

ARTICLE



Comparative efficacy of digital and nondigital texts on reading comprehension and EFL learners' perceptions of their merits

Khalid Al-Seghayer, Al Imam Mohammad Ibn Saud Islamic University

Abstract

This study investigated EFL learners' differential comprehension of paper-, e-, and web-texts and their perceived effects on reading comprehension. A multiple-choice test was administered in each form to 48 Saudi EFL learners, and General Estimating Equations (GEE) was used for within-subject observations of test scores for the text in each medium. Six questions assessed the form's effect on literal, inferential, and evaluative comprehension levels. To examine factors influencing comprehension, participants completed a 22-item survey of reading across media on which descriptive and inferential statistical analyses were performed. Semi-structured interviews were conducted, recorded, transcribed, coded, and categorized. Participants understood printed text significantly better on all three levels of reading comprehension, while e-texts' effect was significantly greater than that of web-texts at the literal and inferential levels; however, the two differed negligibly at the evaluative level. Survey responses indicated better understanding and retention of information in printed text. EFL learners found that scrolling through e-text impaired comprehension, and interactive features in e- and web-text proved distracting, while numerous links in web-text led to cognitive overload and increased frustration; however, web-text's non-linearity facilitated L2 reading comprehension. The interviews identified factors that facilitated reading comprehension of printed text. The study's implications and future research directions are discussed.

Keywords: *Comparative Efficacy, Digital and Nondigital Texts, Reading Comprehension, EFL Learners, Perceptions*

Language(s) Learned in This Study: *English*

APA Citation: Al-Seghayer, K. (2024). Comparative efficacy of digital and nondigital texts on reading comprehension and EFL learners' perceptions of their merits. *Learning & Technology*, 28(1), 1–30.
<https://hdl.handle.net/10125/73589>

Introduction

The field of second language (L2) reading is undergoing a transitional period due to the increasing pervasiveness of electronic reading, with its diverse features and advantages. Electronic reading has affected all aspects of teaching and learning L2 reading, particularly reading comprehension, which is the core topic in reading circles or any reading processes or tasks. Simultaneously, recent breakthroughs have identified factors contributing to print-based reading comprehension. Print and electronic reading environments are not mutually exclusive, and both are fixtures in the field. They function together as essential and effective instructional reading tools that will continue to enrich and play an indispensable role in L2 reading comprehension; thus, their full potential and possibilities remain to be explored. Specifically, the potential modal differences in comprehension among English as a foreign language (EFL) readers need to be thoroughly examined. Reading literacy has evolved to include the ability to read both paper- and web-based materials (Wu, 2014). Since text mediums drive the reading act, the advent of new reading technologies presents unique opportunities to study L2 reading comprehension.

Thus, L2 reading comprehension across platforms must be examined to determine whether EFL learners' reading comprehension abilities when reading English texts on a screen are consistent with their printed reading comprehension abilities. Bikowski and Casal (2018) argued that many EFL learners were ill-equipped to learn in a digital environment. The effects of presentation medium on general comprehension performance and specific comprehension levels will inform L2 reading pedagogy. Gilbert (2017) and Al-Seghayer (2017) emphasized that both printed print and digital texts would be essential to future L2 reading instruction. As such, we must better understand the ramifications of reading digital versus printed texts to determine the most effective instructional methods for maximal reading comprehension. This would illuminate learners' perceptions about the efficacy of their comprehension under digital and print conditions as well as how their attitudes affect their actual comprehension outcomes. Unfortunately, few studies in the EFL context have empirically substantiated L2 reading comprehension in both digital and conventional reading environments.

This situation raises an important question: To what extent does reading modality influence EFL learners' comprehension? To address this question, this study compared performance on three levels of reading comprehension under digital and print conditions. The study also assessed how EFL learners' perceptions of printed, web, and e-texts affected their reading comprehension, which forms they comprehended most and least, and why they made these choices. Moreover, EFL learners' perceptions of the factors that affected their success or failure in comprehension when reading the three text forms were discussed.

This study contributes to the general body of knowledge on L2 reading comprehension across print and digital texts by determining the text form most conducive to EFL learners' comprehension and by identifying self-perceived factors influencing their understanding of print and electronic texts. Such new insights will help L2 reading program designers create more effective print- and digital-based reading environments and better understand the nature of comprehension components in general and within both types of texts.

Literature Review

L2 Reading Comprehension of Digital and Nondigital Texts

EFL learners encounter three different text forms: printed text, e-text, and web text (each is defined in the [Materials and Instruments](#) section). It is unclear whether these textual forms affect reading comprehension to the same degree. Coiro and Dobler (2007) and Coiro (2011) noted that many processes involved in comprehending digital text were similar to traditional paper text; however, some important differences did exist, including but not limited to the new comprehension demands of querying search engines, understanding search results, navigating hyperlinks, and critically evaluating online information—all of which required new thought processes. These authors contended that traditional comprehension skills and strategies were necessary but ultimately inadequate when reading and locating information online. Other studies have echoed this perspective, suggesting that little difference in reading comprehension exists between print and e-texts (Daniel & Woody, 2013; Grzeschik et al., 2011; Sun et al., 2013; Young, 2014).

Margolin et al. (2013) argued that any references to e-texts must be specified before discussing similarities and differences between electronic and print text comprehension levels. E-texts require reading more linearly and are designed to recreate the appearance of printed text. Conversely, web text requires more efficient information-seeking strategies. Furthermore, web text engages readers in processing and integrating text and non-text components such as graphics, images, and multimedia content. Girón-García (2013) bolstered these assertions by stressing the differentiation among “new literacies,” “spontaneous new literacies,” and “new technology skills.” New literacies refer to surfing the web. New technology skills are needed to use Internet resources to solve problems and perform activities. Meanwhile, print reading comprehension can only inform the understanding of online reading comprehension to a limited degree (Coiro, 2011, 2020). However, Liu and Ko (2016) contended that paper-based reading skills remained the basis for online reading. Park and Warschauer (2016) and Taylor (2019) added that technological tools

assisted L2 learners in developing their reading skills as they facilitated the cognitive processes integral to L2 reading comprehension.

The remainder of this literature review explores these issues in greater detail, particularly in an EFL context. Empirical studies are categorized into two orientations: studies that focus on L2 reading comprehension between digital and non-digital texts and studies of EFL learners' perceptions when reading either text form.

Abdi (2013) compared 49 Iranian EFL learners' gains in reading comprehension ability after having read digital and printed texts. The experimental group viewed digital instructional reading materials and the control group received traditional printed or nondigital reading materials for four weeks. The author found that digital texts increased reading comprehension ability relative to those exposed to traditional texts. Adopting a similar perspective, Rahmani (2013) examined the impact of paper-based instruction and computer-assisted instruction on EFL learners' reading comprehension and found a significant difference between those learners who received computer-assisted instruction and those who received paper-based instruction. Similarly, Boshraadi and Biria (2014) found that multimodal texts increased the reading comprehension levels of 60 Iranian EFL learners relative to printed texts. Shang (2015), however, found no significant difference between print- and hypertext-based interventions' effects on the reading comprehension outcomes of 28 nontraditional (older and with greater work experience) EFL learners. Ebrahimi (2016) compared the effects of reading electronic and paper versions of texts on the comprehension levels of 60 Malaysian EFL learners. Participants were assigned to read 10 short literary prose texts and were divided into experimental and control groups, with the former being ensconced in a digital literature reading environment whereas the latter group was placed in a printed one. A reading comprehension test revealed that participants who read the short literary prose texts in a digital format performed significantly better on the comprehension test than those who read the printed equivalent.

Chiang (2016) continued this line of inquiry by investigating how differences between reading Kindle e-text (experimental group) and print text (control group) affected the reading comprehension of 36 Taiwanese EFL learners. Both groups read the same five novels as either e-books or traditional books and then completed the English Reading Comprehension Test (ERCT). No significant differences in reading comprehension were found between the two groups.

EFL Learners' Perceptions of Reading Digital and Nondigital Texts

This section focuses on studies of EFL learners' perceptions of the use of printed versus digital texts in teaching and learning L2 reading. For example, in an earlier study, Tseng (2010) examined Taiwanese EFL learners' perceptions regarding online reading and found that participants disliked reading from computer screens. Various factors contributed to the participants' adverse attitude toward online reading, including eyestrain, tiredness, and distraction. Huang (2013) explored EFL learners' perceptions of an e-book reading program that lasted a year in which participants read one e-book each week. The findings indicated that the participants perceived the e-book as a means to cultivate better reading habits and increase motivation while being more available, portable, and eco-friendly than print-based texts.

Tsai (2016) investigated EFL learners' perceptions of, and preferences for, reading printed texts versus e-texts according to reading proficiency level and gender. No significant gender differences were found; however, the high-proficiency group preferred printed text whereas the low-proficiency group preferred e-text. Ebrahimi (2016) found that 83% of participants strongly preferred reading digital texts, which the participants attributed to ease of access, the ability to locate information digitally, and media-rich environments. The remaining 17% attributed their better comprehension of printed text to the ability to make handwritten notes, underline unfamiliar words, and highlight important points. Chou (2016) examined EFL students' perceptions of e-books and whether their perceptions change over time. The results showed that participants valued the intangible nature of e-books and regarded reading e-books as an unpleasant experience.

A related study by Gilbert (2017) examined 145 ESL learners' perceptions of digital versus printed reading using interviews and journal entries, finding that a majority preferred printed texts when either seeking careful or in-depth reading or reading for pleasure. Conversely, digital text was favored when engaging in information research; recreational and academic reading, therefore, appeared to have differential effects on the preference of text formats. Digital text was more aesthetically appealing to participants; however, they found multimedia features, hyperlinks, pop-up ads, and flashing text to be distracting and bothersome. Furthermore, they perceived the information within the printed text to be more trustworthy due to the presumed adherence to fact-checking quality control guidelines required from paper-based publishers. Participants identified enhanced speed as well as ease of accessibility and flexibility in terms of time and space as the leading advantages of online reading. Similarly, a 50-item questionnaire administered by Chiang (2016) revealed that most participants preferred reading novels in print rather than e-text. Additionally, Manalu (2019) examined 65 Indonesian EFL learners' perceptions of reading digital texts and found that 80% of them perceived digital texts reading positively because they were motivating, interesting, and suited to their expected way of reading.

Overall, the research indicates that digital texts increase reading comprehension relative to printed text. However, EFL learners' perceptions of their comprehension levels have revealed mixed results, from which several conclusions can be drawn. First, there is a lack of data on the effects of printed versus e-text on L2 reading comprehension and on EFL learners' subjective ratings of both forms' ease of comprehension. In this regard, Alisaari et al. (2028) and Pardede (2019) accentuated that previous studies yielded more varied and contradictory results. Second, studies have only measured overall reading comprehension ability. Furthermore, recent studies have limited their examinations to EFL learners' general rather than specific perceptions; these learners' preference for printed over screen text transcends the mere visual difference. Recent studies have also overlooked self-assessments of comprehension efficacy across modalities, instead documenting only self-reported feelings. This study will address these gaps.

Overview of the Present Study

Today, EFL learners are exposed not only to printed text but also e-text and web text. The proportion of text that is viewed digitally has increased, mainly because of the growing availability of personal digital devices that offer high-resolution displays and direct haptic manipulation. Thus, digital reading has become the norm. Each text form has its own unique affordances that influence L2 reading processes and reading comprehension outcomes in particular. Discerning variations in the efficacy of text-content comprehension in printed text, web text, and e-text is vital for identifying the factors that enhance reading comprehension. A burgeoning body of literature in the EFL field has explored reading in these three text forms with an emphasis on electronic forms. This existing research has focused mainly on the process and efficacy of reading from computer screens, the readability of texts, and the speed of reading and proofreading on paper products versus computer screens, rather than on reading comprehension outcomes.

Consequently, this study explores whether reading electronic forms (e-text and web text) results in comprehension levels that are comparable to those achieved from reading traditional ink-on-paper texts. To this end, the study measures subjective and objective comprehension levels with respect to the three text forms as well as subjective assessments of the factors mediating the comprehensibility of each form. This knowledge can serve as a stepping stone for future research on L2 comprehension in relation to reading various text forms. The following five research questions are posed:

1. How does the comprehension of EFL learners differ when they read texts in print forms from when they read electronic forms (e-text and web text)?
2. What effects do the three text forms have on literal, inferential, and evaluative reading comprehension levels?
3. How do EFL learners perceive the ways in which the three forms affect their reading comprehension?

4. What specific factors do EFL learners believe to be influential in their comprehension when reading each of the three text forms?
5. Which of the three forms do EFL learners believe contributes most and which contributes least to effective comprehension and why?

The first question addresses the effects of text modes on reading comprehension in general, while the second explores the effects of text modes on the three reading comprehension levels. Question three addresses EFL readers' perceptions of the effects of printed text, e-text, and web text on L2 reading comprehension, based on data from the responses of the EFL learners to the survey that was developed by the researcher. However, questions four and five explore the factors that affect the success or failure of the EFL readers in terms of comprehension and address their perspectives regarding how much reading from each of the different text forms facilitates their L2 reading comprehension. The data for these two questions were derived from interviews conducted with participants.

Methodology

Participants

This study was conducted in the English department of a Saudi state university. Forty-eight undergraduate English majors aged 18–23 years old ($M = 22.5$) enrolled in the College of Languages and Translation were solicited to participate. This sample included 27 men and 21 women. All of the participants were directly contacted by the researcher and invited to participate in the study. In order to qualify for the study, participants were expected to meet certain criteria. A number of considerations guided the sample selected for this study. The participants comprised a homogenous group in that they attended the same program and were native speakers of Arabic and non-native speakers of English, with similar levels of English proficiency, by virtue of their TOEFL scores and academic placement in six junior-level courses. Their homogeneity was also assessed with the ACTFL Proficiency Guidelines. All participants were expected to have attained high intermediate proficiency TOEFL scores (i.e., 500–530) and a high intermediate proficiency level in reading—their instructors confirmed the participants' good command of reading skills. [Appendix A](#) summarizes the participants' background demographics and their experience with reading printed and digital English texts.

Design Overview

This mixed quasi-experimental study included one between-subjects and one within-subjects factor (reading ability and the three text forms, respectively). The different text forms (i.e., the independent variables) were manipulated by exposing participants to identical treatment conditions, with equivalent groups or a single-group and a non-pre-test/post-test comparison group; participants served as their own controls in each condition. The primary dependent variable (i.e., the difference in text comprehension scores across the three modalities) was measured using three tests, one test for each modality. The presentation of text forms was randomized to prevent order effects.

The study used standard surveys to record self-reported comprehension levels and to investigate factors that influence EFL learners' comprehension when reading printed and non-printed texts. The survey addressed EFL readers' perceptions of printed, e-, and web texts' effects on L2 reading comprehension and the factors that affected their success or failure in comprehension. The instrument was developed by the researcher following an extensive review of the literature, and data were subjected to simple descriptive and inferential statistical analyses. Semi-structured interviews were then used to identify participants' perceptions of each form's advantages for comprehension and their preferred forms. They also self-assessed their degree of comprehension. Interview responses were transcribed, coded, and evaluated for emergent themes.

The study combined quantitative and qualitative techniques, thereby permitting a more nuanced analysis while cross validating the other instruments' data. These multiple data also contributed to the identification of text forms' effects on EFL learners' L2 comprehension of short expository English texts. Quantitative

data were first collected to acquire an overview of actual comprehension levels; qualitative data were gathered subsequently to elaborate on the general picture.

Procedures

The study comprised two phases over three sessions. First, in a 90-minute introductory session, participants met the researcher either individually or in small groups in a seminar room equipped with laptop computers and a *Morae* screen room (the software that records users' actions). Laptops displayed preselected digital texts. Informed consent was obtained, and participants were asked to complete a printed informational background questionnaire as well as the TOEFL test, which consists of three multiple-choice categories: listening, grammar, and reading tests.

The second phase of the procedure was conducted in two one-hour experimental sessions. During each session, participants were asked to read two analogous expository digital texts on the computer screen under two conditions (web and e-text) and in printed text (30 minutes each, although the reading time for each article was unrestricted to promote more naturalistic reading behavior). After reading each text, they then completed comprehension tests (10–15 minutes each), a brief interview to ensure a 100% return rate (15–20 minutes, although the interview duration was not restricted), and a survey (15–20 min). All participants completed the survey; no data were missing. All tasks were completed within a 4-hour period bisected by a 15-minute break.

Materials and Instruments

Reading Passages

Three passages were selected from a self-improvement book, *The Big Book of Small Stuff* (Carlson, 2006). The three passages, “Be Careful What You Ask For” (BCWYAF), “Lower Your Expectations” (LYE), and “Don’t Live in an Imagined Future” (DLIF), were expository texts judged to be unfamiliar to most high intermediate EFL learners. Furthermore, the topics were suspected to appeal to participants on the premise that young adults strive for self-improvement and cognitive insight.

These passages were selected according to eight criteria: the texts (1) share the same subject matter, (2) literary style, (3) are of the same length, (4) exhibit the same degree of difficulty, (5) are authentic passages, (6) require minimal background knowledge, (7) express ideas with a logical rhetorical organization, and (8) are culturally appropriate. Arias (2007) and Ghahroudi and Sheikhzadeh (2017) pointed out that these were the most important criteria that should be involved in selecting reading text. The selected passages have appropriate syntactic complexity for high intermediate EFL learners because they comprise short, simple sentences. The mean sentence length was 22.72 words in BCWYAF, 22.02 in LYE, and 22.33 in DLIF; the percentage of simple sentences was 50%, 40%, and 43.9%, that of complex sentences was 10.5%, 9%, and 12%, and that of compound sentences was 39.4%, 52.5%, and 39%, respectively. The high percentage of simple sentences rendered the texts appropriate for high intermediate EFL learners. The three texts' difficulty was analyzed using the Lix formula (Table 1), a readability formula recommended by Schultz (1981) for analyzing foreign texts.

Table 1

Lix Readability Formula

Text	# of words	# of sentences	Words per sentence	Words over 6 letters long	D + E	F x 100	Lix
BCWYAF	818	36	22.72	142	164.7	16,470	20.13

LYE	815	37	22.02	135	157.02	15,702	19.26
DLIF	804	36	22.33	137	159.33	1,593	19.81

Reading Comprehension Measures

The three-level model of reading comprehension, following the modes of comprehension proposed by Day and Park (2005), was adapted to assess literal, inferential, and evaluative comprehension skills. Reading comprehension at each level was tested using a unidimensional multiple-choice test comprising six questions, each of which listed four alternative answers. Two literal questions asked participants to identify the author's explicit statements, two inferential questions asked them to determine the relations between events in the text and to draw conclusions that were not stated explicitly, and two evaluative questions required them to evaluate a situation and form a judgment. Results assessed both superficial and in-depth comprehension.

Construction of the multiple-choice items considered passage dependency, breadth of coverage, absence of response cues, distractors' plausibility, precise wording, and randomization. Test items required a genuine understanding of the content. Reading comprehension tests were equivalent in style and types of questions posed. After reading the print texts, participants were given a hard copy of the tests with concise instructions. After reading the digital texts, participants clicked a "Begin Quiz" button, which took them to the multiple-choice test, during which they were allowed to scroll and switch between the digital texts and the tests.

Scoring Procedures

Correct answers earned 1 point; incorrect answers earned 0 points. The maximum score for each test was 6. The answers were electronically routed to a MySQL database with the help of custom PHP code.

Multimodal Forms of Reading Texts

Participants read the three texts as static paper and dynamic screen-based texts. Traditional printed text represents the linear, sequential, and static form, with a fixed surface and linear written text. Computer-mediated or screen-based texts, including online and web-based text, are multimodal, multidirectional, nonlinear, nonsequential, dynamic, and interactive, whereas e-texts are another digital text modality presented via digital reading devices and shown as single pages that fill the screen. The three text modalities were identical in page layout, including font size and color, typeface, and line spacing (B5, 12-point, and 1.3, respectively).

Printed Text

BCWYAF was copied from a book using a laser printer on B5 (176.9 × 250 mm) white paper in black, 12-point Times New Roman font. The copied article's legibility was maintained. Printed text is "designed to be read in a linear fashion" and its "features are not malleable" (Coiro, 2003, p.4).

E-Text

LYE was originally a printed article prepared for screen-based delivery. The hard-copy article was scanned and converted to optical character recognition (OCR) text, then converted to PDF form and optimized as an epub-format document. The reader could scroll forward or use the page-forwarding navigation in the e-book converter/reader. As such, it is electronically generated and is designed to be read over electronic devices. The path of e-text is prefixed and predictable. E-text is static or fixed digital text that closely mimics the appearance of printed text; therefore, the reader can make only minor, if any, adjustments to the digital text in terms of appearance, size, and other features.

Web Text

DLIF was converted into digital form or web text with a menu listing the unit titles that participants would encounter in an instructional digital context. The text was divided into smaller paragraph units that were displayed independently on the computer screen. The paragraphs' content, length, and syntactic structure remained unchanged. Each paragraph or unit comprised 80–110 words.

The window that displayed the text was divided into three frames. The top displayed the title of the text (DLIF), the lower left displayed an overview of the main text units, and the lower right contained navigation buttons. The developed web-text included embedded hyperlinks and an interactive learning platform with features such as a dictionary supplemented with images and video. A *Diigo* toolbar was added to annotate text with sticky notes and highlighting. Thus, participants could follow hyperlinked terms for additional information. To improve the usability of the interface and facilitate the reading experience, the web-text was developed on the principles of usability proposed by Lim et al. (2012), including attributes of learnability, effectiveness, and efficiency. Web-text is accessed from the internet in the form of a web page and is read in a nonlinear way. It has non-sequential page structures. Thus, the path of web-text takes a random and unpredictable manner. Accompanying the web-text with audio, video, image, and hypertext makes it more interactive. Furthermore, it involves using unique techniques; that is, navigating via links to other resources or pieces of text and surfing is part and parcel of on-screen reading.

Constructing the Reading Comprehension Across Mediums Survey

Reading comprehension was measured with the Reading Comprehension Across Mediums (RCAM) questionnaire comprising 22 statements rated on a 5-point Likert scale describing the potential effects that print and non-print forms might have on L2 reading comprehension, divided into three sections.

Section 1 solicited demographic information, including years spent learning to read in English, self-assessed English reading ability, computer experience and comfort, reading habits and practices, typical Internet browsing duration, and the degree of enjoyability while reading English text. Section 2 included 12 statements designed to elicit responses regarding the participants' perception of each form's effects on their reading comprehension. Section 3 included 10 statements probing participants' opinions on factors that facilitate or hinder their comprehension.

Interview

To obtain more insight into the effects of reading comprehension across media platforms, the participants were interviewed and asked to elaborate on the facilitative effects on their L2 reading comprehension that they perceived from different text forms. Five open-ended questions were posed and additional information was solicited, when appropriate. The requested additional information served to maintain the participant's meaning and to avoid imposing the researcher's interpretation of what the participant said. Questions were arranged according to the laddering method of interviewing. The interview began with a prepared concept question, then explored knowledge, and ended with philosophical questions. The questions were:

1. Which text form helps you understand better and why?
2. What specific characteristics or features of each text form help you understand?
3. Which text forms do you understand least and why?
4. From your perspective, which text forms affect reading comprehension negatively?
5. Which text forms would you recommend to anyone who wants to develop his/her reading comprehension skills?

The survey and the interview questions were translated into Arabic. To ensure that the translated interview questions and survey were equivalent to the original instruments, that the translations of both were accurate and reflected the nuances of the Arabic language, and that the original meaning had not been lost, several steps were considered. First, two bilingual professional translators (Arabic and English) holding PhD in translation studies did forward–backward translation to the developed interview questions and the survey.

Second, the two experts, along with the researcher (the developer of both), reviewed all versions of the translations and determined whether the translated and original versions achieved semantic, idiomatic, experiential, and conceptual equivalence.

Validating the Research Instruments

Reading Texts and Tests

Three EFL reading specialists, three test specialists, and five EFL students who did not take part in this study offered insights and suggestions on the tests, which they rated the tests on a 5-point Likert scale according to the following criteria: (a) clarity of instructions, (b) expectation of the stated purpose, (c) appropriateness of test length, (d) item passage-dependence, (e) breadth of coverage, (f) absence of response bias, (g) plausibility of distractors, (h) appropriate wording, and (i) randomization of test items. An open-ended question was provided for suggestions. Responses were subjected to statistical analyses to estimate content validity. The experts' comments and suggestions were incorporated into the final test versions.

An item analysis of the multiple choice was performed to obtain information regarding item difficulty and discrimination levels. In addition, an estimate of the reliability of the internal consistency of the tests was made from a single administration of the tests by using the Kuder-Richardson formula 20. The internal consistency reliability was found to be estimated as 0.75 for the multiple-choice test used for BCWYAF, 0.74 for the one used for LYE, and 0.76 for the multiple-choice test used for DLIF. An item analysis revealed an index of difficulty that ranged from, for the three multiple-choice tests, 0.55 to 0.80, 0.52 to 0.89, and 0.53 to 0.81. Also, an item analysis showed an index of discriminability ranging from, for the three multiple-choice tests, 0.20 to 0.55, 0.20 to 0.45, and 0.22 to 0.53.

Survey

Several measures were used to ensure the validity and reliability of the RCAM survey. Three experts examined its validity and considered its content, clarity, and appropriateness; their suggestions were incorporated. The survey was also piloted to test its adequacy and anticipate any potential problems. The pilot-study sample consisted of five EFL learners. These learners did not participate in the actual study and were similar to those data points for the actual participants. All of the procedures used in the pilot study were executed exactly as they were administered in the study. Several cycles of pre-testing and revision were performed. Reliability was assessed using Cronbach's alpha (α), and the overall reliability alpha for 22 total items value of 0.77 obtained confirmed adequate internal consistency and reliability.

Interview Analysis Procedure

Interviews were recorded, transcribed, coded, and categorized. A digital PC-compatible, voice-activated recorder was used to prepare verbatim transcripts followed by textual and thematic analysis. Voice-recognition software (VRS) was used to automatically transcribe the seven hours of voice recordings. Analysis underwent several phases. The first involved meticulous reading of the transcripts for an overall understanding, wherein the transcripts' accuracy was validated by listening to and comparing each recording to the written transcript. The second (initial) coding phase grouped similar topics. The third (focused) phase involved (a) abbreviating the topics as codes and assigning codes to the appropriate segment, and (b) coining descriptive words for the topics and translating them into categories. The fourth (grouping) phase involved grouping-related topics. The final (theme) phase assigned related topics or categories to emerging themes. Debriefing confirmed this method's trustworthiness.

Results

The results are presented in four sections. The first details EFL learners' comprehension levels of traditional and electronic texts. The second describes each form's effect on comprehension levels, and the third presents the participants' opinions of these effects. The final section presents their perceptions of the factors within each form that mediate the degree of comprehension.

Data Analysis Procedures for the First and Second Questions

Sample Description and Normality Assessments

The data consisted of two samples of assessments. Sample one included 48 repeated reading comprehension assessments obtained after reading texts in each of the three text forms: printed on paper (traditional), presented on a computer screen (e-text), and presented on a web page (web text). This sample included 144 observations (i.e., 3 x 48). Sample two involved 47 repeated assessments of three facets of reading comprehension, including literal, inferential, and evaluative, which were obtained after reading texts in each of the three different forms. There were 423 observations (i.e., 9 x 47). The normality of the data in each sample was tested using the Shapiro-Wilk test, the results of which are reported in [Appendix B](#). This statistical test is very sensitive to sample size, so deviations of more than .03 from the maximum W value of 1.0 are inevitably detected as significant at $p < .05$. Consequently, it is conventional to use a W value of .90 as the threshold, below which higher departures from normality are considered as problematic.

[Appendix B](#) reveals that the data for traditional text, which is one of the three experimental conditions in sample one, and for all nine conditions in sample two had W values of below .90 and must therefore be considered as problematic departures from normality. These normality violations preclude using conventional parametric statistics to test for significant differences between the experimental conditions in both samples. In such cases, the Generalized Estimating Equations (GEE) provides an alternative method for testing for differences between multiple means that do not assume normality. Since this method is also considered to be preferable to analysis of variance (ANOVA) when the data include repeated measurements of the same cases, it was applied to address both research questions. The alpha for the tests of the questions was set at .05.

Tests of Research Questions

Research question 1 looked at whether using different text forms (traditional, e-text, and web text) to acquire information produced different L2 reading comprehension outcomes. The descriptive statistics for the three conditions are presented in [Table 2](#). The test for the effectiveness of the text forms is presented in [Table 3](#) and indicates that it was significant overall.

Table 2

Descriptive Statistics for Text Forms in Sample One

Text format	N	Minimum	Maximum	Mean	SD
Traditional	48	2	6	4.79	1.202
E-text	48	0	6	3.33	1.534
Web text	48	1	6	3.06	1.278

Table 3*Test of Model Effect for Research Question One*

Type III			
	Wald		
Source	Chi-Squared	<i>df</i>	<i>p</i>
(Intercept)	636.137	1	< .001
Text Type	80.809	2	< .001

The pairwise contrasts reported in Table 4 indicate that reading comprehension was significantly higher for the traditional text forms than for the other two and that reading comprehension did not differ significantly between the e-text and web text forms.

Research question 2 looked at whether the alternative text forms had differential effects on the literal, inferential, and evaluative facets of L2 reading comprehension. Because of the completely crossed and repeated measures design of this study, it was possible to treat the three aspects of reading comprehension as independent variables rather than as three separate dependent variables. Table 5 presents the descriptive statistics for the text modes and the factors involved in the comprehension facets as well as the combinations of the modes and facets. The tests of the effects of the text forms and comprehension facets and their interactions are presented in Table 6. These tests were performed using a Type III GEE analysis in which Type III refers to the effect of each factor on the dependent variable exclusive of the unrelated effects of all other factors. The results indicate that the main effects of the text forms and comprehension facets were highly significant, and their interaction was not significant.

Table 4*Pairwise Contrasts of the Text Form Categories*

(I) Text Type	(J) Text Type	Mean Difference (I-J)	SE	<i>df</i>	Sidak <i>p</i>	95% Wald Confidence Interval for Difference	
						Lower	Upper
Traditional	E-text	1.46	.222	1	< .001	.93	1.99
	Web text	1.73	.201	1	< .001	1.25	2.21
E-text	Web text	.27	.214	1	.499	-.24	.78

Table 5

Descriptive Statistics for Text Forms, Comprehension Facets, and Their Combinations in Sample Two

Text form	Comprehension Facet	Mean	SD
Traditional	Literal	1.60	.496
	Inferential	1.51	.718
	Evaluative	1.49	.655
Traditional Total		1.53	.627
E-text	Literal	1.36	.605
	Inferential	1.15	.659
	Evaluative	.94	.791
E-text Total		1.15	.706
Web text	Literal	1.04	.550
	Inferential	1.04	.624
	Evaluative	.94	.734
Web text Total		1.01	.638
Comprehension Facet Total	Literal	1.33	.594
	Inferential	1.23	.693
	Evaluative	1.12	.770

Table 6

Results of Generalized Estimating Equation Analysis for Effects of Text Forms and Comprehension Facets on Reading Comprehension

Source	Wald		
	Chi-Squared	df	p
Text form	47.459	2	< .001

Comprehension Facet	12.505	2	.002
Text form Comprehension Facet	4.434	4	.350

The results of pairwise contrasts that are presented in [Appendix C](#) indicate that in 15 of the 18 comparisons the traditional text led to significantly higher levels of comprehension in the three reading comprehension facets than did the other two text forms. The advantage of the traditional text over e-text was not significant in the remaining three comparisons. There were only two significant differences in the 15 comparisons between the combinations of the e-text or web text forms and the comprehension facets. These reflected the significantly higher comprehension of e-text in the literal comprehension facet compared to the comprehension levels in the evaluative comprehension facet for both e-text and web text. Therefore, there was negligible evidence of any interaction effect among the text forms on reading comprehension. The traditional text form was found to be overwhelmingly more effective than the other two in yielding better comprehension in all three facets.

Results of the Reading Comprehension Across Mediums Survey

[Table 7](#) presents the descriptive statistics of the 12 survey items on the reading comprehension scale that measured the learners' perceptions of each text's effects. Most participants (67.4%, $M = 3.15$, $SD = 1.38$) reported increased retention of information in printed texts relative to digital texts. Similarly, about half the participants (49%, $M = 3.43$, $SD = 1.34$) believed printed text promoted active, in-depth reading more so than digital text. Furthermore, most indicated that they understood best when reading printed text (63.2%, $M = 3.09$, $SD = 1.28$), and that digital text's characteristics posed greater challenges than those of printed text ($M = 3.23$, $SD = 1.30$). Most perceived that e-text adversely affected reading comprehension ($M = 3.4$, $SD = 1.37$), although 30.6% indicated that it was most conducive to understanding.

Table 7

Descriptive Statistics for the Perception of Printed, E-text, and Web-text's Effects on the L2 Reading Comprehension First Scale and its Component Items

Statement	M	Med	SD
1. I retain more information when I read printed text rather than e-text or web-text.	3.15	3	1.38
2. I retain more information when I read e-text than when I read printed texts or web-text.	2.19	2	1.24
3. I retain more information when I read web-text than when I read printed text or e-text.	2.85	3	1.26
4. I feel I understand better when I read printed text rather than e-texts or web-text.	3.09	3	1.28
5. I feel I understand better when I read e-text rather than printed or web-text.	3.3	3	1.25
6. I feel I understand better when I read web-text rather than printed or	2.32	2	1.43

e-text.			
7. I think that printed text promotes active and deep reading more than e-text and web-text.	3.43	3	1.34
8. I think that e-text promotes active and deep reading more than printed text and web-text.	3.11	3	1.12
9. I think that web text promotes active and deep reading more than printed text e-text.	1.85	1	1.06
10. E-text affects L2 reading comprehension positively.	2.98	3	1.09
11. E-text affects L2 reading comprehension adversely.	3.4	3	1.37
12. Certain characteristics of e-text and web-text present learners with greater challenges and make L2 reading comprehension more complex than reading printed text.	3.23	3	1.30

Table 8 presents the descriptive statistics for learners' perceptions of the factors that might mediate comprehension of the three texts. Participants did not feel that features of digital texts that were unavailable in printed texts might improve L2 reading comprehension ($M = 2.83$, $SD = 1.30$). The same perception ($M = 2.15$, $SD = 0.90$) held true for web-text's non-linearity; generally, participants believed this affected the measure. Similarly, participants believed that scrolling through e-text impaired their comprehension ($M = 3.23$, $SD = 1.37$) and that interactive features of digital texts both distracted from ($M = 3$, $SD = 1.39$) and hindered comprehension ($M = 2.53$, $SD = 1.13$). The opinion that the Internet provides novel interactive features and thereby improves reading comprehension held the smallest proportion of adherents ($M = 1.98$, $SD = 0.89$). The inability to turn pages in digital texts was perceived as detrimental to comprehension ($M = 3.17$, $SD = 1.40$). Interestingly, the mean score of 2.49 ($SD = 1.36$) indicated that most participants did not strongly agree that the presence of numerous hyperlinks in the web-text leads to cognitive overload, frustration, and confusion.

Data of participants' perceptions were analyzed as percentages. Less than 40% of respondents believed that digital texts offered advantages unavailable in printed text; only 35% believed that digital texts' interactive features enhanced comprehension. The majority (65%) of respondents perceived advantages in new, interactive text forms; however, 70% favored printed text as it allowed the use of physical markers for orientation and for approximating the text's length. Three-quarters of respondents believed that digital texts negatively affected comprehension due to the inability to turn pages.

Table 8

Descriptive Statistics for the Factors that Affect Success or Failure in the L2 Reading Comprehension of Printed Text, E-text, and Web-text Scale and its Component Items

Statement	M	Med	SD
13. E-text and web-text offer several features that are unavailable in paper and potentially improve L2 reading comprehension.	2.83	3	1.30

14. Non-linearity of web-text affects L2 reading L2 comprehension positively.	2.15	2	0.90
15. Scrolling through e-text impairs L2 reading comprehension.	3.23	3	1.37
16. Interactive features on e-text and web-text distract L2 readers from the text.	3	3	1.39
17. Interactive features facilitate L2 reading comprehension.	2.53	1.13	1.13
18. The challenging nature of literacy in an online environment affects the development of online reading comprehension.	2.98	3	1.34
19. The Internet provides new text formats and different ways to interact with the information on the web pages and thus improves reading comprehension.	1.98	2	0.98
20. The presence of numerous links in web-text can lead to cognitive overload and make learners feel frustrated and lost when completing the L2 reading comprehension task.	2.49	2	1.36
21. Comprehension is affected negatively in e-text and web-text because when reading documents, readers cannot turn page by page as they do in a printed book.	3.17	3	1.40
22. Readers understand better in a printed text environment because they are aware of exactly where they are in the printed text and the physical length of such a text.	2.4	2	1.33

The data were analyzed further with the Spearman rank-order correlation analysis—because it is a non-parametric test that uses ranked data—to explore the strength and direction of the relations between two variables measured on an ordinal scale at least. A significant Spearman rank-order correlation of 0.52 was found between increased retention of printed text and the belief that numerous hyperlinks cause cognitive overload and impair comprehension (Appendix D). Proponents of digital texts argued that the Internet improved comprehension by offering new forms and innovative ways to interact with the information; however, this correlation was weak (0.35). A significant correlation (0.55) indicated that printed text was more easily understood due to physical markers to facilitate orientation.

Statement 1 in Table 7 was negatively correlated (-0.35^*) to statement 13 in Table 8. This might indicate that, although respondents recognize the potential advantages of digital environments, these advantages nevertheless negatively affect actual reading comprehension. Statement 9 (Table 7) was negatively correlated to statements 15 (-0.29) and 16 (-0.35) in Table 8, suggesting that if more respondents believe that e-texts increase reading comprehension, fewer believe that their unique features decrease it.

Similarly, statement 5 was negatively correlated to statements 18 (-0.32) and 22 (-0.38) in Table 8. If more people believe that digital texts' interactive features positively affect reading comprehension, fewer believe that print texts hold the advantage. Finally, statement 20 (Table 8) was negatively correlated (-0.40) to statement 6 in Table 7. If a person believes that hyperlinks in the web-text impede comprehension, they are less likely to prefer this medium.

EFL Learners' Perceptions of Digital and Nondigital Texts' Merits

Research questions 4 and 5 addressed EFL learners' perceptions of factors mediating their degree of

comprehension. Participants' insights were drawn from five open-ended questions and elaborative questions (e.g., *Can you elaborate more on this point? Can you be more specific? Can you give an example to illustrate your point?*) that underwent thorough qualitative analysis. A total of 416 remarks were made. Questions about which form resulted in better understanding and why generated 90 (21.6%) and 155 (37%) remarks, respectively. Sixty-six comments (15.8%) addressed their views on the least effective form and underlying explanations, whereas 50 comments (12%) referred to the form adversely affected comprehension. Fifty-five comments (13%) recommended forms that EFL learners should use to develop their reading comprehension skills.

Factors Fostering Understanding: Print vs. Digital Texts

When asked "*Which text form helps you understand better, and why?*", 90 comments favored printed text on three specific dimensions: tactile aspects, deep understanding, and interactive notes. Several participants preferred printed text for its tactile properties (e.g., turning or touching pages) and its allowance of manual highlighting/underlining. "Seeing" their place on the page also helped locate information and deepen comprehension. One participant said, "*...it allowed me to activate and use multiple senses, and this helped me to have a deeper level of understanding of the text and enabled me to retain its content longer.*" Other reasons printed text proved superior for some included enhanced long-term retention, prolonged sustained attention, and increased reading speed.

However, digital forms may help EFL learners better understand texts. E-text was considered easy to use, increasing cognitive resources available for careful, detailed reading. One participant commented, "*I was able to understand the e-text because it was not divided into small paragraphs, which in fact motivated me to read more and feel that the text I was reading was not long.*" Similarly, comprehension of the web-text was largely attributed to its unique features, especially its appealing visual designs.

Text Features That Facilitate Reading Comprehension

Participants were asked: "*What specific characteristics or features does each text form have that help you understand?*" In 155 comments, the most beneficial features were attributed to printed text, then e-text, and, lastly, the web-text. Print features, including fixed pages, layouts, or dimensions, easy navigation, ease of locating the beginning, and the ability to flip between pages, enhanced comprehension. Printed text allowed the gauging of the proportion read and to-be read. These features permitted readers to see their location, alternated quickly between pages, and retained sight of the entire text, which facilitated the generation of coherent mental maps. One participant remarked, "*Print text was easy to carry and [made it easy to] move among its parts.*" Another said, "*When reading print text, you can know your exact place easily, and it makes you able to read more carefully.*"

E-text features facilitating comprehension included embedded dictionaries and electronic searching, interactive features such as the ability to scroll and search within the text, and customizable settings (e.g., font size, brightness, color contrast). One participant expressed, "*I can scroll up and down, which enabled me to read more and move from one part to another.*"

Web-text features that improved comprehension concerned its accessibility, which helped readers grasp the text's structure and main ideas, presented the text dynamically, omitted the need to flip through pages, and offered hyperlinked text, search functions, and pictures. These features helped participants engage with the content and provided clues for deeper processing. One participant reported, "*Having each paragraph in one web page allowed me to concentrate on what each discusses.*"

Least Comprehended Text Form

The participants were asked: "*Which text form do you understand least and why?*" Sixty-six responses specified both e-text (32) and web-text (31) as least comprehended relative to printed text (3). Digital texts were said to cause eyestrain, mental fatigue, and discomfort. The lack of tactile experience resulted in difficulty navigating electronic texts, forgetting content frequently, and losing their place. E-texts failed to enhance comprehension because of a relative lack of control over the reading process, the less flexible

environment, loss of focus, and the need to scroll, which had a disruptive effect on their comprehension.

Web text also included factors impairing the participants' reading comprehension, such as difficulty tracking what they read, and distracting hyperlinks and pictures that interrupted reading. Multitasking led to a non-linear reading process. *"I feel that my understanding of the web-text was not good, because I easily forget what I read earlier and [because of] the many clicks I had to make,"* one participant said.

Text Forms Adversely Affecting Reading Comprehension

Participants were asked: *"From your perspective, which texts affect reading comprehension negatively?"* Responses, which referred largely to digital texts, fell into three domains: personal, technical, and text processing. Personally, participants believed that e-text negatively affected their comprehension because of its boring, static form devoid of interactive features and replete with distractions. Technically, they cited the inability to manually highlight and limited text interaction opportunities.

E-text also impaired content processing. Participants relayed that the web-text felt disjointed; revisiting sections was difficult, what was read was often forgotten, and long-term content retention proved challenging. The fragmented text, the hyperlinks, and the images were also found to decrease coherence and reading speed and reduce available working memory capacity, which increases vulnerability to distraction. One participant said, *"Accompanying images relevant to the text are fine and helpful but [they] slow me down, as I needed to process the content and make connections with the text."*

Text Form Recommended to Augment Reading Comprehension Skills

Finally, the participants were asked: *"Which text forms would you recommend to anyone who wants to develop his/her reading comprehension skills?"* The overwhelming majority suggested the printed text to help EFL learners improve their reading comprehension, but recommendations were broad in nature, offering that learning with paper-and-pen and writing in cursive were beneficial to comprehension relative to notetaking with a keyboard. Digital texts also lacked physicality, which appeared important for comprehension; the web-text in particular engendered a strong sense of disorientation.

Discussion

The quantitative and qualitative results presented demonstrate that participants understood printed text significantly better than the others, and its effect on the three levels of reading comprehension was also significantly greater. E-text's effects significantly surpassed that of web-text at the literal and inferential levels; however, the two differed negligibly at the evaluative level. RCAM Survey responses demonstrated an advantage for printed text, which promoted more active reading and deeper retention than its digital counterparts. In the interview data, participants cited various factors that helped them understand printed text best and identified its features that facilitated their reading comprehension compared to the other two forms. Overall, the results confirmed that their general reading and three levels of reading comprehension were better when they read printed rather than digital texts. In addition, participants indicated that they understand printed texts better because of various features that enhanced comprehension.

Multiple-choice questions clearly indicated enhanced comprehension of printed text over digital texts; screens ultimately appear to be an inferior medium for such activities. Explanations were varied and included the disruptive effects of scrolling and hyperlinks. These mentally taxing features drain cognitive resources and render semantic and affective memory retrieval increasingly difficult; such retrievals rely on working memory resources to operate effectively. On this note, Delgado et al. (2018) stated that scrolling imposed a cognitive load on the reading task by increasing the difficulty of orienting spatially to the text. Similarly, Hou et al. (2017) found that scrolling impeded readers' capacity to create an effective cognitive map of the text.

E-reading environments may also lead to a fragmented and less cohesive representation of text content, particularly as the number of hypertext units increases without explicit indication of their interrelatedness,

provision of guides to help navigate searches, or other cues as to the information's structural organization. Thus, reading in an electronic environment impedes the integration of content into a unified representation and thereby impedes in-depth comprehension (Al-Seghayer, 2017). Furthermore, as Salmerón et al. (2018) and Delgado et al. (2018) have indicated, digital text reading requires the activation of a set of cognitive processes, including sustained attention (where the reader is deeply immersed in the text), and executive processes that may not be fully developed in EFL learners reading digital texts. EFL participants in our study appeared to adopt a shallower processing style in digital reading environments.

This finding conflicts with existing research, such as that of Abdi (2013), Boshraadi and Biria (2014), and Ebrahimi (2016), who reported that digital texts were more beneficial for EFL learners' reading comprehension than printed texts. This discrepancy may be due to differing methods or areas of investigation. Previous studies examined text forms' effects on reading comprehension after participants were exposed to digital instructional reading materials for several weeks, whereas the current study investigated text forms' impact on L2 reading comprehension, as explained below. Moreover, it allowed a within-subject examination of reading comprehension of equivalent texts across mediums. Overall, the results corroborated those of previous studies—particularly those of Shang (2015) and Chiang (2016), whose results confirmed that EFL learners had higher comprehension scores when reading printed rather than digital texts.

The study also compared performance on three levels of reading comprehension, revealing that printed text significantly outperformed digital texts on all three levels. E-text's effects were significantly greater than those of web-text at both the literal and inferential levels, but the two differed negligibly at the evaluative level. The difference in comprehension scores may be related to the in-depth processing required for comprehension tasks; respondents appeared less engaged when reading digital rather than printed text. When reading the former, they tended to read more rapidly and superficially, prioritized concrete details over abstractions, or simply located information stated explicitly in the text and spent less time reading than was necessary. As such, they lacked a more deliberate and conscientious, which is integral to successful reading comprehension.

Relatedly, Chen and Catrambone (2015) observed that people exerted less cognitive effort when reading digital rather than printed text. Similarly, Jabr (2013) added that e-text was more ephemeral in nature, and Singer and Alexander (2017) contended that when texts were read with the objective of thorough understanding, print prevailed as the more effective medium. It may also be that when high degrees of engagement were demanded, digital text readers could not affect metacognitive reading regulation (i.e., re-reading difficult sections, searching for relationships, making inferences, and continuous self-monitoring of comprehension), a significant determinant of thorough comprehension.

Regarding the difference between e-text and web-text at the literal and inferential comprehension levels, a plausible explanation may be that participants devoted significantly more cognitive resources to web-text. As for the similarity at the evaluative level, different cognitive demands were placed on EFL learners. It required engaging in deeper interactions with digital texts to analyze and interpret the content read critically. It appeared that most cognitive resources were devoted to responding to web-text's features, including segmentations, links, multiple paths, multimedia, navigation aids, dynamic presentations, unintuitive content structures, and non-linearity, which cumulatively decreased evaluative comprehension of a given digital text. Wolf and Barzillai (2009) convincingly argued that critical reading might take years to develop.

Survey analyses demonstrated that participants believed reading printed text led to greater information retention than did digital texts. EFL learners found certain characteristics of web-text more challenging, although its non-linearity positively affected L2 reading comprehension. In contrast, scrolling through e-text impaired comprehension, interactive features in digital texts were distracting, and the numerous links in web-text led to cognitive overload and frustration. Participants may have responded more favorably to printed text as there was no need to remember their current location, decide where to go next, keep track of pages viewed, or determine the semantic relations among units. In contrast, the other two forms required the reallocation of mental resources to cope with digital text features at the expense of content

comprehension. This result aligns with previous research (e.g., Chiang, 2016; Gilbert, 2017; Tsai, 2016) that only examined EFL learners' general perceptions of reading digital versus paperbound texts, whereas this study examined factors that influenced their comprehension of text on a digital screen versus on paper, as well as those that affect L2 reading comprehension success or failure based on these text modes.

The analysis of the interview transcripts revealed that various factors enabled the participants to understand printed text better, and student participants could identify its features that facilitated reading comprehension. They also highlighted aspects of digital text that impaired their reading comprehension and recommended that EFL learners opt for print text when aiming to develop reading comprehension skills. The participants' perspectives may be attributed to various factors. Most notably, digital texts' characteristics and tools increased reading difficulty and imposed a higher cognitive load on EFL readers, making screen reading inferior to printed text. Additional factors may have stemmed from difficulty retrieving textual information encountered in digital texts. For example, participants could not create a cognitive map (which they did when reading printed text) that would allow them to easily visualize the location of information. In fact, this link to spatial memory is precluded with digital text reading (Rosenwald, 2015). Similarly, Hahnel et al. (2016) argued that less proficient readers—such as this study's participants, who achieved intermediate levels of English reading proficiency—may have difficulty extracting relevant details from digital texts, relating ideas amongst different pages, or making inferences based on the connections between text information and background knowledge, ultimately resulting in poor comprehension.

Implications for Practice

This study provides several pedagogical and technological implications. In terms of pedagogy, EFL instructors must possess sufficient technologies to select the appropriate mode of reading and to know how to harness and integrate emerging technologies for teaching L2 reading. Presumably, as indicated by Bikowski and Casal (2018), this is because digital text reading skills are largely honed beyond the classroom, whereas classroom learning experiences are largely print-based. EFL instructors should remain cognizant of factors influencing comprehension of web and printed texts and be trained accordingly. Instructors must also be adequately trained to teach EFL learners the skills required to comprehend both digital and conventional text forms. In this regard, Monica and Abbott (2016) stressed the importance of providing EFL instructors with research-based best practices for using digital and print material effectively.

English instructors may also benefit from broader technological training opportunities that provide hands-on experience incorporating texts across modalities into lesson plans and delivering L2 reading instruction based on sound pedagogical and practical skills. Instructors should be kept up to date on relevant research breakthroughs. Specifically, to enhance EFL reading comprehension, instructors can be shown how to (a) use available technological reading resources effectively; (b) create or select reading activities enabling learners to navigate and explore digital texts in more thoughtful ways, and to recognize their comprehension difficulties; (c) integrate traditional and technological reading resources into the L2 classroom; (d) provide instructional solutions in printed and digital reading environments; (e) provide instruction and training in various conventional, novel, and varied literacy-based text forms; (f) increase critical thinking skills; and (g) set the expected outcomes when assigning reading on a digital platform.

Another important implication of the study is the necessity for continuous development of tools that measure L2 online reading comprehension, particularly because current assessment instruments are designed to measure old literacies in an era of new literacies. The proposed valid, reliable, and practical assessments of L2 online reading comprehension extend beyond traditional reading assessments and can combine both older and newer reading comprehension theories. Coiro (2011) encouraged the generation of new measures based simply on the differing nature of such skills when reading web-text. Similarly, Mangen et al. (2013) stated that reading comprehension of digital text differs fundamentally from that of printed, linear text. In the same vein, Cardullo et al. (2012) posited that digital reading environments were multifaceted and required more complex processing strategies. Consistent revision and updating of these

strategies is crucial due to the rapid rate of technological advancement and emerging practices in L2 reading.

Another key pedagogical consideration is that EFL practitioners should not view reading via a narrow, binary lens (i.e., traditional vs. digital). Moje (2009) proposed that reading specialists continue to closely explore the possibilities of online reading in ways that “resist the dichotomy of old and new and instead situate literate practices on more of a continuum” (p. 359). Therefore, EFL reading instructors should encourage and train their EFL learners to capitalize on the vast array of online and print-based reading resources, specifically the scaffolded learning support embedded in electronic reading environments. Moreover, they should train students on ways to transform relevant knowledge from printed text into online reading activities and emphasize that printed and digital texts are not mutually exclusive. Correspondingly, Hill (2011) contended that instructors’ knowledge of traditional L2 reading comprehension could be enriched by incorporating online reading factors.

The final practical contribution of this study is the emphasis on much-needed efforts to accomplish the following three goals: (a) merging traditional and digital reading cultures; (b) continuously integrating emerging research on printed and digital text reading comprehension to paint a more complete picture of how comprehension develops across time and reading contexts, and (c) creating new reading comprehension methods encompassing the unique characteristics of both reading environments.

Limitations and Future Considerations

Certain limitations constrain the interpretations of our results. First, reading comprehension was measured using multiple-choice tests. Alternative multivariate assessment techniques that tap different aspects of reading comprehension, including oral and written protocols (e.g., cued and free recall, text summaries, and brief and extended constructed responses), delayed testing, sentence recognition, reading logs, computer-based tracking mechanisms, and monitoring learners’ online reading behaviors, may provide further insights. Second, the variables investigated were determined after consulting the relevant literature; consequently, other variables were excluded that may have yielded a more sophisticated understanding of digital and print texts’ effects on L2 reading comprehension as well as EFL learners’ perceptions of text media’s positive or adverse influence on their reading comprehension. Third, another limitation of the study is that it focused only on a single genre. Different genres where the students have a greater or lesser background or world knowledge could yield different results. Also, the purpose of reading—pleasure, work-related, and many others—could make a difference.

Finally, our sample size was modest, which limits generalizability. The study population was also homogenous, further limiting generalizability. Extending the population to include individuals using English in various contexts as a foreign or second language and to different types of English learners may yield insightful results. Additionally, the small-scale nature of the study is evident in the limited number of selected passages. Despite these caveats, the study nonetheless presents unique data capable of enlightening the field of L2 reading.

Based on these limitations and trends in new literacy and L2 reading comprehension, several avenues for future research are suggested. One proposition is to compare EFL learners’ stated perceptions against their actual performance. Another proposition is to assess the concurrent effects of the three text modes on related factors, such as learners’ language proficiency, gender differences, and situational or instructional factors. Future studies may also focus on the relationship between EFL learners’ and teachers’ perceptions of digital and non-digital reading platforms. Reading comprehension of self-selected topics in traditional and online reading environments may also generate counterintuitive results.

An interesting suggestion may be to examine reading comprehension gains over a longer length of time when EFL learners exclusively self-select print and digital English texts. This area of investigation would determine the long-term uses and efficacy of online reading compared to traditional reading methods. Future work should explore what behaviors EFL learners actually engage in when they read printed or

digital English texts and how reading comprehension skills develop in both arenas.

Conclusion

This study represents a preliminary effort to empirically examine the comparative effectiveness of digital and nondigital texts on reading comprehension and EFL learners' perceptions of the text forms' merits. Further research is needed to develop a thorough understanding of L2 reading comprehension by determining the text form under which EFL learners best understand and by identifying the factors that learners perceive as influential to their comprehension of print and electronic texts. The findings of this study act as a stepping stone toward new lines of research on the EFL learner's reading comprehension of digital versus paperbound texts. Additional efforts are needed to closely examine factors that affect the relative success or failure of L2 reading comprehension of printed text, e-text, and web-text, as well as learners' perceptions of the effect of each form on L2 reading comprehension.

References

- Abdi, R. (2013). The effect of using hypertext materials on reading comprehension ability of EFL learners. *Procedia - Social and Behavioral Sciences*, 83, 557–562. <https://doi.org/10.1016/j.sbspro.2013.06.106>
- Alisaari, J., Turunen, T., Kajamies, A., Korpela, M., & Hurme, T.-R. (2018). Reading comprehension in digital and printed texts. *L1-Educational Studies in Language and Literature*, 18(1), 1–18. <https://doi.org/10.17239/L1ESLL-2018.18.01.15>
- Al-Seghayer, K. (2017). Effects of electronic reading environments' structure on L2 reading comprehension. *English Language Teaching*, 10(12), 88–106. <http://doi.org/10.5539/elt.v10n12p88>
- Arias, I. J. (2007). Selecting reading materials wisely. *LETRAS*, 41, 131–151. <https://www.revistas.una.ac.cr/index.php/letras/article/view/648/583>
- Bikowski, D., & Casal, J. E. (2018). Interactive digital textbooks and engagement: A learning strategies framework. *Language Learning & Technology*, 22(1), 119–136. <http://dx.doi.org/10125/44584>
- Boshraadi, A., & Biria, R. (2014). The efficacy of multimodal vs print-based texts for teaching reading comprehension skills to Iranian high school third graders. *International Journal of Language Learning and Applied Linguistics World (IJLLALW)*, 5(1), 365–380.
- Cardullo, V., Zygoris-Coe, V., Wilson, N. S., Craanen, P. M., & Stafford, T. R. (2012). How students comprehend using e-readers and traditional text: Suggestions from the classroom. *American Reading Forum Annual Yearbook*, 32, 1–15.
- Carlson, R. (2006). *The big book of small stuff: 100 of the best inspirations from Don't Sweat the Small Stuff*. Hyperion Books.
- Chen, D.-W., & Catrambone, R. (2015). Paper vs. screen: Effects on reading comprehension, metacognition, and reader behaviour. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 59(1), 332–336. <https://doi.org/10.1177/1541931215591069>
- Chiang, M. (2016). Utilizing electronic reading device (Kindle) in English as foreign language reading class. *Sino-US English Teaching*, 13(4), 233–244. <https://doi.org/10.17265/1539-8072/2016.04.001>
- Chou, I.-C. (2016). Reading for the purpose of responding to literature: EFL students' perceptions of e-books. *Computer Assisted Language Learning*, 29(1), 1–20. <https://doi.org/10.1080/09588221.2024.881388>

- Coiro, J., (2003). Reading comprehension on the Internet: Expanding our understanding of reading comprehension to encompass new literacies. *The Reading Teacher*, 56(5), 458–464.
- Coiro, J. (2011). Predicting reading comprehension on the Internet: Contributions of offline reading skills, online reading skills, and prior knowledge. *Journal of Literacy Research*, 43(4), 352–392. <https://doi.org/10.1177/1086296X11421979>
- Coiro, J. (2020). Toward a multifaceted heuristic of digital reading to inform assessment, research, practice, and policy. *Reading Research Quarterly*, 55(1), 1–23. <https://doi.org/10.1002/rrq.302>
- Coiro, J., & Dobler, E. (2007). Exploring the online reading comprehension strategies used by sixth-grade skilled readers to search for and locate information on the Internet. *Reading Research Quarterly*, 42(2), 214–257. <https://doi.org/10.1598/RRQ.42.2.2>
- Daniel, D. B., & Woody, W. D. (2013). E-textbooks at what cost? Performance and use of electronic v. print texts. *Computers & Education*, 62, 18–23. <https://doi.org/10.1016/j.compedu.2012.10.016>
- Day, R. R., & Park, J.-S. (2005). Developing reading comprehension questions. *Reading in a Foreign Language*, 17(1), 60–73. <https://files.eric.ed.gov/fulltext/EJ689120.pdf>
- Delgado, P., Vargas, C., Ackerman, R., & Salmerón, L. (2018). Don't throw away your printed books: A meta-analysis on the effects of reading media on reading comprehension. *Educational Research Review*, 25, 23–25. <https://doi.org/10.1016/j.edurev.2018.09.003>
- Ebrahimi, S. S. (2016). Effect of digital reading on comprehension of English prose texts in EFL/ESL contexts. *International Journal of English Language and Literature Studies*, 5(2), 111–117. <https://doi.org/10.18488/journal.23/2016.5.2/23.2.111.117>
- Ghahroudi, M. R., & Sheikhzadeh, E. (2017). Selecting reading texts for university Iranian EFL students. *Journal of Advances in English Language Teaching*, 5(3), 25–30. <https://european-science.com/jaelt/article/view/5120/2444>
- Gilbert, J. (2017). A study of ESL students' perceptions of their digital reading. *The Reading Matrix: An International Online Journal*, 17(2), 179–195. <https://www.readingmatrix.com/files/17-z2d49xa9.pdf>
- Girón García, C. (2013). *Learning styles and reading modes in the development of language learning autonomy through Cybertasks* [Unpublished doctoral dissertation]. Universitat Jaume I. <http://hal.handle.net/10803/125440>
- Grzeschik, K., Kruppa, Y., Marti, D., & Donner, P. (2011). Reading in 2110 – Reading behavior and reading devices: A case study. *The Electronic Library*, 29(3), 288–302. <https://doi.org/10.1108/02640471111141052>
- Hahnel, C., Goldhammer, F., Naumann, J., & Kröhne, U. (2016). Effects of linear reading, basic computer skills, evaluating online information, and navigation on reading digital text. *Computers in Human Behavior*, 55, 486–500. <https://doi.org/10.1016/j.chb.2015.09.042>
- Hill, C. (2011). What can teachers do to improve reading comprehension?: An examination of second language reading research and implications for English language teaching practices. *The Arbutus Review*, 2(1), 62–74. <https://journals.uvic.ca/index.php/arbutus/article/view/9063/2665>
- Hou, J., Rashid, J., & Lee, K. M. (2017). Cognitive map or medium materiality? Reading on paper and screen. *Computers in Human Behavior*, 67, 84–94. <https://doi.org/10.1016/j.chb.2016.10.014>
- Huang, H.-C. (2013). E-reading and e-discussion: EFL learners' perceptions of an e-book reading program. *Computer Assisted Language Learning*, 26(3), 258–281. <https://doi.org/10.1080/09588221.2012.656313>

- Jabr, F. (2013, April 11). *The reading brain in the digital age: The science of paper versus screens*. Scientific American. <https://www.scientificamerican.com/article/reading-paper-screens/>
- Liu, F.-I., & Ko, H.-W. (2016, October 28–30). *The relationship among ICT skills, traditional reading skills and online reading ability* [Paper presentation]. 13th IADIS International Conference on Cognition and Exploratory Learning in Digital Age (CELDA 2016), Mannheim, Germany.
- Lim, C., Song, H.-D., & Lee, Y. (2012). Improving the usability of the user interface for a digital textbook platform for elementary-school students. *Educational Technology Research and Development*, 60, 159–173. <https://doi.org/10.1007/s11423-011-9222-5>
- Manalu, B. H. (2019). Students' perception of digital texts reading: A case study at the English Education Department of Universitas Kristen Indonesia. *Journal of English Teaching*, 5(3), 191–203. <https://doi.org/10.33541/jet.v5i3.1312>
- Mangen, A., Walgermo, B. R., & Brønneck, K. (2013). Reading linear texts on paper versus computer screen: Effects on reading comprehension. *International Journal of Educational Research*, 58, 61–68. <https://doi.org/10.1016/j.ijer.2012.12.002>
- Margolin, S. J., Driscoll, C., Toland, M. J., & Kegler, J. (2013). E-readers, computer screens, or paper: does reading comprehension change across media platforms? *Applied Cognitive Psychology*, 27(4), 512–519. <https://doi.org/10.1002/acp.2930>
- Moje, E. B. (2009). A call for new research on new and multi-literacies. *Research in the Teaching of English*, 43(4), 348–362. <https://www.jstor.org/stable/27784339>
- Monica, F., & Abbott, M. (2016). Using election readers: Action research in an intermediate adult ESL class. *The Canadian Journal of Action Research*, 17(2), 3–18. <https://doi.org/10.33524/cjar.v17i2.259>
- Rahmani, M. (2013). The effect of CALL on EFL learners' reading comprehension and attitude towards the use of technology. *Journal of Teaching English Language Studies*, 1(3), 39–56. https://journals.iau.ir/article_533261_46141b8bd373a01f7f3945d1defb689e.pdf
- Pardede, P. (2019). Print vs digital reading comprehension in EFL. *Journal of English Teaching*, 5(2), 77–90. <https://doi.org/10.33541/jet.v5i2.1059>
- Park, Y. & Warschauer, M. (2016). Reading instruction in a technological age. In X. Chen, V. Dronjic, & R. Helms-Park (Eds.), *Reading in a second language: Cognitive and psycholinguistic issues* (pp. 282–302). Routledge.
- Rosenwald, Michael S. (2015, February 22). *Why digital natives prefer reading in print. Yes, you read that right*. The Washington Post. https://www.washingtonpost.com/local/why-digital-natives-prefer-reading-in-print-yes-you-read-that-right/2015/02/22/8596ca86-b871-11e4-9423-f3d0a1ec335c_story.html
- Salmerón, L., García, A., & Vidal-Abarca, E. (2018). The development of adolescents' comprehension-based internet reading skills. *Learning and Individual Differences*, 61, 31–39. <https://doi.org/10.1016/j.lindif.2017.11.006>
- Schultz, R. (1981). Literature and readability: Bridging the gap in foreign language reading. *Modern Language Journal*, 65(1), 43–53. <https://doi.org/10.1111/j.1540-4781.1981.tb00952.x>
- Shang, H.-F. (2015). An investigation of scaffolded reading on EFL hypertext comprehension. *Australasian Journal of Educational Technology*, 31(3), 293–312. <https://doi.org/10.14742/ajet.1735>

- Singer, L. M., & Alexander, P. A. (2017). Reading across mediums: Effects of reading digital and print texts on comprehension and calibration. *The Journal of Experimental Education*, 85(1), 155–172. <https://doi.org/10.1080/00220973.2016.1143794>
- Sun, S.-Y., Shieh, C.-J., & Huang, K.-P. (2013). A research on comprehension differences between print and screen reading. *South African Journal of Economic and Management Sciences*, 16(5), 87–101. https://scielo.org.za/scielo.php?script=sci_arttext&pid=S2222-34362013000500010
- Taylor, A. (2019). CALL and L2 reading: Current research and application. In N. Arnold & L. Ducate (Eds.), *Engaging language learners through CALL: From theory and research to informed practice* (pp. 179–207). Equinox Publishing.
- Tsai, C.-C. (2016). A case study of English-major students' preferences for English reading from a printed text versus electronic text. *The New Educational Review*, 46(4), 142–151. <https://doi.org/10.15804/tner.2016.46.4.12>
- Tseng, M.-C. (2010). Factors that influence online reading: An investigation into EFL students' perceptions. *The Reading Matrix: An International Online Journal*, 10(1), 96–105. https://readingmatrix.com/articles/april_2010/tseng.pdf
- Wolf, M., & Barzillai, M. (2009). The importance of deep reading. *Educational Leadership*, 66(6), 32–37. <https://www.ascd.org/el/articles/the-importance-of-deep-reading>
- Wu, J.-Y. (2014). Gender differences in online reading engagement, metacognitive strategies, navigation skills and reading literacy. *Journal of Computer Assisted Learning*, 30(3), 252–271. <https://doi.org/10.1111/jcal.12054>
- Young, J. (2014). A study of print and computer-based reading to measure and compare rates of comprehension and retention. *New Library World*, 115(7/8), 376–393. <https://doi.org/10.1108/NLW-05-2014-0051>

Appendix A. Participant Demographics

Gender				
Male	27			
Female	21			
Ages:				
18–19	years	2	%	
20–22	years	42%		
23–25	years	57%		
For how many years have you been trying to improve your reading skills in English?	1–3	4–6	6+	
	24%	23%	42%	
Hours spent reading in English	<1	1–2	3–4	4+
	29%	42%	19%	8%
Hours spent browsing the Internet daily	4+	3–4	1–2	<1
	6%	70%	17%	6%
Hours spent reading English texts when browsing the Internet	4+	3–4	1–2	<1
	0%	38.2%	23.5%	36%
Motive behind reading English texts when browsing the Internet	To learn English	To be informed	School requirements	Other reasons
	38%	46.8%	0%	14.8%
What do you read in English?	Always	Sometimes	I don't do it	
Newspaper	20%	27.7%	51.8%	
Magazine	15.5%	26.6%	57.7%	
Books	24.5%	56.6%	18.8%	
Stories	27.2%	49%	23.6%	
Others	45%	26%	45%	
Types of reading when surfing the Internet:	Always	Sometimes	I don't do it	
Email	81%	13.7	5%	
News	37.2%	33.3%	29.4%	
Articles	44%	46%	10%	
Others	24.4%	5.8%	67.6%	

Self-reported English reading proficiency level	Excellent 26%	Good 51%	Fair 21%	Poor 2%
-------------------------------------------------	------------------	-------------	-------------	------------

Appendix B. Results of Shapiro-Wilk Normality Test of the Data in the Two Samples

Sample	Condition	Shapiro-Wilk		
		Statistic (<i>W</i>)	<i>df</i>	<i>p</i>
One	Traditional text	.848	48	< .001
	E-text	.941	48	.018
	Web text	.922	48	.004
Two	Printed Literal	.623	47	< .001
	Printed Inferential	.675	47	< .001
	Printed Evaluative	.716	47	< .001
	E-text Literal	.748	47	< .001
	E-text Inferential	.790	47	< .001
	E-text Evaluative	.803	47	< .001
	Web text Literal	.723	47	< .001
	Web text Inferential	.777	47	< .001
	Web text Evaluative	.809	47	< .001

Appendix C. Pairwise Contrasts of the Text Forms x Comprehension Facets

(I) Text Format *	(J) Text Format *	Mean Difference (I-J)	SE	df	Sidak Sig.
Traditional * Descriptive	Traditional * Inferential	.09	.089	1	1.000
	Traditional * Evaluative	.11	.096	1	1.000
	E-text * Descriptive	.23	.105	1	.613
	E-text * Inferential	.45	.108	1	.001
	E-text * Evaluative	.66	.145	1	<.001
	Web-text * Descriptive	.55	.112	1	<.001
	Web-text * Inferential	.55	.103	1	<.001
	Web-text * Evaluative	.66	.105	1	<.001
Traditional * Inferential	Traditional * Evaluative	.02	.106	1	1.000
	E-text * Descriptive	.15	.128	1	1.000
	E-text * Inferential	.36	.139	1	.288
	E-text * Evaluative	.57	.170	1	.025
	Web-text * Descriptive	.47	.134	1	.017
	Web-text * Inferential	.47	.120	1	.003
	Web-text * Evaluative	.57	.130	1	<.001
Traditional * Evaluative	E-text * Descriptive	.13	.093	1	.999
	E-text * Inferential	.34	.129	1	.255
	E-text * Evaluative	.55	.141	1	.003
	Web-text * Descriptive	.45	.130	1	.022

	Web-text * Inferential	.45	.112	1	.002
	Web-text * Evaluative	.55	.123	1	<.001
E-text * Descriptive	E-text * Inferential	.21	.127	1	.972
	E-text * Evaluative	.43	.127	1	.028
	Web-text * Descriptive	.32	.128	1	.368
	Web-text * Inferential	.32	.113	1	.157
	Web-text * Evaluative	.43	.127	1	.028
E-text * Inferential	E-text * Evaluative	.21	.141	1	.994
	Web-text * Descriptive	.11	.128	1	1.000
	Web-text * Inferential	.11	.117	1	1.000
	Web-text * Evaluative	.21	.116	1	.919
E-text * Evaluative	Web-text * Descriptive	-.11	.135	1	1.000
	Web-text * Inferential	-.11	.132	1	1.000
	Web-text * Evaluative	.00	.162	1	1.000
Web-text * Descriptive	Web-text * Inferential	.00	.117	1	1.000
	Web-text * Evaluative	.11	.128	1	1.000
Web-text * Inferential	Web-text * Evaluative	.11	.132	1	1.000

Appendix D. Variables' Correlation Coefficients

	Q13	Q14	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23
Q1	0.226	-.354*				.380**		.519**	.317*	.386**
Q2	-0.2				.321*	-.303*	.352*			
Q3	-0.22				.387**	-0.16				
Q5	.425**					.399**		.438**	.411**	
Q6	-0.24					.411**	.357*			
Q7	-0.18					-.340*		-.397**		
Q8	0.261									
Q9	-0.22	.486**	-.291*	-.346*	.458**		.301*			
Q10	-0.25	.381**			0.277		.334*			
Q11	-.362*	.347*			.289*					
Q12	.478**		.306*		-0.04	.381**		.335*		

About the Author

Khalid Al-Seghayer earned his Ph.D. in Applied Linguistics from the University of Pittsburgh. His research interests include CALL and L2 reading. His work has been published in several journals including LL&T and *CALICO Journal*. He serves as an editorial board member and reviewer for various journals.

E-mail: alseghayer@yahoo.com

ORCID: <https://orcid.org/0000-0002-7814-3111>