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Legibility of Websites Which are Designed for Instructional Purposes

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Abstract: In this study, legibility of web pages which are designed for instructional purposes were compared according to font types and foreground/background color combinations. Three different font styles which are sans-serif (Verdana), serif (Times New Roman) and monotype (Courier New) were used. 15 background/foreground color combinations were investigated; basic colors that are available on most browsers were selected. Also four different background/foreground color contrast combinations were chosen (dark text on dark ground, light text on light ground, light text on dark ground and dark text on light ground). In the current study a survey method was used to investigate the attitudes of the students towards the legibility of web pages. The sample consisted of 124 students of the Computer and Instructional Technologies Department, Istanbul. All the students were capable of visual literacy and web technologies. At the end of the study it was found that Verdana is regarded as the most legible font type and white ground/black text is the best color combination for web pages. Also, there was a significant difference according to color contrast; web pages which are prepared with dark text on light ground are more legible than other combination.

Key words: Interface design · legibility · usability · web design

INTRODUCTION

Reading text from a website is somewhat different from reading text from the hard copy [1]. Above all; design, speed, content fails when users can not read the text [2]. That's why legibility of the web pages, which are designed for instructional purposes, is very important for efficient communication. Legibility depends on many factors: color combinations; foreground/background contrast, font, font size, word style (bold, italicized etc.), computer pixel size, along with many others [3, 4]. There are plenty of opinions, preferences, observations and even proposed algorithms related to legibility [5-7], but very little published, objective data that directly relates to webpage style screen displays [8]. In this paper, the issues that are related with the use of typography and color are investigated.

The typography of presenting characters on website is as critical as on the hard copy and can have a direct impact on the legibility [1, 9]. Many studies have examined the effects of variations in typeface characteristics on legibility and readability. Differences in font increase or decrease the ability of an individual to distinguish or read letters [7]. Nevertheless, experts do not always agree which fonts are more legible or which ones are most appropriate for web use. Some typefaces are more legible than others on the screen. For example, a traditional typeface such as Times New Roman is considered to be one of the most legible on paper, but at screen resolution its size is too small and its shapes look irregular [10]. However, Georgia and Verdana were designed specifically for legibility on the computer screen; they have exaggerated x-heights and are very large compared to more traditional typefaces in the same point size.

Fonts are categorized into "families" based on their characteristics. Different fonts result from combinations of a number of font characteristics, including serifs, stroke width and letter height and width [11]. Basically, there are two font styles. These styles are serif and sans serif [12]. The serif is the small tail added to the ends of letter strokes as a decoration. An example of serif fonts includes Times New Roman. Sans-serif fonts have plain endings and they do not have the flared extensions, strokes or other kinds of ornamentation. Sans serif fonts include Verdana [13]. While serif fonts are traditionally used for the printed page, they do not always work well when projected on screen [12, 14]. Monospace is the other font type and these font types get their name from the fact that each letter takes up the same width of space. Even letters

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which might seem to require different widths, such as an uppercase "W" and a lowercase "i" take up the same width in monospace fonts. Common monospace fonts are Courier and Courier New [13].

Also, one of the most difficult tasks for web designer is being able to select harmoniously matching color combinations, because the effective use of color is vital for legibility in web design. Evidence demonstrates that color enhances learning and motivation. However, color can be easily misused so as to be ineffective or even detrimental [15]. For these reasons, the proper choice of background and foreground colors is important in assuring good legibility. Some color combinations are better than others. One should avoid red with green, red with blue, blue with green, because some combinations of background and foreground colors make pages virtually unreadable for visually disabled users [2]. So, more than four simultaneous colors should be avoided and the use color should be consistent [15]. In addition, contrast is very important in any written text. Contrast is the value difference between two areas; the value is the amount of lightness or darkness in a color. For example, black on white has a high contrast, while black on gray has a lower contrast [8]. Using colors with high contrast between the text and the background is a basic rule that should be followed by all websites to ensure legibility [2, 16, 17].

Text is much easier to read when there is a high degree of contrast between the text and the background [13]. Optimal legibility requires black text on a white background [2]. However, this combination is not ideal for all users. There is much confusion when discussing contrast and color. For young readers, low contrast can be irritating and fatiguing, but for older readers and the colorblind it can be impossible to read. Thus, the contrast between background and foreground color may play a crucial role in the legibility of the web pages.

Considering all these points; in this paper legibility of websites which are designed for instructional purposes was investigated. As mentioned above, it is not feasible to test every combination of variables, because legibility depends on many factors and there are thousands of combinations. In this respect, we studied some basic variables such as font type, foreground/background color contrast and foreground/background color combinations. Times New Roman (Times NR), Courier New and Verdana were used for font type. Also four different combinations (dark ground/dark text, light ground/light text, dark ground/light text and light ground/dark text) were chosen for background/foreground color contrast.

Research questions: In this study; research questions can be stated as follows;

1. Is there any difference among the legibility of web pages according to font types (Verdana, Courier New and Times New Roman)?
2. Is there any difference among the legibility of web pages according to background/ foreground color combinations?
3. Is there any difference among the legibility of web pages according to background/ foreground color contrast combinations?
4. Is there any difference among the legibility of web pages according to background-foreground color/font type combinations?

MATERIALS AND METHODS

Method and sample: In the current study, a survey method was used to investigate the attitudes of the students towards the legibility of web pages. The study was conducted in the second semester of 2004-2005 education year. The sample of the study consisted of 124 students of the Computer and Instructional Technologies Department, Marmara University, Istanbul. 35.5% of 124 students are female and 64.5% of them are male. This department aims particularly to equip the students with computer based instruction and educational technology. The students are capable of visual literacy and web based multimedia applications.

Data collection and procedure: A web site of 45 pages was designed in the study for the students to evaluate the web pages for legibility. For each page, consisted of 150-200 words, a different combination of font style and a different combination of background / foreground color was used. The pages were created using ASP and a five-point Likert scale as the survey options, was placed in the bottom-right corner of the page. The students taking part in the study evaluated each page out of 5 regarding its level of legibility. What each item on the Likert scale indicated is as follows: “1: very bad; 2: bad; 3: average; 4: good; 5: very good”.

Pentium IV based PC computers, with a 2.00 GHz; 15-inch monitors with a resolution setting of 1024 x 768 pixels were used in the study which was performed on a network simultaneously at 4 different computer laboratories. The computer operating system used was Microsoft’s Windows XP. The format of the texts was

presented as an HTML web page. The browser used was Microsoft's Internet Explorer 6.0. For the study, first of all each student was given a username and password and at the end of the study, which lasted for an hour, the points given to each page was gathered on a server on an SQL database. To ensure that the students fulfill the evaluation completely, the web pages were designed so that the students were not allowed to see the following page before evaluating the current one. In the end, the evaluations of the 124 students for the 45 pages were saved on the Microsoft Access data file on the server.

Three different font types were used in the study. The decision for the font types was made considering the font families; whether serif, sans-serif or monotype. These are Times New Roman (serif), Verdana (sans-serif) and Courier New (monotype). These three different font types stated above was used in combination with 15 different background/foreground colors. Therefore 45 different web pages were designed for the study. In each web page there are texts consisted of 150-200 words.

15 different background/foreground color combinations were chosen for the study. These are the combinations of; Red text on Blue Ground, Green text on Red Ground, Yellow text on Green Ground, Blue text on Black Ground, White text on Red Ground, Red text on White Ground, Orange text on Black Ground, Yellow text on Blue Ground, Blue text on Yellow Ground, Yellow text on Black Ground, White text on Blue Ground, Green text on White Ground, White text on Black Ground, Blue text on White Ground, Black text on White Ground. The colors which were chosen are the ones which aren't affected by the browsers. The color values on the hexadecimal numbering system is as follows; Green: #006633. Red: #FF0000. Yellow: #FFFF99. Blue: #0000FF, Black: #000000. White: #FFFFFF.

Data Analysis: For the data analysis, first, the descriptive statistics for the font types (Verdana, Times New Roman and Courier New) are presented below and the most readable font type is determined. Then, the results for the background/foreground color combinations are analyzed and the most preferred background/foreground color combination is stated.

In the third stage of data analysis the results for background/foreground color contrast are analyzed. Lastly, the descriptive statistics for the background-ground color/ font type combinations are presented and the most readable background-ground color/ font type combination is determined.

PRESENTATION OF THE FINDINGS

The descriptive statistics for the font types are presented in Fig. 1. Students were assigned to respond the statement using a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). So, the mean of the legibility of font types ranged from 1 to 5.

As it appears from Fig. 1, the most readable font type is Verdana which has a mean value of 3.08. Also the mean of Courier New is 2.63 and the mean of Times New Roman is 2.57. In this respect; it can be said that readability of sans serif font types are better than serif font types and monotype for instructional web pages. Times New Roman is considered to be one of the most legible on paper; however, Verdana is the most popular font designed for on-screen viewing. It has a simple, straightforward design and the characters are not easily confused. Another advantage of Verdana is that it is a relatively large font and the words take up more space than words in any other font, even at the same point size.

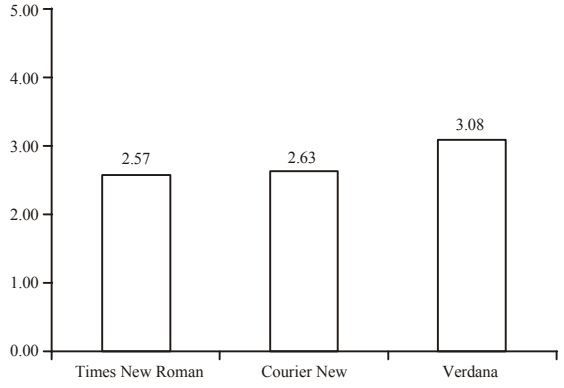

Fig. 1: Comparing the legibility of font types

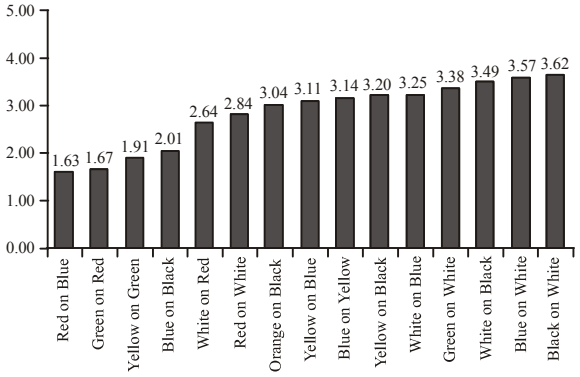

Fig. 2: Comparing the legibility of web pages according to background/foreground color combinations

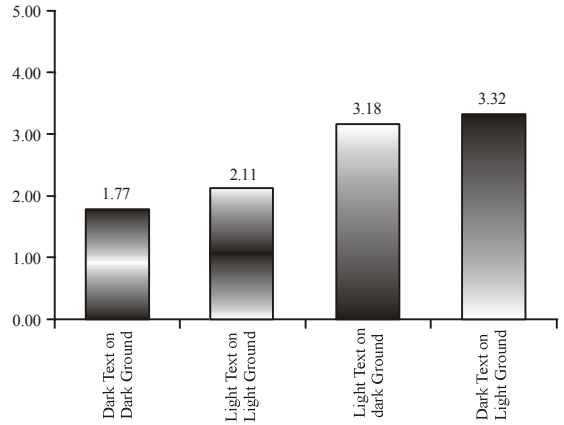

Fig. 3: Comparing the legibility of web pages according to background/foreground color contrast combinations

As you can see from Fig. 2, the most legible color combination is black text on white background ($\bar{x}$=3.62). This result is supported by conventional wisdom about color usage. Black on white has been the most recommended color combination by the professional designers [2, 18]. Also, there is a stronger preference for the combination of blue text on white background ($\bar{x}$=3.57). The two least legible combinations are red on blue ($\bar{x}$=1.63) and green on red ($\bar{x}$=1.67). All others fell from somewhere between these extremes.

Figure 2 shows that web pages which are prepared with dark text on light ground are more legible than other combinations ($\bar{x}$=3.32). Also, light text on dark ground is acceptable ($\bar{x}$=3.18). These results reveal that background/foreground color combinations which maintain a high contrast are more preferred than others. As seen from Fig. 1; in every color combination surveyed the darker text on a lighter background was rated more legible than its reverse. For example; black text on white background ranked higher than white text on blue background. It is the same for blue text or red text on white background. Therefore, text is much easier to read when there is a high degree of contrast between the text and the background.

In Table 1 means and standard deviations of the 45 different combinations are presented. According to the results, the most legible background-foreground color/font type combinations are black text on white ground with Verdana ($\bar{x}$=3.94); white text on black ground with Verdana ($\bar{x}$=3.88); blue text on white ground with courier ($\bar{x}$=3.80). The three least legible combinations are green text on red ground with Times New Roman ($\bar{x}$=1.37);

Table 1: Descriptive statistics of the legibility of foreground- background color and font type combinations

Foreground/ Background Color Combination with Font Type	N	Mean	ss
Black Text on White Ground with Verdana	124	3.94	0.85
White Text on Black Ground with Verdana	124	3.88	0.82
Blue Text on White Ground with Courier	124	3.80	0.76
Blue Text on White Ground with Verdana	124	3.72	0.67
Yellow Text on Black Ground with Verdana	124	3.62	0.89
Blue Text on Yellow Ground with Verdana	124	3.61	0.77
White Text on Blue Ground with Times NR	124	3.60	0.76
Green Text on White Ground with Verdana	124	3.56	0.64
Black Text on White Ground with Times NR	124	3.49	0.89
Blue Text on Yellow Ground with Courier	124	3.48	0.86
Green Text on White Ground with Courier	124	3.46	0.74
White Text on Blue Ground with Courier	124	3.46	0.79
Black Text on White Ground with Courier	124	3.44	0.91
White Text on Black Ground with Courier	124	3.35	0.87
Yellow Text on Blue Ground with Verdana	124	3.35	0.74
White Text on Red Ground with Verdana	124	3.32	0.84
Red Text on White Ground with Verdana	124	3.25	0.99
Orange Text on Black Ground with Times NR	124	3.24	0.69
White Text on Black Ground with Times NR	124	3.23	0.69
Orange Text on Black Ground with Courier	124	3.22	0.73
Blue Text on White Ground with Courier	124	3.20	0.74
Green Text on White Ground with Times NR	124	3.12	0.81
Yellow Text on Blue Ground with Courier	124	3.09	0.67
White Text on Blue Ground with Verdana	124	3.09	0.93
Yellow Text on Black Ground with Times NR	124	3.03	0.74
Yellow Text on Black Ground with Courier	124	2.95	0.73
Yellow Text on Blue Ground with Courier	124	2.90	0.69
Red Text on White Ground with Courier	124	2.67	0.82
Orange Text on Black Ground with Verdana	124	2.66	0.80
Red Text on White Ground with Times NR	124	2.61	0.68
White Text on Red Ground with Courier	124	2.37	0.70
Blue Text on Yellow Ground with Times NR	124	2.35	0.77
Yellow Text on Green Ground with Verdana	124	2.33	0.88
White Text on Red Ground with Times NR	124	2.24	0.69
Blue Text on Black Ground with Verdana	124	2.22	0.87
Green Text on Red Ground with Verdana	124	2.04	0.90
Blue Text on Black Ground with Courier	124	1.98	0.79
Red Text on Blue Ground with Verdana	124	1.87	0.75
Blue Text on Black Ground with Times NR	124	1.82	0.71
Yellow Text on Green Ground with Times NR	124	1.77	0.77
Yellow Text on Green Ground with Courier	124	1.62	0.72
Red Text on Blue Ground with Courier	124	1.61	0.73
Green Text on Red Ground with Courier	124	1.61	0.81
Red Text on Blue Ground with Times NR	124	1.41	0.66
Green Text on Red Ground with Times NR	124	1.37	0.68

red text on blue ground with Times New Roman ($\bar{x}$=1.41); green text on red ground with courier ($\bar{x}$=1.61). Other combinations change between these extremes.

DISCUSSION

Recent studies have resulted in inconsistent findings, making it difficult to say which font family is best suited for the instructional web design. In the current study, it is found that Verdana has the best legibility for web pages on the screen. Sans serif font types such as Verdana are designed specifically for legibility on the computer screen; they have exaggerated x-heights and are very large compared to more traditional typefaces in the same point size. Besides, serif fonts such as Times New Roman are generally regarded as the most readable font family for printed text, conventional wisdom has been that sans-serif fonts are more suited to electronic formats. However, there is contradictory information about which font is the best to use for web-based content. Hozl [18] claims that sans serif font with uniform line thickness is easier to read; but Crawford [19] doesn't agree with this idea. On the other hand, Horton [20] warns against serif fonts in smaller font sizes. Nevertheless, sans serif fonts offer better legibility for instructional web pages because these fonts are designed specifically for legibility on the computer screen. Also, it has been suggested that serifs have the potential to act as visual noise, cluttering incoming visual information. This gives sans serif fonts an advantage over serif fonts because sans serif fonts have uniform stroke width and no serifs [7].

For the web designer, it is not feasible to select harmoniously matching color combinations. So, one of the most difficult question is "what color combinations shall I use on instructional web pages?" In the current study, we found that black text or blue text on white ground is best suited for the instructional web design. These findings show parallel result with Hill and Scharff [8] who said black text on white to be one of the best. Also, Nielsen [21] says "optimal legibility requires black text on a white background". However, in this study, subjective ratings may not be consistent with performance. For example, although black text on white ground was found the most legible combination, it may not be the most legible in empirical studies. Thus, more researches need to be done in order to investigate the proper color combination. Another fact that can be inferred from the results is that foreground and background color combinations which are on the extreme ends of the color spectrum (i.e. blue and red) do not provide sufficient contrast for screen displays. In this study we found that these kinds of combinations have the least legibility. So, for instructional web pages it is not advisable to mix colors that are on the extreme ends of color spectrum.

Experts do not always agree which background/ foreground color contrast combination is the most appropriate for web use. For example, Nielsen [21] says, "color using with high contrast between the text and the background is a basic rule that should be followed by all websites to ensure legibility"; however, Powell [22] suggests designers to "avoid sharp contrast between foreground and background". In our study, it has been revealed that the contrast is very important for web page design. Text is much easier to read when there is a high degree of contrast between the text and the background. On screen displays low contrast can be irritating and fatiguing to young users [8]. Previous works showed that a combination of the overall text contrast and the background contrast provided a useful measure [17]. Conventional wisdom has been that high degree of contrast between the text and the background are more suited to electronic format. This hypothesis was supported by the current study.

REFERENCES

1. Chi, C.F, D. Cai and M. You, 2003. Applying image descriptors to the assessment of legibility in Chinese characters. Ergonomics, 46 (8): 825-841.
2. Nielsen, J., 2000. Designing web usability: the practice of simplicity, Indianapolis, IN: New Riders Publishing.
3. Arditi, A., 2005. Enhancing the visual environment for older and visually impaired persons. Alzheimer's Care Quarterly, 6 (4): 294-299.
4. Milne, S., A. Dickinson, A. Carmichael, A. Sloan, R. Eisma and P. Gregor, 2005. Are guidelines enough? An introduction to designing web sites accessible to older people. IBM Systems Journal, 44 (3): 557-571.
5. Jacko, J.A., A.B. Barreto, G.J. Marrnet, J.Y.M. Chu, H.S. Bautsch, I.U. Scott and R.H. Rosa, 2000. Low vision: the role of visual acuity in the efficiency of cursor movement. Paper presented at the 4th International ACM Conference on Assistive Technologies, ASSETS, New York: ACM Press, November 2000.
6. Hanson, V.L. and J.T. Richards, 2005. Achieving a more usable World Wide Web. Behaviour and Information Technology, 24(3): 231-246.

7. Wood, R., K. Davis and L. Scharff, 2005. Effects of typeface and font size on legibility for children. American Journal of Psychological Research, 1 (1): 86-102.
8. Hill, A.L. and F.V. Scharff, 1997. Readability of screen displays with various foreground/ background color combinations, font styles and font types. Proceedings of the Eleventh National Conference on Undergraduate Research, Vol II, pp: 742-746.
9. Arditi, A., 2000. Print and web design for the visually impaired. Visual Arts Trends, 3S: 2.4-2.5.
10. Lynch, P.J. and S. Horton, 1999. Web style guide: basic design principles for creating web sites, 2nd ed., Yale University Press.
11. Lannon, J.M. (Ed.). 2000. Designing pages and documents. technical communication (8th ed.), New York: Addison Wesley Longman.
12. Vetter, R., C. Ward and S. Shapiro, 1995. Using color and text in multimedia projections. IEEE Multimedia, 2 (4): 46-54.
13. The WebAIM Guide to Web Accessibility, 2005. 3th edition of WebAIM's training CD-ROM.
14. Crosby, J., 1994. Twelve tips for effective electronic presentation. Medical Teacher, 16 (1): 3-8.
15. Alessi, S.M. and S.R. Trollip, 2001. Multimedia for learning: methods and development. 3rd. Edition. Boston: Allyn and Bacon.
16. Rivlin, C., R. Lewis and D.C. Rachel, 1990. Guidelines for screen design. Oxford: Blackwell Scientific Publications.
17. Scharff, F.V., A.L. Hill and A. Ahumada, 2000. Discriminability measures for predicting readability of text on textured backgrounds. Optic Express, 6 (4): 81-90.
18. Holzl, J., 1997. Twelve tips for effective PowerPoint presentations for the technologically challenged. Medical Teacher, 19 (3): 175-179.
19. Crawford, W., 2003. Just My Type. E-Content, 26 (6): 42.
20. Horton, W.K., 1990. Designing and writing online documentation. New York: Wiley.
21. Nielsen, J., 2000. Prioritizing web usability. New Riders Publishing.
22. Powell, J.E., 1990. Designing user interfaces. Microtrend Books. San Marcos.