Print Versus Digital: The Effect of Format on Performance in Editing Text

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Abstract

As of today, our knowledge on the nature of digital reading and of the comparison between print and digital reading, is very limited. Most recent studies focus on digital reading under passive conditions, in which text comprehension is tested, without asking the reader to "act" on the text by editing, recognizing or correcting errors and improving the text's quality. In light of the present-days increase in situations that require active digital text-reading in learning (e.g. grading students works or reviewing papers and books), there is a growing importance in shedding light on the comparison between print and digital reading under active conditions. In this pioneering study, we examined the active-reading abilities of students, who were asked to read, edit, recognize errors and improve the quality of short articles, in a print and in a digital format. Surprisingly, and in contrast to the common reported findings from print versus digital reading studies, no significant differences were found between the performances of participants in the two formats. A similar no-difference was found for all text-errors categories, as well as for gender differences. We found that digital readers completed their tasks earlier than the print readers, but their performance was not lower. We suggest that the absence of significant differences between print and digital formats indicates that digital reading becomes an everyday practice among users, who gain digital reading proficiency. This process, of closing the gap between print and digital readers is reported in recent literature.

Keywords: Format, comprehension, digital, text, digital reading, print versus digital reading.

Introduction

In recent years, information consumers face a rapid growth in the availability of digital text in lieu of the printed one, as evident from the proliferation of online newspapers, electronic books, electronic encyclopedias, online academic journals and blogs (Birkerts, 2004; Heider, Laverick, & Bennett, 2009; Hillesund, 2008; Vaughan, 2002), as well as the expansion of e-book readers (MacManus, 2009). This shift towards digital text is also evident in the academia, where already today, most texts are read in a digital format (Heider et al., 2009; Nelson, 2008).

Reading from digital displays – especially from computer screens - creates severe usability problems that the readers must cope with (Bus & Neuman, 2009; O'Hara & Sellen, 1997; Quinn & Stark-Adam, 2007; Van Den Broek, Kendeou, & White, 2009). Among these problems are the large reading-distance from the display, the long lines, the problem in shifting the eye-gaze from line to line (Evans, Charland, & Saint-Aubin, 2009) and the blurring of text on computer monitors. In addition, text-fragmentation and the resulted decrease in text' coherence (Albrecht & O'brien, 1993; Ozuru, Dempsey, & McNamara, 2009), which are associated with the non-linear nature of the hyper text, harm text comprehension (Chang & Ley, 2006; Rouet, 2000;

Van den Broek et al., 2009) and present readers with a high cognitive load (Ackerman, 2009; Rouet, 2000) and disorientation (Armitage et al., 2004).

The above-cited usability problems related to digital reading, have led to extensive research efforts in order to characterize the nature of digital reading and learning, in comparison to reading from print (e.g. Baker, Bernard & Riley, 2002; Brady & Phillips, 2003; Brown, 2001; Eshet-Alkalai & Chajut, 2007; Eshet-Alkalai & Geri, 2007; Evans et al., 2009; Hiebert, Menon, Martin, & Bach, 2009; Quinn & Stark-Adam, 2007; Reinking, 2005; Shaikh, 2004), and to establish standards for effective digital text design. The current study examined differences in the ability of readers to recognize and correct errors in print and in digital formats.

Many recent studies reported that reading from print and from digital displays differs significantly in a wide range of aspects:

- **Methodological reading**: Lieu (2005) described screen-reading as characterized by more time spent on browsing and scanning, keyword spotting, one-time reading, non-linear reading, and reading more selectively, while less time is spent on in-depth reading and concentrated reading. Similar findings were reported by Evans et al., 2009). In their eye-tracking study, Quinn and Stark-Adam (2007) reported that print readers tend to read the text methodologically, line-by line, whereas, digital readers tend to "jump" from place to place in the text as they read.
- **Reading pace:** Reading from a digital display is slower than from print (Evans et al., 2009; Gould et al., 1987; O'Hara & Sellen, 1997).
- **Discomfort and disorientation**: Readers of digital texts usually report of fatigue and discomfort (Rouet, 2000) and that the lack of a "physical text" creates a feeling of disorientation (Armitage et al., 2004; Lazar et al., 2003).
- **Text comprehension:** Rouet (2000) found that reading a digital text involves a higher perceived cognitive load (Van den Broek et al., 2009) and a lower comprehension and memorization (Morineau et al., 2005), compared to a printed text.
- **Digital text design:** A few studies reported that the conversion of text from a print to a digital display and vise versa (Hillesund, 2010) results in reducing text comprehension (Eshet-Alkalai & Geri, 2010), especially when a text, which was designed to be read in print, is scanned and read "as is" from a digital display.
- **Ownership and Readers preferences**: Studies of digital reading preferences clearly indicate that most readers prefer to read long academic text in print (Ackerman, 2011), whereas they are willing to read short news-like reports in a digital format (e.g. Spencer, 2006). Nila, Sathe, Grady, and Nunzia (2002) found that university students preferred reading from electronic journals, whereas the faculty staff preferred the printed journals. Interestingly, Chang & Ley (2006) reported that students, who preferred reading academic text from the monitor, were the higher-achieving students. Usually, readers indicate that they prefer the printed version of articles because of the sense of ownership provided by the printed text (Armitage et al., 2004; Griffith, Krampf, & Palmer, 2001).

In recent years, with the penetration of digital reading and writing technologies into higher education, submission of academic works in a digital format has become a common practice in most institutions (Heider et al., 2009; Nelson, 2008; Whitworth & Friedman, 2009). Consequently, students are required to submit in digital format seminars, assignments and even examinations, and instructors are required to read, annotate and grade them in front of a digital display (Bus & Neuman, 2009). Many distance learning academic institutes even developed special environments for online submission and assessment of academic works. In recent years,

there is a growing amount of indications of frustration among academic staff, concerning inconvenience, workload and problems which are involved in this process of online text-editing and text-assessment (Chang & Ley, 2006; Heider et al., 2009; O'Hara & Sellen, 1997; Vaughan, 2002; Birkerts, 2004). Surprisingly, as far as we know, the research literature lacks studies that focused on active text editing of digital versus print formats.

This research investigates active reading (i.e. the reader's ability to edit text) in a print versus a digital display. We hypothesized that significant differences between the two formats will be found, as reported in so many other studies comparing reading in print vs. digital displays. The research investigates differences in the ability of readers to edit text in print and in digital formats, and, consequently, to improve the text's clarity.

Methodology

Participants

Ninety-three undergraduate Social Sciences students (82.8% females, 18.2% males) participated in the study. The average age was 23.9 (*SD*=4.40). All participants were born in Israel and Hebrew was their native language. They all had personal computers, and used them intensively— 61.3% used computers at least 2 hours per day and 38.8% used them 1 hour or less per day. 93.5% reported that they were proficient in the *Word* application.

Research tools

a. **Text-errors Taxonomical Framework:** A taxonomical framework of text-errors was established and validated with the aid of 5 experts in linguistics and text editing. The framework classifies text changes and errors into six major categories (i.e. mistyping, homophonic, morphologic, semantic, syntactic and clarity errors (Table 1).

b. Texts for analysis: Two popular articles of the same length (600 words), topic (environmental awareness) and author, that were published in Hebrew in *Haaretz* newspaper – *Galeria* Magazine) were selected for this study. Each article was changed by the researchers to include errors from each category of the taxonomical framework. The changes in each article were validated in a pilot study on a group of 21 students.

c. **Demographic Questionnaire:** The questionnaire collected demographic data, such as gender, age, experience with technologies, and self-report of learning disabilities of participants.

d. **Reflection:** Participants were asked to evaluate their performance, to reflect on their experience in correcting the two texts and on the difficulties they faced during the task. They were also asked for their preferred format: print or digital.

Task: Participants were given 20 minutes in order to read, correct and make improvements in the two articles. Every participant corrected one article in print, and the other in digital format. Each article was corrected in a different session – at least one week apart. Order of formats and the texts was counterbalanced. Questionnaires were filled after task completion.

Table 1: Text-Errors taxonomical framework

1. **Mistype:** • Typing error (e.g. one incorrect letter) • Extra space within a word • Deleted space between words • Metathesis
2. **Homophonic errors**
3. **Morphological errors** • Gender errors (in Hebrew there is a distinction between verb conjugation for men women) • Singular- Plural • Numbers • Verb conjugation • Person • Definiteness marker (He Hayedia in Hebrew, or "the" in English)
4. **Semantic errors**
5. **Syntactic errors**
6. **Clarity** • Prepositions • Redundancy • Synonyms • New paragraph • Unsuitable paragraph • Punctuation

Data analysis: Each participant's performance for the two articles was analyzed according to the Text-Errors Taxonomical Framework (Table 1). The text-errors correction and all other editorial changes made by each participant, were classified into Positive (changes which improved the article's quality), Negative (changes which harmed the article's quality) and Neutral (changes that did not affect the article's quality). In order to assess each participant's performance, each participant's corrections were sum-up for each category.

In order to allow comparison of the participant's performance in print and digital formats, and a correlation between their performance in the different categories and sub-categories of the Text-Errors Framework (Table 1), the new **Error Correction Index (ECI)** was established. Since the number of errors in each text was identical, this index reflects the level of performance. ECI was calculated for each participant as follows:

ECI= Total Positive text-corrections, minus Total Negative text corrections, minus Total Unidentified Errors, divided by Sum of Errors.

Since a normal distribution of ECI values was found in all the Text-Errors Framework categories (except for the Syntactic category), we used a categorical distribution in analyzing the data from both print and digital formats.

Findings

The correlation between the categories of the Text-Errors Framework was checked with Spearman correlation. Medium-strong correlations were found between all the categories, within each format's type. In other words, participants' performance in each category was similar for both print and digital formats and participants who performed high in one format, also performed high in the other.

In order to examine the participants' success percentage in the print and the digital format, we calculate the percentage of success of all participants' responses. No significant difference was found between the two formats, Print=30.40% (*SD*=.14) Digital=30.10% (*SD*=.15), *t*=.30, *df*=88, NS).

In order to examine the correlation and performance differences between the ECI values for the Text-Errors categories and sub-categories in print and in digital formats, a Pearson test and a t-test were conducted (Table 2).

Table 2: Editing text in print vs. digital formats: Correlations and performance differences

Variable	Print Format		Digital Format		*r*	*T (df=88)*
	Mean	***SD***	**Mean**	***SD***		
Mistype	.44	.37	.44	.41	.30**	-.04
Homophonic	-.05	.59	.09	.62	.46***	-2.08*
Morphological	-.33	.42	-.34	.41	.63***	.18
Semantic	-.39	.52	-.41	.43	.58***	.48
Clarity	-.51	.35	-.52	.37	.74***	.63
	-.29					

*p<.05 **p<.01 ***p<.001

In order to check the correlation between the print and the digital formats for the syntactic categoy, a chi square test for independent samples was performed, resulting in a significant correlation (χ^2=10.53, *df*=4, *p*<0.05).

The significant positive correlation between the performance of participants in print and in digital formats indicates that participants who performed well in one format also performed well in the other. Across the majority of categories we did not find any significant differences between active reading in print format and digital format, except for the Homophonic category.

A Cohen's d was used in order to check the effect size. A small significant difference was found between the two formats except for a minor difference in the Homophonic category (Cohen's d.=0.23).

In order to examine demographic variables, tests of both within and between subjects were conducted. No significant differences were found in computer usage intensity, as well as in mastery level of using *Word.*

Interesting differences between print and digital were found for the time duration, required for participants to complete their tasks (Figure 1). In other words, print's readers needed more time than digital readers in order to reach the same level of success.

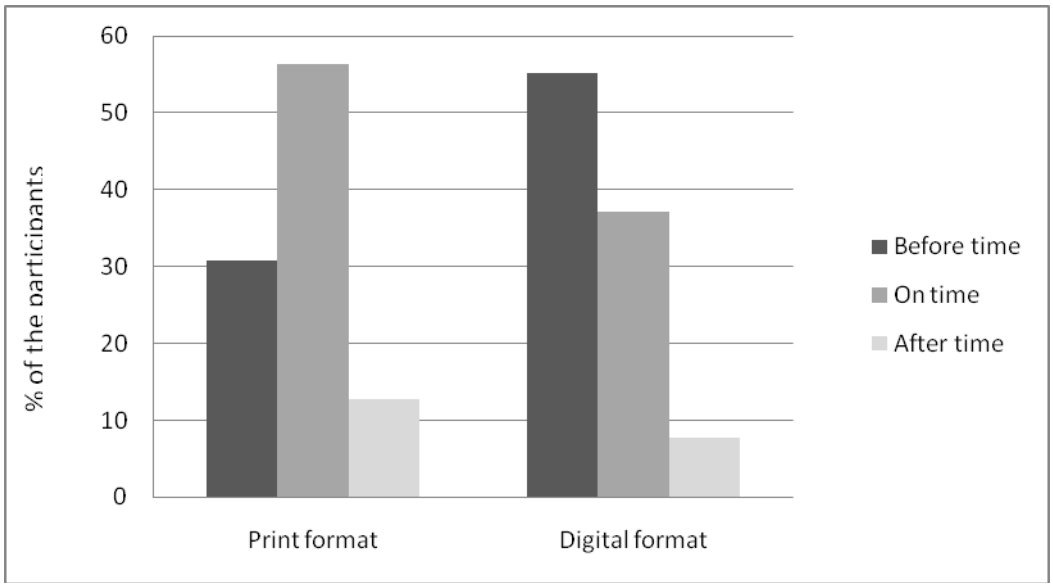

Figure 1: Task-completion in print versus digital formats

Despite the fact that time required to complete the task had no effect on the participants' performance, as shown in Figure 1,in the digital format most participants completed their task **before time**, whereas in the print format, most participants completed their task **on time** (χ^2=32.41, df=4, p<0.001). No clear format preference difference was found: 50.3% of the participants favored the print format and 45.3% favored the digital format. 4.7% favored both formats similarly. No interaction was found between the format's preference and the participant's performance.

Discussion and conclusions

In recent research literature, many studies report on differences between print and digital reading. For example, Eshet-Alkalai & Geri (2007; 2010) found that younger participants read text more critically in a digital format, whereas older people read the same text more critically in a print format, and that converting text from print to digital display and visa versa, harms comprehension. Ackerman (2009; 2011) found that without time-constraints, a comprehension from digital text was lower than print, whereas under conditions of time-constraints, no difference was found. Ackerman's findings are similar to the findings of the present study - there is no difference in the performance between print and digital readers.

Despite the reports on differences between print and digital reading, our findings clearly suggest that there is almost no performance difference between the print and the digital formats. The fact that this finding is consistent for all the text-error categories and sub-groups in our study (e.g. gender), reinforces the validity of the research methodology and of the findings.

Our findings, of no difference between print and digital reading, can be explained from two points of view:

1. **Active vs. passive methodology**: Until today, most studies on print vs. digital reading were conducted under **passive** conditions, in which participants were tested for text-comprehension, without the need to act on the text by editing it. The current study was conducted under **"active reading"** conditions, in which participants are tested for their ability to revise and edit a given text. Our findings, which are contradictory to the common findings in recent print vs. digital studies, may result from the difference in research

methodologies (passive vs. active) which were utilized. More research on active reading is required, to shed light on this issue.

2. **Gaining proficiency**: Several recent studies (e.g. Eshet-Alkalai & Chajut, 2009; 2010) showed that the gap between users of different technological platforms closes as users become proficient in using these platforms. It is possible that our findings reflect the fact that after many years of reading online texts, the present-days young readers, who belong to the "native generation" (Prensky, 2001), already master digital reading equally to print reading. The trend of closing the gap between print and digital reading is illustrated clearly by recent reports (e.g. Fenn & LeHong, 2011), which suggest that today, the digital information consumption almost equals the consumption of information in print, and by the fact that in 2010, the sales of e-books in *Amazon*, exceeded for the first time the sales of printed books (The Economist, 2011).

More research on print versus digital reading in active conditions is necessary in order to clarify the nature of today's digital reading.

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