laptops, tablets, and other technological devices than ever. As a result, many of our daily activities have remarkably changed, among which is reading. More particularly, this technological proliferation brings about an increasing shift toward onscreen reading, especially among young readers [1]. Besides, technology nowadays is depicted as a priority in the process of empowering education. Therefore, there is a significant growing use of computer-assisted language learning (CALL) and computer-assisted language testing (CALT) to promote and assess language skills. Fully aware of its potential to improve teaching and learning, the Moroccan Ministry of Education launched different

programs, projects, and initiatives (e.g., the "GENIE" Program) to equip all Moroccan schools and universities with computers and other ICT equipment.

Furthermore, the Internet nowadays provides students with rich reading resources of different textual genres and diverse subject domains, which might pose new reading challenges for comprehension [2]. More precisely, screen-based texts provide readers with more freedom and flexibility, allowing them to read texts in the order they choose and have immediate access to information in the size and presentation they want [3]. Although some might believe that reading is the same regardless of the reading format, some research studies have proven that electronic texts differ from printed texts at the psychomotor, perceptual, and cognitive levels [4]. In light of the previous considerations, this study is inspired by the belief that teachers, educationalists, and stakeholders should learn more about the phenomenon of screen-based reading comprehension. Also, this experimental study was conducted to increase understanding of the phenomenological inquiry of onscreen reading comprehension and how it is different or similar to paper-based reading comprehension. Moreover, this study aimed to fill the gap in the field of onscreen reading comprehension in the EFL context. Considering the aforementioned, this study comes with the objective of examining whether or not computer-based reading would affect students' comprehension of reading an expository text compared to reading on paper.

2. Literature Review

The remarkable shift from reading printed texts to reading electronic ones begs the question of whether or not computer screens affect readers' comprehension. To shed light on this inquiry, this research background examined a long and intricate debate about readers' comprehension of electronic versus printed texts.

To start with, Uso-Juan and Riz-Madrid [5] examined whether the hypertextual medium influences learners' reading comprehension. A sample of 50 female university students with lower

intermediate proficiency levels was divided into two experimental groups. 25 students read a research article in a printed format, while the other 25 students read the same text in its online version. The study's findings revealed that the reading comprehension levels of students reading printed texts and hypertexts were similar. These findings are in agreement with that of Porion et al. [6] who found no significant difference in students' reading comprehension performance on paper versus the computer screen. Along similar lines, Dundar and Akcayir [7] conducted a similar study comparing students' reading comprehension of electronic texts and printed texts. 20 students were randomly divided into a control group and an experimental group. The control group students read printed texts in an ordinary book, while the experimental group students read the same electronic texts on a tablet P.C. display. Qualitative and quantitative data yielded by this study provided convincing evidence that there is no significant difference between students using printed texts and those using screen-based texts at the reading comprehension level.

These results are consistent with those of Margolin et al. [8]. After randomly assigning 90 participants to paper, computers, or e-reader conditions, they were asked to read five narrative and five expository passages and answer 56 multiple-choice comprehension questions. The comparison of comprehension results from paper, computer, and e-reader conditions showed that the presentation formats do not affect comprehension of narrative and expository texts differently. Similarly, Schugar et al. [9] compared students' reading comprehension of e-texts versus paper texts. 30 university students were assigned to either the control or treatment group. The T-test and repeated measures ANOVA analyses revealed no discernible difference in reading comprehension between students reading e-texts versus printed texts. These findings are consistent with Jones and Brown [10] who investigated the effects of electronic books on 22 students' reading comprehension and enjoyment. Students were asked to read three different stories in three different reading formats. They read the first story on paper, the second on a laptop, and the third on an E-book. After reading passages from the stories, students were assigned to answer comprehension tests and complete enjoyment surveys. The ANOVA results showed that the text format did not matter as much as the level of enjoyment students received from the text.

Overall, the findings of the previously mentioned studies provided confirmatory evidence that reading on screens does not affect students' reading comprehension. These findings may be due to three potential reasons. First, the structures of screen-based texts employed in these studies were very simplified and/or linear. Second, the students sampled in these studies employed more reading strategies to

compensate for the digital environment's inherent difficulties. Third, the sampled participants might have had a high level of familiarity with screen-based reading, making their comprehension of electronic texts identical to paper-based ones. In this regard, Friedman [11] indicated that the Internet is now the primary information retrieval source for students. As a result, due to their familiarity with screens, students seem to have acquired sufficient experience and necessary techniques to overcome the difficulties they face while reading on screen.

Notwithstanding, in contrast to earlier findings, the assumption that reading comprehension performance is the same regardless of the presentation medium of reading texts is still inconclusive. Although the aforementioned experimental studies indicated no considerable difference in comprehension exists between the screen and paper-based texts, other researchers have refuted these findings. Baron [12], for instance, highlighted different drawbacks inherent in the digital environment, such as multitasking, eyestrain, and lack of concentration. According to her, these drawbacks negatively affect readers' cognitive performance on screen. In the same vein, other researchers, such as Mangen et al. [13], concluded that students who read texts on screens were more likely to have lower scores on reading comprehension tests than those who read texts on paper. According to this study, the negative impact of electronic texts on reading comprehension performance can be ascribed to several factors, such as multitasking, scrolling, and visual fatigue.

Likewise, Halamish and Elbaz [14] examined the effect of the screen and paper reading formats on children's reading comprehension. 38 participants read two short texts on screen and two other texts on paper before they were asked to answer a reading comprehension test. Results of the study indicated that reading comprehension is better on paper than on screen. Based on these results, the study implied that the mounting reliance on onscreen reading in educational settings might still be premature. In fact, when comparing it with traditional text reading, electronic texts' structural uniqueness and the digital environment's richness offer more freedom and flexibility, which impose more responsibility and decision-making on readers [15]. Therefore, Coiro and Dobler believe that it became a prerequisite for readers to adopt new and more complex skills and strategies to comprehend electronic texts.

In support of this view, Lee and Tedder [16] declared that the multiplicity of electronic pathways (links) and the richness of information impose a more significant cognitive load and disorientation. In other words, the fact that electronic texts allow readers to freely choose their own reading path to construct the meaning of the text they read imposes additional cognitive demands, and eventually results in readers' cognitive overload [17]. Accordingly, Destefano and

Lefevre [17] concluded that comprehension performance in linear texts is better than in hypertexts.

Nevertheless, screen-based reading is not something that students can do without nowadays. Unlike the first standpoints that blamed screen-based reading for lower comprehension, other researchers in the field indicated no negative effects of the screen on readers' comprehension. On the contrary, some researchers believe that the digital environment provides the perfect reading environment, for it helps them nurture rich and flexible comprehension of a complex content area [18]. Moreover, advocates of screen-based reading such as Dewitt et al. (2013) [19] stated that the community of digital native students is growing in higher education establishments; consequently, students today have a high level of familiarity with electronic texts.

Contrary to the two standpoints already mentioned in this research background, a third different standpoint emerged regarding this intricate debate. To illustrate, Tajuddin and Mohamad [20] conducted a quasi-experimental study investigating the effects of paper versus screen on reading comprehension among undergraduate university students. The participants were separated into two groups. The first group read paper-based expository texts, while the second group read screen-based texts on laptops. Each text was followed by multiple-choice questions to assess the participants' reading comprehension. The study concluded that students have better reading comprehension performance on screen than on paper. This view was supported by Dağlı Gökbulut and Güneyli [21], who compared the reading comprehension of texts presented through a computer screen versus printed texts. Their findings supported the standpoint that electronic texts are more likely to improve readers' comprehension than printed texts. The findings of these studies were also supported by Müller-Kalthoff and Möller [22] who indicated that hypertext structures engage readers in building connections between its information nodes. Their study concluded that students' engagement in building connections between the hypertext's information nodes results in better comprehension of the text.

To sum it up, a close examination of the aforementioned findings revealed that existing experimental studies are not yet conclusive in reaching a consensus on the inquiry of the reading comprehension performance on screens versus in print. Overall, we can distinguish between two opposing schools of thought that characterize the debate between screen-based vs. paper-based reading comprehension. Conservatives or critics who raise doubts about the jeopardy of screen platforms on reading comprehension and progressives or advocates who embrace and promote the increasing shift from paper to screens. Otherwise stated, screen critics (e.g., Halamish and Elbaz, [14]; Mangen et al., [13]) believe

that readers' comprehension of paper-based texts is better than electronic ones. At the same time, its advocates (e.g., Dağlı Gökbulut and Güneyli, [21]; Tajuddin and Mohamad, [20]) assert that electronic texts positively affect readers' comprehension. In reverse, unlike these two opposing views, a third standpoint (e.g. Margolin et al. [8]; Porion et al. [6]) concluded that cognitive requirements in reading electronic texts are similar to those of printed texts, which makes reading comprehension the same regardless of the text format.

3. Methodology

The present study was undertaken due to the dire need to examine whether or not computer screens affect students' reading comprehension. To this end, this study investigated the effect of computer versus paper-based reading on the comprehension of Moroccan EFL first-year university students. The sample chosen for the present study consisted of 60 Moroccan EFL first-year university students from the Department of English Studies at the Faculty of Arts and Human Sciences in Agadir, Morocco. The computer-based group (n=30) read an expository text on the computer screen, whereas the paper-based group (n=30) read the same expository text on paper. Both groups were asked to write down their answers on one piece of paper that contained the short-answer questions; enough space was provided under each question for participants to write their answers. Besides, a follow-up semi-structured interview was conducted with the participants immediately after the reading test to examine their attitudes toward their computer-screen reading experience. The obtained qualitative data was meant to help deepen our understanding of the potential effect of each of the two different reading modes.

Accordingly, this study addresses the following research question:

Is there a statistical difference in the reading comprehension of Moroccan EFL first-year university students using a computer-based text and a paper-based text?

What are the participants' attitudes towards the computer-based and the paper-based reading condition?

Based on the above research question, the following hypotheses were developed:

H1. Null Hypothesis: Students who read computer-based and paper-based texts will not display different statistical reading comprehension levels.

H2. Directional Hypothesis 1: Students who read the paper-based text will display higher statistical reading comprehension levels than students who read the computer-based text.

H3. Directional Hypothesis 2: Students who read the computer-based text will display higher statistical

reading comprehension levels than students who read the paper-based text.

3.1. Design

The experiment employed a between-subjects design, wherein the participants were randomly assigned to either paper or computer-screen conditions. This design is basic in the sense that it only has two conditions, the minimum required to conduct a between-subjects experiment [23]. In one condition, students read the electronic text on the computer screen, and in the other condition, students read the same text in print. Thus, each student in this experiment participated in only one of these two conditions. The independent variable has two levels (a computer-based reading text and a printed reading text). The dependent variable includes the students' reading comprehension scores as measured by the short-answer test. Besides, immediately after the reading test, a follow-up semi-structured interview was held with the participants to explore their attitudes towards their reading experience.

3.2. Participants

One group among 10 intact groups of Moroccan EFL university students enrolled at the Department of English Studies was randomly selected to participate in this study. The 60 students who attended class on the day of the experiment were randomly assigned to either the paper or computer-screen condition. This sample is heterogeneous in terms of gender, native language background, and age. Each of the two groups consisted of males and females belonging to the middle economic class, whose native language is Moroccan Arabic and/or Tamazight. Their age range varies between 19 and 25. All participants revealed that they own and frequently use a personal computer and/or a laptop.

30 participants belonging to the computer-based group read an electronic text in the Faculty's computer room. On the other hand, the other 30 participants belonging to the paper-based group read the exact text in print in a conventional classroom at the same Faculty. Besides, the computers employed in the present study were the same ones participants used in their information technology (I.T.) course. This assures that the participants are familiar with the use of computers employed in the present study.

3.3 Materials and Instrumentations

The subsections below elaborate on how each material and instrument was employed to meet the objectives of this study.

3.3.1. The reading selection. The text selected for this study is a two-page untitled expository text. It consists of 7 paragraphs with a total number of 627 words with no graphical or pictorial illustrations. The researcher discussed the suitability of the text content with two of the participants' EFL teachers, and ensured the adequacy of the text difficulty with students' proficiency level. Both teachers asserted that the linguistic difficulty of the text is compatible with students' proficiency level. More importantly, a sample of 10 students was chosen to participate in the piloting phase to ensure that the timing and comprehension questions were adequate for students' proficiency levels. The piloting phase confirmed that the text was neither hard nor easy. Also, participants in the piloting phase stated that the text aroused their curiosity and keenness to read and answer the comprehension test. Additionally, the piloting phase revealed that the allocated time -45 minutes- was sufficient to read the text and answer the follow-up comprehension questions. Finally, yet importantly, the length of the reading text utilized in the present study was similar to texts that students usually encounter in their reading classes.

3.3.2. Reading formats. The participants in this study read the same expository text under one of the two conditions. The computer group read the expository text on the computer screen, while the paper-based group read the same text on paper. Regarding the computer group, the computer displays were 17 LCD monitors. Participants were familiar with the computers employed in the present study, for they were the same computers that participants used in their information technology (I.T.) course. The reading text was presented to participants in a two-page Microsoft Office Word 2007 file format, 210 mm x 297 mm. The text color was black, the font size was 12 points, Arial, at 120% scale. As for the paper-based group, the participants read the exact text on two printed papers. The size of the paper was (210 mm _ 297 mm). The font was black, 12 points Arial. Accordingly, the only difference between the two groups was the reading formats, paper versus computer screen.

Participants in both groups were permitted to go back and reread the text passage while answering the comprehension questions. Thus, participants who read the text on the computer screens scrolled up and down the pages, while participants who read in print flickered through them. Besides, participants were also free to write, comment, and highlight the text while reading. All participants were required to answer the comprehension test on an A4 paper delivered to them. Enough space was provided under each question for participants to write their answers.

3.3.3. The short-answer test. The choice behind the short-answer testing method was motivated by the fact that Moroccan students are familiar with this testing method of measuring reading comprehension. Moreover, short-answer questions (SAQs) have a high degree of validity. Unlike some other methods of testing reading, SAQs guarantee -to a great degree- that the responses are attributed to students' comprehension of the text and not to any other irrelevant variable. In other words, using short-answer questions in the present study ensured that the testees' correct responses were mainly due to their comprehension of the text and not to any other extraneous factors. Moreover, as indicated by Weir [24], the strength of this testing method lies in its effectiveness in engaging readers in seeking and creating answers and not in choosing between provided answers.

Participants were reminded to keep their answers precise and concise. To this end, participants were given limited yet sufficient space to write their answers below each question and were informed that no additional answer sheet would be provided. Regarding the comprehension questions, the type of questions adopted in this study involved literal, reorganization, and inferential comprehension questions. With reference to the scores, the scale employed in this study was: two points for a correct response, one point for an incomplete answer, and zero points for an incorrect or no response. The two-point scale was adopted for all the questions regardless of their type.

3.3.4. The follow-up semi-structured interview. The interview questions examined the participants' attitudes toward their computer-screen reading experience vis-à-vis their paper-based one. Eliciting the participants' attitudes helped formulate a profound understanding of their computer-screen reading experience and the potential effects of the computer screen on their reading comprehension. According to Ajzen and Fishbein [25], people's attitude toward an object consists of three main components: affective (what individuals feel), cognitive (what individuals believe), and behavioral (what individuals do). Therefore, the interview questions revolved around these three components. Thus, some interview questions examined the participants' feelings and interests in their paper and computer-screen reading experience. Other questions revolved around the participants' beliefs about the effects of the computer screen on their comprehension performance. Also, other specific questions examined the participants' behaviors while reading on the computer screen vis-à-vis print.

3.4. Procedure

This study involved comparing two randomly assigned groups, the computer-based group and the paper-based group. The randomly selected intact group initially included 160 EFL students, who are registered in their first-semester at the Department of English. Prior to the experiment, they were asked to write their names on folded papers. They were provided with some information regarding the nature of the experiment and were asked to fill out a short form on demographics. Afterwards, the researcher scrambled the papers and assigned the first folded paper to the computer-based group, the next to the paper-based group, and so on. After counting the required number of participants, which is 60, the researcher kindly requested that the remaining unselected students leave the classroom. Right after, with another teacher's assistance, participants from the paper-based group remained in the classroom to sit for the short-answer test, while participants assigned to the computer-based group were taken by the researcher to the computer room to sit for the same test. The time allotted for the comprehension test was 45 minutes. Thus, all participants were required to submit their tests within this time limit.

All students were allowed to return to the text to answer their questions. Not allowing students to go back to the text would test not only the participants' comprehension but also their memory, which was not the objective of the present study. Additionally, the follow-up semi-structured interview was conducted with the participants immediately after the short answer test. The interview lasted for about 15 minutes. The participants' responses were recorded using a smartphone and then carefully transcribed for the data analysis.

3.5. Analysis

Two types of statistical analyses were run on the data obtained from the test scores. Initially, the data were submitted to descriptive analysis (X, SD). Additionally, the t-test for independent variables was also employed for inferential analysis. The rationale behind opting for inferential statistics stemmed from the fact that descriptive statistics alone could not tell whether or not the difference in the mean scores was reliable. Therefore, inferential statistics were used to reveal the significance of the difference found between the mean scores in the descriptive statistics. The alpha level of significance was set at a liberal .05. As for the follow-up interview, the participants' recordings were transcribed and then categorized to show their reactions to their reading experience, suggestions and insights about the text, and the difficulties they encountered during their reading. Content analysis of the participants' transcripts was

conducted by naming, coding, and classifying emerging patterns and themes of data [26].

4. Results

The following section presents the major findings of the study. Specifically, this section analyzes the results gathered via the short-answer test and the follow-up semi-structured interview. The results are analyzed under two themes: The effect of computer-based versus paper-based texts on students' reading comprehension, and the participants' attitudes towards computer-screen reading vis-à-vis paper-based reading.

4.1. The effect of computer-based versus paper-based texts on students' reading comprehension

The descriptive statistics of the participants' performance in both the paper and computer conditions, as seen in Table 1 below, revealed a slight difference between the means of the two groups. More precisely, participants in the paper condition obtained a slightly higher mean score of 6,92 than participants in the computer-screen condition, whose mean score is 6,69.

Table 1. Mean and Standard Deviation on the Short-Answer Test

	Number of test-takers	Highest and lowest scores (out of 12)	Mean score	Standard deviation
Computer-based group	30	03 - 11	06,69	02,4
Paper-based group	30	02 - 10	06,92	02,17

However, inferential statistics were then employed to examine whether the slight difference in the participants' comprehension test scores was due to the computer screen or just chance. Therefore, to test the hypotheses already defined by the researcher, the independent samples t-test was run with the alpha level of significance set at a liberal .05. As for the decision rule and T-value, it was found that the decision rule was between -2, 06 and 2,06, and the $t = -0,06$. Since the t result was not less than -2,06 or greater than 2,06, the null hypothesis of this study was accepted. No significant difference was revealed between the paper and the computer groups. Thus, these results confirm that computer screens do not affect students' reading comprehension.

Table 2. T-value of the paper and computer groups

	Sum of square	Degree of freedom	T-value
The computer-based group	69,12	12	- 0,06
The paper-based group	56,4	12	

4.2. The participants' attitudes towards computer-screen reading vis-à-vis paper-based reading

The follow-up semi-structured interview was conducted with the participants instantaneously after the short-answer test to examine their attitudes towards their computer-screen reading experience vis-à-vis their paper one.

All interviewees in the computer group expressed positive feelings toward their computer-screen reading experience. They asserted that they have genuinely enjoyed their computer-screen reading experience, describing it as up-to-date, stress-free, exciting, and motivating. The following comments by the participants nicely summarized their feelings:

"We love technology and computers; therefore, we like the idea that reading courses at the Faculty will one day become digital."

Another interviewee added:

"I didn't feel the usual fear I used to have when I faced the exam paper."

However, one interviewee declared that a technical problem with the computer mouse made her reading experience somehow uncomfortable. Besides, when asked about the limitations they think may hinder their reading comprehension on computer screens, all participants in the computer group reported that eyestrain could be a severe problem that might have negative effects on their reading of computer-based texts.

With regard to their interest in completing their reading task, all interviewees in the computer group affirmed their absolute interest in completing their reading on the computer screen. However, whether or not they think they would perform better if they read the same text in a printed medium triggered conflicting views. For example, some interviewees in the computer-based group believed that the reading medium did not affect their comprehension performance. As evidenced by this comment:

"We do not think that the reading medium influences our reading comprehension by any means."

If we sit for the same reading test, we will obtain the same results regardless of whether the text is on paper or onscreen."

Other participants, however, stated that they believe that their love of technological devices motivates them to read and perform better in their reading-comprehension tasks. On the other hand, all participants in the paper-based condition indicated that their reading experience was ordinary. Most of them asserted that the most positive aspect of reading on paper is the higher level of focus that characterizes the conventional reading environment, for there is no access to the Internet that can distract them. For instance, one interviewee stated in this regard:

"Contrary to reading on the computer screen, I think the printed reading enables us to concentrate more on the reading text."

Also, the participants in the control group highlighted that the paper-based texts enable them to highlight, underline and comment while reading the text, which -according to them- is impossible to do on screens. In addition, when the paper-based group was asked about their interest in reading the text, half of them confirmed that they were interested in completing their reading, while the other half acknowledged that they read the text and answered its questions just because they were required to do so. In this regard, a particularly interesting comment was:

"Reading printed texts is dull; I wish there was more access to computerized reading material at the Faculty."

Whether or not the participants in the paper group thought they would perform better if they had read the same text on the computer-screen, the majority of the interviewees believed that their performance would have been the same regardless of the reading medium. Nevertheless, very few interviewees believed that the results would have been lower, had they read on the computer screen, for they believed that difficulties in highlighting, underlining, and commenting on screen would hamper their comprehension of the text.

5. Discussion

The fundamental question in this study was whether or not reading on the computer screen would have a different impact on students' comprehension of expository text as compared with reading on paper. The results demonstrated no significant difference in the reading comprehension performance between participants reading on paper and computer-screen conditions. The present study's findings seem to validate the one conducted by Schugar et al. [9] that compared the reading comprehension of students

reading e-texts to paper texts. Their study revealed no statistically significant difference in students' comprehension of e-texts versus paper texts. A similar result was also reported by Uso-Juan and Riz-Madrid [5] who examined whether the hypertextual reading format influences learners' reading comprehension. Their finding lent support to the standpoint that the reading comprehension of students who read printed texts and those who read electronic ones was identical. Also, the present study's finding is consistent with the one conducted by Jones and Brown [10] who investigated the reading comprehension of E-books versus traditional printed books. Their results showed that the book format did not matter as much as the level of enjoyment students received from the storyline.

Additionally, the present study's findings corroborate the findings of some other previous studies such as Dundar and Akcayir [7] who yielded convincing evidence that reading comprehension was equivalent for both learners who used Tablet screens and printed Papers. Likewise, this study also supports Muter and Maurutto [27] who reported no significant comprehension difference between readers reading in print and onscreen short stories. By the same token, these findings are in agreement with that of Porion et al. [6] who found no significant difference in the students' reading comprehension performance on paper versus the computer screen. These results are also consistent with those of Margolin et al. [8] who concluded that presentation modes of paper, computers, and e-readers do not differentially affect students' comprehension of texts.

Nonetheless, the present study's results contradict the one conducted by Mangen et al. [13] who investigated the effects of the technological interface on reading comprehension. The major findings of their study indicated that students who read texts on screen were more likely to have lower scores on the reading comprehension tests compared to the students who read texts on paper. Mangen et al. [13] ascribed the negative impact of the screen on students' comprehension to disrupted mental maps of the text, multitasking, and visual fatigue. Similarly, Halamish and Elbaz [14] found that reading comprehension is better when reading on paper than on screen. Furthermore, in contrast to the present study's findings, Belmore [28] conducted a study in which he concluded that students who read short passages on screen revealed lower comprehension levels than participants reading on paper. Belmore [28] ascribed the existing comprehension discrepancy between the screen and print conditions to the participants' unfamiliarity with the screen as a reading presentation medium. Likewise, the present study's results are inconsistent with the findings by Destefano and Lefevre [17]. In their study, they argued that hypertext

presentations impose additional cognitive load, which negatively affects comprehension.

Notwithstanding, cognitive overload, disrupted mental map, multitasking, and visual fatigue problems reported in the studies above did not influence the participants' level of comprehension in the present study. Possible explanations for this might be attributed to four probable factors. First, the length of the text employed in this study is relatively short. Reading lengthy texts onscreen is frequently related to the problem of eyestrain, which may affect students' comprehension performance. Second, this study adopted a simplified and linearly structured text with no embedded hyperlinks. In this regard, the studies investigating cognitive load and disorientation problems in hypertexts affirm that the more a hypertext contains embedded links, the more decisions readers have to make and the more comprehension challenges they have to deal with [17]. Third, participants who read on screen in the present study may have used more reading strategies than those who read in print, which enabled them to compensate for the difficulties inherent in the digital environment.

According to Dias and Sousa [29], strategies such as management and navigation strategies are vital for overcoming the complexities of electronic texts. In this respect, Friedman [11] indicated that the Internet is now the primary information retrieval source. As a result, due to their familiarity with screens, students seem to have acquired sufficient experience and necessary techniques to overcome the difficulties they may face while reading on screen. Last but not least, students in the present study are familiar with the computer screens on which they read the text, for they are the same computers they use for their I.T. classes.

In a nutshell, the present study was conducted because of the absence of conclusive and consistent research comparing paper versus screen reading comprehension performance. The results supported the null hypothesis, and thus revealed no significant difference in the students' reading comprehension performance of computer-based versus paper-based texts.

6. Conclusion

The findings of this study provide comforting results, especially since new technologies have often been blamed for causing readers to multitask, become disoriented, and be cognitively overloaded. This study concluded that the computer-screen medium does not negatively affect students' textual comprehension. Moreover, students in the present study revealed positive attitudes towards their computer-screen reading experience, describing it as up-to-date, stress-free, exciting, and motivating.

The pedagogical implications of the findings of this research for education and EFL reading are

valuable and worth considering by teachers, educators, and stakeholders in general. Initially, this study recommends that students be allowed some level of access to computers in school libraries to motivate students, encourage research, and promote reading. Equally important, this study also suggests that curriculum developers in Morocco include some computer-assisted reading (CAR) activities in Moroccan textbooks. Also, this study strongly suggests that EFL teachers encourage their students to use screen-based resources (e.g., online websites, dictionaries, Wikis, and online references) to promote learning in general and reading in particular.

Notwithstanding, a significant amount of previous research has raised concerns about some reading problems that might occur due to the complexity of electronic texts. Therefore, stakeholders should be aware of the problems that characterize the onscreen reading environment, such as cognitive overload, disorientation, multitasking, and eye fatigue. More importantly, stakeholders should consider how to deal with these new constraints while embarking on integrating ICT tools into the educational system. Also, teachers should raise students' awareness of such onscreen reading limitations and the best ways to overcome them. For instance, teachers and researchers are recommended to search, suggest, and provide reading strategies and instructional programs for students to ameliorate their reading comprehension of electronic texts.

7. Limitations and suggestions for future research

It is hoped that this study's findings have contributed to the body of research attempting to examine whether or not computer screens affect students' reading comprehension. However, like any other research, the present study has limitations that future researchers should consider when conducting similar empirical studies.

The first possible limitation of this study is the sample size chosen for the experiment. 60 participants in both groups could be a limited sample that might negatively affect the rigorous detection of the effect of the computer screen on students' comprehension. The smaller the sample is, the more likely the scores will pull the mean to one of the two ways. However, the random sampling process and other procedures were taken to minimize the consequences of the small sample in this study. Another limitation that hinders the generalizability of this study's finding is the type/genre of the text chosen for the comprehension-reading test. Undoubtedly, this study does not claim that one text type/genre can represent all types of electronic texts students read.

Regarding suggestions for future research, the computer-based text structure adopted in the present study was a linearly structured Microsoft Office Word

document with no graphical or pictorial illustrations. Future research should examine the effect of different types of electronic texts on students' comprehension performance. In other words, further research should consider examining nonlinear hypertexts or online texts that give students access to multiple links to gain more insights into the screen-based reading phenomenon. Moreover, this study encourages researchers to examine and suggest reading strategies and instructional programs to ameliorate students' reading comprehension of electronic texts.

Furthermore, the present study used a text consisting of seven paragraphs with a total number of 627 words. A further suggestion would be to see if reading lengthy texts on computer screens would affect reading comprehension. Further research can also include the impact of computer-based reading on more reading spheres, such as reading behavior, speed, accuracy, and fatigue. Last but not least, longitudinal research on reading interaction with screen computers is also worth investigating.

8. References

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