

INCORPORATING USABILITY FACTOR IN READABILITY FORMULA TO ENHANCE WEB READABILITY

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Abstract

From a long time, readability formulas have remained favorite and trustworthy in analyzing the readability, however, researches have now made their trust worthiness a bit shaky as they lack usability components in them. In this paper, the readability formulas are analyzed against usability factors. For this purpose, a group of 40 readers belonging to different age groups, gender, educational backgrounds and variant skills, were selected to analyze the effect of color contrast on readability.

The readability measures in terms of usability constraints are put on the scrutiny for the validity and effectiveness of the formulas. The usability factors that can be met by emending or modifying the readability formulas are put forth to get the desired success ratio for ease of reading.

Among the identified factors, the color contrast of foreground and background is picked and a survey was conducted that ensured the strong effect of color contrast on readability. The color contrast factor is adjusted in the readability formula that resulted better and enhanced readability analysis.

Keywords: Readability, usability and readability formulas, critics on readability formulas, color contrast and readability, enhanced readability formula.

1. Introduction

Readability has remained a hot issue from many decades and researchers have focused on improving readability by taking it in different perspectives. Readability is the key aspect to improve not only the learning quality but a good way of earning by making the target audience understand the importance of what you are presenting to them.

Taking the readability in researchers' prospective, Dale and Chall (1949) stated that all factors in the printed text participated in building readability success. They defined readability success as the understanding, interest and optimal reading speed of the readers. They highlighted that not only writing but the effective readability depended on everything present in the material collectively participating in its success.

Klare (1963) defined readability as "the ease of understanding or comprehension due to the style of writing". He focused on readability in writing perspective.

The creator of the SMOG readability formula defined readability as the degree of ease to which targeted class of readers found certain material satisfactory (McLaughlin, 1969).

Hussain et al. (2011a) states that web readability depends on understanding of any text and having plain language any one can improve the readability of website. DuBay (2004) established that ease of reading is readability.

There are different factors that strongly affect readability, like font size, color contrast, busy backgrounds, text alignment, letter spacing, text density, font style, text line height and length and understanding of vocabulary. There are

different readability formulas that are used to measure readability of text; however, these readability formulas do not satisfy usability issues. This study also discusses these readability formulas by focusing on following research questions:

- How to incorporate usability in readability formula in order to get better user experience?
- What impact does the color contrast have on readability and usability?

In this paper, we have incorporated usability factor, i.e. color contrast of background and foreground of any webpage. For this survey, we have selected 40 readers belonging to different age groups, gender, educational backgrounds and variant skills.

2. Background

Many researchers have proposed readability formulas to analyze readability of the text. These readability formulas have been used, found satisfactory and are, therefore, in practices for many decades. People have been using it to identify the ratio of readability ease. The readability formulas are basically to focus over all readability constraints and are to suppose to be global in implementation perspective with no specific audience.

Is Readability Formula Effective? The researches have now made the effectiveness of these formulas questionable as by the observation; it has been analyzed that instead of general, they actually are specific in targeting readers. In contrast to Dale and Chall (1949), the currently used formulas do not consider all those elements contributing in effectiveness of readability and, thus, give unreliable results. Alongwith many researchers, Bruce et al. (1981) contributed in identifying the uncovered factors in readability formulas like the readers prior knowledge, reading context, readers' cultural differences, motivation, interest, complexity of idea, dialect, rhetorical structure, competitiveness and other factors.

The readability formulas are still questionable in terms of other usability factors. The recent research contributed a lot in determining the weaknesses of used formulas. One of the strongly effecting factors is color contrast of foreground and background of the web contents. Extensive

work has been done on analyzing the impact of color contrast on readability analysis of the text and the studies have concluded that color contrast strongly affects the success ration of the readability analysis (Timpany, 2009; Yu and Miller, 2010; Hussain et al., 2011b). Moreover, the impact of color contrast difference was observed as a strong instinct affecting the readability of different age groups (Hussain and Sohaib, 2011). They found that the color contrast affects the users of all age groups. Similarly, the color contrast affects aesthetics and the speed of the readers thus affecting the readability of the contents at the same time (Hall and Hanna, 2004). Timpany (2009) highlighted the importance and strength of the color contrast on readability analysis. He concluded that black text on a white background was found to be read the fastest in print and blue text on a white background was found to be read the fastest on screen. Overall most of the researchers have come up with findings that color contrast plays a vital role in accuracy of readability analysis. This all has raised a need to formulate a formula satisfying the usability needs to help in determining the accurate and trust worthy results of readability from the usable readability formula.

3. Literature Review

Redish (2000) states that the readability formulas are still with weaknesses. They cover only few factors affecting readability and there are still many factors left unrevealed. According to him, these formulas are targeted for academic books only and thus do not consider the cultural and background differences of readers, the effectiveness and appropriateness of the text used.

Many researchers showed concern over the difficulty, density and complexity of idea (Morriss and Holversen, 1938; Dolch, 1939).

Klare (1963) states that firstly formula measures only one aspect of writing style; secondly, it measures only one aspect of the style difficulty; thirdly, formula does not measure difficulty perfectly; and fourthly, formulas are not measured for good style. Klare (1976) put emphasis on the importance of reader's skills and motivation in evaluating the readability.

Finn (1978) pointed out that readability formulas failed to consider the frequent vocabulary repetition that directly affected the reading success by losing the readers' interest.

Bruce et al. (1981) declared that readability formulas failed to fulfill their promise. They said that formulas did not consider current reading process, their statistics were shaky and were thus inappropriate.

Studies put forth a primary criticism that the predictor variables, on which the formulas are built (i.e., sentence length and word frequency), are not the best predictors of comprehension (Duffy and Kabance, 1982; Duffy, 1985).

Redish and Seizer (1985) states that the “usability test for the readability analysis is more effective than the proposed readability formulas as the formula addresses only a specific characteristic or is for the targeted grade level only”.

Klare (1985) highlighted the importance of prior knowledge of a reader as an important factor contributing in readability.

Schrifer (2000) stated that “the formulas were a quick objective benchmark for indexing readability. But they are inherently subjective”.

Considering the color contrast as factor not evaluated by the present readability formulas, the importance of contrast difference is highlighted by various researchers (Bouma, 1980; Mills and Weldon, 1987). They focused on luminance and luminance contrast and proved that it is an important factor in mediating the effect of fore and background color contrast. This research was found very useful in identifying the fore and background color combination. Many studies contributed that high level of color contrast is effective in readability analysis (Radl, 1980; Bruce and Foster, 1982).

For web readability, the color contrast affects the readability and legibility of the contents. If light text is placed on dark background it becomes difficult to read (AT&T, 1989).

Powell (1990), in his research paper, suggested avoiding sharp color contrast between foreground and background. He proposed that red on green was the best combination. However, his results were turned down by many researchers, who advocated that black and white were a better combination than red and green.

Hill (1997) stressed that color combination, font type and word style played an important role in determining the web readability of the web

contents. He further accentuated that the color contrast highly affected the legibility of the text as well. Shieh and Lin (2000) identified a strong relationship between readability and subjective preferences and predicted blue page as preferred one. Lin (2003) mentions that the contrast ratio only has an impact on readability performance when the contrast ratio for some colors is below a minimum baseline.

Work on the impact of text background color combination on readability, retention, aesthetics, and behavioral intention showed that colors with higher levels of contrast were expected to lead to higher readability ratings and retention (quiz) scores (Hall and Hanna, 2004). It was found out that for a set of CRT colors with large differences CIE94 is a good choice for better readability (Luo et al., 2004). Gradišar et al. (2006) communicated that readability colored text was affected by at least five factors. He experimented on the combination of 30 different text colors that were presented on the CRT display by measurement of speed of reading through Chapman-Cook Speed. It has been found out by Zuffi et al. (2007) that light text on dark background was more difficult to read and that the minimum luminance contrast between foreground and background color in terms of CIELAB lightness difference should be about 27 units. They concluded that the minimum value of lightness difference between text and background affected the ease of reading of textual information.

Humar et al. (2008) concluded from their study that generally dark backgrounds lead to better results for colors with the greatest luminance contrast. Friedman (2008) said that the white spaces affect the readability and it aids in balancing the large amount of text and helps eye drift over the content.

Timpany (2009), in his research, has analyzed the effect of color contrast on readability and found that combination of text and background has strong effect on readability and concluded that black text on a white background was found to be read the fastest in print and blue text on a white background was found to be read the fastest on screen.

Yu and Miller (2010) stated that white spaces aid in the readability. Similarly, Hussain et al.

(2011a) emphasized that like basic understanding of ICT, various factors like scroll bar, arrow, graphic, etc. affect the readability of the web contents. They further communicated that color contrast, white space, line spacing, font style, font size, text width, headings and graphics and animation, play a vital role in specifying the success of readability. Hussain and Sohaib (2011) said that the color contrast affects the users of all age groups. From the researches of many decades, the importance of color contrast in readability analysis can clearly be depicted.

Methodology

A survey was conducted to analyze the effectiveness of readability formulas in terms of

usability, and to know the impact of usability on readability. The uncovered component of color contrast of foreground and background color in readability formulas was picked to check its effect on the readability. The impact of lack of color contrast in readability formulas was considered to estimate its effectiveness in readability.

Famous readability formulas were used to analyze the readability of randomly selected text. In order to check its validity in the presence of uncovered usability factors in readability formulas, the same text was then exposed to the readers including uncovered factor. The usability factor of color contrast of fore- and background

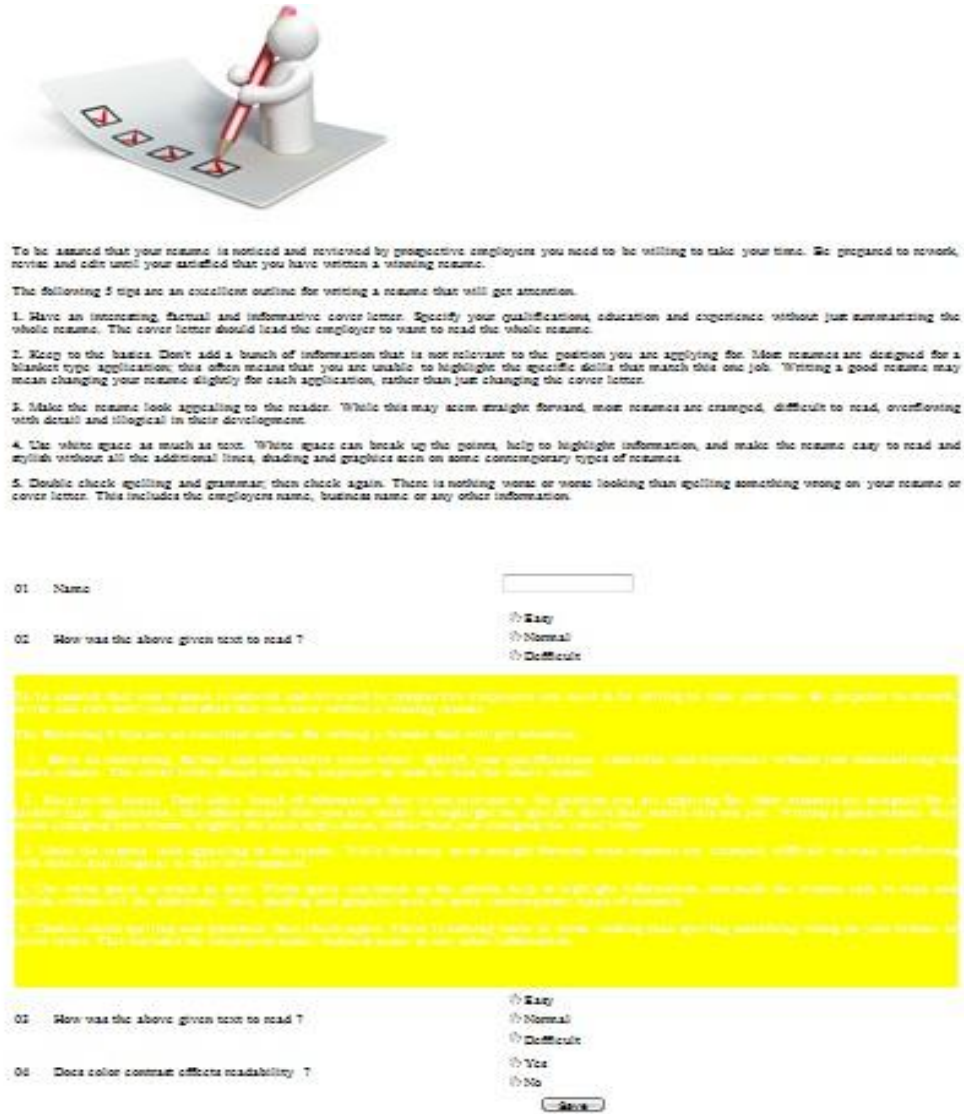


Figure 1. Survey page of the web site build for the purpose of readability analysis in context of effect of color contrast on readability.

color was the presented factor in the analysis of text readability. The readers were exposed to good and poor color contrast and were then asked about the readability of the text in both cases. A web site was built to conduct the survey. Figure 1 shows the web page used for the survey.

For this purpose the readers of different age groups, expertise levels and variant educational backgrounds were exposed to analyze the readability of the text. The undergraduate students, professionals of different fields, different age groups and backgrounds were the readers to analyze the readability (Fig. 2).

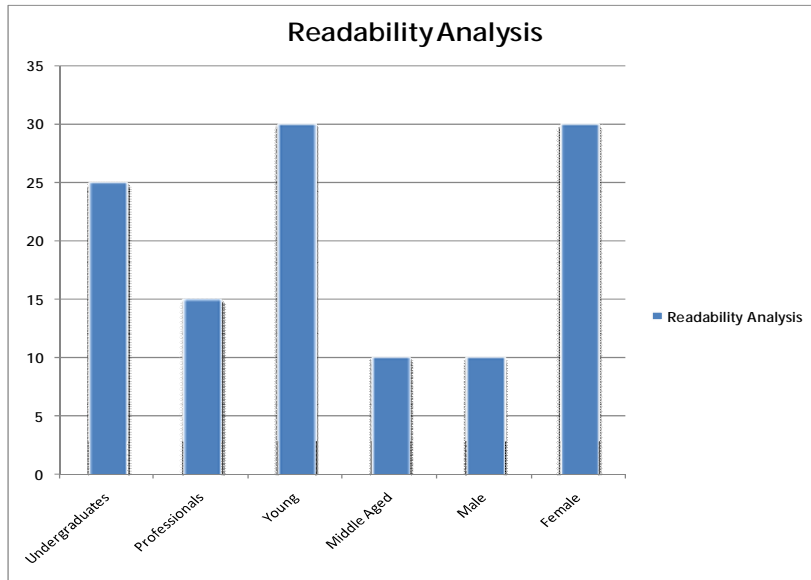


Figure 2: Category of readers selected for the survey

4. Findings

The analysis of readability with consideration of missing usability factor of color contrast in most widely used readability formulas demonstrate that the absence of this factor

strongly affects the readability success. The previous research based surveys reveal that color contrast is a strong factor contributing in the analysis of readability (Figure 3).

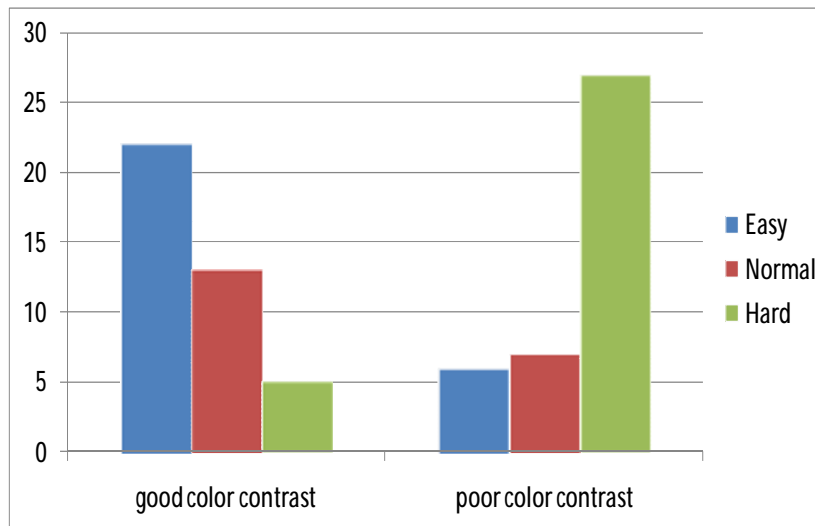


Figure 3. Readability Analysis in good and poor color contrast

It can clearly be observed from the statistical data that the color contrast is an important factor affecting the readability; a poor color contrast reduces the readability success to a considerable ratio in spite of its good readability prediction by the readability formulas. Table 1 shows the categorization and number of readers selected for the survey.

Table 1. Category and number of Readers selected for the survey

Category	Number
Undergraduates	25
Professionals	15
Young	30
Middle Aged	10
Male	10
Female	30

The text, used in the survey, was exposed to six famous and most widely used readability formulas. When the readability of the text was checked by Flesch Reading Ease formula, it resulted 63.2 that indicates a standard reading level of the text, similarly the readability of the text was analyzed by gunning fog readability formula that resulted 9.8, indicating the average score stating that the text is fairly easy to read.

The readability of the text by Flesch-Kincaid was 7.5 for Eighth Grade standard similarly the SMOG readability formula says that its readability is 7.2 and is readable till seventh grade level; moreover, the readability findings of the selected text are listed in the Figure 4.

Readability Formula	Level	Value
Flesch Reading Ease	Standard/Average	63.2
Gunning Fog	Fairly Easy to Read	9.8
Flesch-Kincaid	Eighth Grade	7.5
Coleman-Liau Index	Eleventh Grade	11
SMOG Index	Seventh Grade	7.2
Automated Readability Index	12-14 years old	7.6

Figure 4. Readability Analysis by Famous Readability Formulas

From the survey, it has been observed that although the text was considered readable to greater extent but due to poor color contrast of foreground and background color, the readability of the text was reduced to highly considerable value in fact resulted in very poor readability. It can, therefore, be said that color contrast of foreground and background has great impact on readability.

It has been analyzed that the color contrast has been considered as an important component by W3C Guideline Checkpoint 2.2 states that there should be sufficient color contrast of foreground and background color to ensure good readability and an algorithm was proposed to ensure the accurate range color difference. The proposed range for color brightness difference is 125. The range for color difference is 500 and thus these values shows strong impact on readability of the text.

Enhanced Readability Formula

Thus, along with other factors, the component of color contrast of foreground and background color cannot be ignored. We have, therefore, incorporated this usability factor in the flesch readability ease formula to enhance its performance to provide better readability analysis.

$$URF = \frac{206.835 - (1.15 \times ASL) - (84.6 \times ASW) + FBCD}{500}$$

where URF = Usable Readability Formula

ASL = Average Sentence Length

ASW= Average Syllables per Word

FBCD = Fore ground Background Color Difference

This readability formula will consider the color contrast factor and will calculate the color contrast of the text to be analyzed for readability evaluation providing more accurate and

considerable results. In this formula, the sentence length, complexity of words and the color contrast are the key factors to identify the readability of the text.

The negative values of the URF show poor readability results while the value from 0 to 1000 shows the readability ease. The greater the values, the higher will be the readability. Moreover, the results of this formula are not customized by particular grade level testing rather it generally predicts the readability of the text.

Considering the text used in the survey the readability of the text with poor background according to the amended formula is:

$$\text{URF} = 63 + 270 - 500 = -167$$

where 63 is obtained by analyzing the text contents by flesch. FBCD 270 is calculated by the online Foreground/background tester tool (yellow background with white text) and thus with negative value predicting a poor readability. This is what was observed by the reader's opinion in the survey.

5. Conclusion and Future Work

It is observed that the currently used readability formulas are still lacking usability components. Among identified usability factors, color contrast was analyzed to see its impact on readability analysis and it was observed that absence of color contrast strongly affected the efficiency of readability formulas. It can, therefore, be stated that considering the color contrast in readability formulas can result in better readability analysis. The color contrast was, therefore, incorporated in the readability formula and thus modified readability formula can predict better readability results. There are still ways open to work for the betterment of readability analysis and the uncovered factors like the hue of the color contrast can be incorporated to enhance the efficiency of the readability formulas and providing the world with the ease of better readability predicting tools.

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