The Optimum Font Size and Type for Students Aged 9-12 Reading Arabic Characters on Screen: A Case Study

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Abstract. More and more, interest in the way data is displayed on screen has increased, especially with the increase in the number of people using e-text for learning purposes. So, this requires more focus on factors that affect screen legibility. Text display factors, such as font size, line length and font type, have an impact on reading online. Two font types [Arabic Traditional and Simplified Arabic] in four different sizes [10, 14, 16 and 18] are measured using Arabic text. On-line processes were measured using reading –aloud technique. Accuracy of reading was also measured by the average of errors that students made when reading the text, while reading speed was tested by the time it took students to read the text. However, results indicated that Arabic text in font size 10 is not readable to students aged 10 to 12. On the other hand, font sizes sixteen and eighteen are more readable than any smaller-sized font, the averages of error size 18 improve in all font types, while age has a significant impact on reading speed. Simplified Arabic font is reported as readable to students aged 10-12, especially in sizes 14 and 18.

1. Introduction

The online reading environment has specific characteristics that make it different from reading paper-based literature. Some researchers, such as Alan [1], reported that presenting text on a screen is broadly similar to displaying it on a page, even though there are a number of distinct differences, as in quality, size, and orientation. This approach may create difficulty when reading on screen. Coyle [2] contends that the reason behind the failure of e- book to render the print book electronically rather than developing new standards is to guide designers and writers when designing e- text. This idea was supported by many studies that examined e-text display. For example, Maria [3] and Lonsdale [4] examined the effect of question layout and answer sheet on reading English. Study findings show that text layout affects reading performance significantly.

The font size is one of the typographical elements that have received considerable attention by researchers interested in studying display text on the screen by investigating their effect on reading speed and accuracy. The findings of these researchers could be classified into three groups; the first group reported significant effect of font size and type on online reading, the second group reported limited effect, while the third group reported no effect. Points usually used to measure the size of letters include the cap high of the letters plus a small interval of the space above and below the letters. Points are also used to measure the distance between lines.

In the same perspective, the studies that confirmed the effect of font size and type did not agree on the optimal size and type that could be considered as standards for designing e-text. For example, Bernard et al. [5] tested three different font size points (10, 12, and 14) with 8 font types. Using a sample size with 20 participants aged between 18 and 55, they were asked to read passages of over 1000 words. The study reported that speed and accuracy was affected by font size and font at 12 point size was read faster than size 10. There is thus a positive relationship between speed reading and accuracy. This finding was confirmed by Shurtleff [6] and National findings [7]. Furthermore, findings by Smith [8] indicated that characters' height has significant effect on search time and accuracy, e.g. the average accuracy was about 91% in size 2.2 mm. This average went down to 81% in size 1.4 mm, while in 3.3 mm the search speed increased but decreased when the characters' height is up to 3.3 mm.

In addition, Jayeeta et al. [9] reported that there was no statistical difference in reading speed between font sizes 10 and 12, while, some researchers point out that readable font size starts from 14 point [9-13] [12] [10].

Otherwise, other researchers in the typographic literature [14] [15] [16] [9] believed that serifs have a significant impact on the readability of text on screen because they think serifs increased letter discriminability. Few researchers, such as Chien and Chen [17], argued that increasing size does not necessarily improve the perception of legibility. While Kolers and Duchnicky [18] debated whether smaller characters, with more characters per line, are read faster.

These studies only concerned the Latin alphabet, which makes it necessary to ask the question: do these findings apply to all languages? there are notable differences between most languages in the world and as seen in "Figure 1" below, presenting the word 'book' in different languages, there is a difference in width and length.

圖書/ book / كتاب/ 予約 / הספר/ წიგნი / ספר/ 책/

Figure 1. Model based fault detection.

However, font type was reported as having an effect on variables but this impact does not relate to font size that was reported as the main factor affecting reading from screen. Verdana size 14 was reported as the most readable font followed by Arial in the same size, while Times New Roman was the worst [19] [9]. This finding was rejected by Banerjee [9] who points out that Times New Roman font in sizes 10 and 12 are the same as size 14 of Courier New font.

A justified text can be very readable if designer ensures that the spacing between letters and words is consistent. Italics reduced the legibility of characters and words [20].

Overall, the findings of empirical studies across several conditions show that font size is the main typographical factor that affects text display on screen while this factor is also affected by other variables such as font type and line length. But to draw a clearer conclusion, more research needs to be done that considers these relationships.

2. Arabic script

Research into the reading process and usability of e-text raise new factors related to language structure, which make comparison between English and Arabic unfair for several reasons. These two languages have different morphological structures. In addition, the Arabic writing system is quite different from other languages such as English and Chinese. It belongs to an alphabetic system where words are written in units, and there are salient spaces between them. While the Chinese language belongs to a logographic system, and words are written in units, there are no salient spaces between Chinese words. Each letter has two conditions; connecting to other letters or separate from them.

There are three cases of connecting letters; thus, Arabic text can be divided into 19 cases based on style.

Otherwise, English has a concatenative morphological structure, whereas Arabic is non-concatenative based on the notion of root. On the other hand, 15 letters in Arabic language have dots in them, and a large number of the letters differ depending only on the number of dots or where dots are put, while in English only letters have dots [21]. For example, in "Figure 2" the first letter ث and the second one ت differ in the number of dots which makes it difficult for children to differentiate between them especially when the font size is small. Also, when one word contains two letters which have dots and are conjoined, it becomes difficult to differentiate between them. This problem does not exist in the English language [EL] and thus, it is difficult to apply the criteria created based on EL to displaying other languages such as the Arabic language [AL]

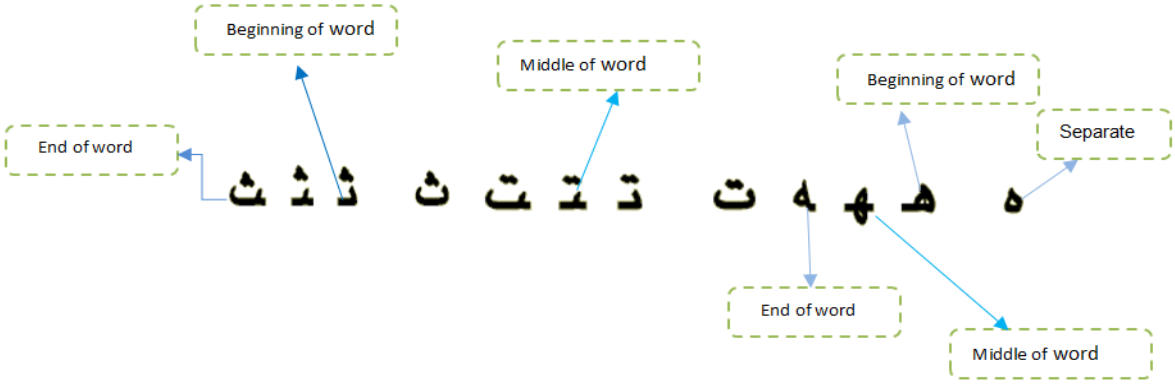

Figure 2. Show example of Arabic letters in different shapes.

In addition, Arabic letters have up to four different shapes depending on their relative position in the text. Amin [22] highlighted some facts related to Arabic characters which are summarised in "Table 1", and compared to Latin. These differences lead to differences in the characters' width, position and morphological structure.

Table 1. Presenting the similarity and difference between Arabic characters and Latin characters.

Arabic language	Latin language
Arabic language is written from right to left.	Latin language is written from left to right.
Use letters and vowel. In some cases the absence of vowel diacritics dictates a different meaning.	Use letters.
Words are separated by spaces.	Words are separated by spaces.
Some words can be divided into smaller units called sub words.	
Some characters of the same font have different sizes.	
Combines seven vowels.	

In the Arabic language, vowels are not part of the language, while in Latin orthography they are part of the alphabet, and text cannot be displayed without them. Arabic text that is designed for adults and skilled readers is presented without vowelized text but it is very important for novice Arabic readers, because certain letters and words can only be distinguished from each other through a single

stroke or dot. Short vowels may be above, and/or in, and/or below the letters for letter-sound pronunciation. Abu-Rabia [23] [24] tested Arabic vowels and their influence on the reading accuracy of poor and skilled native Arabic speakers of different ages. The findings suggest that vowels were important factors in assisting word recognition among poor and skilled readers. Moreover, testing the effect of vowels on the Hebrew language in terms of comprehension and reading time shows that vowels make no significant difference as to reading time but they influence comprehension [25]. Furthermore, Abu-Rabia [23] and Abu-Rabia and Siegel [24] argue that understanding the development of reading could help build a better comprehensive reading theory.

In the present research, the legibility of Arabic text presented on screen to children aged 9 to 12 will be investigated in order to identify and measure the optimal font size using two font types [Arabic traditional and simplified Arabic] in four different font sizes [10, 14, 16 and 18].

3. Experiment design

3.1. Participants.

30 Students, studying at a Libyan school in the UK, participated as volunteers to do the experiment. Their ages ranged from 10 to 12. There were 15 female and 15 male students, 26 of whom were studying in an English school for more than one year, and 9 participants were born in the UK with the Arabic language as their mother tongue. Participating students were also classified into two groups based on education levels and reading scores; the first group included students who scored in reading course a mark of at least 5 out of 10, while the second group included students whose scores were less than 5 as seen in" table 2".

Table 2. Show the sample size.

Age	N	Total	gender	
10	10		male	15
11	10	30		
12	10		female	15

3.2 Material design

Taking into account the previous findings which show that there is a positive correlation between content's length and reading rate, the text used in the experiment was divided into two parts, each part representing a separate window. In each test, different lessons were used, although all the lessons were taken from the reading school book for primary stage in Libya and the eight lessons discussed different subjects of general interest. In addition, the four windows have equal length (31 words per lines, 27 lines per text and non-margins).

The sentences were printed with black letters on grey background. Four font sizes (10, 14, 16, and 18) were tested with two font types as shown in "Table 3". Finally, the text in both conditions was presented in a single column.

"Table 4" shows an example of text layout using 14 point as font size and Times New Roman as font type.

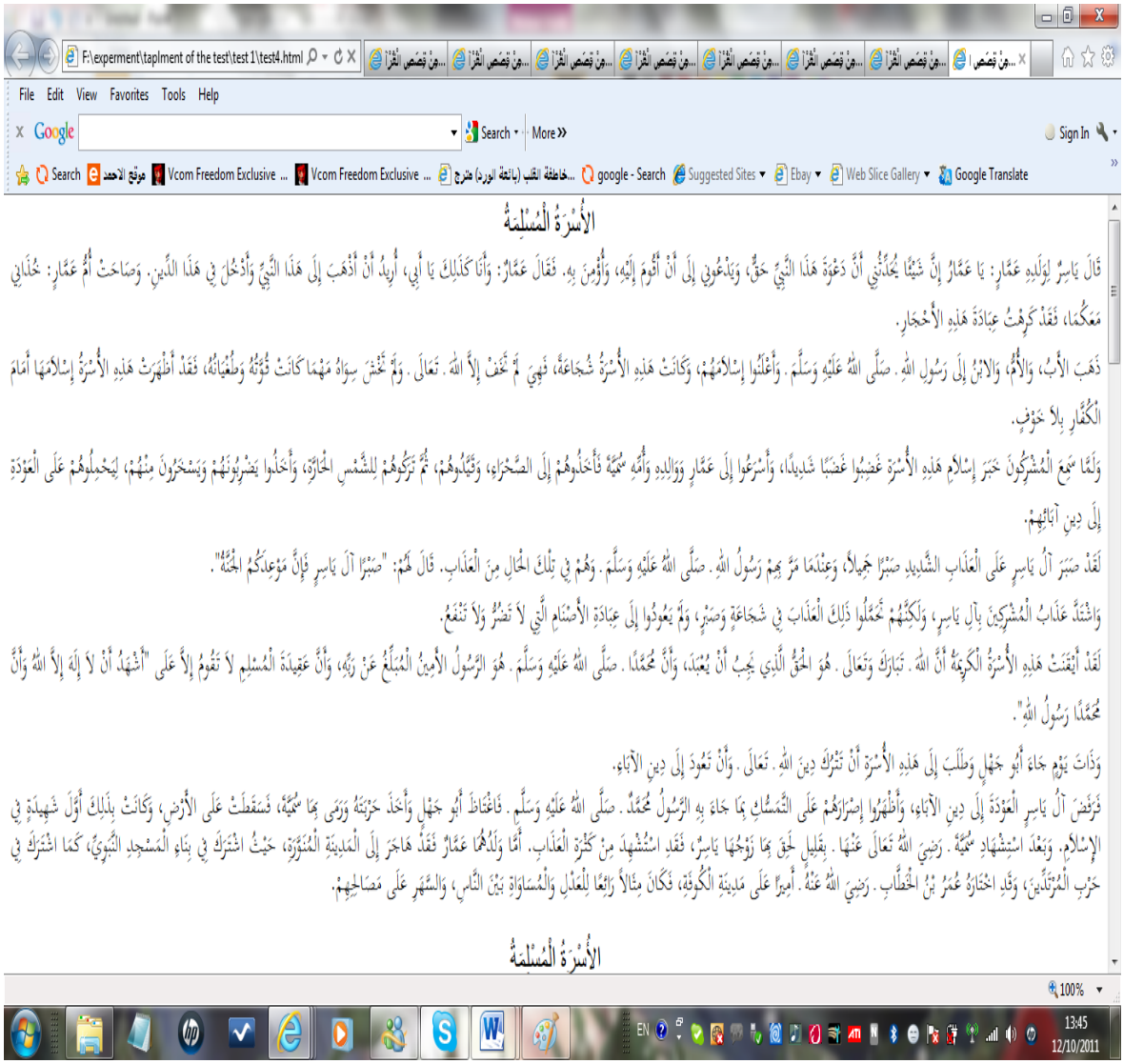

Figure 3. Show text in different sizes.

Table 3. Show the structure of testing material.

Test (1)	**Test (2)**	**Test (3)**	**Test (4)**
Black font White background **Font size:** title : 10 **Font type**: Traditional Arabic and simplified Arabic **Display**: one Colum, single space between lines. Text : bold **Word number**: 279	Black font White background **Font size:** title 14 **Font type:** Traditional Arabic and simplified Arabic **Display**: one Colum, single space between lines. Text : bold **Word number**: 191.	Black font White background **Font size:** title 16 **Font type:** Traditional Arabic, Arial, Time new roman, simplified and **Display:** one Colum, single space between lines. Text : bold **Word number:** 275.	Black font White background **Font size:** title : 18 **Font type:** Traditional Arabic and simplified Arabic. **Display**: one Column Single space between lines. Text : bold **Word number:** 254.

Table 4. Example of sentences in Arabic language used in this study of two different fonts, simplified Arabic and Traditional Arabic

Font type	Font size (10)	
Simplified Arabic		أرسل الله تعالى نبيه إبراهيم إلى قومه
Traditional Arabic		أَرْسَلَ اللهُ تَعَالَى نَبِيَّهُ إِبْرَاهِيمَ إِلَى قَوْمِه
	Font size(14)	
Simplified Arabic		أَرْسَلَ اللهُ تَعَالَى نَبِيَّهُ إِبْرَاهِيمَ إِلَى قَوْمِه
Traditional Arabic		أَرْسَلَ اللهُ تَعَالَى نَبِيَّهُ إِبْرَاهِيمَ إِلَى قَوْمِه
	Font size (16)	
Simplified Arabic		أَرْسَلَ اللهُ تَعَالَى نَبِيَّهُ إِبْرَاهِيمَ إِلَى قَوْمِه
Traditional Arabic		أَرْسَلَ اللهُ تَعَالَى نَبِيَّهُ إِبْرَاهِيمَ إِلَى قَوْمِه
	Font (18)	
Simplified Arabic		أَرْسَلَ اللهُ تَعَالَى نَبِيَّهُ إِبْرَاهِيمَ إِلَى قَوْمِه
Traditional Arabic		أَرْسَلَ اللهُ تَعَالَى نَبِيَّهُ إِبْرَاهِيمَ إِلَى قَوْمِه

3.3 Conditions of workplace

The display medium was placed on a 140 cm height table. The distance from the screen to the surface of the table was 100 mm. The distance of eye-to- screen was 500 mm. The screen inclination was 105. Moreover, participants all used the same PH Pavilion dv6 [Intel i5 core processors] laptop, with the choice of using a mouse attached peripherally. The screen size of the laptop was 15.6 inches with display setting of 1366 x 768 pixels. Internet Explorer 6.0 was used as the browser environment to present the test software and task.

3.4 Procedure

Each student was tested individually, and each test lasted approximately between 30 to 40 minutes. Before starting the test, it was emphasised that participants should work as quickly and accurately as possible, and then the experimenter told them about the aim of the experiment. They were then asked to read aloud to measure their ability to read. The voice of the student was recorded and was controlled using a digital watch with a precision of one second. Each lesson was timed separately using the same procedures. The experimenter noted how participants read the text and reported the difficulty faced by the students when reading. These comments were later used to interpret the quantitative data. Following each lesson, and on a separate page, there was a question and answer sheet to test the accuracy of locating particular information. Finally, after reading and answering the task, students made their judgements about the different text layouts [different font sizes matching to different font types], by answering a brief questionnaire which recorded their personal details combined with these two questions:

- Which characters are more difficult to read?
- Which font size is easier to read?

4. Result

4.1 Reading performance of Arabic Traditional font

According to "Table 5" and "Figure 4", which demonstrate the results of descriptive statistics for Arabic traditional font in four sizes [10, 14, 16 and 18], it is obvious that the highest error is made in font of size ten, and this is followed by sizes fourteen, sixteen and eighteen. Notice that since the distribution of each font group is found to be non-normal, the analysis relied on the median as an indicator of error level, e.g. the medians for sizes ten and fourteen are .397 (about 39.7%) and .317 (about 31.7), respectively, which are high. However, the error drops down dramatically to very low when the size of the font is sixteen and eighteen, namely the errors for fonts sixteen and eighteen are .048 (about 4.8%) and .054 (about 5.45%), respectively. The mean of errors shows huge differences between the size groups, where it seems clear that font of sizes sixteen and eighteen are more readable than any font smaller than sixteen. Based on the maximum values given in the table, it is worth mentioning that the error percentage in reading can reach 45.9% for size ten and 39% for size fourteen, which is remarkably high.

Table 5. Show descriptive statistics data of reading accuracy for Arabic Traditional font in four font sizes.

Statistic	10 Traditional Arabic	14 Traditional Arabic	16 Traditional Arabic	18 Traditional Arabic
Mean	.393	.305	.050	.054
Median	.397	.317	.048	.054
Mode	.358	.322	.058	.054
Variance	.012	.001	.001	.000
Minimum	.315	.254	.028	.031
Maximum	.459	.390	.093	.071

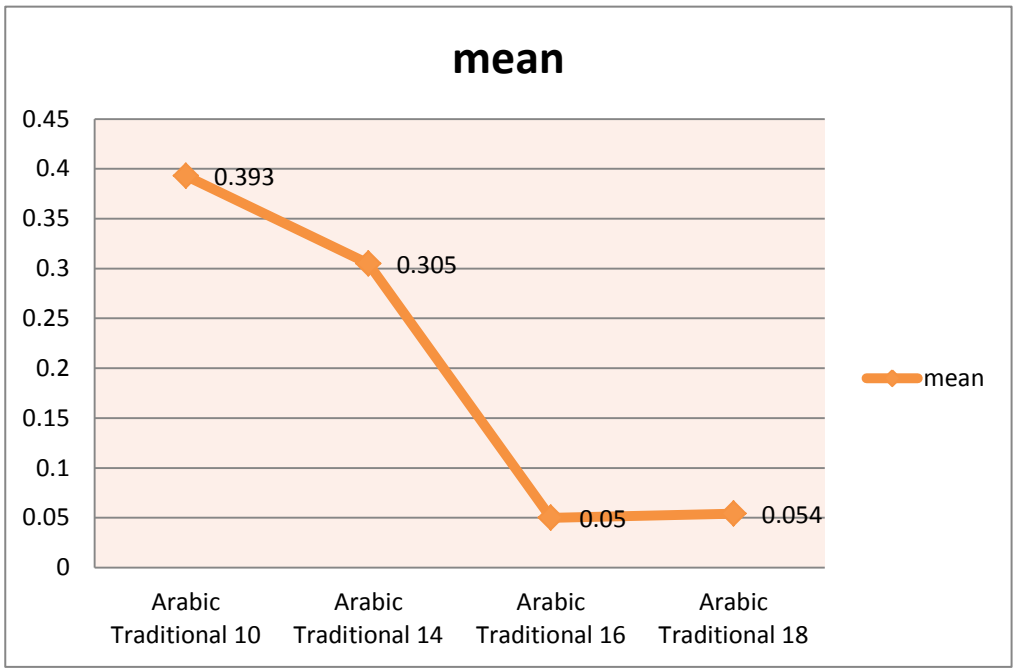

Figure 4. Show descriptive statistics data of accuracy of reading for Arabic Traditional in four font sizes.

However, to investigate the relationship between the four sizes of traditional Arabic font and the error percentages resulting from using these sizes, the Friedman test is used to test the difference in median error for the four fonts. The Friedman test indicates strong differences in error percentages among the four groups ($\chi 2$= 82, p-value < .001) as seen in "table 6".

Next, follow-up tests will need to be conducted in order to evaluate comparisons between pairs of medians using the Wilcoxon test. Using the Bonferroni adjustment for controlling adequately for type I error, the adjusted level of significance will be .05/6 = .008. Based on the adjusted p-value, the median error percentage of traditional Arabic font for size ten is significantly greater than the median error for sizes fourteen, sixteen and eighteen, p-value < .008. Also, the median error percentage for size fourteen is found to be significantly higher than the error provided by median error for sizes sixteen and eighteen. However, the median error percentage for size sixteen does not differ significantly from the median error for size eighteen. Notice that these two sizes (sixteen and eighteen) show the lowest error made by the students which is about .048 (4.8%) and .054 (5.4%) respectively.

Table 6. Show Pairs comparison using the Wilcoxon test in terms of traditional Arabic font groups.

	10-14	10-16	10-18	14-16	14-18	16-18
Z	**-4.782**	**-4.782**	**-4.782**	**-4.784**	**-4.782**	**-2.149**
p-value	**.000**	**.000**	**.000**	**.000**	**.000**	**.032**

To measure the degree of association between age and gender with speed and error, Spearman's correlation is used for each font size. Based on "table 7", we observe that the age of students tends to have a negative correlation with speed; this means that as age increases, the time spent on reading decreases. The correlation becomes stronger as long as the font size becomes bigger and all of the correlations are found to be significant. In terms of errors in reading, the researcher finds that when it comes to age the correlation is negative and significant for all of the font sizes. It is obvious that the correlation drops when the font size becomes bigger. In other words, age will have a low association with error if the font size is big but it should be kept in mind that this relationship is still significant, and hence should not be ignored.

Alternatively, the results reveal that gender shows a very weak correlation with both speed and error. The findings indicated that for font of size fourteen there is a significant correlation between gender and error; the correlation is -.402. It seems difficult to interpret this result. For measuring the correlation between speed and error, the researcher observes that a higher speed of reading is positively combined with a higher error, which is a surprising result. This finding may be attributed to the following: students who have a low level of reading will take a long time to finish the text and hence time will not lead to them reducing their error.

Table 7. Shows Spearman's correlations between the variables using Arabic traditional font.

	Ten		Fourteen		Sixteen		Eighteen	
	Speed	**Error**	**Speed**	**Error**	**Speed**	**Error**	**Speed**	**Error**
Age	-.302*	-.661***	-.603***	-.379**	-.775***	-.781**	-.664***	-.408**
Gender	-.055	-.127	-.019	-.402*	.070	.062	.027	.012
	Speed		**Speed**		**Speed**		**Speed**	
Error	.377*		.413**		.816**		.469**	

4.2. Reading performance of Simplified Arabic font:

For simplified Arabic font, error seems to dramatically drop as demonstrated by the computed mean, median and mode given in "table 8". It is observed that a considerable reduction in error percentage results from fonts of sizes 16 and 18; these percentages are 7.4% and 2.6% respectively. In addition,

the highest errors are made by font of size ten (M= 0.3830) and this is followed by sizes 14, 16 and 18, respectively. This result is confirmed by the boxplot given in "figure 5" which presents the means of reading error using four different sizes of Simplified Arabic font.

Table 8. Shows descriptive statistics data of accuracy of reading for simplified Arabic font in four font sizes.

Statistic	10	14	16	18
Mean	**.383**	**.145**	**.074**	**.026**
Median	**.364**	**.143**	**.075**	**.026**
Mode	**.358**	**.127**	**.084**	**.026**
Variance	**.0021**	**.0003**	**.0001**	**.00003**
Minimum	**.287**	**.119**	**.054**	**.017**
Maximum	**.484**	**.177**	**.093**	**.037**

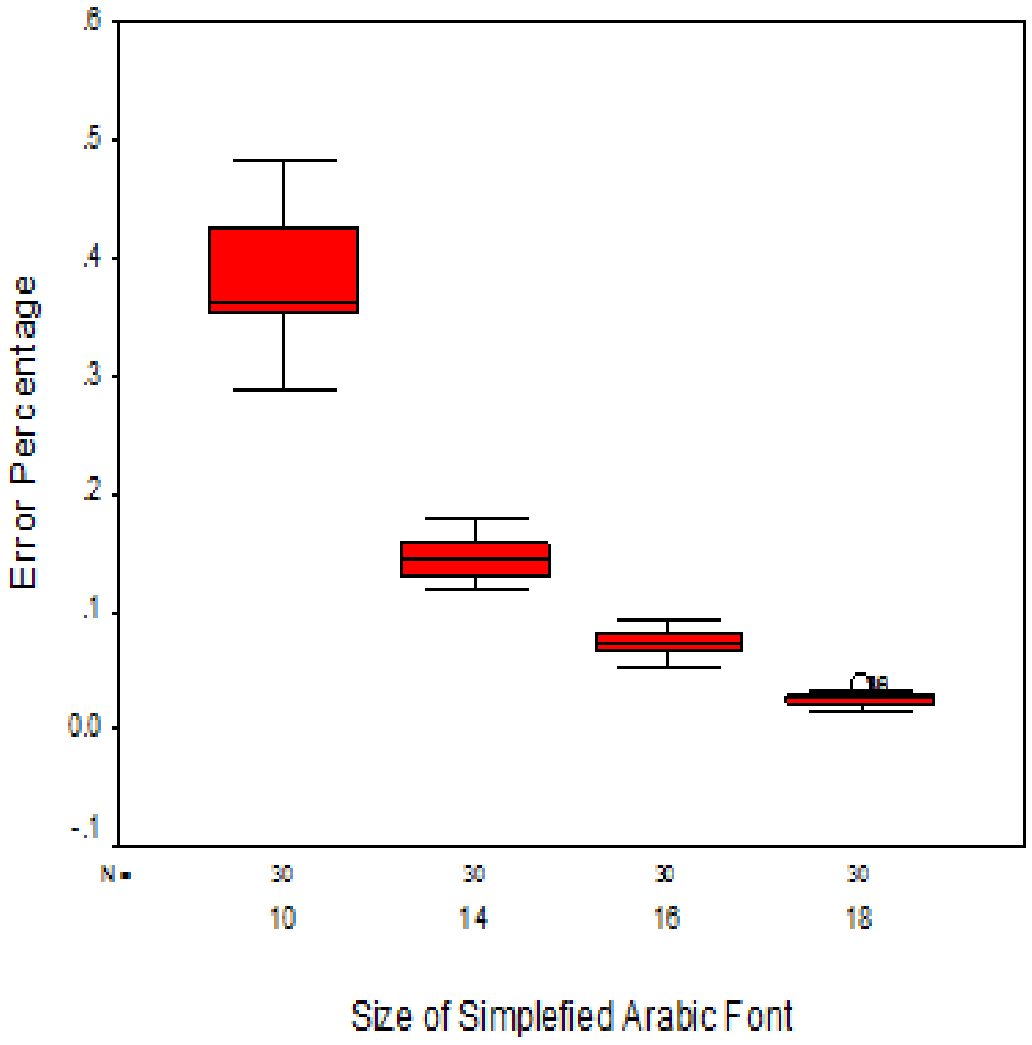

Figure 5. Show mean disruption of error.

Similar to the aforementioned fonts, the Friedman test, shown in "table 9" which is 90.00, indicates a highly significant difference among errors resulting from reading the four sizes of Simplified Arabic font. The Wilcoxon test, given in "table 10", tells us that a highly significant difference is determined by each of the pairs of two font sizes. Hence, to reduce the percentage of reading error, it is better to use a larger font size.

Table 9. Shows Friedman test for four groups of simplified Arabic font.

Font size	Mean rank	Chi-square	p-value
Ten	4.00	90.00	.000
fourteen	3.00		
sixteen	2.00		
Eighteen	1.00		

Table 10. Shows Pairs comparison using the Wilcoxon test in terms of Simplified Arabic font group.

	10-14	10-16	10-18	14-16	14-18	16-18
Z	-4.782	-4.782	-4.782	-4.787	-4.783	-4.783
p-value	.000	.000	.000	.000	.000	.000

For Spearman's correlation, age tends to have a moderate correlation with the speed and error of reading. But this correlation is highly significant and hence it is possible to say that when a student grows, the chances of reading errors occurring will be lower. By looking at gender, we do not observe any significant correlation with speed and error. In terms of the relationship between speed and error, the highest correlation, which is .602, is obtained for size ten, but then the correlation becomes somewhat weak for the rest of the sizes as seen in "table 11".

Table 11. Spearman test testing the correlation between reading speed and errors according into age and gender.

	Ten		**Fourteen**		**Sixteen**		**Eighteen**	
	Speed	**Error**	**Speed**	**Error**	**Speed**	**Error**	**Speed**	**Error**
Age	**-.488****	**-.542****	**-.645****	**-.206****	**-.580****	**-.106**	**-.429***	**-.483***
Gender	**-.056**	**-.075**	**-.076**	**-.033**	**-.053**	**-.070**	**.204**	**.027**
	Speed		**Speed**		**Speed**		**Speed**	
Error	**.602****		**.351***		**.249**		**.471***	

Finally, short questionnaire answers show that students aged 10 to 11, who represent 80% of the sample, prefer size 18 as reading size, while 4 students aged 12 found that the text is clear to read from size 16 (20%).

4.3 Reading speed

Results of this experiment showed that the reading speed depends on the font size more than font type. As to the impact of characters' size, results showed that reading speed decreased significantly with the increase in font size as shown in "table 12" and "figure 6" which present the descriptive statistics data reading speed in Arabic Traditional and Simplified Arabic for four font sizes [10, 14, 16 and 18]. E.g. the mean reading time of Arabic Traditional font decreased from 20.07 minutes in size 10 to 16.37 minutes in size 14, whereas the mean reading time for size 18 was 11.20 minutes. On the other hand, the average reading time for Simplified Arabic font in size 18 was the lowest in all sizes except size 10 (M= 20.10, SD= 3.84). E.g. the reading speed in Arabic Traditional font of size 18 is less by 44.19 % than size 10 which is less by 35.41%.

Table 12. Show means & Standard Deviations of reading time under each of font size.

Font size	Arabic Traditional		Simplified Arabic	
	M	**SD**	**M**	**SD**
10	20.07	2.66	20.10	3.84
14	16.37	3.84	15.27	3.71
16	14.60	4.91	14.03	4.57
18	11.20	4.06	9.07	2.23

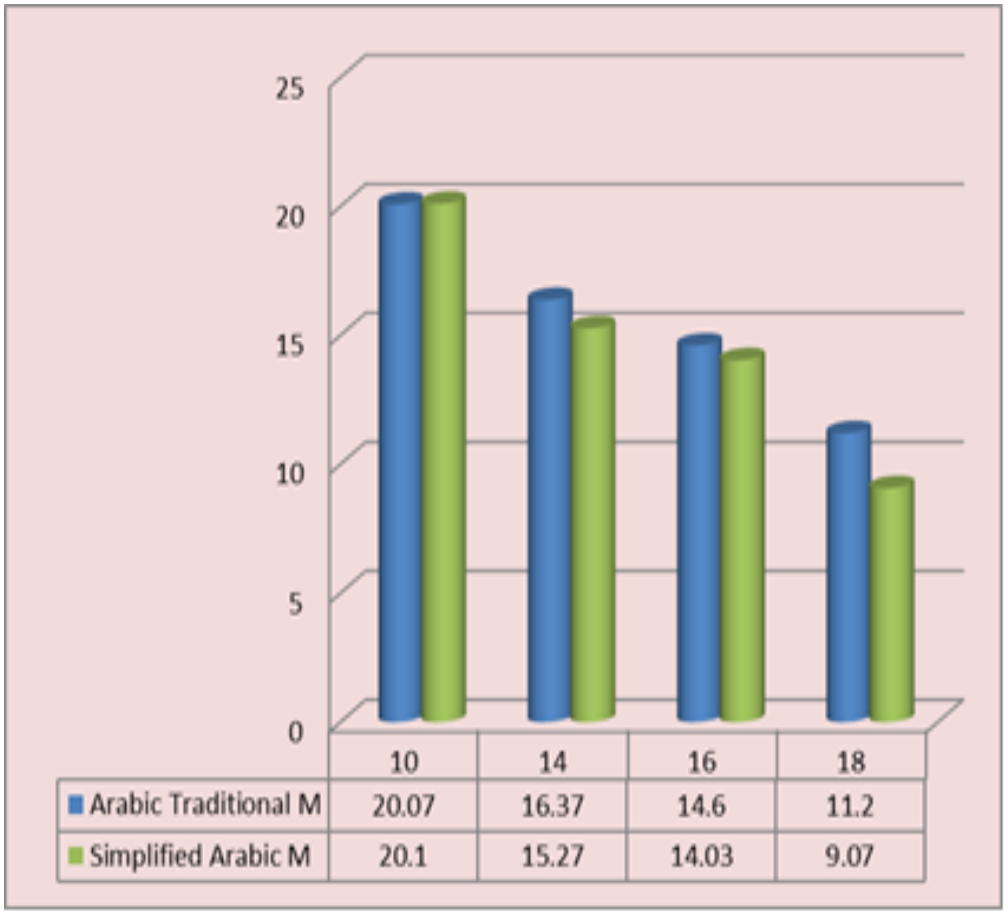

Figure 6. Show mean of reading time under each of font size.

Sequentially, age has been measured as an independent variable to define optimal font size and type. According to "tables 13" and "figure 7" which display mean and standard definition of all fonts in different sizes, readable font size differs according to the age of the reader. E.g. reading speed of students aged 10, when reading text presented using Arabic Traditional in size 18 (M= 13.50/ SD= 2.76) is higher than students aged 12 who read the same text in size 16 (M= 8.20/ SD= 1.69) by 55.67%. In addition, it is notable that the difference in reading performance between age group 10 and 11 is similar in all font sizes and types. For instance, comparing reading speed of students aged 10 in size 10 (Simplified Arabic) with students aged 11 shows a slight difference (3.6%). This convergence in the performance of students at the age of 10 and 11 is obvious in sizes 10, 14 and 16.

Table 13. Display means & Standard Deviations of reading time under each of font size.

age	Arabic Traditional								Simplified Arabic							
	Size 10		Size 14		Size 16		Size 18		Size 10		Size 14		Size 16		Size 18	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
10	21.20	3.26	18.80	1.75	18	2.11	13.50	2.76	22.20	2.62	17.90	2.38	16.80	2.49	10.60	2.07
11	20.20	1.81	17.40	4.01	17.60	1.51	13.70	1.49	21.40	2.84	17	2.11	16.90	1.91	8.80	2.15
12	18.80	5.73	12.90	2.69	8.20	169	6.40	2.22	16.70	3.40	10.90	1.45	8.40	2.12	7.80	1.62

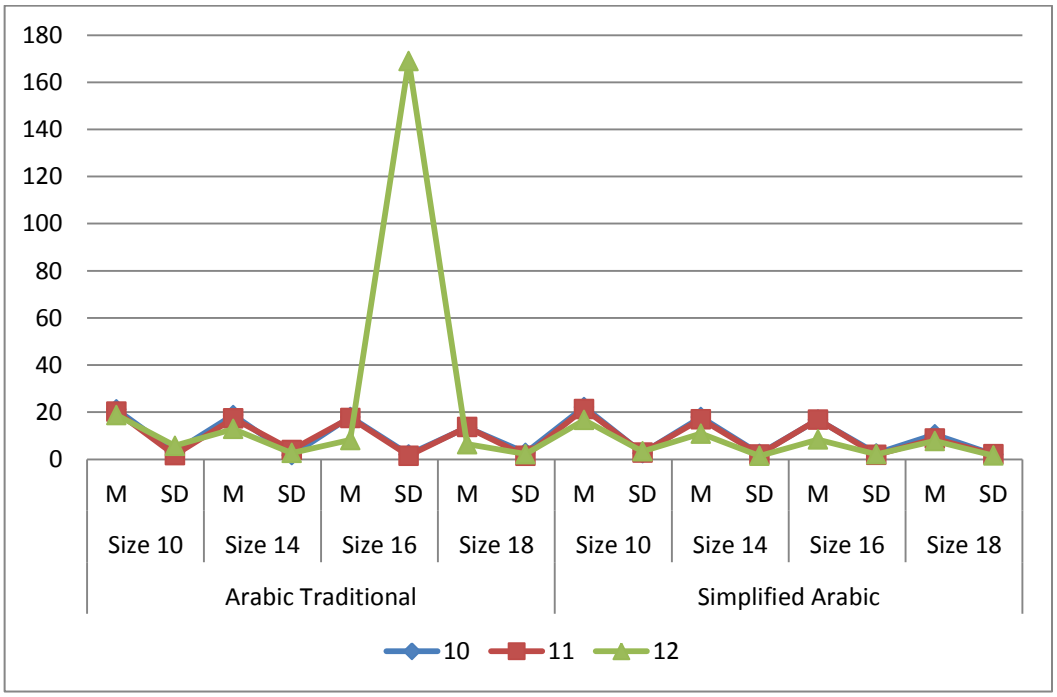

Figure 7. the means & Standard Deviations of reading time under each of font size.

5. Discussion

In this experiment, Arabic text was used to define the optimum font size and type to read from screen for students aged 10 to 12. Accuracy of reading was measured by the average of error that students made when reading the text, while reading speed was determined by the time it took students to read the text. Previous studies demonstrate that the text is readable in font size 10 to 12 for adults using English characters, but Alotaibi [26] has found that 14 is a readable font with Arabic text. Furthermore, some researchers [18] [3] linked poor reading not just to font size but also to line length and interlinear spacing.

The results of this experiment showed that the highest error is made with font size ten, and this is followed by sizes fourteen, sixteen and eighteen, which confirm the relationship between font size and word vision. This result is not consistent with Alotaibi's survey [26] which determines that the 14 point is the best font size for reading Arabic characters in print material by students aged 18 to 28. Also, it supports the finding that age tends to have a negative correlation with reading speed; in other words, when age increases the reading time decreases. This correlation is strong in Arabic text because of the Arabic vowels which are key factors for defining the legible font size for children. Thus, the legible font should be able to show the difference between dots and the vowels, and this

cannot be achieved using font size 10, 12, 14 or even 16 in spite of the low rate of errors. However, more research is needed to investigate the relationship between language structure and font size. Therefore, font sizes 14 and 16 are readable for readers aged 12 and over and can be used to display Arabic text on screen. In the same way, font size 18 is recommended for reading Arabic text online.

Alternatively, in this experiment, reading speed is generally slower in font sizes 14 and 16 as well as in 10 for the low reading groups, especially in age 10. Also, the improvement in the level of reading is notable, whether in error or time, starting from size 16 regardless of the font type.

The effects of character size on participants were more significant with characters of the Arabic language; this is contrary to some research findings that font types impact the reading speed in different languages such as English [27]. Besides, Alotaibi [28] investigated the effect of font size and type on reading speed in printed Arabic text and concluded that font type as well as font size impact the reading speed. Therefore, reading Arabic on screen for children aged 10 to 12 is not influenced by font types as in other languages.

In order to investigate the difference in reading performance among students based on gender, this is used as an independent variable to clarify their impact on this type of research. Most previous research were not concerned with finding out if there was difference in reading performance so as to avoid this variable in future research. However, the findings of this experiment showed no difference in reading performance between male students and female students.

Arabic traditional font should be avoided when designing Arabic text for children even if the Arabic traditional font in size 16 was more readable than Simplified Arabic font in the same size.

6. Future work

Future work will move in the following direction: (a) it is notable that reading performance of children is influenced by font size and font type which means more investigations of different Arabic fonts to determine the optimal font for presenting Arabic text; (b) further studies should examine the causes of the difficulty in reading Arabic characters in sizes 12 and 14 as Latin characters.

References

[1] Alan, C., *designing computer- based learning materials*. 2001: Gower Publishing Limited.

[2] Coyle, K., *E- reading* The Journal of Academic Librarianship, 2008. **34**(2): p. 160 - 162.

[3] Maria dos santos Lonsdale, m.C.D., and Linda Reynolds, *reading in examination- type situations: the effects of text layout on performance.* Research in reading, 2006. **29**(4): p. 433- 453.

[4] D. De Stefano and J. Lefevre, *Cognitive load in hypertext reading: a review.* Computers in Human Behaviour, 2007. **23**: p. 1616-1641.

[5] Bernard, M., et al. (2002) *A comparison of popular online fonts: which size and type is best?* Usability News **Volume**,

[6] Shurtleff, D., *Studies in television legibility: a review of the literature.* Information Display 1967. **4**: p. 40–45.

[7] National, A., *American National Standard for Human Factors Engineering of Visual Display Terminal Workstations* A.H.S.N. 100-1988, Editor. 1988: Santa Monica.

[8] Smith, W.J., *ISO and ANSI Ergonomic standards for computer products: a guide to implementation and compliance*. 1996: Prentice Hall.

[9] Banerjee, J., et al., *Readability, Subjective Preference and Mental Workload Studies on Young Indian Adults for Selection of Optimum Font Type and Size during Onscreen Reading.* Al Ame en J Med S c i, 2011. **4** (2): p. 131- 143.

[10] L, R., *Legibility studies: Their relevance to present-day documentation methods 1979;.* J Documentation 1979. **35**(4): p. 307-340.

[11] TS, T., B. JL, and H. H., *Readability of Fonts in the Windows Environment*, in *ACM CHI Conference on Human Factors in Computing Systems*. 1995. p. 127-128.
[12] D, B., et al. *A study of fonts designed for screen display*. in *CHI*. 1998.
[13] J, L. and S. PV, *The influence of font type and line length on visual search and information retrieval in web pages.* Int J Human-Computer Studies, 2006. **64**: p. 395-404.
[14] Mansfield, J.S., G.E. Legge, and M.C. Bane, *Psychophysics of reading Xv: Font effects in normal and low vision* Investigative Ophthalmology and Visual Science, 1996. **37**(8): p. 1492–1501.
[15] Mackeben, M., *Typefaces influence peripheral letter recognition and can be optimized for reading with eccentric viewing. ,* . Paper presented at the Vision 99. 1999, New York: NY.
[16] Arditi, A. and J. Cho, *Serifs and font legibility.* Vision research, 2005. **45**(23): p. 2926-2933.
[17] Chen, C.-H. and Y.-H. Chien, *Effect of dynamic display and speed of display movement on reading Chinese text presented on a small screen.* Perceptual and Motor Skills, 2005. **100**(3): p. 865-873.
[18] Kolers, P., R.L. Duchnicky, and D.C. Ferguson., *Eye movement measurement of read ability of crt displays* Human Factors, 1981. **23**: p. 517-527.
[19] JE, S., et al., *Text legibility and the letter superiority effect.* Human Factors, 2005. **47**(4): p. 797- 815.
[20] Sheedy, J.E., et al., *Text legibility and the letter superiority effect.* The jurnal of the human Factors and Ergonomics Society 2005. **47**(4): p. 797- 815.
[21] Shahreza, M. *Persian/ Arabic text font estimation using dots*. in *IEEE International Symposium on Signal Processing and Information Technology*. 2006.
[22] Amin, A., *recognition of printed Arabic text based on global features and decision tree learning techniques* pattern Recognition, 2000 **33**: p. 1309- 1323.
[23] Abu-Rabia, S., *The Effect of Arabic Vowels on the Reading Comprehension of Second- and Sixth-Grade Native Arab Children.* Journal of Psycholinguistic Research, 1999. **28**(1): p. 93-101.
[24] Abu-Rabia, S., *The role of vowels and context in the reading of highly skilled native Arabic readers.* Journal of Psycholinguistic Research, 1996. **25**(6): p. 629-641.
[25] Simmonds, D.R., L., *Data presentation and visual literacy in medicine and science*. 1994, Oxford: Butterworth-Heinemann.
[26] Alotaibi, A.Z., *The effect of font size and type on reading performance with Arabic words in normally sighted and simulated cataract subjects.* Clinical & Experimental Optometry, 2007. **90**(3): p. 203-203.
[27] Feely, M., et al., *Investigation into font characteristics for optimum reading fluency in readers with sight problems.* International Congress Series, 2005. **1282**: p. 530- 533.
[28] Alotaibi, A.Z., *The effect of font size and type on reading performance with Arabic words in normally sighted and simulated cataract subjects* optometry 2006. **90**(3): p. 203- 206.