Öztop, F., & Nayci, Ö. (2021). Does the digital generation comprehend better from the screen or from the paper?: a meta-analysis. *International Online Journal of Education and Teaching (IOJET), 8*(2). 1206-1224.

Received : 17.10.2020
Revised version received : 20.01.2021
Accepted : 05.02.2021

DOES THE DIGITAL GENERATION COMPREHEND BETTER FROM THE SCREEN OR FROM THE PAPER?: A META-ANALYSIS

Research article

Feyyaz Öztop
Sirnak University
feyyazoztop@gmail.com

Ömer Nayci
Sirnak University
nayciomer@gmail.com

Feyyaz Öztop is a lecturer at Sirnak University Program of Child Development. He is currently continuing his doctorate education at the Gazi University Educational Sciences Institute Primary Education Department.

Ömer Nayci is an Assistant Professor at Sirnak University Program of Child Development. He received Ph.D. in the Department of Curriculum Development at Ankara University.

DOES THE DIGITAL GENERATION COMPREHEND BETTER FROM THE SCREEN OR FROM THE PAPER?: A META-ANALYSIS

Feyyaz Öztop

feyyazoztop@gmail.com

Ömer Nayci

nayciomer@gmail.com

Abstract

This research was carried out to determine whether the comprehension level differs according to the reading environment by examining the studies comparing the comprehension level according to reading from the screen and from the paper by using meta-analysis method. Meta-analysis method was used in this research. The data of the study were obtained from 12 studies (29 comparisons). All of these studies are studies in which Turkish texts are used in reading. The analysis of the obtained data was carried out using the Comprehensive Meta-Analysis software. In the interpretation of the studies, random effects model was taken as basis. As a result of the analyses performed, a significant and medium effect size (g=-0.423, p=0.003) was found in favor of reading from the paper. Therefore, this result shows that comprehension achievement is higher in reading from the paper than reading from the screen. In addition, it was determined that the effect sizes did not differ significantly according to the publication year, grade level, text type and digital tool. It is recommended to perform studies on improving the screen interface and screen reading skills.

Keywords: Digital generation, screen, paper, reading comprehension, meta-analysis.

1. Introduction

The process of change and transformation occurring in the context of technology has also affected education as well as every aspect of life. It can be said that the developments in technology have brought new orientations in education, especially in the learning and teaching process, and this has brought along many new tools, equipment and applications. Mentioned developments, the development of artificial intelligence as well as its application have had significant effects in the field of education, and the developments in this context have led to the emergence of many new possibilities (Wang, Yu, Hu, & Li, 2020). As a matter of fact, today, educators and students widely use many applications related to artificial intelligence (Taşçı & Çelebi, 2020). As a natural consequence of developments in question, the nature of face-to-face teaching has changed, blended and online courses have become widespread rapidly (Redmond, 2011). This has brought various dimensions to the interaction process that takes place in the context of technology supported learning-teaching (Hillman, Willis, & Gunawardena, 1994; Moore, 1989).

Interaction can be between individuals and technological tools as well as between individuals. In the online environment, despite the difference in place, communication can be provided in audio, written and visual form in case of need (Kaya, 2002), and among the participants knowledge and experiences can be shared. These sharings are transferred to the online environment so that information sharing can reach large masses. While these sharings were performed with means such as books, magazines and encyclopedias, today in line with the developments in information and communication technologies, they have started to be transfered to the digital environment in different ways. Digital reading has also increased, as information on demand has also become widespread (Kol & Schcolnik, 2000). It is seen that

many concepts are used in the literature in the light of developments in information access and acquisition of information from digital tools. One of these is the concept of "screen reading".

Screen reading is an active process in which the individual creates new meanings from the information presented on the screen and structures it in his mind (Güneş, 2016). This reading medium which is rapidly becoming widespread in every field differs from the paper reading. In screen reading, a part of writing which is half of a paper page is presented one after another on the screen, and the reader tries to understand this information which s/he gets piece by piece. For this reason, screen reading is also called “piecemeal reading” (Güneş, 2009).

Screen reading is based on the continuous interaction of three components: reader, text and environment. The most active component of this process is the reader. The reader performs various operations such as seeing, perceiving, vocalizing, understanding, associating, questioning, and structuring in the mind the writings on the screen (Güneş, 2010). Since the reader, in other words, the learner who actively takes advantage of the process is the most active component; information, media and technology skills have an important place among the 21st century skills that s/he should have (Partnership for 21st Century Learning (P21), 2013). As a result of the active use of the mentioned skills in the teaching and learning process, the learner acquires new information, accordingly s/he creates his cognitive synthesis and continue his/her development in a universal, life oriented manner. For this, the individual frequently encounters computers and its derivatives in the context of the screen.

It can be said that digital texts are preferred more than printed sources in terms of facilitating access to information and accessing more resources apart from the traditional understanding. This situation becomes more evident especially when physical access is limited. Computer technology and software provided opportunities for transferring printed lecture notes, articles and textbooks from a paper page to the computer screen. Thus, it provides the learner with choice and flexibility in many subjects such as presenting a quality option in terms of duplication of the text and sharing it with others (Spencer, 2006).

Reading from the screen is a type of reading that emerges due to the development of computer and internet technology and changes as the computer and internet technology develops (Duran & Alevli, 2014). Reading from the screen differs from reading from printed text in terms of skills and processes. All the researchers conducted to date revealed that screen reading has important differences from the paper reading in terms of eye movements, comprehending and mental processes. These differences affect reading, understanding and structuring in mind processes and require new skills and techniques (Güneş, 2010). Increasing use of digital material for learning purposes has many effects on printed sources and screen (Martin & Platt, 2001). Many studies have been conducted in the related literature. Especially in the 1980s and early 1990s, researches on reading performance from monitors belonging to image technologies focused mostly on speed and accuracy measurements and focused less on comprehension (Garland & Noyes, 2004). Today, in the studies carried out in this field both at home and abroad; it is seen that more focus is given on issues such as reading comprehension, sense-making, reading speed and attitude towards text, reading skills, reading preferences and behaviors, reading style, its effect on motivation, its effect on bodily movements (Başaran, 2014; Chen, Cheng, Chang, Zheng, & Huang, 2014; Ertuğrul, 2013; Kurata, Ishita, Miyata, & Minami, 2017; Mangen, Walgermo, & Brønnick, 2013; Mizrachi, 2015; Rajanen, Salminen, & Ravaja, 2016; Schilhab, Balling, & Kuzmicova, 2018; Uther, Ross, Randell, & Pye, 2019; Yaman & Dağtaş, 2013).

As a result of the increase in transition to studying on the screen in recent years, one of the issues that researchers have emphasized is whether the reading comprehension is affected by the change in the reading environment (Delgado & Salmerón, 2021; Halamish & Elbaz,

2019; Kazazoğlu, 2020; Lebedeva, Veselovskaya, & Kupreshchenko, 2020; Støle, Mangen, & Schwippert, 2020; Zou & Ou, 2020). The most important purpose of reading is understanding (Mellard, Fall, & Woods, 2010; Özen & Ertem, 2014). Determining the extent to which the understanding is achieved is important in terms of both determining the distance taken by the learner as a result of the education and teacher's seeing the level reached from the beginning of the process (Ünal & Köksal, 2007). Although the skill of reading comprehension is a subject that is emphasized in language lessons, it also has an important place in all academic and daily life of individuals. It has been revealed that there are relationships between reading comprehension skill in Turkish, social studies, science and technology, and mathematics classes and success in classes (Yılmaz, 2011), critical thinking skills (Aloqaili, 2011; Hosseini, Khodaei, Sarfallah, & Dolatabadi, 2012). It has been highlighted that reading is a basic skill on which sound job opportunities and personal autonomy are based as well as academic success (Calhoon, 2005). It is an undeniable fact that reading comprehension is of great importance for a student or an adult whenever reading takes place, since the skill of reading comprehension is used continuously to obtain information (Tamsi, Zuhri, & Kurniasih, 2013).

In this century, in which digital technology has become widespread in all areas of our lives, individuals read from the screen rather than from printed sources. It is getting harder day by day for individuals to leave the screen and return to paper due to habits. Therefore, the importance of understanding what is read on the screen has increased even more. Thus, the need to evaluate comprehension success in screen reading and to take steps in this direction has increased. As a result of this, it has been a subject to be considered whether comprehension success is higher when reading from screen or from printed material. Although many studies have been conducted to enlighten this issue, many compilation and meta-analysis studies have also been carried out due to the different results which have been obtained in different studies. Clinton (2019), Delgado, Vargas, Ackerman, and Salmerón, (2018) and Kong, Seo, and Zhai (2018) reached the conclusion that reading on paper is better than reading from the screen in terms of reading comprehension. However, Wang, Jiao, Young, Brooks, and Olson (2008) found that studies on the tests in paper-pencil form and computer form have no significant effect on reading achievements according to the environment. In the study comparing multiple choice tests applied on computer and on printed text by Kingston (2008), they emphasized that the results differed, while some findings pointed to the advantages of printed text, the others emphasized that the advantages of digital text were at the forefront. In this respect, it is stated that the results of such studies are not always consistent. In another study by Singer and Alexander (2017), the results showed that the environment played an effective role under certain text and conditions or for certain readers. Besides, it is emphasized that in terms of the studies included in the research; there is an increase in the studies conducted and in the variety of digital devices used, the research environment and the choice of participants are constant and in terms of text length and text manipulations there are three types of tendencies.

Although there are studies analyzing reading comprehension on screen and paper by compiling comparative studies in the international arena, the absence of a meta-analysis study on studies comparing the level of reading comprehension on screen and paper in Turkish texts has led to the need for doing this research. This study conducted is considered significant in terms of putting forth the difference in the comprehension level according to the reading environment and guiding the steps to be taken and the studies to be carried out on this subject. In this direction, the study was conducted in order to examine whether the comprehension level differs according to reading from the screen and reading from the paper using the meta-analysis method.

In the context of this purpose, answers to the following questions were sought within the scope of the research:

- Does the level of comprehension differ from reading on screen and reading on paper?
- Is there a significant difference between effect sizes according to publication year?
- Is there a significant difference between effect sizes according to grade level?
- Is there a significant difference between the effect sizes according to the type of text used in reading?
- Is there a significant difference between the effect sizes according to the digital tool used in reading?

2. Method

2.1. Research Design

In this research, meta-analysis method was used to examine whether the comprehension level differs according to screen reading and paper reading or not. Meta-analysis is the classification of similar studies about a subject, theme or field of study according to certain criteria and the interpretation of these studies by gathering the quantitative findings (Dinçer, 2014). Meta-analysis is a way to generalize the results (Ellis, 2010). Meta-analysis is a statistical analysis in which different study findings are combined and analysed again (Glass, 1976).

2.2. Data Collection Procedure

The data of the research were collected in April 2020. TÜBİTAK ULAKBİM (The Scientific and Technological Research Council of Turkey / Turkish Academic Network and Information Center), Web of Science, Ebschost, YÖK (Council of Higher Education) National Thesis Center, Google Academic platforms and databases were scanned by using "Screen", "Paper", "Printed", "Digital", "Reading", "Comprehension" and "Reading Comprehension" keywords and their English meanings. The studies listed as a result of the scanning were evaluated according to the determined inclusion criteria. The determined inclusion criteria can be listed as follows;

- In the study, reading comprehension level according to reading from the screen and reading from the paper (printed material) should be compared.
- Reading studies should be done by Turkish texts
- The study should be an article, a master's thesis or a doctoral thesis.
- The study should be conducted with students showing normal development. Studies conducted with students having special needs are not included in the meta-analysis.
- Studies should have the necessary statistical information for meta-analysis such as sample size, average, standard deviation etc.

As a result of the examinations, 16 studies were determined in accordance with the inclusion criteria. However, 4 of these studies were found to be articles produced from the thesis. In this case, only articles were included in the meta-analysis and related theses were eliminated. Finally, 12 studies were included in the meta-analysis. 10 of these studies are articles and 2 of them are master's theses. 29 comparisons from these studies were examined.

2.3. Data Analysis

A coding form was created by the researchers for the analysis of the studies determined according to the inclusion criteria. In this coding form, the publication year of the studies, grade level, text used in reading, digital tool used in reading and statistical information are included.

In order to avoid confusion regarding the 5th grade due to the change in the education system after 2012, the grade levels were described as primary education by its name in the old system instead of elementary school - middle school. Manual calculation of effect sizes and homogeneity is error-prone and time consuming (Cooper, 2017). So, all analyses of the study were done using Comprehensive Meta-Analysis software. This software is a comprehensive meta-analysis software allowing many tests required for meta-analysis to be performed. Comprehensive Meta-Analysis software has many advantages such as being able to work with many different data types, ease of use, automatic calculation of effect sizes, editing forest plot, exporting graphics (Borenstein, 2005; Borenstein, Hedges, Higgins, & Rothstein, 2009).

In the study, analyses were carried out for evaluating publication bias. Publication bias occurs when published study results do not represent the overall completed research results (Littell, Corcoran, & Pillai, 2008; Rothstein, Sutton, & Borenstian, 2005). Meticulous selection of the studies to be included and the definition of the hidden studies provide protection against publication bias (Lipsey & Wilson, 2001). The more evidence is found about whether there is bias or not, the decision to be made in this regard will be more accurate (Card, 2012). Hence, it was decided whether the studies included in meta-analysis have publication bias or not by using the Funnel chart, Rosenthal's Safe N method, Orwin's Safe N method, Begg and Mazumdar rank correlation test and Egger regression test.

It is also important on which model the effect size of the studies will be interpreted. In meta-analysis, two models are used: fixed effects and random effects model. In case of the distribution of the effect sizes of the studies being homogeneous, the fixed effects model is used, and in case of the distribution being heterogeneous, the random effects model is used (Borenstein et al., 2009; Ellis, 2010). The fixed effects model is based on the assumption that the effect size values of each study are the same, and the random effects model is based on the assumption that the effect size values of the studies are different (Ellis, 2010). While determining the model, Q, I2 and p values were examined for heterogeneity. According to the findings, since it was determined that the heterogeneity was high, it was considered appropriate to conduct moderator analyses. The characteristics of the studies with higher and lower effect sizes can be determined by moderator analyses (Card, 2012).

In the studies comparing group averages, Cohen d, Hedges g and Glass Δ formulas are commonly used for calculating the effect sizes. These three indexes provide information about the magnitude of an effect relative to the standard deviation (Ellis, 2010). Hedges g calculates average values by correcting them (Borenstein et al., 2009). Therefore, Hedges' g coefficient was used in the calculation of the effect sizes in this study and the confidence level was accepted as 95% in the analyses. Reporting the effect sizes in a standard form allows studies to be compared (Ellis, 2010). In this study, the effects were classified as follows: $-0.15 \leq g < 0.15$ insignificant effect size, $0.15 \leq g < 0.40$ small effect size, $0.40 \leq g < 0.75$, medium effect size, $0.75 \leq g < 1.10$, large effect size, $1.10 \leq g < 1.45$ very large effect size $1.45 \leq g$ perfect effect size (Thalheimer & Cook, 2002, as cited in Dinçer, 2014). In the context of this study, as a result of the analysis, the effect size is interpreted in favor of reading from the paper when a negative value is found, and in favor of reading from the screen when a positive value is found.

3. Results

In this section, first descriptive information about the studies, then publication bias, heterogeneity, general / individual effect size and moderator analysis findings are given place. Descriptive information about the studies is presented in Table 1. Here, information about

publication year, grade level, text type used in reading and digital tool variables used in reading are given place.

Table 1. *Descriptive Information About The Studies*

Variable		Frequency
Publication Year	2012	2
	2013	12
	2014	5
	2015	1
	2017	4
	2018	2
	2019	3
Grade Level	Primary Ed. 4. grade	6
	Primary Ed. 5. grade	15
	Primary Ed. 6. grade	3
	Primary Ed. 8. grade	2
	Primary Ed. 5, 6, 7 and 8. grade	3
Text Type Used in Reading	Informative	11
	Narrative	11
	Mixed	2
	Unspecified	5
Digital Tool Used in Reading	Smart Phone	1
	PC	24
	Tablet PC	2
	Unspecified	2
Total		29

According to Table 1, it is seen that the theses that were made in 2013 are the most among the studies. The 2015 is the year with the least study. According to the grade level, it is seen that the studies conducted with primary education 5th grade students are at the highest level and the studies conducted with primary education 8th grade students are at the lowest level. According to the type of text used in reading, it is seen that reading studies conducted with narrative (f=11) and informative texts (f=11) are equal. While the number of studies conducted with mixed type texts is 2, the number of studies conducted with unspecified text type is 5. Among the studies, it is seen that most studies are the ones in which computers (desktop or laptop) (f=24) are used for reading. It draws the attention that there are 2 studies using a tablet computer in reading, 1 study using smart phones, and 1 study that does not specify the digital tool used in reading.

Publication Bias

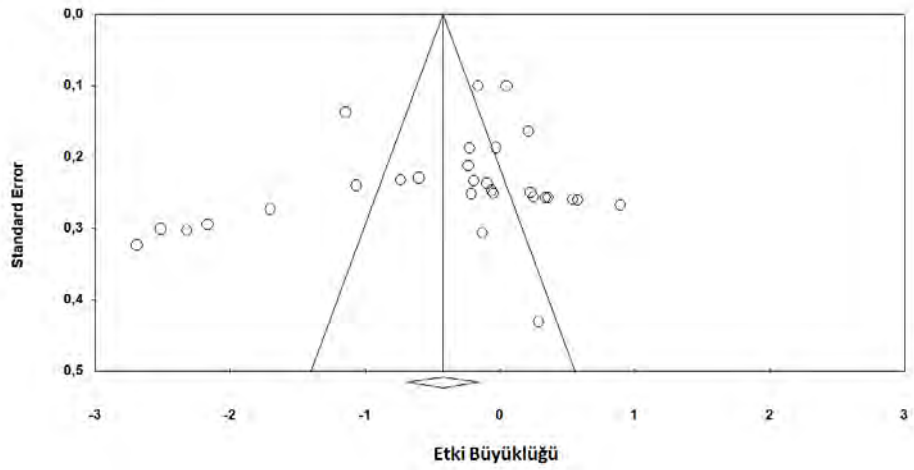

Figure 1. Funnel Chart

In the Funnel chart in Figure 1, the effect size distribution of the studies having a symmetric appearance indicates that there is no publication bias, and having a asymmetric appearance indicates that there is publication bias (Borenstein et al., 2009; Sterne, Becker, & Egger, 2005). When Figure 1 is examined, since the effect sizes of the study display an almost symmetrical distribution, it can be said that there is no publication bias. Also Rosenthal safe N method was used to determine whether there is publication bias or not. Calculation findings for Rosenthal safe N method are given in Table 2.

Table 2. *Calculation Findings for Rosenthal Safe N Method*

Z value for the observed studies	-9,05569
P value for the observed studies	0,00000
Alpha	0,5
Direction	2
Z value for Alpha	1,95996
Number of observed studies	29
Safe N number	591

Rosental safe N method shows how many more studies having zero effect size should be included in the meta-analysis in order to convert p value to meaningless value (p=0.05) (Borenstein et al., 2009). This proposal of Rosental is based on the idea that researchers do not want to publish studies of insignificant value, therefore they hide these studies (Becker, 2005). As the N number obtained as a result of this calculation is very low, there can be hesitations about the publication bias (Borenstein et al., 2009). When Table 2 is examined, it is seen that the Rosenthal safe N number was found as 591 as a result of the analysis. This high value supports that there is no publication bias.

Another method which was used to decide whether there is publication bias or not is Orwin's Safe N-number method. Orwin's approach is related to determining the number of studies having zero effect size required to reduce the average effect size to a certain level (Lipsey & Wilson, 2001). Orwin's approach is different from Rosental's approach because while Rosenthal's calculations are about the meaninglessness of the study, Orwin's calculations are about reducing to a certain effect size (Becker, 2005). In other words, it can be said that it is aimed to determine how many more studies should be included in the meta-analysis in order

to reach a meaningless p value in Rosental's formula and a determined general effect size in Orwin's formula. In this study, the number of studies that have to be included in the meta-analysis in order to reduce the general effect to a minor effect level has been calculated. As a result of the calculation, the Orwin's safe N number was determined to be 32. This is another result that supports the lack of publication bias. In addition, Begg and Mazumdar rank correlation test and Egger's regression tests were also applied for publication bias. The data related to them are given below.

Table 3. *Begg and Mazumdar Rank Correlation Test Findings*

Kendall's S statistic (P-Q)	-34, 0000
Tau	-0,08374
Z value for Tau	0,63777
P value	0,52362

Begg and Mazumdar rank correlation test examines the relationship between effect and variances (Vevea, Coburn, & Sutton, 2019). According to Begg and Mazumdar (1994), this test is the complementary of the funnel chart. The statistically insignificant test results show that there is no publication bias (Vevea et al., 2019). As seen in Table 3, findings obtained from the Begg and Mazumdar rank correlation test performed (tau=-0.08 p=0.52362 p> 0.05) indicate that the study does not have publication bias. It is seen that p value is not statistically significant also as a result of the Egger's regression test (P=0.228). Therefore, this test offers evidence indicating that there is no publication bias as well. When the performed test results are evaluated in general, it can be said that there is no publication bias in this study.

Heterogeneity and Effect Size Calculations

Table 4. *Effect Size of Studies according to Fixed Effects Model*

Model	Effect Size	Standard Error	95% Confidence Interval		Heterogeneity			
			Lower Limit	Upper Limit	Df(q)	Q Value	I2	p
Fixed effects	-,306	0,038	-0,380	-0,231	28	367,379	92,378	0,000

When Table 4 is examined, it is seen that Q value is 367,379. It can be said that this value is greater than the value 41,337 which corresponds to the 28 degrees of freedom in the chi-square table, and also its effect sizes distribution has a heterogeneous feature because of P value (P=0,000) being statistically significant. In addition, I2 value being found as 92.378% indicates that there is a high degree of heterogeneity. In this direction, random effects model was used to calculate the effect sizes in the research. The effect size of the studies according to the random effects model is presented in Table 5.

Table 5. *The Effect Size of the Studies according to the Random Effects Model*

Model	Effect Size	Standard Error	95% Confidence Interval		p
			Lower Limit	Upper Limit	
Random Effects	-0,423	0,143	-0,703	-0,143	0,003

When Table 5 is examined, the average effect size value calculated according to the random effects model was found to be significant and as -0.423. The standard error of the effect size is 0.143 and its lower limit is -0.703 and its upper limit is -0.143 in the 95% confidence interval. These values indicate a moderate effect in favor of reading from the paper. The forest plot regarding the effect size of the studies is given in Figure 2.

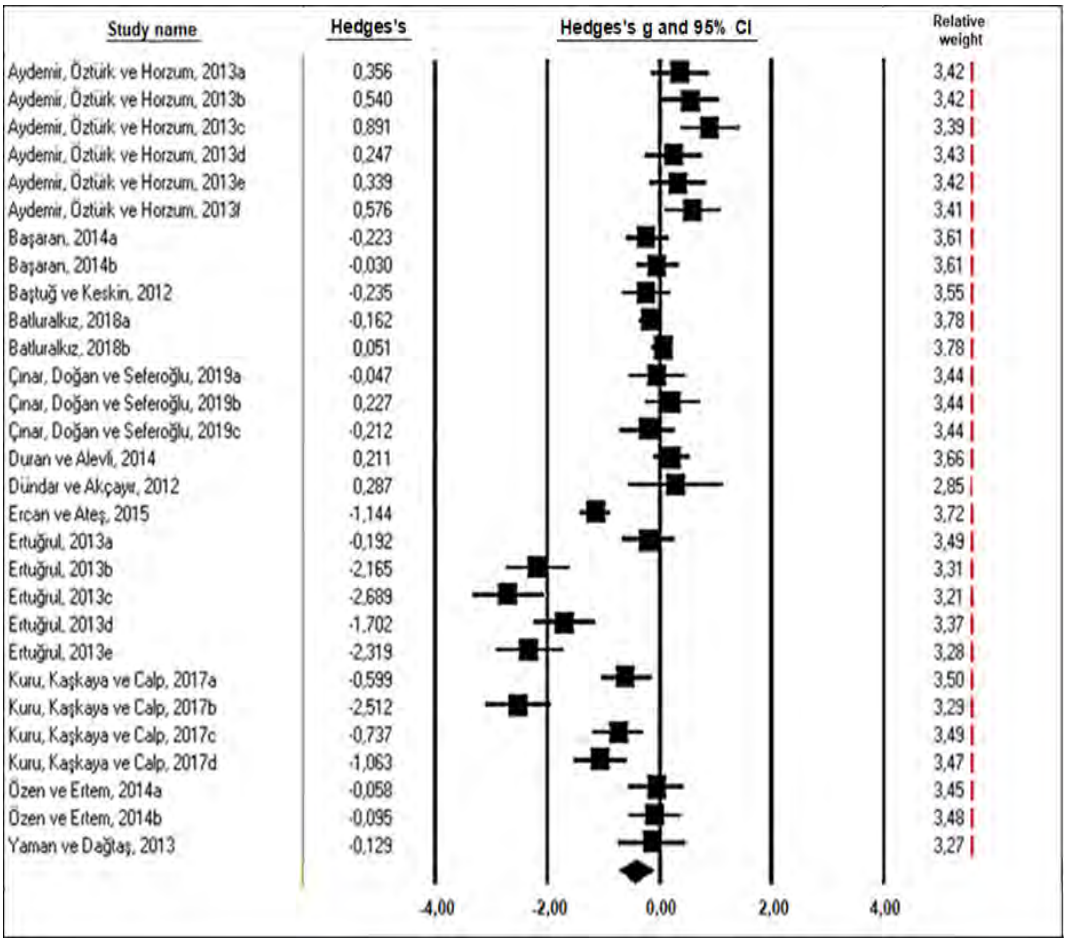

Figure2. The Effect Sizes of the Studies and Forest Plot

The black square at the bottom of the figure in Figure 2 shows the overall effect size. The black squares having lines to their left and right represent the effect sizes of individual studies. The horizontal lines to the left of the black squares indicate the confidence interval. It is observed that the study with the lowest confidence interval is the study of Batluralkız (2008a, 2008b) and the study with the highest confidence interval is the study of Dündar and Akçayır (2012). And on the far right side of the figure, the weights of the studies are located. It is seen that the study with the highest weighting is the study of Ercan and Ateş (2015) and the study with the lowest weighting is the study of Dündar and Akçayır (2012).

It is seen that the effect size values of the individual studies ranged between -2,689 and 0,891. It is seen that 19 of the studies have a negative positive effect size value and 10 of them have a positive effect size value. It can be said that 5 of these studies have an insignificant (4 in favor of reading from the paper, 1 in favor of reading from the screen), 11 of them have a small (5 in favor of paper reading, 6 in favor of screen reading), 4 of them have a medium (2 in favor of paper reading, 2 in favor of screen reading), 3 of them have a large (2 in favor of paper reading, 1 in favor of screen reading), 1 of them have a very large (in favor of paper

reading) and 5 of them have a perfect (in favor of paper reading) effect. It can be said that there are more studies with high effect in favor of reading from the paper.

Moderator Analyses

Table 6. *Effect Size Differences according to the Publication Year*

Publication Year	Number of Studies	Effect Size	%95 Confidence Interval		Between-Groups Homogeneity Value (QB)	p
			Lower Limit	Upper Limit		
2012	2	-0,002	-1,122	1,119		
2013	12	-0,500	-0,946	-0,054		
2014	5	-0,038	-0,710	0,634		
2015	1	-1,144	-2,616	0,329	8,220	0,222
2017	4	-1,209	-1,974	-0,444		
2018	2	-0,055	-1,088	0,978		
2019	3	-0,010	-0,893	0,872		

The first variable examined according to the effect sizes in the research is publication year. When Table 6 is analysed, the effect sizes were found as -0,002 for 2012, -0,500 for 2013, -0,038 for 2014, -1,144 for 2015, -1,209 for 2017, -0,055 for 2018 and -0,010 for 2019. As a result of the test conducted to determine whether there is a significant difference between the effect sizes of the studies according to the publication year, it was determined that the effect sizes did not differ significantly according to the publication year (QB=8.220, p> 0.05). Another moderator variable whose effect was examined in the study is the grade level variable. The effect size differences of the studies according to the grade level are given in Table 7.

Table 7. *Effect Size Differences according to the Grade Level*

Grade Level	Number of Studies	Effect Size	%95 Confidence Interval		Between-Groups Homogeneity Value (QB)	p
			Lower Limit	Upper Limit		
Prim. Ed. 4. grade	6	-0,839	-1,495	-0,183		
Prim. Ed. 5. grade	15	-0,404	-0,826	0,018		
Prim. Ed. 6. grade	3	-0,415	-1,314	0,485	2,959	0,565
Prim. Ed. 8. grade	2	0,049	-1,092	1,190		
Prim. Ed. 5., 6., 7. and 8. grade	3	-0,010	-0,945	0,924		

As seen in Table 7, average effect sizes according to grade level were calculated as g=-8.394 for primary education 4th grade students, g=-0,404 for primary education 5th grade students, g=-0,415 for primary education 6th grade students, g=0,049 for primary education 8th grade students and g=-0,010 for primary education 5th, 6th, 7th and 8th grade students. As a result of the test conducted to determine whether there is a significant difference between the effect sizes of the studies according to the grade level, it was determined that the effect sizes did not differ significantly according to the grade level (QB=2.959, p> 0.05). Nevertheless, when the effect sizes are compared, it is seen that lower grades have a stronger effect in favor of reading from the paper compared to upper grades. As the grade level increases, the situation shifts in favor of reading from the screen. In the study, also the text type variable used in

reading was examined as moderator variable. The findings with regards to the effect size differences according to the text type used in reading are given in Table 8.

Table 8. *Effect Size Differences according to the Text Type Used in Reading*

Text Type Used in Reading	Number of Studies	Effect Size	%95 Confidence Interval		Between-Groups Homogeneity Value (QB)	p
			Lower Limit	Upper Limit		
Informative test	11	-0,632	-1,064	-0,199		
Narrative text	11	0,056	-0,371	0,483	5,451	0,066
Mixed	2	-0,673	-1,677	0,332		

As seen in Table 8, effect sizes according to the text type used in reading are examined in three groups. Average effect sizes were found to be g=-0632 in informative text, g=0.056 in narrative text and (-0.667) in mixed studies. As a result of the test conducted to determine whether there is a significant difference between the effect sizes of the studies according to the text type used in reading, it was determined that the effect sizes did not differ significantly according to the text type used in reading (QB=5.451, p> 0.05). Nevertheless, when the effect sizes are compared, it can be seen that informative texts have a medium effect (g=-0.632) in favor of reading from the paper, and narrative texts have an insignificant effect (g=0.056) in favor of reading from the screen. In the study, the digital tool variable used in reading was also examined as a moderator variable. Findings with regards to the effect size differences according to the digital tool used in reading are given in Table 9.

Table 9. *Effect Size Differences according to the Digital Tool Used in Reading*

Digital Tool Used in Reading	Number of Studies	Effect Size	%95 Confidence Interval		Between-Groups Homogeneity Value (QB)	p
			Lower Limit	Upper Limit		
Smart Phone	1	-0,047	-1,779	1,685		
PC	24	-0,527	-0,881	-0,174	1,577	0,455
Tablet PC	2	0,255	-1,014	1,523		

When Table 9 is examined, the effect sizes according to the digital tool used in reading were examined in three different groups. Average effect sizes were found as g=-0.047 for smartphone, g=-0.527 for PC and g=0.255 for tablet PC. As a result of the test conducted to determine whether there is a significant difference between the effect sizes of the studies according to the digital tool used in reading, it was determined that the effect sizes did not differ significantly according to the digital tool used in reading (QB=1,577, p> 0.05). However, when the effect sizes are compared, it is seen that the computer has a medium effect in favor of reading from the paper (g=-527), the smartphone has an insignificant effect in favor of reading from the paper (g =-0.047) and the tablet has a small effect in favor of reading from the screen (g=0.255).

4. Discussion, Conclusion and Recommendations

In this study which was conducted to examine whether the level of understanding differs according to screen reading and paper reading by meta-analysis method, a significant and medium (g=-0.423, p=0.003) effect size was found in favor of reading from the paper.

Therefore, this result shows that the reading comprehension level is higher in reading from the paper than reading from the screen. A number of meta-analysis studies conducted abroad also set forth that the comprehension level in reading from the paper is higher, supporting the results of this study (Clinton, 2019; Delgado et al., 2018; Kong et al., 2018). Therefore, it can be said that the printed materials have a more positive effect on reading achievement compared to the screen. Transferring the texts to the screen led to the role of many elements related to the screen such as brightness, color, etc. to be deemed important during the reading process. In screen reading, eye movements change, it becomes difficult to apply some reading techniques, and the processes of understanding and structuring in the mind become difficult (Güneş, 2010). While reading from the paper contributes more to focusing (Baron, 2015), screen reading is more prone to being distracted and focusing problems can be seen. Wang et al. (2008), on the other hand, determined in the meta-analysis study they carried out on paper-pencil and PC form that there was no significant difference between reading achievements according to the environment differing from this study.

In this study which examines whether the comprehension level differs according to reading from the screen and reading from the paper, also analyses were conducted for some sub-factors that may affect the effect sizes. One of the factors discussed is the publication year variable. As a result of the analyses performed, it was determined that the effect size did not differ significantly according to the publication year. These findings show that the publication year does not significantly change the comprehension level according to the reading environment. Kong et al. (2018) similarly determined in the meta-analysis studies they conducted that the effect sizes did not differ significantly according to the year variable. Even if the texts read from the past to present remain the same, changes in the environment in which the texts are presented and in the reading habits of individuals in digital environment can be seen. In this study, no significant difference was observed in reading comprehension according to the environment in terms of years.

A different variable whose effect is examined is the grade level. As a result of the analyses, it was determined that the effect size did not differ significantly according to the grade level. Delgado et al. (2018) also found that effect sizes did not differ significantly according to the grade level variable in meta-analysis studies. This finding shows that the grade level does not significantly change the differentation in the comprehension level according to the reading environment. Nevertheless, when the effect sizes are compared, it is seen that lower grades have a stronger effect in favor of reading from the paper compared to the upper grades. As the grade level increases, it is seen that there is a shift in favor of reading from the screen. In other words, students at higher grade level have a higher level of reading comprehension on the screen. It can be said that lower level students have difficulty in reading from the screen due to the need for various high level mental skills such as intense attention, remembering, fast recognition of words, fast combination of information and questioning (Güneş, 2010). To support this idea, the study conducted by Helder, Van Leijenhorst, and van den Broek (2016) at the primary school level found that lower grade students had poorer comprehension skills and had more difficulty in coherence, in direct proportion to their age.

Another factor whose effect is observed is the text type used in reading. As a result of the analysis, it was determined that the effect size did not differ significantly according to the text type used in reading. This finding shows that the text type used in reading does not significantly change the differentiation in the comprehension level according to the reading environment. Nevertheless, when the effect sizes are compared, it is noteworthy that informative texts have a medium effect in favor of reading from the paper, and narrative texts have an insignificant effect in favor of reading from the screen. In their meta-analysis study, Clinton, (2019) and Delgado et al. (2018) similarly found that informative texts have an effect

in favor of reading from the paper, whereas in narrative texts there is an effect that does not matter for the two environments. As can be seen, reading the narrative texts from the screen or paper does not affect the comprehension much. Since individuals encounter more narrative texts from the beginning of school and are familiar with these texts, they may struggle when they encounter informative texts. In addition, informative texts can be encountered as a text type that has difficulties, as it reveals concepts and relationships that readers do not know (Coté, Goldman, & Saul, 1998) and deals with more abstract concepts (Şahin, 2013). It can be said it is expected that a better reading comprehension is realised in reading informative texts from the paper due to its nature.

Finally, the effect sizes were examined according to the digital tool used in reading. As a result of the analysis, it was determined that the effect sizes did not differ significantly according to the digital tool used in reading. In the meta-analysis study of Kong et al. (2018), similarly, the effect sizes did not differ significantly according to the digital tool. These findings show that the digital tool used in reading does not significantly change the differentiation in the comprehension level according to the reading environment. Nevertheless, when the effect sizes are compared, it is seen that PC has a medium effect in favor of reading from the paper, the smartphone has an insignificant effect in favor of reading from the paper and the tablet has a small effect in favor of reading from the screen. It draws attention that reading from tablets which is the digital device having the screen closest to the size of a book has a higher comprehension level than reading from computers having large screens. Delgado et al. (2018), in their meta-analysis study, found that hand devices are more effective in comprehension of reading from the screen compared to the computers, supporting this finding. Providing the flow of texts read on computers with the mouse can affect reading skills. Since tablets offer readers an experience as if they were reading from a printed book due to having a touch screen and an easy-to-use interface, (Chen et al., 2014), it can be said that there will be less disconnection and reading skills will approach a level close to traditional reading. The text being directly opposite the eye on the desktop or laptop computers and thus the eye not getting the same angle which it gets while reading printed materials can be considered as another possible reason for this result. For an effective and efficient reading, the monitor should be placed 10-15 cm below eye level, in the manner to read by tilting the head slightly down (Güneş, 2009).

This meta-analysis study, conducted with a limited number of studies, shows that the use of printed materials in reading contributes more positively to comprehension success. As screens enter our lives more and more, the importance of understanding what is read from the screen is increasing. In order to increase the level of reading comprehension on the screen, importance should be given to the development of screen reading skills and screen interface. This study is thought to create an awareness for researchers, educators, digital content developers and the society and contribute to the literature.

In line with the results obtained from the study, the following suggestions can be made:

- Studies in which only Turkish texts were used in reading were included in this meta-analysis study. The meta-analysis of studies comparing the comprehension level in foreign language education according to the reading environment can be made.
- Studies to improve screen reading skills can be carried out.
- Within the context of the screen interface, studies can be conducted on factors such as screen size, text size, text font style, brightness that may affect reading from the screen.
- Comparative studies can be conducted on groups that have been using digital devices for a long time and who have been using them for a short time.

- Comprehension levels of reading from the screen and from the paper can be compared according to the type of comprehension tests (multiple choice, open-ended etc.).

References

Aloqaili A. S. (2011). The relationship between reading comprehension and critical thinking: A theoritical study. *Journal of King Saud University-Languange and Translation*, 24, 35-41. doi: doi:10.1016/j.jksult.2011.01.001

*Aydemir, Z., Öztürk, E., & Horzum, M. B. (2013). Ekrandan okumanın 5. sınıf öğrencilerinin bilgilendirici ve öyküleyici metin türünde okuduğunu anlama düzeylerine etkisi [The Effect of Reading from Screen on The 5th Grade Elementary Students' Level of Reading Comprehension on Informative and Narrative Type of Texts]. *Kuram ve Uygulamada Eğitim Bilimleri*, *13*(4), 2263-2276.

Baron, N. S. (2015). *Words onscreen: The fate of reading in a digital world*. Oxford: Oxford University Press.

*Başaran, M. (2014). 4. sınıf seviyesinde ekrandan ve kâğıttan okumanın okuduğunu anlama, okuma hızı ve metne karşı geliştirilen tutum üzerindeki etkisi [Effect of reading on screen and paper on elementary school 4th grade students' reading comprehension reading speed and their attitudes]. *Uşak Üniversitesi Sosyal Bilimler Dergisi*, *7*(2), 248-268.

*Baştuğ M., & Keskin, H. K. (2012). Okuma becerilerinin okuma ortamı açısından karşılaştırılması: ekran mı kâğıt mı? [Comparison of reading skills in terms of the reading environment: screen vs. paper] *Atatürk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, *16* (3), 73-83.

*Batluralkız, Ç. (2018). *Basılı ve dijital ortamlarda ortaokul öğrencilerinin okuduğunu anlama becerilerinin karşılaştırılması [Comparing the reading comprehension skills of primary school students ın print vs digital setting]*. Unpublished master's thesis, Kütahya Dumlupınar Üniversitesi, Kütahya.

Becker, B. J. (2005). *Failsafe n or file-drawer number*. In H. Rothstein, A. J. Sutton, and M. Borenstein (Ed.), Publication bias in meta-analysis: Prevention, assessment and adjustment (s. 111-125). Chichester: John Wiley and Sons Ltd

Begg, C.B., & Mazumdar, M. (1994) Operating Characteristics of a Rank Correlation Test for Publication Bias. *Biometrics*, *50*(4), 1088-1101.

Borenstein, M. (2005). *Software for publication bias.* In H. Rothstein, A. J. Sutton, and M. Borenstein (Ed.), Publication bias in meta-analysis: Prevention, assessment and adjustment (s. 193–220). Chichester: John Wiley and Sons Ltd

Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2009). *Introduction to meta-analysis*. Chichester: John Wiley & Sons, Ltd.

Calhoon, M.B. (2005). Effects of a peer-mediated phonological skill and reading comprehension program on reading skill acquisition for middle school students with reading disabilities. *Journal of Learning Disabilities*, *38*(5), 424–433.

Card, N. A. (2012). *Applied meta-analysis for social science research.* New York: The Guilford Press.

Chen, G., Cheng, W., Chang, T. W., Zheng, X., & Huang, R. (2014). A comparison of reading comprehension across paper, computer screens, and tablets: Does tablet familiarity

matter?. *Journal of Computers in Education, 1*(2-3), 213-225. doi: 10.1007/s40692-014-0012-z

Clinton, V. (2019). Reading from paper compared to screens: A systematic review and meta-analysis. *Journal of Research in Reading, 42*(2), 288–325. doi:10.1111/1467-9817.12269

Cooper, H. (2017). *Research synthesis and meta-analysis: A step-by-step approach.* Thousand Oaks: Sage Publications.

Coté, N., Goldman, Susan R., & Saul, E. U. (1998). Students making sense of Informational text relations between processing and representation. *Discourse Processes, 25* (1), 1-53.

*Çınar, M., Doğan, D., & Seferoğlu, S. S. (2019). The effects of reading on pixel vs. paper: a comparative study. *Behaviour & Information Technology*, doi:10.1080/0144929X.2019.1685594

Delgado, P., & Salmerón, L. (2021). The inattentive on-screen reading: Reading medium affects attention and reading comprehension under time pressure. *Learning and Instruction*, 71, 101396. doi:10.1016/j.learninstruc.2020.101396

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*, 23-38. doi: 10.1016/j.edurev.2018.09.003

Dinçer, S. (2014). *Eğitim bilimlerinde uygulamalı meta-analiz*. Ankara: Pegem Akademi.

*Duran, E., & Alevli, O. (2014). Ekrandan okumanın sekizinci sınıf öğrencilerinde anlamaya etkisi [The effect of reading on screen on comprehension of eight grade students]. *Okuma Yazma Eğitimi Araştırmaları*, *2*(1), 1-11.

*Dündar, H., & Akçayır, M. (2012). Tablet vs. paper: the effect on learners' reading performance. *International Electronic Journal of Elementary Education*, *4*(3), 441-450.

Ellis, P. D., (2010). *The essential guide to effect sizes: Statistical power, meta-analysis, and the interpretation of research results*. Cambridge: Cambridge University Press.

*Ercan, A. N., & Ateş, M. (2015). Ekrandan okuma ile kâğıttan okumanın anlama düzeyi açısından karşılaştırılması [The comparison of reading from paper and screen in terms of comprehension levels]. *Turkish Studies*, *10* (7), 395-406. doi:10.7827/TurkishStudies.8032

*Ertuğrul, B. (2013). *İlköğretim beşinci sınıflarda ekrandan okumanın anlamaya etkisi [The effect of screen reading on understanding in primary fifth class]*. Unpublished master's thesis, Uşak Üniversitesi, Uşak.

Garland, K. J., & Noyes, J. M. (2004). CRT monitors: Do they interfere with learning?. *Behaviour & Information Technology, 23*(1), 43-52. doi:10.1080/01449290310001638504

Glass, G. V. (1976). Primary, secondary, and meta-analysis of research. *Educational Researcher, 5(10),* 3-8. doi:10.2307/1174772

Güneş, F. (2009). Ekran okumada verimlilik. *Kalkınmada Anahtar Verimlilik Gazetesi,* (Milli Prodüktivite Merkezi Aylık Yayın Organı), August, 248,26-28.

Güneş, F. (2010). Öğrencilerde ekran okuma ve ekranik düşünme [Thinking based on screen and screen reading of students]. *Mustafa Kemal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 7*(14), 1-20.

Güneş, F. (2016). Kâğıttan ekrana okuma alanındaki gelişmeler [From paper to screen developments in the field of reading]. *Bartın Üniversitesi Eğitim Fakültesi Dergisi*, *5*(1), 1-18. doi:10.14686/buefad.v5i1.5000155474

Halamish, V., & Elbaz, E. (2019). Children‘s reading comprehension and meta comprehension on screen versus on paper. *Computers and Education*, 103737. doi: 10.1016/j.compedu.2019.103737

Helder, A., Van Leijenhorst, L., & van den Broek, P. (2016). Coherence monitoring by good and poor comprehenders in elementary school: Comparing offline and online measures. *Learning and Individual Differences*, 48, 17–23. doi:10.1016/j.lindif.2016.02.008

Hillman, D. C., Willis, D. J., & Gunawardena, C. N. (1994). Learner-interface interaction in distance education: An extension of contemporary models and strategies for practitioners. *The American Journal of Distance Education*, *8*(2), 30-42.

Hosseini, E., Khodaei, F. B., Sarfallah, S., & Dolatabadi, H. R. (2012). Exploring the relationship between critical thinking, reading comprehension and reading strategies of English University students. *World Applied Sciences Journal*, 17, 1356-1364.

Kaya, Z. (2002). *Uzaktan eğitim*. Ankara: Pegem Yayıncılık.

Kazazoğlu, S. (2020). Is printed-text the best choice? A mixed-method case study on reading comprehension. *Journal of Language and Linguistic Studies*, *16*(1), 458.

Kingston, N. M. (2008). Comparability of computer-and paper-administered multiple-choice tests for K–12 populations: A synthesis. *Applied Measurement in Education*, *22*(1), 22-37. doi:10.1080/08957340802558326

Kol, S., & Schcolnik, M. (2000). Enhancing screen reading strategies. *CALICO Journal*, *18*(1), 67-80.

Kong, Y., Seo, Y.S., & Zhai, L. (2018). Comparison of reading performance on screen and on paper: A meta-analysis. *Computers & Education*, 123, 138–149. doi: 10.1016/j.compedu.2018.05.005

Kurata, K., Ishita, E., Miyata, Y., & Minami, Y. (2017). Print or digital? Reading behavior and preferences in Japan. *Journal of the Association for Information Science and Technology*, *68*(4), 884-894. doi:10.1002/asi.23712

*Kuru, O., Kaşkaya, A., & Calp, Ş. (2017). İlkokul 4. sınıf öğrencilerinin kağıttan ve ekrandan okuduğunu anlama becerilerinin sınanması; öğretmen ve öğrenci görüşleri [Comparison of the reading skills of 4th grade primary school students from the paper and from the screen, the viewpoints of teachers and students]. *Sosyal Bilimler Dergisi*, *7*(13), 70-84.

Lebedeva, M. Y., Veselovskaya, T. S., & Kupreshchenko, O. F. (2020). Features of perception and understanding of digital texts: interdisciplinary view. *Perspektivy naukii obrazovania – Perspectives of Science and Education*, *46* (4), 74-98. doi: 10.32744/pse.2020.4.5

Lipsey, M. W., & Wilson, D. B. (2001). *Practical meta-analysis*. Thousand Oaks: Sage Publications.

Littell, J. H., Corcoran, J., & Pillai, V. (2008). *Systematic reviews and meta-analysis.* New York: Oxford University Press

Mangen, A., Walgermo, B.R., & Brønnick, K. (2013). Reading linear texts on paper versus computer screen: Effects on reading comprehension. *International Journal of Educational Research, 58*, 61-68. doi: 10.1016/j.ijer.2012.12.002

Martin, L. A., & Platt, M. W., (2001). Printing and screen reading in the medical school curriculum: Guttenberg vs. the cathode ray tube. *Behaviour & Information Technology, 20*, 143 – 148. doi: 10.1080/01449290110048043

Mellard, D. F., Fall, E., & Woods, K. L. (2010). A path analysis of reading comprehension for adults with low literacy. *Journal of Learning Disabilities*, 43, 154–165.

Mizrachi, D. (2015). Undergraduates' academic reading format preferences and behaviors. *The Journal of Academic Librarianship, 41*(3), 301-311. doi:10.1016/j.acalib.2015.03.009

Moore, M.G. (1989) Editorial: Three types of interaction. *American Journal of Distance Education*, *3*(2), 1-7. doi: 10.1080/08923648909526659

*Özen, M., & Ertem, İ. S. (2014). Metinleri ekrandan okumanın anlam kurma üzerine etkisi [The effect of screen reading of texts on meaning making]. *International Journal of Social Science*, 24, 319-350. doi:10.9761/JASSS2161

Partnership for 21st Century Skills (P21). (2013). *Framework for 21st century learning.* Retrieved April 5, 2020, from https://www.battelleforkids.org/networks/p21

Rajanen, D., Salminen, M., & Ravaja, N. (2016, Jan.). *Reading a newspaper on print versus screen: a motivational perspective.* In 2016 49th Hawaii International Conference on System Sciences (HICSS) (pp. 630-637). IEEE.

Redmond, P. (2011). From face-to-face teaching to online teaching: Pedagogical transitions. In G. Williams, P. Statham, N. Brown, & B. Cleland (Eds.), Changing demands, changing directions. *Proceedings of the ascilite conference* (pp. 1050–1060). Hobart Tasmania, Australia.

Rothstein, H. R., Sutton, A., & Borenstian, M. (2005). *Publication bias in meta-analysis.* In H. Rothstein, A. J. Sutton, & M. Borenstein (Ed.), Publication bias in meta-analysis: Prevention, assessment and adjustment (s. 1-7). Chichester: John Wiley and Sons Ltd

Schilhab, T., Balling, G., & Kuzmicova, A. (2018). Decreasing materiality from print to screen reading. *First Monday, 23* (10) 1-12.

Singer, L. M., & Alexander, P. A. (2017). Reading on paper and digitally: What the past decades of empirical research reveal. *Review of educational research*, *87*(6), 1007-1041.

Spencer, C. (2006). Research on learners' preferences for reading from a printed text or from a computer screen. *Journal of Distance Education, 21*(1), 33-50.

Sterne, J.A.C., Becker, B. J., & Egger, M. (2005). *The funnel plot*. In H. Rothstein, A. J. Sutton, and M. Borenstein (Ed.), Publication bias in meta-analysis: Prevention, assessment and adjustment (s. 75-98). Chichester: John Wiley and Sons Ltd.

Støle, H., Mangen, A., & Schwippert, K. (2020). Assessing children's reading comprehension on paper and screen: A mode-effect study. *Computers & Education*, 151,1-13. doi: https://doi.org/10.1016/j.compedu.2020.103861

Şahin, A. (2013). The effect of text types on reading comprehension. *Mevlana International Journal of Education (MIJE), 3*(2), 57-67.

Tamsi, R. K., Zuhri, F., & Kurniasih, E. (2013). The implementation of skimming and scanning strategies in teaching reading narrative text for the tenth grade students of SMAN 21 SURABAYA. *Retain*, *1*(2), 1–7.

Taşcı, G., & Çelebi, M. (2020). Eğitimde yeni bir paradigma: "yükseköğretimde yapay zekâ" ["A new paradigm in education: "artificial intelligence in higher education"]. *OPUS*

Uluslararası Toplum Araştırmaları Dergisi, *16* (29), 2346-2370. doi:10.26466/opus.747634

Uther, M., Ross, K., Randell, J., & Pye, R. (2019, July). *Digital vs. hard copy? A preliminary study of reading style in children using touch screen and paper books.* In International Conference on Human-Computer Interaction (pp. 495-502). Springer, Cham.

Ünal, E., & Köksal, K. (2007). Okuduğunu anlama ve sorular. *Üniversite ve Toplum: Bilim, Eğitim ve Düşünce Dergisi*, *7*(4), 1-12.

Vevea, J. L., Coburn, K., & Sutton, A. (2019). *Publication bias.* In H. Cooper, L. V. Hedges, J. C. Valentine (Ed.), The Handbook of Research Synthesis and Meta-Analysis (s. 383-429). New York: Russell Sage Foundation.

Wang, S., Jiao, H., Young, M., Brooks, T., & Olson, J. (2008). Comparability of computer-based and paper-and-pencil testing in K-12 reading assessments: A meta-analysis of testing mode effects. *Educational and Psychological Measurement, 68*(1), 5–24. doi:10.1177/0013164407305592

Wang, S., Yu, H., Hu, X., & Li, J. (2020). Participant or spectator? Comprehending the willingness of faculty to use intelligent tutoring systems in the artificial intelligence era. *British Journal of Educational Technology, 51*(5*),* 1657-1673. doi:10.1111/bjet.12998

*Yaman, H., & Dağtaş, A. (2013). Ekrandan okumanın okuduğunu anlamaya etkisi [İmpact of reading from screen on reading comprehension]. *Okuma Yazma Eğitimi Araştırmaları*, *1* (2), 64-79.

Yılmaz, M. (2011). İlköğretim 4. sınıf öğrencilerinin okuduğunu anlama seviyeleri ile türkçe, matematik, sosyal bilgiler ve fen ve teknoloji derslerindeki başarıları arasındaki ilişkinin belirlenmesi [Determining among to correlation of 4th grade students' success in turkish, maths, social seciences and science and technology lessons of reading comprehension levels]. *Dumlupınar Üniversitesi Sosyal Bilimler Dergisi*, *29*(29), 9-13.

Zou, X.-L., & Ou, L. (2020). EFL reading test on mobile versus on paper: a study from metacognitive strategy use to test-media impacts. *Educational Assessment, Evaluation and Accountability*. 1-20. doi:10.1007/s11092-020-09320-0

**Studies included in meta-analysis.*