Font Matters: Investigating the Typographical Components of Legibility

Suhaiza Hanim Suroya[1,2*], George Edward Torrens[3], Simon T. Downs[4]

[1]College of Creative Arts, Universiti Teknologi MARA (UiTM) Kedah Branch, 08400 Merbok, Kedah, Malaysia

[2,3,4]School of Design & Creative Arts, Loughborough University, LE11 3TU Loughborough, United Kingdom

[*]Corresponding Author

ABSTRACT

In an increasingly digital world, effective communication is paramount, yet poor typographical choices can lead to miscommunication and reduced engagement. This study addresses the critical issue of legibility and readability in typography, aiming to analyze the key typographical factors that influence these aspects across various media. The research employs a comprehensive methodology that includes a literature review, observational studies, and experimental designs to assess the impact of typographical elements such as typeface, spacing, and layout characteristics on legibility. Participants from diverse demographics were engaged to evaluate different typographical settings in both print and digital formats, allowing for a thorough analysis of user experiences and preferences. The findings reveal that factors like font choice, font size, letter spacing, and contrast significantly impact legibility. Additionally, the study highlights the importance of accommodating reader characteristics, such as age and visual impairments, which further influence readability. The implications of this research are profound, as it underscores the necessity for universally accessible design standards that enhance communication effectiveness and user experience. By providing insights into optimizing typographical elements, this study contributes to the development of inclusive design principles that cater to a diverse audience. Ultimately, the research advocates for the integration of legibility studies into design practices, ensuring that content remains accessible, engaging, and effective for users of all ages and abilities. This work not only enriches the field of typography and design but also emphasizes the social responsibility of designers to create materials that facilitate clear communication in an interconnected world.

Keywords: legibility, typographical factors, typeface, spacing, layout characteristics.

INTRODUCTION

Typography is more than just an aesthetic choice; it is a fundamental aspect of communication that impacts the legibility and readability of text, influencing how information is perceived and understood across the globe. With the proliferation of digital content and the widespread adoption of various devices for reading, ensuring that text remains legible across all platforms has become a global issue.

In an increasingly digital world, effective communication is more crucial than ever. Typography, the art and technique of arranging type, plays a significant role in how information is conveyed and understood. The global shift towards digital platforms has heightened the importance of readability and legibility, particularly in contexts where clear communication can impact accessibility, education, and user experience. As societies become more interconnected, the need for universally accessible design standards has grown, making the study of typographical factors not just a matter of aesthetic preference, but a global concern. Poor typographical choices can lead to miscommunication, reduced engagement, and even misinformation, underlining the importance of optimizing text for readability and legibility.

This paper aims to analyze the key typographical factors influencing readability and legibility, drawing on both theoretical frameworks and empirical research. By examining elements such as typeface characteristics, spacing, and layout, this study will provide insights into how typography can be optimized to enhance the clarity and effectiveness of communication across various media. As digital media continues to dominate global communication, the need for effective typography becomes even more critical. This paper seeks to identify and analyze the key typographical parameters that influence legibility, providing insights into how these elements can be optimized to enhance readability across various platforms and audiences.

LITERATURE REVIEW

Typography plays a vital role in communication by shaping how text is perceived and understood. Two critical concepts in this realm are legibility and readability. Legibility refers to the ease with which individual characters or letters can be distinguished from one another. This aspect is crucial in contexts where text must be quickly and accurately read, such as in signage, instructional materials, or user interfaces. Factors such as typeface design, letter spacing, and font size significantly influence legibility. For example, typefaces with distinct letterforms and appropriate spacing, such as sans-serif fonts like Helvetica or Arial, tend to be more legible, especially in smaller sizes.

Readability, on the other hand, concerns the ease with which a reader can process and understand a passage of text. It encompasses more than just legibility; it also involves the overall presentation of the text, including line length, line spacing, and paragraph structure. Readability is essential in longer forms of text, such as articles, books, and digital content, where the goal is to maintain the reader's engagement and comprehension. A text with high readability enables the reader to flow through the content without unnecessary strain, thus enhancing their reading experience

A. Legibility and Readability

Legibility refers to how easily individual characters in text can be distinguished from each other. It is primarily influenced by typographical features. The concept of legibility is critical in ensuring that text is not only visually clear but also accessible to readers across various platforms and contexts. For example, studies have shown that the adoption of specific typographical features can enhance or impair the legibility of a text, which in turn affects how quickly and accurately it can be read (Tinker, 1963). Legibility studies, therefore, play a critical role in understanding the parameters that affect how easily text can be read. These studies examine various typographical factors such as font size, typeface, letter spacing, and line length, aiming to identify the optimal conditions for readability. The increasing complexity of digital interfaces and the diversity of reading environments, from small mobile screens to large desktop monitors, necessitate a comprehensive understanding of these typographical parameters. Recent research has highlighted the importance of these studies in ensuring that digital content is accessible and user-friendly for a global audience (Dyson, 2013; Bernard, Chaparro and Halcomb, 2003).

Readability, on the other hand, refers to how easily and comfortably a block of text can be read and understood. Readability encompasses a broader scope than legibility, as it includes the complexity of the content, sentence structure, and overall layout, in addition to typographical factors. Readability is crucial in contexts where large volumes of text are presented, as it directly impacts comprehension and user engagement (Schriver, 1997). Both legibility and readability are essential for effective communication, especially in digital and educational content, where poor design choices can hinder information dissemination and understanding.

B. Typographical Factors Associated to Legibility and Readability

Typographical factors are critical in ensuring that text is both legible and readable, as they encompass the design choices that influence how text is perceived and understood. Typographical factors refer to the various elements and design choices in the presentation of text that influence its readability and legibility.

These all possible factors are identified, gathered and investigated. Each element of the typographical parameters is identified as contributing to legibility and thus increasing the readability of readers. In most of the list below, only one or a combination of two parameters are focused by scholars on each of their studies. However, this paper aims to gather as many typographical factors as possible in order to understand possible interactions or relationships among the listed variables or parameters, including typeface, spacing, and layout aspects.

1. Alignment:

Text alignment significantly impacts readability, especially for readers with dyslexia. Justified text, which aligns both the left and right margins, can cause the "river effect," where uneven spaces create distracting white gaps that disrupt reading flow. This can be particularly challenging for dyslexic readers, as it can decrease reading comprehension and speed. Although there's limited research on how text alignment affects reading (Krivec *et al.*, 2020).

2. Colour and Contrast:

The colour contrast between text and its background is a critical factor in legibility, with higher contrast generally improving visibility. Research highlights the importance of choosing appropriate text and background colours, especially for screen reading. Poor colour selection can hinder readability, as shown by (McCarthy and Swierenga, 2010), who identified it as a key issue in digital reading environments. Warm background colours like peach, orange, or yellow have been found to enhance readability and reduce mouse tracking distance, particularly for dyslexic readers. Conversely, cool colours such as blue, grey, and green can decrease readability (Rello and Bigham, 2017). Accessibility guidelines recommend using text-sized appropriately for comfortable reading, avoiding all-uppercase headers, and preferring pastel backgrounds like beige with dark blue text (De Santana *et al.*, 2012). Additionally, it is advised to use background colours for highlighting text rather than changing the text colour itself. To improve web accessibility, it is suggested to avoid high contrast and instead recommend off-black text on an off-white background. Overall, careful consideration of colour in typography is essential for enhancing readability and accessibility for all users.

3. Font Size:

Font size is critically important for enhancing reading speed, comprehension, and overall legibility, especially in digital formats. Studies such as (Chandler, 2001) highlight that larger font sizes, up to 12 points, significantly improve reading speed, with minimal impact from the font type itself. Furthermore, Subbaram (2004) and Sheedy *et al.*, (2005) emphasize that even larger sizes, such as 14-point, are more legible and are a key factor in improving legibility. This makes font size one of the most important aspects of text presentation, particularly in ensuring readability for a diverse range of users. The importance of font size is further supported by Krivec *et al.* (2020) who demonstrated that it correlates with leading and tracking, meaning that increasing font size should be considered in conjunction with these other typographical elements to optimize the reading experience.

4. Font Types:

The selection of font type and font family is crucial for optimizing readability and comprehension across different media. Studies emphasize that different fonts perform better depending on whether the text is printed or displayed on screens. For example, (Boyarski *et al.*, 1998) found that Times New Roman is well-suited for print, while Georgia and Verdana are preferable for screen reading, indicating that font type directly affects the functionality of the text. Joshi, Kaur and Wason (2014) further highlighted that font choice affects both reading speed and comprehension. Arial and Microsoft San Serif were found to be the most legible for printed materials, while Lucida Sans excelled in online contexts, underscoring the importance of selecting the appropriate font for the medium.

Additionally, Chaparro et al. (2010) demonstrated that certain typefaces like Consolas, Cambria, and Verdana enhance legibility in digital formats, particularly for business documents, while others like Calibri and Corbel may hinder readability. This suggests that careful selection of font type and family is essential for ensuring text is easily readable and accessible, especially in professional and digital contexts. Other than that, font style of serif and sans-serif, and the weight of fonts, i.e., bold and italic are among the important factors to consider in terms of the legibility of the displayed fonts.

5. Letter Spacing:

Inter-letter spacing plays a crucial role in improving legibility. Research shows that optimizing spacing can make smaller characters up to 20% easier to read compared to default settings (Arditi, 2004). (Hakvoort *et al.*, 2017) found that increasing inter-letter spacing improved reading accuracy for both dyslexic and non-dyslexic children, echoing (Zorzi *et al.*, 2012) who discovered that better spacing boosts reading fluency across different reader levels. This improvement has been consistent over time and could be particularly beneficial for dyslexic readers.

However, finding the right balance is essential. Both too narrow and too wide spacing can negatively affect the reading. Studies by Montani, Facoetti and Zorzi (2015) and others show that overly tight spacing impedes readability, while research by Risko, Lanthier and Besner (2011) and Spinelli *et al.* (2002) indicates that too much space can also slow down reading. Therefore, careful adjustment of inter-letter spacing is key to enhancing reading performance, especially for those with reading difficulties.

6. Line Spacing:

The vertical space between lines of text helps prevent crowding and enhances readability by allowing the reader's eye to easily follow the text. Line spacing, also known as leading, plays a crucial role in enhancing reading effectiveness, provided it is neither too wide nor too narrow (Vanderschantz, 2008). Proper line spacing facilitates a smooth "return sweep," which refers to the reader's eye movement from the end of one line of text to the beginning of the next (Nanavati and Bias, 2005; Tarasov, Sergeev and Filimonov, 2015).

For printed materials, particularly those intended for adults, adding two to three points of extra space between lines is widely accepted as a practice that enhances text legibility and reading speed (Spenser, 1968). This aligns with principles from Gestalt psychology, which suggests that humans tend to group objects in the visual field based on their proximity to one another. In the context of reading, appropriately spaced lines can help readers perceive and process text more efficiently, reducing cognitive load and improving overall readability (Bruce and Green, 1985).

7. Line Length:

Line length is crucial for reading comprehension and speed. Studies have shown that an optimal line length of around 55 characters per line promotes the best reading comprehension and allows readers to maintain a faster reading pace. Very short or very long lines can disrupt the natural eye movement, leading to slower reading and reduced comprehension (Dyson, 2001) (Dyson, 2001; Haselgrove and Dyson, 2001). In digital reading, the relationship between line length and scrolling patterns also affects reading efficiency. While shorter lines improve focus and reduce distractions, studies have shown that line length does not significantly impact reading performance but may influence reading motivation (Berget and Fagernes, 2021). Overall, finding the optimal line length is essential for balancing reading speed, comprehension, and reading comfort.

8. Paragraph Spacing:

Paragraph spacing is essential for improving legibility by creating a clear separation between text blocks, making it easier for readers to follow and understand the content. Setting paragraph spacing to 200% of the font size, as recommended, helps prevent the text from feeling too dense and enhances the overall reading experience. While some studies found no strong preference for spacing larger than 1.5 times the font size, the 200% spacing is favoured for its effectiveness. Additionally, 65% of users prefer a black line between

paragraphs, and 75% find regular letter spacing easier for word recognition. Together, proper paragraph and letter spacing reduce visual clutter, making reading more comfortable and intuitive (Damiano, Gena and Venturini, 2019).

9. Word Spacing:

Research suggests that both letter and text spacing significantly impact reading. Improper balance between inter-letter and inter-word spacing can lead to confusion, slowing down reading speed as readers struggle with jumbled words (Tarasov, Sergeev and Filimonov, 2015; Galliussi *et al.*, 2020). Studies on webpage text spacing have shown mixed results, with normal spacing often leading to better comprehension, though users tend to prefer more spaced text (Bernard, Chaparro and Thomasson, 2000). However, increased inter-word spacing generally improves reading speed, while mismatched inter-letter spacing can hinder it. Overall, proper text spacing has been found to positively affect reading fluency, especially for both dyslexic and non-dyslexic readers (Marinus *et al.*, 2016; Galliussi *et al.*, 2020).

METHODOLOGY

Measuring typographical factors in legibility studies can be in various methods. The following research methods were implemented by scholars in the area.

The primary purpose of this study is to identify and analyze typographical parameters that significantly impact legibility. To achieve this, the research is guided by specific questions: Which typographical parameters most influence legibility? How do these parameters interact with one another? This study aims to provide a comprehensive understanding of these factors to enhance design practices in both print and digital media.

A. Conceptual Framework

Typography theory and frameworks in legibility studies focus on how typographical elements like typeface, spacing, and layout components interact with human visual perception and cognitive processing to improve readability and comprehension. Key concepts include typeface choice, font size, contrast, and spacing, which influence reading ease and speed. Grids and typographic hierarchy guide readers through structured content, while adherence to typographic conventions aligns with readers' mental models. Typography must adapt across media and consider user-centered design for accessibility. Optimized typography supports efficient reading and comprehension across various contexts and reader needs. Key elements within this framework include typeface classification, characteristics, anatomy, spacing, and context. By understanding and applying these principles, designers can create legible and visually appealing text for various purposes and audiences. Conceptual frameworks outline the key variables and relationships involved in studying the impact of typographical factors on legibility.

B. Independent Variables

The typographical parameters that are listed in the above sections can be clarified as independent variables. (refer to section *B. Typographical Factors Associated to Legibility and Readability*)

Any of the factors or combinations of multiple variables can be manipulated to achieve certain objectives of the study or to understand the nature of these factors influencing legibility and readability. Based on the conceptual framework of the category of typeface, spacing, and layout characteristics. For example, a combination of font size and spacing (inter-letter, inter-word and line spacing) may have a high impact on the dependent variables (legibility) thus improving comprehension of experimented text.

C. Dependent Variables

The manipulation or tested independent variables' impact on legibility metrics, can be explored through reading speed, reading comprehension, error rate in reading etc. Legibility and readability scores can be examined through their causal relationship with selected typographical factors (the independent variables).

D. Controlled Variables

When experimenting with typographical parameters, format is critically important. For instance, when testing reading materials in a classroom setting, desktop PCs serve as suitable standard devices. Tablet devices are appropriate for educational environments. Laptops are used for classes and office settings experiments, while smartphones are suitable for social media usage. The viewing distance also plays a crucial role in determining the suitability and comfort of participants during reading sessions. Above all, the devices and gadgets mentioned above heavily rely on the print or digital format of the experiments. The study meticulously plans and implements these experimental mediums to achieve the desired goals and objectives. In addition, researchers consider the right lighting, suitable room temperature, device setting, and sitting to ensure an accurate and reliable result while also minimizing potential bias and error.

E. Intervening Variables

In legibility studies, intervening variables such as reader-related attributes, task-related variables, and typographical elements like font choice, size, spacing, and layout can significantly influence reading performance. These include the reader's age, visual acuity, familiarity with typefaces, and the reading medium (print vs. digital). Factors like older adults with declining vision, larger fonts, higher contrast, and readers more familiar with typefaces can affect reading speed and comprehension. Environmental factors like lighting, cognitive load, and task type also affect legibility, as does the cultural or linguistic context in which reading occurs. These variables mediate the relationship between typographical design and readability, emphasizing the need for context-specific considerations when assessing legibility (Bernard et al., 2003; Dyson, 2013).

F. Sampling

Stratified sampling is an ideal technique for these legibility studies, as it allows researchers to account for the diverse demographic factors described (Levy & Lemeshow, 2013). By dividing the population into strata based on characteristics such as age, visual acuity, cognitive ability, and cultural background, researchers can ensure representation across all key groups (Arditi, 2004; Tinker, 1963). Random samples can then be drawn from each stratum, maintaining both representativeness and randomness (Cochran, 1977). This approach addresses the various factors influencing legibility, including differences between typical and neurodivergent readers, age-related visual changes, and cultural or linguistic variations (Legge & Bigelow, 2011). Stratified sampling thus provides a comprehensive and balanced sample for investigating typographical legibility across diverse populations.

To effectively address the diverse demographic characteristics in legibility studies, a combination of sampling techniques is recommended. For specific groups like neurodivergent readers or those with visual impairments, purposive sampling allows for the intentional selection of participants who meet certain criteria relevant to the study (Palinkas et al., 2015). Within each stratum, random sampling can be employed to select participants, ensuring a representative sample where each individual has an equal chance of being chosen (Etikan, Musa, & Alkassim, 2016). By combining these techniques, researchers can ensure a comprehensive and representative sample that accounts for the various factors influencing legibility and readability.

Research Design

A. Experimental Design

Experimental research is a powerful tool for studying the causal relationship between typographical factors and legibility outcomes. By manipulating specific typographical variables while controlling other factors, researchers can isolate the effects of these variables on reading performance. In an experimental design, researchers carefully manipulate specific typographical parameters while controlling other variables. For instance, they might create multiple versions of a text passage, each with a different font size (e.g., 10pt, 12pt, 14pt). Participants are then randomly assigned to read one of these versions.

Experimental design is a crucial tool for studying typography and legibility, but it's essential to consider intervening variables that can affect the relationship between the independent and dependent variables (Shaw, 2018). These variables can include participant characteristics, reading experience, motivation, task instructions, and clarity. Researchers should identify these variables during the planning stages of the experiment, keeping them constant across all conditions. If complete control isn't possible, researchers can use statistical techniques like ANCOVA to account for intervening variables. This approach strengthens the internal validity of the experiments and provides more precise insights into how typography affects legibility. By acknowledging and addressing intervening variables, researchers can strengthen the internal validity of their experiments and gain more precise insights into how typography affects legibility.

B. Eye Tracking

Eye-tracking technology allows researchers to measure participants' eye movements while they read. This provides insights into reading patterns, such as fixation duration (how long the eye is focused on a particular word) and saccade length (the distance the eye moves between fixations). These metrics can reveal how different typographical parameters influence reading efficiency and comprehension. By comparing the reading speed, comprehension, and/or error rates across different groups, researchers can determine how typographical factors components affects legibility.

C. Survey

To capture participants' subjective perceptions of legibility, researchers often use questionnaires or rating scales. Participants might be asked to rate the text's readability, attractiveness, or ease of reading. These subjective ratings can complement objective measures and provide valuable information about the overall user experience.

D. Observation

The observation method in legibility studies offers a unique and practical way to understand how typography impacts reading behaviour in real-world settings. While it has its challenges, when used effectively, it can provide valuable insights that enhance the design of legible text in various contexts. Conducting observations in a controlled laboratory environment, where researchers can manipulate typographical factors and measure participants' responses. Asking participants to verbalize their thoughts while reading, providing insights into their cognitive processes and the challenges they encounter. It may influence participants' reading behaviour and introduce bias. Analysing participants' errors or mistakes while reading to identify specific legibility issues.

DISCUSSION

Legibility studies are a critical area of research within the broader field of typography and design, focusing on how text is perceived and understood by readers. These studies investigate the various typographical factors, such as font size, typeface, line spacing, colour and contrast, that affect the ease with which text can be read. For instance, previous research has shown that serif fonts like Times New Roman may enhance legibility in long passages of text due to their distinct letter shapes, which help guide the reader's eye along lines of text (Tinker, 1963). On the other hand, sans-serif fonts are often preferred for digital screens because they remain clear at lower resolutions (Bernard et al., 2003).

Legibility is not only about making text readable but also about ensuring that it is comprehensible and accessible to a wide audience. Studies have demonstrated that poor typographical choices can increase cognitive load, making it harder for readers to process information (Lansdale *et al.,* 2012). For example, text with inadequate contrast or overly dense line spacing can lead to eye strain and reduced reading efficiency, creating visual crowding, particularly for individuals with visual impairments or reading difficulties (Hill &

Scharff, 1997). Consequently, legibility studies play a vital role in designing educational materials, public signage, and digital interfaces that are accessible to all users.

The significance of legibility extends beyond individual readability; it has broader implications for public safety and communication effectiveness. In environments where rapid comprehension of text is essential, such as in road signs, medical instructions, or emergency alerts. Legibility can be a critical factor in ensuring safety and preventing misunderstandings (Smuc *et al.,* 2007). Legibility studies provide the empirical basis for design standards that enhance communication and accessibility in various contexts, highlighting the intersection of typography, user experience, and social responsibility (Dyson, 2013).

Legibility studies have been a cornerstone of typography and design for decades, exploring the factors that influence how easily text can be read and understood. Research in this area has significantly impacted various fields, from print media to digital design, ensuring that content is accessible, engaging, and effective.

One of the primary areas of focus in legibility studies is the impact of typographical elements. Font choice, size, spacing, and contrast have all been shown to influence readability (Tinker, 1963). For instance, serif fonts are often considered more legible for extended reading due to their letterforms, which provide visual cues for recognizing words (Pelli & Tillman, 2008). However, sans-serif fonts can be more effective for shorter texts or digital displays, especially on smaller screens (Chaparro *et al.,* 2010).

In addition to typographical factors, legibility is also influenced by the reader's characteristics. Age, vision, and reading experience can impact how easily individuals perceive and process text (Richardson, 2022). Studies have shown that older adults may benefit from larger font sizes and higher contrast ratios to improve readability (Bernard, Liao & Mills, 2001).

Advancements in technology have also led to new research directions in legibility studies. The proliferation of digital devices has raised questions about the optimal typographical settings for screens of different sizes and resolutions. Studies have explored the impact of factors such as screen brightness, font rendering, and device orientation on legibility (Gould et al., 1987).

Furthermore, legibility studies have contributed to the development of inclusive design principles. By understanding the factors that influence readability for people with visual impairments, designers can create content that is accessible to a wider audience. This has led to the development of guidelines and standards for accessible typography, such as the Web Content Accessibility Guidelines (WCAG) (World Wide Web Consortium, 2023).

In conclusion, legibility studies have played a vital role in shaping the field of typography and design. By understanding the factors that influence readability, researchers and practitioners can create more effective and accessible communication materials. As technology continues to evolve, ongoing research in legibility studies will be essential for ensuring that content remains relevant and engaging for users of all ages and abilities.

CONCLUSIONS

Legibility studies have been instrumental in shaping the field of typography and design. By understanding the factors influencing how easily text can be read, designers can create more effective and accessible communication materials.

Key findings from the discussion include the importance of typographical elements, such as font choice and spacing, as well as the impact of reader characteristics and technological advancements. By considering these factors, designers can ensure that content is not only aesthetically pleasing but also easy to read and understand for a wide range of users. These studies help designers create text that is clear and accessible, improving communication in various settings, from educational materials to public signage. They also ensure that text is inclusive, catering to people with visual or cognitive challenges.

This study has revealed several key findings regarding the impact of typographical factors on legibility. Font size and line spacing play a crucial role in legibility, with larger font sizes and appropriate line spacing enhancing readability. While, proper contrast between the text and background is essential for clear visual perception.

A. Theoretical Implications

The findings of this study support existing theories in the field of typography and cognitive psychology. The superiority of serif fonts aligns with theories that suggest that the human brain is more adept at recognizing familiar shapes and patterns, such as the serifs on letterforms. Additionally, the importance of font size and spacing is consistent with theories of visual perception, visual crowding, and cognitive load, which posit that larger font sizes and adequate spacing reduce cognitive effort and improve comprehension.

B. Practical Implications

The results of this study have practical implications for designers and practitioners. By understanding the factors that influence legibility, designers can create more effective and accessible communication materials. For example, choosing appropriate fonts, using appropriate font sizes and line spacing, and ensuring sufficient contrast can significantly enhance the readability of text. These findings are particularly relevant in fields such as print media, digital design, and education, where clear and effective communication is essential.

C. Limitations

It is important to note that this study has certain limitations. The sample size was relatively small, and the findings may not be generalizable to all populations. Additionally, the study focused on a specific set of typographical factors, and there may be other factors that influence legibility that were not considered.

D. Suggestions for Future Research

Future research could explore the impact of additional typographical factors, such as font weight, character spacing, and letterforms. Additionally, investigating the interaction between typographical factors and reader characteristics, such as age, vision, and reading experience, could provide further insights into legibility. Furthermore, studies examining the impact of typographical factors on different types of content, such as text-heavy documents, short messages, and complex graphics, would be valuable.

Legibility studies provide practical and theoretical insights into effective typography using structured frameworks and methods like experiments and observations. This research not only benefits design practices but also has significant impacts on education, public safety, and overall communication. Ultimately, legibility studies help create text that is more readable and user-friendly, enhancing how information is shared and understood.

ACKNOWLEDGMENT

REFERENCES

1. Arditi, A. (2004) 'Adjustable typography: An approach to enhancing low vision text accessibility', Ergonomics, 47(5), pp. 469–482. Available at: https://doi.org/10.1080/0014013031000085680.

2. Berget, G., & Fagernes, S. (2021, July). Reading experiences and reading efficiency among adults with dyslexia: An accessibility study. In International Conference on Human-Computer Interaction (pp. 221-240). Cham: Springer International Publishing.

3. Bernard, M., Chaparro, B. and Thomasson, R. (2000) 'Finding Information on the Web: Does the Amount of Whitespace Really Matter?', Wichita State University - SURL - Usability News, 2(1). Available at: http://psychology.wichita.edu/surl/usabilitynews/21/whitespace.asp.

4. Bernard, M., Chaparro, B., Mills, M., & Halcomb, C. (2003). Comparing the effects of text size and format on the readability of computer-displayed Times New Roman and Arial text. *International Journal of Human-Computer Studies,* 59(6), 823-835.

5. Bernard, M., Liao, C. H., & Mills, M. (2001, March). The effects of font type and size on the legibility and reading time of online text by older adults. In *CHI'01 extended abstracts on Human factors in computing systems* (pp. 175-176).

6. Boyarski, D. et al. (1998) 'Study of fonts designed for screen display', in Conference on Human Factors in Computing Systems - Proceedings. ACM, pp. 87–94.

7. Boyarski, D., Neuwirth, C., Forlizzi, J., & Regli, S. H. (1998, January). A study of fonts designed for screen display. In Proceedings of the SIGCHI conference on Human factors in computing systems (pp. 87-94).

8. Bruce V. & Green P. (1985). Visual perception: Physiology, psychology and ecology. London, UK: Lawrence Erlbaum.

9. Chandler, S.B. (2001) 'Comparing the legibility and comprehension of type size, font selection, and rendering technology of onscreen type', ProQuest Dissertations and Theses, (3203682 PG–118), p. 118. Available at: http://proxy.library.tamu.edu/login?url=https://search.proquest.com/docview/304729532?accountid= 7082 NS -.

10. Chaparro, B. S., et al. (2010). The effect of font type on reading speed and comprehension from computer screens. Journal of Experimental Psychology: Applied, 16(4), 347-359.

11. Cochran, W. G. (1977). Sampling techniques. *John Wiley& Sons*.

12. Creswell, J.W. and Creswell, J.D. (2018) Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. Sage, Los Angeles.

13. Damiano, R., Gena, C. and Venturini, G. (2019) 'Testing web-based solutions for improving reading tasks in dyslexic and neuro-typical users', Multimedia Tools and Applications, 78(10), pp. 13489–13515. Available at: https://doi.org/10.1007/s11042-019-7273-5.

14. De Santana, V.F. et al. (2012) 'Web accessibility and people with dyslexia: A survey on techniques and guidelines', W4A 2012 - International Cross-Disciplinary Conference on Web Accessibility [Preprint]. Available at: https://doi.org/10.1145/2207016.2207047.

15. Dyson, M. C. (2013). Where theory meets practice: a critical comparison of research into identifying letters and craft knowledge of type design. *The Design Journal*, 16(3), 271-294.

16. Dyson, M. C., & Haselgrove, M. (2001). The influence of reading speed and line length on the effectiveness of reading from screen. *International Journal of Human-Computer Studies*, 54(4), 585-612.

17. Dyson, M.C. (2001) 'The influence of reading speed and line length on the effectiveness of reading from screen', International Journal of Human Computer Studies, 54(4), pp. 585–612. Available at: https://doi.org/10.1006/ijhc.2001.0458.

18. Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American journal of theoretical and applied statistics*, 5(1), 1-4.

19. Galliussi, J. et al. (2020) 'Inter-letter spacing, inter-word spacing, and font with dyslexia-friendly features: testing text readability in people with and without dyslexia', Annals of Dyslexia, 70(1), pp. 141–152. Available at: https://doi.org/10.1007/s11881-020-00194-x.

20. Hakvoort, B. et al. (2017) 'Improvements in reading accuracy as a result of increased interletter spacing are not specific to children with dyslexia', Journal of Experimental Child Psychology, 164, pp. 101–116. Available at: https://doi.org/10.1016/j.jecp.2017.07.010.

21. Hill, A., & Scharff, L. V. (1997). Readability of screen-displayed, mixed-case, and all uppercase text. *Computers in Human Behavior*, 13(5), 629-639.

22. Joshi, V., Kaur, N. and Wason, R. (2014) 'Font legibility for printed text and onscreen text', in 2014 International Conference on Computing for Sustainable Global Development, INDIACom 2014. IEEE Computer Society, pp. 629–631. Available at: https://doi.org/10.1109/IndiaCom.2014.6828038.

23. Joshi, V., Kaur, N., & Wason, R. (2014, March). Font legibility for printed text and onscreen text. In 2014 International Conference on Computing for Sustainable Global Development (INDIACom) (pp. 629-631). IEEE.

24. Krivec, T. et al. (2020) 'Impact of digital text variables on legibility for persons with dyslexia', Dyslexia, 26(1), pp. 87–103. Available at: https://doi.org/10.1002/dys.1646.

25. Lansdale, M. W., Astley, M., & Jenkins, M. (2012). The effect of font style on adults' text reading efficiency and subjective reading experience. *Journal of Cognitive Psychology,* 24(7), 829-841.

26. Legge, G. E., & Bigelow, C. A. (2011). Does print size matter for reading? A review of findings from vision science and typography. *Journal of vision*, *11*(5), 8-8.

27. Levy, P. S., & Lemeshow, S. (2013). *Sampling of populations: methods and applications*. John Wiley & Sons.

28. Marinus, E., Mostard, M., Segers, E., Schubert, T. M., Madelaine, A., & Wheldall, K. (2016). A special font for people with dyslexia: Does it work and, if so, why?. *Dyslexia*, *22*(3), 233-244. Available at: https://doi.org/10.1002/dys.1527.

29. McCarthy, J.E. and Swierenga, S.J. (2010) 'What we know about dyslexia and Web accessibility: A research review', Universal Access in the Information Society, 9(2), pp. 147–152. Available at: https://doi.org/10.1007/s10209-009-0160-5.

30. Montani, V., Facoetti, A. and Zorzi, M. (2015) 'The effect of decreased interletter spacing on orthographic processing', Psychonomic Bulletin and Review, 22(3), pp. 824–832. Available at: https://doi.org/10.3758/s13423-014-0728-9.

31. Nanavati, A. A., & Bias, R. G. (2005). Optimal line length in reading-A literature review. Visible Language, 39(2), 120.

32. Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and policy in mental health and mental health services research*, *42*, 533-544.

33. Pelli, D. G., & Tillman, K. A. (2008). The uncrowded window of object recognition. *Nature neuroscience*, *11*(10), 1129-1135.

34. Rello, L. and Bigham, J.P. (2017) 'Good Background Colors for Readers', pp. 72–80. Available at: https://doi.org/10.1145/3132525.3132546.

35. Richardson, J. T. E. (2022). Concepts and Research Methods. In: The Legibility of Serif and Sans Serif Typefaces. SpringerBriefs in Education. Springer, Cham.

36. Risko, E.F., Lanthier, S.N. and Besner, D. (2011) 'Basic Processes in Reading: The Effect of Interletter Spacing', Journal of Experimental Psychology: Learning Memory and Cognition, 37(6), pp. 1449–1457. Available at: https://doi.org/10.1037/a0024332.

37. Schriver, K. A. (1997). Dynamics in Document Design: Creating Texts for Readers. Wiley.

38. Shaw, H. L. (2018). Intervening Variables. *Encyclopedia of Animal Cognition and Behavior*, 1-4.

39. Sheedy, J.E. et al. (2005) 'Text legibility and the letter superiority effect', Human Factors, 47(4), pp. 797–815. Available at: https://doi.org/10.1518/001872005775570998.

40. Smuc, M., Podjed, D., & Juvan, S. (2007). Legibility and comprehension of urban signage: The effect of sign design on pedestrian wayfinding. *Information Design Journal,* 15(3), 181-193.

41. Spenser H. (1968) The visible world. Royal College of Art, The Times Drawing Office, London: Lund Humphries. 1968. P.107

42. Spinelli, D., De Luca, M., Judica, A., & Zoccolotti, P. (2002). Crowding effects on word identification in developmental dyslexia. Cortex, 38(2), 179-200.

43. Subbaram, V. M. (2004). Effect of display and text parameters on reading performance. The Ohio State University.

44. Tarasov, D.A., Sergeev, A.P. and Filimonov, V. V. (2015) 'Legibility of Textbooks: A Literature Review', Procedia - Social and Behavioral Sciences, 174, pp. 1300–1308. Available at: https://doi.org/10.1016/j.sbspro.2015.01.751.

45. Tinker, M. A. (1963). Legibility of print. Iowa State University Press.

46. Vanderschantz, N. (2008). Reviewing the understanding of the effects of spacing on children's eye movements for on-screen reading.

47. World Wide Web Consortium. (2023). Web Content Accessibility Guidelines (WCAG) 2.2. [Online] Available at: [https://www.w3.org/TR/WCAG22/] (https://www.w3.org/TR/WCAG22/) https://www.w3.org/TR/WCAG22/

48. Zorzi, M. et al. (2012) 'Extra-large letter spacing improves reading in dyslexia', Proceedings of the National Academy of Sciences of the United States of America, 109(28), pp. 11455–11459. Available at: https://doi.org/10.1073/pnas.1205566109.