

Designing Reading Platform UIs and Standardizing Accessibility

A study of digital reading preferences across disability communities that impact the user experience for all readers

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Abstract: In an era where everyone will experience a disability at some point (even if temporary), inclusive design is increasingly vital to information accessibility for all users. This study aims to learn the digital reading preferences of various disability communities and address implications for a design for all approach to improve the digital reading experience for everyone. Method. Research questions systematically guided the exploratory review, resulting in 14 studies that underwent thematic analysis with inductive coding. Results. With a lens from the information science, user experience, and disability studies fields, this paper presents five themes identified across the studies. Digital reading preferences of people with and without disabilities and recommendations for digital reading designs are discussed. Conclusion. Culture, assumptions, and misperceptions of accessibility, disability, technology, and literacy play a part in how society and social accessibility impact people with and without disabilities. This paper presents preliminary findings, gaps, and limitations that provide future steps for this project and other research directions. The viewpoint of disability communities may help increase the accessibility, usability, and enjoyment of digital reading more broadly, where design for all can be the tool for standardizing accessibility, which benefits everyone.

Keywords: accessibility, disability, digital reading, web reading, inclusive design, design for all, universal design, user experience, information retrieval

1. Introduction

Reading has many purposes: for education, employment, and enjoyment. Books are read worldwide, in various languages, and by people of varying ages, among other identity characteristics. Everyone has preferences, including genres or mediums, such as physical printed or digital books. This literature review sought to learn the digital reading preferences of the disability community and addresses implications for the design for all approach. Although there are many categories of disability—including sensory (e.g., vision, hearing), motor, cognitive/learning, and temporary—this review is focused on the larger, broad population to identify any overlapping preferences among disability types. This knowledge can inform recommended practices in user experience design and web design for creating screen-based reading platforms from the perspective of a person with a disability. This topic is of importance as 1.3 billion people worldwide (16%) have a disability, and everyone will experience a disability at some point in their life, even if temporary (CDC, 2023). For example, a broken wrist is a temporary motor disability, a person undergoing eye surgery will have temporary vision impairment, and cognitive decline affects people as they age. Additionally, with 25% of the U.S. population (and 16% worldwide) having disabilities (CDC, 2023), it is mainstream enough that

digital books should be designed with accessibility and usability from the start. A digital book (or web book) is a book that can be read by electronic means, whether as a digital PDF that is read on a computer or tablet, HTML pages, e-reader device that reads a file format such as epub, or another medium that involves the use of the internet (the web) or downloadable file format to read a book with a screen.

Though there is debate about when the first digital book appeared (Koepnick, 2016; Wilber, 2023), many inventions have aided people's ability to read books in digital format. Such digital formats have been instrumental to the increased access to materials that people with disabilities can read for work, school, and personal enjoyment.

1.1. Background and Definitions

Definitions helpful to this paper include the following:

- Disability is 'an interaction between an individual with an impairment and the environment rather than as a deficit of an individual' (NCD, 1998).
- Accessibility involves the design of a product that enables people with a disability to use and enjoy products just as well as someone without a disability. Usability is more about the design of a product and how effective, efficient, and satisfying it is to use. (ADA, n.d.; IDF, n.d.; Schaller, 2021; WHO, 2023).
- Inclusive design and universal design take the design for all approach to cater to the broadest range of people, making it more inclusive or universal (Norman, 2013). Inclusive design also considers the full range of human diversity concerning ability, language, culture, gender, age, and other identity characteristics (IDF, n.d.).
- An electronic book (ebook) is a digital representation of a printed book and is read on devices such as smartphones, tablets, computers, or e-readers (Roden, 2023). Ebooks are typically created in PDF, HTML, or EPUB formats (though there are others). The ebook format allows for flexible formatting and navigation between pages. Ebooks use an e-reader device that either reads proprietary file formats (e.g., MOBI, AZW, PDF) and requires device-dependency or open file formats (e.g., EPUB and DAISY), which are device-independent (can be read on any device) (Junus, 2012).
- An audiobook is a sound recording of a book (previously referred to as a book on tape) played on a compatible device, where some would argue that you are 'listening' to the book rather than 'reading' it (Moyer, 2012).
- Assistive technology is any item or piece of equipment used to increase, maintain, or improve the functional capabilities of people with disabilities (Schaller, 2021). Some examples include screen magnifiers, text-to-speech software, and screen readers. A screen reader is an interactive software used to read ebooks (Grammenos et al., 2009). Popular examples include JAWS and NDVA.

This paper uses 'digital books' to refer to all electronically-enabled books (ebook, audiobook, reading on the web) whether online or offline and regardless of format: PDF, HTML, EPUB, sound file, etc. This paper also considers the social model of disability. According to the social model of disability, disability is one aspect of a person's identity, a natural part of human diversity (Olkin, 2022). Scholars in the disability field argue that disability is often misread by assumptions that people without disabilities make concerning the lived experience of disability (Olkin, 2022; Kasnitz, 2020; Mankoff et al., 2010). Additionally, disability is often misread by affordances, a

perception of need or accommodation, whether one is even wanted or asked for by a person with a disability (Kasnitz, 2020). Assumptions and affordances are also crucial to the user experience (UX) design field, especially the subfield of human-computer interaction (Norman, 2013; Croon, 2022). A human makes assumptions when interacting with technology (e.g., what a user expects to happen when a specific button is clicked). The layout or design of technology gives the user a compelling indicator of a function (or affordance) to help them understand that technology or interaction expectation (e.g., clicking on a hyperlinked chapter two heading in the table of contents would take the user to the beginning of chapter two). It is through these disability and human-centered design lenses that digital reading preferences are explored in this paper.

2. The research problem and research questions

Disability studies and UX / human-centered design disciplines focus on accessibility and are concerned with improving the lived experience of people with disabilities. Additionally, these fields advocate that universal or inclusive design helps everyone, not just people with disabilities (IDF, n.d.; Norman, 2013; Mankoff et al., 2010; Stephanidis, 2014). Another applicable field is information science, which has the foundations for information retrieval through reading digital books. This paper applies these frameworks to the inquiry of digital reading preferences of the disability community (reading of books, e.g., via HTML webpages, PDF, epub, etc.). This paper aims to learn about the digital reading preferences of disability communities to improve the digital reading experience through inclusive design and screen-based interfaces and interactions.

With a framework of universal design, accessibility, and inclusive design, the following research questions are addressed in this paper:

1. What are the digital reading format preferences of members of the disability community, and the reasons for these preferences?
2. What assistive technologies, if any, do readers use when reading digital books?
3. How do/can these preferences also benefit people without disabilities?

3. Methodology

A systematic review protocol was used to conduct this review following the eight common literature review steps, as demonstrated by Xiao and Watson (2019). Once these research questions are answered, the lessons learned will be applied to the author's next phase that includes a study on digital reading preferences of people with disabilities. This paper's exploratory review is the necessary precursor to development of a future survey protocol.

The databases and search engines used in this study included Library Literature and Information Science Full Text, Scopus, ERIC, and Google Scholar. The search string included the following keywords: (web OR electronic OR digital) books; (web OR electronic OR digital) reading; preferences; reading platforms; inclusive design; disability OR disabilities; web technologies; and assistive technologies.

Screening for inclusion applied time limiters since digital books require technology, a ubiquitous and evolving medium. Thus, the literature review focused on articles, book chapters, and web resources from no earlier than 2000, excluding earlier studies that may have outdated information, as web platforms and technologies have changed drastically in the past two decades. Studies in English were sought, and sources with survey instruments were given special consideration. A scoring rubric helped screen for inclusion and assess the quality of the studies,

which resulted in 14 studies that underwent analysis, as seen in Table 1 (An accessible list version of Table 1 is in Appendix A.1).

The list of 14 studies is broken down by disability type or topic, and some sources may be in multiple categories, which helps address the goal of this review, which is to identify digital reading preferences among disability communities.

Table 1. List of studies broken down by disability type or topic

Author and Year	Disabilities in general	Blind, low vision focus	Deaf, hard-of-hearing focus	Learning, Autism focus	Motor, print* focus	Audiobook, Ebook, and e-reader formats
Alonzo et al. (2022)			X			
Grammenos et al. (2009)		X				X
Junus (2012)				X	X	X
Knight et al. (2015)				X		
Lee et al. (2023)		X				X
Mason (2012)		X			X	X
Maatta & Bonnici (2014)					X	X
Moyer (2012)	X			X		X
Mune & Agee (2014)					X	X
McNaught & Alexander (2014)					X	X
Orim et al. (2021)	X					X
Park et al. (2022)		X				
Romen & Svanaes (2008)				X	X	
Stephanidis (2014)	X		X			

3.1. Descriptive Data of Studies Reviewed

The 14 studies were published from 2008 to 2023 and were conducted by authors in the following countries: (2) Greece, (1) Nigeria, (1) Norway, (1) South Korea, (1) United Kingdom, and (8) United States. The studies included articles and book chapters, case studies, user testing, reviews or evaluations of digital reading devices, platforms, or products, and various methods, including surveys, interviews, and accessibility or usability testing.

Table 1 also shows the 14 studies broken down by disability type or topic, which includes the following foci: (3) disabilities in general, (4) blind or low-vision, (2) Deaf or hard-of-hearing, (4) learning or Autism, (6) motor or print which combines visual, hearing, physical, and learning, and (9) audiobook, ebook, or e-reader formats. The review performed a thematic analysis of the data using open coding methods to seek trends or themes in the literature.

4. Results

The review identified five recurring themes across the literature: challenging reading aspects, common accessibility barriers, and workarounds, social accessibility issues including perceptions and assumptions, universal and design for all implications, and reading preferences. The themes identified in each study are listed in Table 2, along with the author's country affiliation, as region diversity is important in addition to diversity across source types (case study, accessibility evaluation, review, etc.) and disability type. The rest of this section highlights summaries and features of the studies according to each theme.

Table 2. Themes found in the literature by author and country affiliation

Author/Year	Country Affiliation	Themes
Alonzo et al. (2022)	United States	Challenging reading aspects Common accessibility barriers and workarounds Social issues, assumptions, and perceptions Universal design, design for all (benefits)
Grammenos et al. (2009)	Greece	Challenging reading aspects Social issues, assumptions, and perceptions Preferences
Junus (2012)	United States	Common accessibility barriers and workarounds
Knight et al. (2015)	United States	Challenging reading aspects Preferences
Lee et al. (2023)	South Korea	Challenging reading aspects Preferences
Mason (2012)	United States	Common accessibility barriers and workarounds Universal design, design for all (benefits) Recommendations
Maatta & Bonnici (2014)	United States	Common accessibility barriers and workarounds
Moyer (2012)	United States	Challenging reading aspects Preferences
Mune & Agee (2014)	United States	Common accessibility barriers and workarounds
McNaught & Alexander (2014)	United States	Common accessibility barriers and workarounds Universal design, design for all (benefits)
Orim et al. (2021)	Nigeria	Common accessibility barriers and workarounds Social issues, assumptions, and perceptions Preferences
Park et al. (2022)	United States	Challenging reading aspects Common accessibility barriers and workarounds Preferences
Romen & Svanaes (2008)	Norway	Common accessibility barriers and workarounds
Stephanidis (2014)	United States	Challenging reading aspects Common accessibility barriers and workarounds Social issues, assumptions, and perceptions Universal design, design for all (benefits)

4.1. Challenging Reading Aspects

Challenging reading aspects are seen across several studies with notable concern on complicated text and overwhelming or overloaded feelings of information density that impact the reader's

comprehension and literacy skills. For example, according to Knight et al., 2015, students with autism spectrum disorder (ASD) experience difficulty comprehending science content due to the background knowledge as abstract and figurative language are needed to comprehend the material. One intervention to aid comprehension and tested by Knight et al. (2015) is the supported electronic text (eText), which helps to focus content with increased font sizes and contrasts, clarifying concepts through hyperlinks to other digital pages, providing graphics and vocabulary definitions, and the use of reading text aloud (text-to-speech). Text-to-speech was also a helpful solution for the challenges of digital reading in the literature for print disabilities (Junus, 2012) and for people who are blind (Grammenos et al., 2009).

Another type of cognitive or learning disability is dyslexia. Ann Milani et al. (as cited in Moyer, 2012) conducted a study on reading challenges and found that students with dyslexia who used audiobooks significantly improved reading accuracy compared to other book formats. Some studies tested these information-dense and overloaded information contexts (Lee et al., 2023; Park et al., 2022; Romen & Svanaes, 2008). For example, Romen and Svanaes (2008) conducted usability testing of this issue, which showed people with disabilities had more problems using websites than people without disabilities, citing the number of links and amount of text on a page as specific challenges.

Relatedly, academic papers tend to be information-dense, which challenges all readers. Research has shown that the inaccessibility of academic papers is still relatively high, and navigating an academic paper with low vision has significant challenges, for example, small fonts that decrease legibility, the ability to easily check references and follow references across the article is challenging for screen readers, and complex layouts impact how accurately a PDF parses an article (Park et al., 2022). With a focus on low-vision readers, Park et al. (2022) explored the design of academic paper interfaces to enable readers to navigate papers. They sought to understand the experiences of these low-vision readers by using a tool that helps address easier navigation and interface preferences. The information load of an academic paper is overwhelming. Low-vision users have a limited amount of screen they can view at a time, which requires extra time to parse out relevant information, as explained by one participant in the study:

My rate of reading was incredibly slow [...] And [...] because I was reading so slowly as well, I would lose track of the central idea, so it was just not working for me (Park et al., 2022).

To illustrate this, there is no easy way to check a citation and get back to where the user left off reading. Despite trying some strategies to deal with navigation challenges, three of six users gave up on navigating a paper, which proved rather challenging (Park et al., 2022).

Lee et al. (2023) conducted a study to improve and propose an accessible digital comic book reader for people with visual impairments. The researchers conducted a formative online survey about ebook and audiobook experiences with 68 participants who were blind or had low vision. This study informed the design of the AccessComics prototype, which received feedback on scene description and sound effects (e.g., 'Bam' and 'Pow') preferences as these aspects are challenging for visually impaired readers to grasp as their descriptions are often left out of comic books that are converted to digital format.

Alonzo et al. (2022) discussed the reading experiences and interests of people who are Deaf or hard-of-hearing that work in the computing industry. Through a survey and interviews, Deaf and hard-of-hearing participants were asked about their experience and use of automated text simplification (ATS) tools that automatically rewrite complex text to simplify reading. Striving to

make reading less of a challenge is essential as approximately 15% of the U.S. population are Deaf or hard-of-hearing, and while many are strong readers, it has been suggested that 17% of deaf adults have low literacy (Alonzo et al., 2022).

Grammenos et al. (2009) devoted a chapter to challenging reading aspects in *The Universal Access Handbook* (edited by C. Stephanidis), introducing electronic books to provide accessible educational materials to blind students. In general, a blind student will access computers with two basic technologies: text-to-speech (which allows for the dynamic reproduction of text in a human-like voice) and Braille displays (a writing system that uses patterns of six to eight raised dots to represent letters and numbers). 'Braille displays work complementary to text-to-speech. It is generally considered that speech is for speed and Braille is for accuracy' (2009, p. 50.2). Screen readers only present one word at a time with either method; thus, it is hard for a blind person to get an overview. Hence, electronic books (ebooks) have a crucial advantage over print books in that the accessibility of speech synthesizers, renditions on Braille displays, and hands-free access help blind people read more easily. However, ebooks have different file formats (e.g., plain text, HTML, PDF, Mobi, DAISY, etc.) that complicate their accessibility. Grammenos et al. (2009) found that existing ebooks that are indeed accessible to blind people are typically novels designed for a single user to read and not educational textbooks that have varying features such as questions, exercises, and annotations.

4.2. Common Accessibility Barriers and Workarounds

Romen and Svanaes (2008) state that the number of links on a page and the amount of text on a page is a reading challenge for people with disabilities. A common solution or aid is text-to-speech software, which helps people on the autism spectrum (Knight et al., 2015), people with print disabilities (Junus, 2012), and people who are blind (Grammenos et al., 2009).

Alonzo et al.'s (2022) study on automated text simplification (ATS) as an assistive reading tool yielded a prioritized list of frequently used workarounds by the Deaf and hard-of-hearing community to overcome complicated texts (e.g., looking up words, finding other texts with similar content) and design considerations for assistive reading tools which include expanding user autonomy with tool use and addressing the social accessibility perception of the technology (a societal issue discussed in detail later).

Complicated text workarounds were discussed in the literature, focusing on visual impairment. For example, to overcome the reading challenges of low-vision readers, Park et al. (2022) looked at using an organic crowdsourcing technique that allows users to leave traces of reading paths for others to leverage. Overall, low-vision users want an interface to help orient their reading and digestion of complex concepts. Some design considerations for accessibility barrier workarounds in academic papers were presented in (Park et al., 2022), including problems specific to low-vision users:

1. Persistent feature access.
2. Equal access to original text.
3. Interfaces that have independence in mind.
4. Destination clarity of linked content.
5. Personal benefits such as adding bookmarks.

The literature addressed accessibility barriers related to device and file formats in depth (Junus, 2012; Romen & Svanaes, 2008; Mason, 2012; Maatta & Bonnici, 2014; McNaught & Alexander, (2014). The rest of this section summarizes these accessibility barriers. According to Junus (2012),

people with print disabilities have great potential to use ebooks if the devices used are well designed, use open formats, and are compatible with assistive technologies. However, the digital publishing industry has made so many formats and e-readers that are inaccessible to people with visual, hearing, or learning disabilities. Mason (2012) agrees that many ebooks are still inaccessible. Accessible ebooks benefit everyone, but the e-reading platforms and devices (and their hundreds of combinations of file formats) result in various levels of accessibility and modes of access; plus, the ebook market rarely provides the accessibility feature information needed to assess the ebook before purchase (Mason, 2012). Mason (2012) continues her evaluation of the pros and cons of various ebook reader hardware: Apple iOS software, Mac, and Windows PC support, noting that at the time of her review, the Nook and all Android platforms tested failed to be accessible. Mason (2012) also discussed the advantages and areas for improvement for Biblio, CourseSmart, EPUB, Adobe Digital Editions, OverDrive, Google Books, iBooks, Kindle, and PDF. With concluding advice and hopes, Mason (2012) states,

In an ideal world all the major ebook technologies would be accessible to print-disabled and blind users. These book platforms would allow users to browse, purchase, and consume content in the most comfortable and appropriate manner for the user's needs and the type of content consumed. All ebook platforms are falling short of this laudable goal. Some options work fairly well and allow reasonable access to text, but all of the platforms discussed in this article need improvement.

To put this into perspective, ebooks are either open or proprietary file formats. EPUB and DAISY are open formats, meaning they are device-independent (they can be read with any e-reader that supports open formats). In comparison, proprietary format ebooks (MOBI, Amazon Kindle's AZW, PDF) may have been originally based on an open format but ultimately configured only to work on a specific e-reader. "In general, open format e-texts are far more accessible than proprietary formats" (Junus, 2012).

Maatta and Bonnici (2014) examined the usability of three electronic reading (e-reader) devices: the Apple iPad 2, Amazon's Kindle Fire, and Barnes and Noble's NOOK tablet. Though upgraded models of these devices are available today, their implications for the study and historical perspective are important, including a lack of studies on e-reader usability testing with diverse users. Common issues discussed among all usability study participants (n=8) included concerns for device weight, location of the power on/off button, Bluetooth capability, acceptance of EPUB formats, and the location and ability to find the device settings to change accessibility features. Maatta and Bonnici (2014) describe several instances where universities and public libraries were being sued (circa 2000-2012) for either requiring e-readers as textbooks or making ebooks available that were not accessible (Matta & Bonnici, 2014). This is perhaps due to the rapid development of the e-reader market at the time, where Maatta and Bonnici (2014) note that there have been limited studies on e-reader usability with members of the disability community, particularly users with print disabilities (e.g., low vision, no vision, and dyslexia). These researchers also found that two of the three devices offered no accessibility features for people with print disabilities requiring assistive technologies. The iPad was found to be accessible for individuals with mild-to-moderate print disabilities but not for people with a higher severity level, as it had limitations in locating the device settings to customize accessibility features.

Similarly, Mune and Agee (2016) tested 16 academic ebook platforms against the features most print-disabled users use and rely on. Their study found that most platforms offered text resizing or zoom capabilities, while only one provided page reflow. None of the platforms allowed user

adjustments to the fonts' color, size, or style. For a document to be fully accessible, an alternative text description for every image or table is required, and only six vendors did this consistently. Only 7 of the 16 vendors had a Voluntary Product Accessibility Template (VPAT), a statement completed by the vendor to demonstrate its compliance with Section 508 requirements. Additionally, three of 16 vendors did not allow the ebook to be downloaded or printed, which is helpful for users who want to read offline. Mune and Agee (2016) recommend standardizing the file format of all books offered, using both the EPUB 3 and PDFs, as the former is preferred for screen reader compatibility, and the latter allows a balanced approach to downloading, printing, and copying (though the PDFs must never be just images).

Romen and Svanaes (2008) sought to validate the usefulness of the Web Content Accessibility Guidelines (WCAG) as a heuristic for website accessibility. Using a controlled usability test with people with visual, motor, or dyslexic impairments (n=7) and without disabilities (n=6), Romen and Svanaes (2008) found that only 27% of the identified accessibility problems were identified through the use of WCAG alone and testers with disabilities experienced a significantly larger number of problems using the website compared to testers without disabilities. Notably, the high number of links on a page and the amount of text on a page were issues for people with visual and motor impairments. For all disability types, there were too many navigation levels and a lack of instructions for advanced functions or form use. The most frequent accessibility problems experienced by the three disability types (visual, motor, and dyslectic) are outlined as follows:

- Problems specific to visually impaired users:
 - Links that start with the same letter and almost read the same. These are difficult to distinguish.
 - Links with identical spelling that point to different places (e.g. "Click here to go to A and here to go to "B").
 - High number of links and redundant links.
- Problems specific to motor-impaired users (tremors, etc.):
 - The screen element/menu/button's surface was larger than the clickable surface.
 - Mouse-over menus that disappear when the user no longer hovers disrupt navigation.
 - Small font sizes and many links placed closely together increase the risk of erroneous clicks.
- Problems specific to motor-impaired users (tremors, etc.):
 - The screen element/menu/button's surface was larger than the clickable surface.
 - Mouse-over menus that disappear when the user no longer hovers disrupt navigation.
 - Small font sizes and many links placed closely together increase the risk of erroneous clicks.
- Problems specific to dyslectic users:
 - Positioning of links and navigational mechanisms.
 - Web pages crowded with a lot of text and links become confusing and difficult to read and navigate.

With Romen and Svanaes's' (2008) study, it is important to note that at the time of this writing, WCAG 1.0 was used (as of 2024, WCAG 2.2 is in use). Despite the older version of WCAG, the study's finding demonstrates that WCAG alone cannot guarantee website accessibility. The study used the two groups of users to test against accessibility (problems experienced only by testers

with disabilities) and usability (problems experienced by both groups) differences on two websites. Romen and Svanaes (2008) found that, on average, testers with disabilities experienced a significantly larger number of problems using the website and conducting the tasks than testers without disabilities (17.1 average problems vs. 9.3).

McNaught and Alexander (2014) argue that the publishing industry should mandate vendors to label the range of accessibility features offered in their products (like labeling is done in the food industry). According to McNaught and Alexander (2014), if the right format and construction of the ebook becomes the standard in ebooks, they will be accessible to a range of users, including people with print disabilities. McNaught and Alexander (2014) also discuss common accessibility barriers:

- File format choices (e.g., PDF documents that are images of text that cannot be read aloud, recolored, or reflowed to fit larger font sizes, and flipbooks struggle with magnified reflowable text and text-to-speech).
- Lack of accessible production decisions (e.g., tagging headings for semantic meaning)
- User interface of delivery platforms lacking the ability to change fonts and background colours.
- Lack of information on accessibility features for a product.

According to McNaught and Alexander (2014), the right format and the right construction of the ebook can offer (p. 35-36): Magnification with text reflow (line lengths can reflow when text is magnified so that the line still fits the width of the screen, improving reading speed); colour contrast changes (helps people with visual impairments or dyslexics with scotopic sensitivity and people working in very dark or very light environments); text-to-speech support; alternative texts for images/tables (helping blind readers and sighted readers in their interpretation of the information); and compatibility with assistive technology devices.

Orim et al. (2021) discussed an important financial and circumstantial dependency that can impact accessibility and preferences for digital reading. Orim et al. (2021) found that a person's level of computer literacy and the ability to pay for the technology is a barrier to ebook use. It is challenging for most students with disabilities (in the Orim et al. study at a public university in Nigeria) as the students come from economically disadvantaged families.

4.3. Social Accessibility Issues (Culture, Assumptions, and Perceptions)

Culture affects everyone's reading habits and preferences. For example, the interpretation of symbols, colors, and gestures have different cultural interpretations. Green and yellow are sacred in certain religions, while the reading direction (left to right, right to left) is based on geographic region (Stephanidis, 2014). Culture also plays a part in disability types and society's perception of what it means to have a disability (Grammenos et al., 2009; Stephanidis, 2014; Alonzo et al., 2022; Orim et al., 2021).

In previous decades, it was common for students with disabilities to be segregated into separate, special classrooms or schools for students with the same disability. According to Grammenos et al. (2009), this practice negatively impacted the student's ability and opportunity for inclusion in society; currently, many countries take a more open approach to inclusive education. Today, students with disabilities can participate in the mainstream classroom alongside students without disabilities, which provides better opportunities for inclusion but also creates a challenge for

getting the same educational materials to students with disabilities in a format that is accessible to them.

This challenge of access to accessible books can have larger societal implications that can affect a culture's literacy rate. Orim et al. (2021) claim that a positive reading habit among students, including those with disabilities, will produce a literate and developed society. Thus, accessibility of books is critical to culture regardless of disability status. There is also a perception of disability and intellectual competence found in some societies, which impacts the social dimensions of culture.

Alonzo et al. (2022) found that Deaf and hard-of-hearing adults prefer reading with automatic text simplification (ATS) technology, though there are social accessibility concerns. People want to be seen as competent and reliable; however, using assistive reading tools or technologies may conflict with their desired image as public perspectives of assistive technology use imply low intelligence or reading levels. Alonzo et al. (2022) also posit this assistive reading tool could be useful to the general population (rather than just for the Deaf community), which would help mitigate negative perceptions of tool use if more people were using it.

Interactions with any computer or device involve reading or writing text. According to Stephanidis (2014), *'Deaf users, at first glance, would not appear to be disadvantaged in their ability to read and write. However, interfaces requiring reading and writing also have the potential to disenfranchise many deaf users'*. This demonstrates another misperception or assumption of the disability community. Studies have shown that most U.S. deaf high school graduates have a fourth grade reading level; thus, sign language interfaces are critical for that subset of the Deaf population who have difficulty reading texts (Stephanidis, 2014). American sign language (ASL) is a natural language distinct from English because it is not based on spoken language. ASL is a visual language where the signer's facial expressions, utilization of the space around them, and movements of the eyes, head, arm, shoulder, and hand convey linguistic information (Stephanidis, 2014). This reading challenge of being able to use sign language in interfaces is lacking in some digital reading platforms.

Culture, along with assumptions and misperceptions of education and literacy, play a part in how society and social accessibility impact people with disabilities. Examples were seen throughout the literature review. It is perhaps summarized best in Stephanidis (2014), which describes the disability spectrum broadly (e.g., difficulty with perception, motion, cognition, and age) to discuss challenges around social issues (barriers to technology, poverty, educational opportunities, social status, etc.) and computer use among these user types and how universal design can benefit everyone.

4.4. Universal Design and Design for All Implications

According to Stephanidis (2014), addressing web accessibility puts universal design factors into perspective regarding how user interfaces (including ebooks) can be designed with accessibility as a foundation for creating a better reading platform for all. Accessible books benefit print-disabled and blind readers because *'when an ebook is presented in an accessible format on an accessible ebook reader, the user can choose to read the book using text-to-speech, Braille, or magnification. Furthermore, accessible ebooks in an open market benefit everyone'* (Mason, 2012). Although advances in publishing and education now show how an accessible book is better, there are still opportunities for change, including accessible books becoming the mainstream product. According to McNaught and Alexander (2014), the Accessible Publishing Best Practice Guidelines for Publishers will help the publishing industry at large create better,

more accessible books. “The more accessible the mainstream product becomes, the fewer costs will be incurred meeting specific learning needs” (2014), which benefits all readers.

Specific examples of accessibility adaptations for people with disabilities also help people without disabilities are found in the literature (Lee et al., 2023; Park et al., 2022; Alonzo et al., 2022). For example, Lee et al. (2023) found people with and without disabilities had the same preferences for real sound effects over spoken word sound effects in digital comic books. Park et al. (2022) discussed how academic papers are information-dense reading for all users. Alonzo et al. (2022) found that a preference for using tools that make it easier to read (simplified text) helps everyone, not just people with hearing impairments.

A notable universal design application in Alonzo et al. (2022) is the Deaf communities’ perspective on how the ATS assistive reading tool is relatable to people who use English as a second language (ESL). Additionally, while not all people who are Deaf or hard-of-hearing use ASL, the study saw the cultural wealth connections between ASL and ESL as a participant explains,

Some deaf hard-of-hearing people or people of color or immigrants...may not know English either, and so they may know another language, or maybe they just only know how to communicate in ASL, so they don’t have the opportunity to practice English so that could impact their reading (Alonzo et al., 2022, p. 16:23).

Other participants saw these shared experiences could not only help ASL and ESL communities, but also international students, people with intellectual disabilities, and children. Accessible design is just better design, helping readers worldwide and of varying ages.

4.5. Reading Preferences

The literature highlights reading preferences from different perspectives, including hard-of-hearing (Alonzo et al., 2022), cognitive/learning (Knight et al., 2015), blind or low vision (Moyer, 2012; Grammenos, et al., 2009; Lee et al., 2023; Park et al., 2022; Orim et al., 2021) discusses preferences more broadly with a circumstantial lens. Some reading preferences were discussed in earlier themes presented, including how all readers prefer less complicated text when reading (Park et al., 2022) and people who are Deaf or hard-of-hearing prefer simplified text, which also helps other people, explicitly mentioning ESL learners, international students, and children (Alonzo et al., 2022). Knight et al. (2015) also found, from a cognitive or learning perspective, that users preferred eText over print books as it helps with comprehension.

In Knight et al. (2015), results showed that middle school science students with ASD enjoyed and preferred the eText format over traditional print-based books. The additions of the hyperlinks to the glossary/definitions and coaches (embedded avatars that explained concepts) were found to be the most beneficial resources. Reading platform use and preferences were also discussed in Grammenos et al. (2009), which tested a platform for creating and reading such books (called Starlight), and the user testers suggested that the platform should include accessible images (magnification options and navigable descriptions), in-line sounds to annotate text, HTML pages (with preference for Starlight over reading on a web browser), and mathematics reading improvements.

Lee et al. (2023) identified accessibility issues of reading comics by people with vision impairments. Based on the preferences of this disability community, design implications for future accessible comics include using various voices, reading speed customization, auto-reading, filtering types of information to be played, scene descriptions, and sound effects. There was

nearly equal preference between the audiobook and ebook formats, though having either format still requires it to be accessible. Most participants preferred a human voice over a synthesized-voice because it helped understand context through emotions, created an immersive experience, and helped make the character voices distinguishable. Additionally, textual sound effects in comics (e.g., ‘BOOM,’ ‘SNAP,’ ‘POW’) provide an animated expression for the story; however, these are often ignored when converted into accessible forms like eBooks (Lee et al., 2023). During testing, most participants (people with and without disabilities) found the scenic descriptions useful and favoured sound effects over spoken word-based sound effects.

Moyer (2012) provides a literature review on audiobooks and ebooks, including digital book formats and accessibility implications. For example, ‘many visually impaired readers who listen to audiobooks often have the same preferences and needs as sighted patrons who enjoy audiobooks’ [Elkin, as cited in Moyer, 2012, p. 342]; and Ann Milani et al. (2010) [as cited in Moyer, 2012, p. 345] found students with dyslexia who used audiobooks experienced significant improvements in reading accuracy. However, Moyer (2012) also notes some opposition to using audiobooks. For example, people who learn Braille and ‘read’ texts prefer this reading method over ‘reading’ by listening to an audiobook, where ‘some researchers are concerned that those who only listen may fail to develop certain areas of the brain’ (Aviv, 2009, as cited in Moyer, 2012, p. 346).

Advances in e-reading technology have substantially changed the reading culture, especially because of ebook portability, ease of sharing, accessibility, and convenience. However, according to Orim et al. (2021), a nation’s development and the digital divide among students with disabilities may also determine whether the traditional or ebook format is preferred. For example, Orim et al. (2021) studied the book format preferences of 60 students with disabilities at a public university in Nigeria and found that students with disabilities choose a book format preference based on their skills, the severity of special needs conditions, the learning environment, and the affordability of the book format. Some level of computer literacy and the ability to pay for the technology is needed for ebook use, which was challenging for most students in their study as they come from economically disadvantaged families. This makes the question of book format preferences of students with disabilities difficult to navigate as there are other variables at play.

5. Discussion

There are many challenges across disability types, and the design to create accessible reading platforms for people with learning disabilities is largely applicable to the other disability types, as well as for people without disabilities. In a similar comparison (and relating to RQ2 and RQ3), the assistive reading tool for text simplification could be useful to a broader population (rather than just the learning disability or Deaf community). Other assistive tools like magnification, text-to-speech, and screen readers (which also help people without vision or learning impairments) would help mitigate negative perceptions of assistive technology use and social accessibility assumptions or other cultural issues.

Magnification was widely discussed as magnifiers for digital reading are helpful for visual impairments but are also very limiting as the viewport’s size makes reading and comprehending difficult. This is an example of an assistive technology that helps a person with disabilities access a text. However, true accessibility remains a challenge because of the electronic format used. ‘*The digital revolution is allowing for a wider range of content to be made available in a more timely and cost-effective fashion*’ (McNaught & Alexander, 2014, p. 39). Yet, the literature found various ebook and e-reader formats, with none truly accessible.

Culture also plays a part across disability types, including how communities interpret color, symbols, and gestures (Stephanidis, 2014). Distinctive cultural aspects, including societal perceptions and social accessibility, also play an important role in digital reading practices and preferences (RQ1). For example, there seems to be a unique connection between ASL and ESL experience and learning environments. The Deaf and heard-of-hearing community studied by Alonzo et al. (2022) shed light on assistive technology tools useful to immigrants, ESL learners, and international students. This has translanguaging pedagogical theory implications as there are dynamic ways for learning, meaning-making, reading, and writing for multiple communities (Hoffman et al., 2017). Translanguaging is a pedagogical theory and language practice in cultural pedagogy (education) and critical theory studies that *“conceptualizes the dynamic ways in which bilinguals use their linguistic repertoire and language practices for learning and meaning-making”* (Hoffman et al., 2017).

Digital reading preferences are disability-centric (RQ1): Low-vision users want interfaces that help orient reading and digestion of complex concepts (Park et al., 2022). However, preferences are also hard to determine as there is a preference by disability constraint vs personal choice (Orim et al., 2021). ‘Starlight’ (book platform) was preferred over reading on a web browser for people who are blind or have low vision (Grammenos et al., 2009). Lee et al. (2023) found a preference for accessible comics included having various voices, reading speed customizations, auto-reading features, and using scene descriptions and sound effects. Nearly equal preference for audiobook vs ebook, and most testers with and without disabilities preferred actual sound effects over spoken word sound effects). Moyer (2012) also found that many people with visual impairment who use audiobooks have the same preference as sighted people who use audiobooks.

Several digital book design recommendations are similarly helpful to various disability types, addressing the implications that universal design can benefit people broadly (RQ3). Appendix A.2 offers a curated collection of recommendations or advice in the review. This includes Mason’s (2012) extensive list of recommended accessibility improvements that are helpful to people broadly. Her plea for digital book creators to make accessible books the standard, rather than just special accessible versions, is a sentiment echoed in the literature as *‘these books make it possible for print-disabled readers to enjoy a novel, get an education, advance in their careers, learn new skills, and join in all of the other activities enjoyed by the book-reading public’* (Mason, 2012). Accessible books are simply better.

5.1. Research Gaps

Although advances in publishing and education now show how an accessible book is better, truly accessible books are still not commonplace on the market. This is a gap in the industry; we continue to wait for technology developers to make accessibility a standard reality. For example, not all academic ebook platforms provide the correct formats or features the disability community requires (Mune & Agee, 2016). As technology frequently changes, so do standards and compliance levels of accessibility, as well as the market conditions that create competition among developers of reading devices and formats—both of which are gaps in the literature.

Moyer (2012) generally addresses digital book formats and implications, including some references to accessibility impacts among people with disabilities. She importantly notes the lack of research-based literature on ebooks and formats (compared to audiobooks that have a longer history), which is foreshadowing the topic of this literature review on digital reading preferences. Stephanidis’ (2014) design for all best practices complement Moyer’s (2012) reference to the disenfranchisement of people with disabilities and inaccessible interfaces. Additionally, most

studies involving e-reader usability are concentrated on devices for trade publications and commercial products (e.g., iPad and Kindle), which have mixed accessibility results that are 'largely dependent on the configuration of the device, browser, and publisher' [Huthwaite et al., as cited in Mune & Agee, 2016, p. 274]. More research is needed on default device settings and devices for a broader range of publication types.

5.2. Limitations

The literature review was conducted by one researcher, where subjectivity could be seen as a limitation. However, an external reviewer unrelated to the study reviewed aspects at various stages—methods, data extraction, analysis, and readability—as a reliability measure. Additionally, the author has personal or observed lived experiences of various disabilities but did not consult people with disabilities on their digital reading preferences in this study. That type of interview or focus group discussion would add value to the study and is considered the next phase in this research. This literature review was the first phase, exploring what is known to date and considering implications for learning about the digital reading preferences of people with disabilities.

6. Conclusion

Digital books apply to education, employment, and enjoyment or hobby reading, but not all books are created with accessibility or usability. This paper sought to gain insights into previous studies on digital reading preferences across various disability communities. Specifically, this review's research questions sought knowledge about format preferences, assistive technologies for digital reading, and how such preferences benefit people without disabilities. This paper uncovered five themes across 14 studies in the literature: the challenges of digital reading by members of the disability community, common accessibility barriers and workarounds, social accessibility issues including perceptions and assumptions, universal design and design for all implications, and reading preferences among people with various disabilities. Culture, along with assumptions and misperceptions of education and literacy, play a part in how society and social accessibility impact people with and without disabilities. Examples were seen throughout this literature review. Reviewing these studies also leads to identifying gaps or limitations that provide possible future research directions, including the author's future co-designed survey for a digital reading preferences study. This knowledge can help address the limitations and advantages of making digital books more inclusive by addressing their design and accessibility among disability characteristics. Assistive reading tools and accessible books help cultures learn and work. The interactions, modalities, and techniques to address a person's unique needs are important to the design of such information communication technologies, including digital reading platform interfaces. The viewpoints of the disability community on digital reading may help increase the accessibility, usability, and enjoyment of digital reading more broadly, which is a call to action emphasized by the disability studies and user experience design fields: Accessible books are better books, where design for all can be the tool for standardizing accessibility which benefits everyone.

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Appendix A: Study Breakdown by Disability or Topic

Study breakdown by disability or topic. Note: This information was also presented in Table 1. This is an accessible list version.

Disabilities in general

- Orim et al. (2021)
- Stephanidis (2014)

Blind, low vision focus

- Grammenos et al. (2009)
- Lee (2023)
- Mason (2012)
- Moyer (2012)
- Park et al. (2022)

Deaf, hard-of-hearing focus

- Alonzo et al. (2022)
- Stephanidis (2014)

Learning and Autism focus

- Junus (2012)
- Knight et al. (2015)
- Moyer, (2012)
- Romen & Svanaes (2008)

Motor and Print focus

Note that print disabilities include visual, hearing, physical book holding, learning: dyslexia, and ADHD.

- Romen & Svanaes (2008)
- Junus (2012)

- Mason (2012)
- Maatta & Bonnici (2014)
- McNaught & Alexander (2014)
- Mune & Agee (2014)

Audiobook, Ebook, and e-reader formats

- Junus (2012)
- Grammenos et al. (2009)
- Lee et al. (2023)
- Mason (2012)
- Maatta & Bonnici (2014)
- McNaught & Alexander (2014)
- Moyer (2012)
- Mune & Agee (2016)
- Orim et al. (2021)

Text-to-speech

- Autism focus in Knight et al. (2015)
- Print disability focus in Junus (2012)
- Blind or low vision focus in Grammenos et al. (2015)

Appendix B: Recommendations

This is a curation of recommendations or advice found in the literature review. The list is alphabetical by author.

Junus (2012) provides advice related to e-reading devices. Many e-reading devices come equipped with standard features useful to readers with disabilities; for example, the text-to-speech feature dictates text aloud. The chapter discusses and compares several available ebook formats and e-readers. Still, people with print disabilities only have a limited number of accessible options and offer the following advice as of 2012:

- DAISY, EPUB, and TXT are the most accessible ebook formats, while accessibly designed PDFs and simple HTML documents provide generally accessible e-text formats.
- Apple handheld products outfitted with iBooks are the most accessible software-based e-reader devices.
- Software-based e-readers such as Blio and the Kindle app either are becoming equipped with text-to-speech capabilities or are relatively compatible with screen readers. Still, the accessibility features on dedicated devices and mobile apps must often be “enabled,” which requires additional steps to configure a device because it is not accessible out of the box.

- There is a general lack of accessibility features in the most popular dedicated e-reader devices.

Mason (2012) provides an extensive list of example areas for improvements related to digital reading, including:

- Migrate old, inaccessible books to accessible technologies.
- Ensure that books are clearly marked inaccessible (or image only).
- Follow a book-purchase model allowing users to purchase books from the portal the platform uses.
- E-readers should comply with the standards of the operating system “to allow screen access and magnification software to access the book player’s controls and the text inside the books,” which enables a comfortable way for a user to magnify a chart, read computer commands in Braille, check the spelling, etc.
- Dedicate method for turning any accessibility feature on or off independently.
- Allowing for meaningful interaction with the text (character, word, line, paragraph, section, page, and chapter levels); for book reading platforms to allow for continuous and paginated readings to help with different reading styles and materials.
- Allow for highlighting of words as they are read; the standard features of e-reading platforms (ability to search, highlight, annotate, and bookmark) must be available to blind users.
- Ebook creators should stop creating special accessible versions and just make rolling accessible changes as part of the actual software used by everyone.

Mune and Agee (2016) recommend using both the EPUB 3 and PDFs as the former is preferred for screen reader compatibility, and the latter allows a balanced approach to downloading, printing, and copying (though the PDFs must never be just images).

Other existing web design practices often found in web searches recommend the following:

- Ensure content uses semantic coding, identifying headings, lists, tables, and images with alternative text.
- Avoid justified tests as they are prone to readability issues and affect comprehension.
- Use clean typography, preferably a sans-serif font for digital or screen reading.
- Avoid using all caps; Don’t underline text; reserve it for hyperlinks.
- Support resizing and zoom capability.
- Consider line spacing and line length.
- When content is enlarged, ensure elements don’t overlap.

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