A Comparison of Sixth Grade Students' Reading Comprehension on Two Different Digital Formats

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Abstract: Digital native students, as opposed to digital immigrants, do more reading on digital environments than on printed environments. The aim of this study was to learn whether reading comprehension, the key factor for learning, would be affected by this change of environment, and whether appropriate text formats for digital natives would give desired results. This study examined whether the reading comprehension levels of sixth graders who read various kinds of academic texts differed based on the text format. 113 students participated in the study whose reading comprehension skills were determined by IOWA test. Four texts in three different disciplines were prepared for the study. A part of the students read the texts on a linear design while the others on a multimedia design. The results demonstrated that for all text types, the main factor on students' reading comprehension levels was not the type of environment but their reading comprehension skills.

Introduction

Since 1980s there has been a new generation who is born into the digital world and is called "digital natives" by Prensky (2001). Prensky (2001) defines digital natives as a generation who is grown up in the digital world using technology as a way to communicate and is good at multitasking. For Digital Natives, the Internet is a familiar territory. They read materials on the Internet for school and for leisure, and they make use of Internet for their information needs more often than traditional reference materials. The increasing digitization of information means that books and print media are no longer the sole source of reading materials available to Digital Natives (Houston, 2011). To serve this ever-growing population of readers who prefer digital environment for reading, the format/design of digital books is one of the key issues for experts to analyze.

This study aims to investigate whether the sixth graders' reading comprehension skills of academic digital texts in different disciplines (social science, science, literature) differ depending on two different digital reading formats, the linear one and multimedia.

Literature Review

In addition to providing alternative ways of supporting the acquisition and development of traditional print-literacy skills, technology changes the nature of text and reading (DeFrance, Khasnabis & Palincsar, 2010). For the past 500 years, literacy has emerged from a variety of social contexts but has been shaped largely by the technologies of the book and the printing press (Leu et al., 2004). But today, both the social context and technologies are rapidly changing; ICT and the internet are in the process of becoming the central technologies of literacy (DeFrance et al., 2010). In 2007, The International Society for Technology in Education (ISTE) released the digital age learning standards for students of 21st century. These are categorized into six: (i) creativity and innovation (ii) communication and collaboration (iii) research and information fluency (iv) critical thinking, problem solving, and decision making (v) digital citizenship (vi) technology operations and concepts (ISTE, 2007). Although (digital) reading comprehension is not listed evidently, it's a fact that reading comprehension is a must for nearly all of the six standards. Accordingly, the definition of digital-age literacy by enGauge (2003) report come up with eight different varieties which includes basic literacy, scientific literacy, technological literacy etc. While giving the definition of the basic literacy as the ability to read, write, listen and speak, it is underlined that the basic literacy skills are more important than ever in the digital world. PISA (OECD, 2011) defines reading literacy as understanding, using, reflecting on and engaging with written texts, in order to achieve one's goals, develop one's knowledge and potential, and participate in society. This broad definition refers to the texts that we read, the processes of reading and the purposes for which we read. It is as applicable to digital reading as it is to print reading.

DeFrance et al. (2010) state that there are at least three ways in which technology is thought to have the potential to support reading comprehension. The first is through supporting decoding so that readers have ready access to the ideas in text. The second is by offering multiple representations of information (e.g., prose, graphics, and animations), and the third is by using technology to teach students to be more strategic in their reading of text.

From the educational point of view, the invention of writing and print texts constitute a crucial cornerstone, having made possible the transition from verbal culture to print culture and thus the preservation, progression and

passing on to the next generations. With the invention and popularization of computers and particularly the Internet, which establishes another cornerstone for humanity, print texts have become available to read in print and digital media. Digital environments, which include computers and the Internet, help an important amount of print texts reach readers via screens of different size and features. Therefore, when deciding on the use of digital environments to convey print texts to readers, it is important to consider the nature of the information before determining the medium used since not only the formatting, but also the medium can impact user performance (Mayes, Sims & Koonce, 2001).

Individuals may read for three purposes (ASC, 2001): First of these is academic reading, which aims at studying and requires reading textbooks and other print materials that fit the individual's capacity. Other forms of reading are recreational reading (novels, biographies etc.) and reading aimed at keeping up-to-date (newspapers, professional publications etc.). Both recreational (free/voluntary) and academic (school-related) reading has a critical value in regard to students' reading development and academic success (Mokhtari, Reichard & Gardner, 2009). After all, realization of education is directly related to students' level of understanding of the message that academic texts contain, i.e. their "reading comprehension". In this regard, the basic life skill of meaningful reading is a cornerstone for success in both school and life (Williams, 2010).

Digital Texts and Design

Online reading, *onscreen reading*, and *e-reading* are seemingly interchangeable terms that do not appear to be defined in literature (Sandberg, 2011). This study is on students' access to the texts required for academic reading on tablet computer screens and uses the term "e-reading" regarding the concept.

Mayes et al. (2001) state that the best medium for conveying information might depend on which aspect of performance is most important and on how the information is displayed. In this context, design of the text is an important factor when conducting academic reading in digital media.

Until recently, research surrounding instructional design and digital learning environment has focused primarily upon postsecondary education. These findings have then been translated to fit the K-12 school environment. Considering the learning characteristics of K-12 learners as compared to the postsecondary learners, there is a need to provide results and recommendations which are more suited to K-12 learners.

In a study concerning text design conducted in Turkey, students have read narrative and expository texts that have been prepared in short and long pages on digital media. Findings of the study indicate that students who read the text from long pages get significantly higher scores on reading comprehension tests than students who read the text from short (Şahin & Alsancak, 2011). Barab, Young, and Wang (1999) compared college students' learning using a linear text with navigational hypertext. It's been revealed that the linear group had significantly higher reading comprehension scores. It's because linear group could only move backwards and forwards through the text and thus they may have covered more of the information than hypertext group.

On the other hand, in another study which investigated the navigational patterns and learning achievement of university students on hypermedia learning environments using paging or scrolling it was found that paging/scrolling neither affected the learning nor the satisfaction of learners. Students who read an academic text which was designed on paging or scrolling did all learn well, with no statistically significant difference (Eyüboğlu & Orhan, 2009). Beishuizen, Stoutjesdijk, and Zanting (1996) conducted a research with undergraduates and focused on exploring the conditions for making hypertext a better environment for both studying and information searching than a linear text. Nevertheless, there were no differences between learning from a hypertext and from a linear text in open study tasks, like studying for an exam. DeStefano and LeFevre (2007) reviewed 38 studies on navigation and learning in hypertext between 1990–2004. They concluded that the related research "did not support the view that hypertext was better for learning, and sometimes it was worse because students may have missed important information".

Research Question

Based on these studies this research aims to find out the answer to the following basic question: "Do the sixth graders' reading comprehension skills differ based on the text type related to two different digital reading environments?"

In order to answer this question, an experimental study has been planned and the following hypothesis has been developed: There is a statistically significant difference between the reading comprehension levels of students who read various kinds of academic texts in linear or multimedia design in a digital reading environment.

The Method

This study examines whether the reading comprehension skills of sixth graders who read various kinds of academic texts differ based on the format of the text read .To this end, an experimental study has been planned. The independent variable of the study is the digital format of reading and the dependent variable is students' reading comprehension skills. Four separate texts belonging to different disciplines were read by students. Students read all the texts on tablets but on two different digital reading formats, the linear and multimedia formats.

Reading Environment

Digital Texts

Four different texts from different disciplines (Science, Social Sciences, and Literature) are used to analyze students' Reading Comprehension skills. The digital texts were in two different formats, in linear and multimedia design. The linear format consisted of only linear text, static pictures, graphics, whereas, the multimedia reading

passages contain texts which are enriched with graphical elements along with audio, video, motion picture, internet link. The main issue of this study is whether a static form in a PDF format or a form enriched with multimedia is more suitable for reading passages to be prepared for today's elementary students. Therefore, as part of the study, two different reading formats in which content of the texts are identical but visual elements and design differ have been generated. These formats are explained hereunder:

1st digital reading environment - Linear: PDF files developed to be used on tablets. Texts have been designed linearly. It is a format that contains colored, stabile pictures, graphics and tables and texts. Students are set free to read any part of the text by dragging pages up and down.

2nd digital reading environment - Multimedia: Multimedia materials developed to be used on tablets. Texts used in the first format have been incorporated to this format without any alterations, but an important number of the pictures, graphics and tables have been converted into videos and animations, multi-image pictures. In addition, hyperlink and audio were used where appropriate.

Before giving the reading passages to students, academicians who were experts in Multimedia design examined the texts and evaluated them according to multimedia design principles.

Data Collection Tools

IOWA for Basic Skills Test: In order to form heterogeneous student groups that provide a satisfactory level of reading comprehension skills, "IOWA for Basic Skills Test Part B" is used. The IOWA Tests of Basic Skills (ITBS), also known as the Iowa Tests, are standardized tests provided as a service to schools by the College of Education of the University of Iowa. Developers E. F. Lindquist, Harry Greene, Ernest Horn, Maude McBroom, and Herbert Spitzer first designed and administered the tests, originally named the Iowa Every Pupil Test of Basic Skills. The test is adapted to Turkish by Avcıoğlu and Akçamete (1996). The test consists of six short texts and a total of 38 questions, 5 to 7 for each short text. Avcıoğlu and Akçamete (1996) have found the Kuder-Richardson 21 (KR_{21}) reliability value of the test to be .83, whereas, it is found to be .70 in the present study.

Reading Comprehension Scale: It is an evaluation instrument consisting of multiple-choice questions testing the four texts involving three different types of contents (social science/science/literature) used in an experimental environment that is developed to evaluate students' reading comprehension skills. The scale has been developed by the researchers and volunteer teachers. The content validity has been checked by experts. Item analysis has been conducted on the questions developed for the texts to be used. During the pilot study, each text has been read and the questions been answered by an average of 150 students. With this pilot study, the Kuder-Richardson 20 (KR_{20}) values for each text differ between 0.62 and 0.74. Reading Comprehension Scale at the end of pilot study consists of 22 questions for the science related texts, 13 questions for the social science related text, and 13 questions for the literature related text, totaling 48 questions. In the present study, for 48 questions from all the texts KR_{20} value was determined as 0.902.

Study Group

The research is conducted with a group of six graders with different socio-economic backgrounds in different primary schools in Istanbul, in the 2013-14 academic year. As part of the study, IOWA for Basic Skills Test has been conducted to all sixth graders in all three schools. IOWA scores of students' differ from 5 to 34 and the average is 21.8. The normalization test for IOWA scores of students' showed that the set of scores forms a normal distribution *(median=22.0; variance=23.51; standard deviation=4.85; skewness=-.091; kurtosis=-.273, and Kolmogorov-Smirnov Z=1.185 (p=.121))*. Students in the study group were assigned into two groups randomly: one have read the texts in linear format (n=60) and other in multimedia format (n=53). The IOWA scores for these two groups form also a normal distribution.

These students were randomly assigned to the stratified sampling groups. For each school there were two groups, each of which consists of 15-20 students. The sample totaling 113 students consisted of girls 52.2% (n=59), and boys 47.8% (n=54). The 6th grade students were approximately around 12 years old. Table 1 shows the frequencies and percentages of the students' technology usage.

	Computer Owner				Cell Phone Owner				Tablet Experience			
	Yes		No		Yes		No		Yes		No	
	f	%	f	%	f	%	f	%	f	%	f	%
Female	32	**54.2**	27	**45.8**	24	**40.7**	35	**59.3**	42	**72.4**	16	**27.6**
Male	36	**66.7**	18	**33.3**	26	**48.1**	28	**51.9**	37	**69.8**	16	**30.2**
Total	68	**60.2**	45	**39.8**	50	**44.2**	63	**55.8**	79	**71.2**	32	**28.8**

Table 1: Frequencies and percentages of students' technology usage

As seen in Table 1, 60.2% of the students reported that they own a computer, 44.2% own a cell phone, and 71.2% have already used a tablet computer before.

Procedure

After determining the groups of students, participants have been divided into five groups and allowed in the library room where the experiment took place in different periods. Each student was given a tablet and instructed to use and explore the same for 15 to 20 minutes. Afterwards, students were asked to open and read the text on the tablet and the questions were provided to the students who declared their reading was finished. Students were allowed to look back at the text while answering questions. Children could often forget parts of the narrative when a

person asked them to re-tell the story or answer questions based on their reading of a text for purposes of testing. The fact that they were found to forget some of the events of the reading did not necessarily mean that they failed to grasp the concepts of the story (Chau, 2008). Each student has read all the texts -always on the same design-, one text per session (45 mins). The experiment was completed within three weeks.

Findings

To find an answer to the question "*Is there a statistically significant difference between the reading comprehension levels of students who read different kinds of academic texts in linear or multimedia design in a digital reading environment?*", an independent group t-test was performed to investigate the effect of digital design. The results of t-test are shown in Table 2.

Digital Reading Environment		**N**		**Ss**	**sd**	**t**	**p**
Science text	PDF	60	12,42	4,767	109,84	-,189	,850
	Multimedia	53	12,58	4,659			
Social Sciences text	PDF	60	7,57	2,965	111	-,031	,975
	Multimedia	53	7,58	3,213			
Literature text	PDF	60	7,02	3,154	110,398	-1,601	,112
	Multimedia	53	7,94	2,996			
All texts	PDF	60	27,00	9,875	109,933	-,606	,545
	Multimedia	53	28,11	9,615			

Table 2: The effect of linear/multimedia design on achievement-independent group t-test

Reading comprehension questions consist of 22 questions for the science related text, 13 questions for the social science related text and 13 questions for the Literature related text, totaling 48 questions. Findings in Table 2 show that students' reading comprehension skills are at average level for all disciplines. Likewise 2012 PISA results from 65 OECD countries show that Turkey is ranked 42nd for reading comprehension skills of students (MEB, 2013).

Table 2 findings indicate that although the average scores of reading comprehension points are higher in the multimedia digital design than linear PDF format, there is no significant difference in test grades of the two groups, linear and multimedia, in each discipline [$t_{(109,8)}$= -,189, p>.05], [$t_{(111)}$= -,031, p>.05], [$t_{(110,39)}$= -1,601, p>.05]. In other words, linear and multimedia text designs for different disciplines did not create any statistically significant difference on reading comprehension of the students'. To investigate the effect of digital design alone, independent t-test analysis was administered to all text grades. The findings in the last line of Table 2 showed that digital text design alone did not make any significant difference in students reading text grades, that is, there is no statistically significant difference in all three groups' reading comprehension skills [$t_{(109,93)}$= -,606, p>.05]. These findings were similar to those of another study made by Connell, Bayliss and Farmer (2012) indicating that text presentation format did not affect reading comprehension, although those reading from eBook readers and tablets read slightly slower than those reading from printed material.

There was no significant difference between students' reading comprehension points in terms of the type of reading environment. Hereby the researchers decided to perform covariance analysis in order to determine the effect of students' reading comprehension skills. In order to decide on using covariance analysis, firstly the data set was checked whether group variances were equal and regression coefficients were equal. It was concluded that covariance analysis could be applied. Results from covariance analysis can be seen in Table 3 and Table 4.

	Digital Reading Environment	N		Corrected
Science text	PDF	60	12,42	12,51
(with 22 questions)	Multimedia	53	12,58	12,48
Social Sciences text	PDF	60	7,57	7,622
(with 13 questions)	Multimedia	53	7,58	7,522
Literature text	PDF	60	7,02	7,073
(with 13 questions)	Multimedia	53	7,94	7,880
All texts	PDF	60	27,00	27,204
	Multimedia	53	28,11	27,883

Table 3: Covariance analysis with group averages and corrected averages

	Source	Type III Sum of Squares	df	Mean Square	F	p	Partial Eta Square
Science text	IOWA score	1196,359	1	1196,359	103,370	,000	,484
	Reading Environment	,022	1	,022	,002	,965	,000
	Error	1273,092	110	11,574			
	Corrected Total	2470,248	112				
Social Sciences text	IOWA score	431,962	1	431,962	76,191	,000	,409
	Reading Environment	,279	1	,279	,049	,825	,000
	Error	623,639	110	5,669			
	Corrected Total	1055,611	112				
Literature text	IOWA score	448,697	1	448,697	81,566	,000	,426
	Reading Environment	18,291	1	18,291	3,325	,071	,029
	Error	605,117	110	5,501			
	Corrected Total	1077,982	112				

All texts	IOWA score	5860,607	1	5860,607	137,142	,000	,555
	Reading Environment	12,960	1	12,960	,303	,583	,003
	Error	4700,713	110	42,734			
	Corrected Total	10596,195	112				

Table 4: ANCOVA results, including eta-squared values

As seen in Table 4, there is no significant difference in the effect of text presentation format, linear and multimedia, between reading comprehension points of the students [$F_{[1]}$=,002, p<,001], [$F_{[1]}$=,049, p<,001], [$F_{[1]}$=3,325 p<,001], [$F_{[1]}$=,303, p<,001]. On the other hand, the effect of students' IOWA scores on reading comprehension points is statistically significant. [$F_{[1]}$=103,37, p<,001], [$F_{[1]}$=76,191, p<,001], [$F_{[1]}$=81,566, p<,001], [$F_{[1]}$=137.142, p<,001].

Partial eta-squared values, which measure the degree of effect of IOWA scores on reading comprehension points, are .484 for science text, .409 for social sciences text, .426 for literature text, and .555 for all texts. Considering the values all together, we see that the effective factor on students' reading comprehension levels is their reading comprehension skills, not the type of reading environment. In other words, different text presentation formats do not pose any effect on reading comprehension levels of students whose reading comprehension skills are low.

Many researchers acknowledge the difficulty in measuring comprehension of text (Grimshaw, Dungworth, McKnight & Morris, 2007; Grant, 2004). Therefore in this research a universal standard IOWA test is used for measuring. As mentioned before, realization of education is directly related to students' level of understanding of the message that academic texts contain. In this regard, the basic life skill of meaningful reading is considered to be a cornerstone for success in both school and life (Williams, 2010).

Conclusions

Grimshaw *et al.* (2007) believes that rich multimedia features such as audio narration, sound effects and animations embedded into electronic books can considerably help children improve their reading comprehension skills. The reasoning is that these features support the text, help the child "decode" new words and children actually improve on their understanding of the text. Nevertheless the findings of the present study did not support Grimshaw's view.

The statistical analyses of the present study in reading from linear or multimedia digital environment showed that:

1. Different disciplines and linear/multimedia design separately or together, did not create any significant difference on the reading comprehension of the students.
2. Different disciplines and linear/multimedia design separately or together, did not create any significant difference on the reading comprehension of the students except that IOWA test scores created significant difference on the reading comprehension of the students. reading comprehension skills of students is the key factor for meaningful reading process, which is independent from the design or discipline of the digital text,

In the present study, that no significant differences in the reading comprehension of the digital text in linear and multimedia format is obtained may be due to students', who have read texts in multimedia format, jumping from one to another and may confused by video, audio presentation, and are cued by colour, in the form of previously determined links, to other information sites. Similarly, Zumbach and Mohraz (2008) found that cognitive load was increased and knowledge acquisition was decreased with the setting of nonlinear information presentation of narrative text structure in their study in which they analyzed hypermedia learning of university students based on different types of cognitive load, text presentation formats (linear/nonlinear) and text types (narrative/encyclopedia). This finding of the rise in cognitive load with the nonlinear text format can be interpreted as being confused by the nonlinear structure of the text. Additionally, Beishuizen, Stoutjesdijk, and Zanting (1996) highlighted that availability of navigation tools are crucial for making hypertext a better study environment than a traditional linear text because hypertext puts heavier cognitive demands on the student.

Grimshaw *et al*. 's (2007) study on children's reading and comprehension skills based on print versus electronic text, tested children under several different conditions including having them read the electronic text of the storybook with and without narration, animations and sound effects. Significant results could be seen amongst the groups except the children who had been placed in the test group that had access to a CD-ROM version of the story with narration turned on generally did the best on the comprehension test. Also Connell et al. (2012) found that while print books generated the fastest reading time, there was no difference in reading comprehension between e-readers and tablet computers.

The findings of present research put forth a vital result demonstrating that reading comprehension skills of students is the key factor for meaningful reading process and learning. However, the recent appearance and early adoption by young people of tablets because of the benefits to using them in terms of portability and touchscreen has raised expectations among those responsible for public policy implementation in the education area; especially in those countries like Turkey that are distributing electronic devices to their teachers and students. This quick acceptance of tablets speeded up the application of projects to bring these devices into the classroom.

The researchers of the present study hope that the finding as to "independent from the design or discipline of the digital text on tablets, reading comprehension skills of students is the key factor for meaningful reading process", which is expected to make important contribution to teachers and educational policy makers as tablets are not magic wands for increasing reading comprehension.

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