Review Article

Digital Literacy in People with Disabilities: An Overview and Narrative Review

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Digital literacy is the ability to use digital technologies to find, evaluate, create, and communicate information. People with disabilities benefit from having these skills because it allows them to access various opportunities in the digital world. To ensure that they can fully participate in the digital realm, digital literacy efforts should prioritize inclusive design principles. People with disabilities often rely on assistive technologies such as screen readers, alternative input devices, voice recognition software, or specialized hardware to navigate digital platforms. Digital literacy programs should not only focus on consuming content but also on creating and sharing it through documents, multimedia, and online platforms. Peer support and collaboration are important for enhancing their learning experience. Additionally, digital literacy programs should address cybersecurity or online safety considerations specific to such people and provide them with training and support for using assistive technologies effectively while educating them about potential risks, privacy settings, and safe online practices. This narrative review highlights the meaning and levels of digital literacy, the digital divide, and history, before expanding on the quantitative metrics in the available research on the theme in the field of people with disabilities. Retrieved data from freely accessible internet search engines revealed 196 publications, including books, chapters in books, original research articles, proceedings of seminars, and reviews, which were classified into harvest plots to be analyzed by their format, timelines, topics, or themes respectively. While results indicate an upward curve in the quantity of publications, especially in the post-millennium era, the topics addressed are unevenly distributed, leaving scope for the future to focus empirical and evidence-based research on themes related to measurement as well as training on digital literacies for both teachers and students with disabilities. By promoting digital literacy in people with disabilities, we can bridge the digital divide and empower them to participate fully in today's increasingly digital society.

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Abbreviations

ADA: Americans with Disability Act; ADD/ADHD: Attention Deficit/Hyperactivity Disorder; AR: Augmented Reality; ASD: Autism Spectrum Disorder; AT: Assistive Technology; CWDs: Children with Disabilities; DHH: Deaf or Hard of Hearing; DL-Digital Literacy; ICT: Information Communication Technology; ID: Intellectual Disabilities; IOT: Internet of Things;IT: Information Technology; LD: Learning Disabilities; NISA; National Information Society Agency; PWDs: People with Disabilities; QOL-Quality of Life; SMI: Severe Mental Illness; VR: Virtual Reality.

Introduction

The term “information literacy” has evolved into “digital literacies” due to the shift from the information age to the digital age[1]. Digitization, which is the transition from print to on-screen reading and writing, has been responsible for this change[2]. The digital revolution has had a significant impact on our daily lives, including those of people with disabilities (PwDs), who face challenges in accessing and using digital technology due to their physical limitations[3]. PwDs also face discrimination and stigma in addition to these difficulties. PWDs encompass a wide range of types and variations, each with varying degrees or levels of impact. Some common types include physical, sensory, cognitive, psychiatric, developmental, and occasionally invisible disabilities[4]. In an early study conducted by Harris, Harris, and Sally[5], observations, interviews, and video recordings were used to examine how children with disabilities (CwDs) aged 4 to 11 years old utilized computers both at home and in school. Their computer usage was facilitated by simplifying and repeating tasks, minimizing distractions and irrelevant stimuli, providing models and demonstrations, offering ample practice opportunities, delivering instructions in manageable steps, and providing immediate or frequent reinforcement with feedback. The positive attitudes of parents and teachers played a crucial role in fostering computer literacy skills in their children.

Digital Divide

There exists a significant disparity in various aspects of life, such as physical access, employment opportunities, healthcare, social integration, and education, between individuals without disabilities and

PWDs. The "digital gap" or "digital divide" is further exacerbating the challenges faced by disabled individuals. Many websites are inaccessible to those with visual impairments due to issues like text color, size, layout, and compatibility with screen readers. Others with impairments may struggle with using a mouse, keyboards, or extended periods of gadget usage. Unlike unaffected individuals who can visit cafes or libraries for internet access when their home Wi-Fi is down, PWDs have to consider factors like transportation, wheelchair accessibility, ramps, lifts, and restroom facilities when venturing outside their homes[6][7]. Cho & Kim[8] found that individuals without disabilities who possess higher education levels, household incomes, motivation for internet use, and stronger DL skills tend to experience more favorable outcomes compared to PWDs.

Critics of the digital divide concept argue that the gap between individuals with and without internet access will eventually diminish in the future. According to the Diffusion of Innovations Theory[9], the increasing use of technology, such as television, radio, and telephones, as a market force rather than relying solely on policies, will contribute to the elimination of this divide[9]. Indicators of the digital divide include the availability and affordability of internet connectivity, ownership of digital devices like computers, smartphones, or tablets, and proficiency in digital skills required to navigate and utilize digital technologies, online platforms, and services. However, it is important to note that PWDs are typically less likely to be online at any given time. They face inequities and barriers in accessing digital tools and content. Enhancing their DL skills is crucial to promote their inclusion through social participation, livelihood opportunities, and overall QOL[10].

MILESTONES IN HISTORY OF COMPUTERS AND PWDs

1808: Pellegrino Turri built the first typewriter to help a blind friend write legibly.
1886: Herman Hollerith, who had a cognitive processing disability, developed the idea of using punch cards to transfer data from the 1890 census and later founded the Tabulating Machine Company.
1960s: Assistive Technologies (AT) for individuals with visual impairments, such as screen readers and braille displays, were developed. An early device was the Optacon, which used a camera to scan text and convert it into tactile feedback that could be read by users who were blind. Another system called "Telesensory" used a closed-circuit television to magnify text for individuals with low vision.
1970s: Adaptive input devices such as alternative keyboards and switches were developed to provide access to individuals with motor impairments.
1980s: Graphical user interfaces (GUIs) and speech recognition software expanded accessibility options for PWDs. The field of AT continued to evolve with advancements in areas such as speech recognition, screen reading software, and inclusive design.
1990s: The Americans with Disabilities Act (ADA) was passed, increasing focus on accessibility in technology and leading to the development of standards and guidelines.
2000s: Mobile devices and touch-screen technology emerged, opening up new possibilities for accessibility, including eye-tracking ad gesture-based input and voice-controlled interfaces to support individuals with cognitive disabilities in areas such as communication, organization, and task management.
2010s: Emergence of wearable devices, such as smartwatches, wristbands, and head-mounted displays having real-time feedback and fitness trackers, has provided new opportunities for tracing, monitoring vital signs, body movements, and managing the well being and health conditions of PWDs. Virtual reality (VR) and augmented reality (AR) technologies are used in therapeutic and rehabilitation settings to enhance their mobility, cognitive skills, and sensory experiences.
2020s: The concept of universal design has promoted the creation of technology and digital platforms that are accessible to PWDs from the initial design phase. The integration of artificial intelligence (AI) technologies has enabled personalized assistance tailoring them to their specific needs and preferences. Online platforms and digital content have made information and resources more accessible to them by allowing for increased participation in education, employment, and social activities.

In the prevailing state of technlogy, **Brain-Computer Interfaces** enable individuals with severe and multiple disabilities to interact with digital devices using their thoughts in place of traditional input methods such as keyboards or touchscreens. **Voice Recognition and Natural Language Processing** digital devices facilitate hands-free operation of devices and enable individuals with speech impairments or cognitive disabilities to communicate more effectively. **Haptic Feedback technology** enables individuals with visual impairments to receive sensory feedback through touch or vibration, enhancing their interaction with digital devices. **Augmented Reality** technology enables interactions with digital content in more immersive and engaging ways by providing visual cues and navigation assistance for individuals with visual impairments, and those with cognitive disabilities (Hutinger, 1996; Hutinger, Johanson, & Stoneburner, 1996; Hutton, 1997; McMillan & MacArthur, 1991; Semmel & Lieber, 1990; Viadero, 1997).

Digital Literacy

Digital Literacy (DL) refers to the ability and skills required to find, evaluate, use, share, and create content using ITs and the internet. DL is essential to live, learn, and work in a society where communication and access to information are increasingly through DTs such as social media, internet platforms, and mobile

devices. Gilster[11] first defined the concept of DL as "the ability to understand and use information in multiple formats from a wide range of sources when presented via computers." To use technology effectively, one must understand its uses and limitations as well as its risks and safety measures. DL involves the ability to locate, assess, produce, and communicate information using information communication technology (ICT). However, the meaning of DL has evolved over time[12], and its usage varies depending on the background, whether it is for media, entertainment, education, or career[13][14][15][16]. DL requires both cognitive and technical abilities and has a positive impact on one's QOL and self-esteem. However, accessibility for PWDs is not always guaranteed or consistent. For instance, smartphones may not be compatible with hearing aids required by the deaf, touch screens may be too sensitive for those with motor impairments, and web pages may lack the text labels needed by screen reading software used by the blind[17]. Augmentative technologies can provide alternative communication methods for PWDs. Several sources have explained the basic conceptual similarities and differences of DL[18][19][20][21].

Martin & Madigan[22] advocate for using the term "Digital Literacies" instead of a singular form because it encompasses various components and cognitive-thinking strategies. This viewpoint is supported by other researchers[23]. The definition of Digital Literacies has evolved significantly from solely covering computer programming skills in the 1960s. It now encompasses IT and ICT literacy, web literacy, online reading, media literacy, meta-literacy, visual literacy, communication literacy, information literacy, computer literacy, e-literacy, network literacy, and other lay terms like "basic skills," "Internet savvy," or "smart working." Multiple authors have explored the origins and concepts of Digital Literacies[22][24][25][26][27][28][29]. Examples of DL skills include operating gadgets, navigating the internet, managing files in various applications, conducting online searches, using smartphones for communication and other applications, understanding device components, practicing online safety, making online payments, efficient keyboard usage, creating/editing documents (word processing, spreadsheets, presentations), utilizing copy-paste functions, sharing files, formatting content, and utilizing digital tools such as podcasts, Bluetooth, Wi-Fi, visual and graphic materials. DL also involves activities like commenting on blogs or forums, securing passwords, understanding basic programming languages, and troubleshooting[30][31][32]. Alsalem[33] examined how Digital Literacies benefit students with disabilities in terms of academic performance, collaborative learning, self-efficacy, self-motivation, positive learning environments, communication, engagement both inside and outside the classroom, independence, and technological skills.

On the other hand, digital illiteracy refers to the lack of information skills and understanding of how to use digital tools and technology. Several factors contribute to digital illiteracy, such as the unaffordability or inaccessibility of digital devices, poor or no internet connectivity, socio-economic disparities, old age or illness, limited education, language or cultural barriers, fear or resistance to technology, and lack of awareness. DL is a significant contributor to the digital divide among vulnerable sections of society, such as the poor and elderly, who are likely to be excluded from mainstream society. It also affects employability and leads to a poor QOL[34][35]. Are there people who lack digital skills entirely? Some individuals with chronic mental illnesses are reported to have no basic digital skills, such as changing passwords, connecting to Wi-Fi, purchasing goods, accessing healthcare online, or setting up an email account.

Spanakis et al.[36] examined the digital skills of individuals with severe mental illness (SMI) and their ability to adapt to modern digitization trends. Using the Essential Digital Skills Framework, the study found that nearly half of the participants lacked foundational skills and internet access skills. These skills included tasks such as changing passwords, adjusting device settings for ease of use, connecting to secure Wi-Fi networks, and utilizing device controls. In another study, Camacho and Torous[37] investigated the impact of DL and an outreach program on self-reported functional skills and clinical outcomes among individuals with SMI. The study revealed statistically significant improvements in seven of these skills.

Venkatesan[38] suggested the concept of a potential "digital skills disorder" as a future disability that encompasses the lack of proficiency in various technical and non-technical skills, such as the use or operation of new-age gadgets, designing/developing websites, apps, or software, not being a virtual netizen, tech-savvy, or often being dubbed as computer illiterate[39][40][41]. The recognition of the economic impact of DL, now considered the fourth literacy, is growing among governments worldwide. There is a strong argument for implementing comprehensive strategies that start with early education and ensure that college graduates possess essential technology competencies when entering the modern workforce[42][43].

Levels of Digital Literacy

DL is not a binary concept, but rather a spectrum that varies in individuals' and communities' ability to understand and utilize digital technologies in different life situations. The National Institute of

Electronics and Information Technology (NIELIT), Ajmer, is implementing courses as part of the National Digital Literacy Mission (NDLM), aligning with the Prime Minister's vision of "Digital India." Through this initiative, eligible households in selected blocks across each state and union territory receive computer skills training. The goal is to provide trainees with basic ICT skills that are relevant to their needs, enabling them to effectively use IT and related applications, actively participate in the democratic process, and enhance their livelihood opportunities. The training aims to empower individuals to access information, knowledge, and skills through the use of digital devices. The course structure consists of two levels: (i) Appreciation of DL and (ii) Basics of DL.

In the first level (i) of the training, the objective is to develop IT literacy in the trainees. They are taught how to operate digital devices such as mobile phones or tablets, send and receive emails, and conduct internet searches for information. Moving on to the higher level (ii), the trainees learn how to effectively access various e-governance services provided to citizens. The syllabus covers topics such as digital device introduction and operation, internet usage, understanding digital technology safety and security, word processing, spreadsheets, presentations, and basic multimedia skills. To be eligible for level 1, individuals can be illiterate or have completed up to 7th grade. For level 2, a minimum qualification of 8th grade is required. The age range for participation is between 14 and 60 years. Eligible households nominate one person from their family to receive training at the nearest Training Centre/Common Service Center (CSC). The duration of the course is 20 hours for level 1, with a minimum of 10 days and a maximum of 30 days. For level 2, the course duration is 40 hours, with a minimum of 20 days and a maximum of 60 days. The training is conducted in any of the official languages of India. Evaluation is carried out by a national-level certifying agency such as NIELIT, NIOS, or IGNOU.

There are various frameworks that define the different levels of DL (DL). One common model includes five levels: (a) Apprentice; (b) Basic; (c) Intermediate; (d) Advanced; and (e) Expert. At the **apprentice level**, the goal is to develop IT literacy in individuals, enabling them to operate digital devices such as mobile phones, tablets, and others, send and receive emails, and conduct internet searches for information[44]. At the **basic level,** individuals are expected to identify and use digital devices for simple tasks such as browsing the internet, sending emails, and using basic software. This requires familiarity with various mainstream digital devices such as desktops, laptops, tablets, interactive whiteboards, personal mobile devices such as smartphones, iPods, cameras, gaming consoles, and communication applications like email, Skype, and Zoom. Specialist assistive technologies like Braille Notetaker, screen readers, Bluetooth, fitness trackers, smartwatches, virtual reality headsets, and others are also included. DL at the

basic level is comparable to the cognitive-intellectual developmental maturity of adults with borderline-mild levels of intellectual disabilities or typical primary school children[45][46][47].

At the **intermediate level** of DL, individuals are expected to have a more comprehensive understanding of digital tools and their application in complex tasks. This includes tasks such as document creation, data management, and the use of social media. At this level, proficiency in working with digital information, including communication, dissemination, creation, and management, is expected. Additionally, individuals should be able to utilize Internet-based tools such as web browsers, search engines, and email effectively. Clear presentation of information, including the use of spreadsheets, is also emphasized. Moving on to the **advanced level,** individuals are required to have skills in using digital tools for tasks like programming, data analysis, and multimedia production. The **expert level** demands a deep understanding of tools and the ability to innovate and create new digital solutions. Computational thinking or problem-solving at this level involves cognitive processes such as data representation, algorithmic work, information analysis, and the ability to generalize solutions that can be applied across various domains of learning[48].

The levels of DL can be analyzed based on their basic usage, application, development, and transformation across three dimensions: cognitive, social, and technical aspects. PWDs have similar DL levels to their age-matched healthy peers, but they face additional challenges and considerations. A challenge is the use of accessible technology, such as screen readers or magnifiers for the blind. Barriers such as inaccessible websites, apps, and documents that are incompatible with AT must be eliminated. Further, there is a need for additional training and support to develop DL skills among PWDs, including accessible training materials, one-on-one support, and peer mentoring. For PIDs, teaching-learning materials should be presented in simplified language with visual aids. Tailor-made individualized interactive learner-paced training with peer tutoring and positive feedback can also be beneficial. In general, DL programs for PWDs must take into account their unique needs and challenges[49]. Park & Nam[50] compared the DL of PWDs to unaffected controls in Korea based on data collected from the National Information Society Agency (NISA) regarding their internet and smart device usage. Among the 1500 individuals examined, 1190 (79.3%) were Internet users, and 535 (35.7%) were smart device users. Among PWDs, 63.9% were Internet users, and 8.8% were smart device users. The results revealed significant effects of disability, gender, age, and education on internet use and production literacy. Tohara[51] explored DL tools and strategies utilized by students with special needs in Malaysia from their perspective and those of their teachers.

Objectives

The topic of DL in relation to PWDs has received limited attention. There is a lack of research addressing the impact of digitization and digital technology on PWDs. The existing literature does not adequately cover the prevalence, challenges, and concerns associated with integrating the digital world into the lives of PWDs. Additionally, there is a need to explore the differences in accessibility, employment opportunities, social inclusion, and education options between PWDs and unaffected populations. The availability of evaluation instruments for measuring digital parameters in PWDs is also an area that requires further investigation. These questions highlight the importance of conducting a literature review on DL in PWDs and its implications for their QOL and digital training programs.

Method

This narrative review aimed to identify peer-reviewed research articles on DL in PWDs. Internet search engines such as Google and MSN were utilized to search databases including Google Scholar, JSTOR, PsycINFO, ERIC, ProQuest, CINAHL, Research Gate, Web of Science, Scopus, and PubMed. The review focused on books, chapters, and publications related to the meaning, characteristics, types, sources, dynamics, measurement, benefits, applications, and negative aspects of DL in PWDs. Only original research articles published in English ISSN journals and ISBN books were included, with specific keywords used for the search, such as, Digital literacy, digital divide, assistive technology—all in conjunction or along with the phrase people with disabilities. Descriptive essays, newsletters, periodicals, unpublished dissertations, and incomplete or misleading cross-references were excluded. Inter-observer reliability checks undertaken by two mutually blinded independent coders for at least a quarter of the entries in the overall sample to minimize the risk of bias yielded a robust correlation coefficient (r: 0.94). Ethical considerations were prioritized to ensure the representation of diverse ethnic groups and their subjective experiences[52]. Inter-observer reliability checks and statistical analysis using SPSS/PC were conducted[53]. Effect sizes were analyzed using Cohen's guidelines[54]. The compilation of enlisted research articles up to December 2023 was analyzed using a harvest plot and adopting PRISMA2020 guidelines (Table 1; Figure 1) based on the aforesaid inclusion/exclusion criteria, and scheme of procedure as follows:

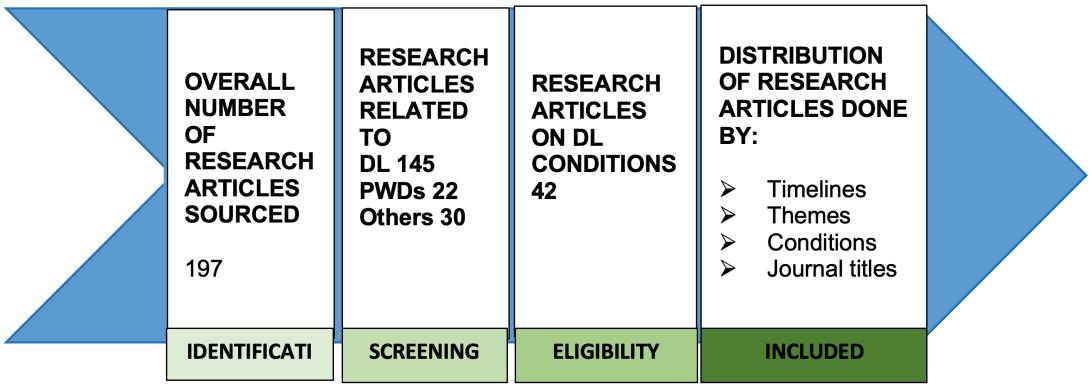

Figure 1. PRISMA Flow Diagram depicting the procedure for review

Results

The aggregated data of references on DL vis-a-vis PWDs are classified into harvest plots by their format, timelines, topics, or themes respectively (Table 1).

As per the **format** of publications, most of the publications on DL in this review are Original Research Articles (N: 143 out of 196; 72.96%), followed by books (N: 26 out of 196; 13.27%), chapters (N: 12 out of 196; 6.12%), review articles (N: 9 out of 196; 4.59%), and proceedings of seminars (N: 3 out of 196; 1.53%). Going by the **title of journals**, Farias-Gaytan, Aguaded, & Ramirez-Montoya[55] found that the largest proportion of publications on DL originating from five continents were in the *Journal of Adolescent and Adult Literacy* with 14 articles, and "*Computers & Education*," and "*Nordic Journal of Digital Literacy*" each having 5 articles. Based on **timelines**, there is a six-fold increase in the number of publications on DL between the year 2000 (N: 10; 5.10%) and the 2020s (N: 55; 28.05%). Most of the **topics or themes of research** are focused on DL and PWDs in general (N: 22 out of 196; 11.22%), and fewer of them studied DL against subtypes of disabilities (N: 42 out of 196; 21.43%). Among the subtypes, most publications are on PIDs (N: 17 out of 196; 8.67%), followed by research on PH (N: 8 out of 196; 4.08%), and HoH/Deaf (N: 7 out of 196; 3.57%). Going by specific topics, training in DL (N: 25 out of 196; 12.76%) and measures of DL (N: 16 out of 196; 8.16%) are studied. Areas such as theories, paradigms, or models of DL, digital rights or their violations, and ethical issues are least prioritized.

Variable	N	%
A. Format		
ORA	143	72.96
Books	26	13.27
Chapters	12	6.12
Reviews	10	5.10
Proceedings of Seminars	5	2.55
Sub Total: 196		
Journals	**153**	**78.06**
(i) Computers & Education	5	2.55
(ii) Nordic Journal of Digital Literacy	5	2.55
(iii) Issues in Informing Science & Information Technology	4	2.04
(iv) Journal of Special Education Technology	4	2.04
(v) Disability & Society	3	1.53
(vi) Education & Information Technologies	3	1.53
(vii) Journal of Intellectual Disabilities	3	1.53
Sub Total: 27		
B. Time-lines		
<2000	10	5.10
2001-2010	27	13.78
2011-2015	36	18.37
2016-2020	68	34.69
2020>	55	28.06
Sub Total: 196		
C. Topics*		
DL	145	73.98

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Variable	N	%
PWDs	22	11.22
Disability-Specific;		
(i) PIDs	17	8.67
(ii) PH	8	4.08
(iii) HoH/Deaf	7	3.57
(iv) SLD	5	2.55
(v) PVI/Blind	2	1.02
(vi) ADHD/ASD	2	1.02
(vii) PMI	1	0.51
Sub Total: 42		
Training	25	12.76
Measures	16	8.16
Gadgets (mobile, internet, email, computers, etc.)	15	7.65
COVID/Corona	6	3.06
Digital Divide	3	1.53
Inclusion	3	1.53
Training Teachers	3	1.53
Training Students	3	1.53
Grand Total	**196**	

Table 1. Harvest plot showing the frequency distribution of compiled literature on DL in PWDs

**Since the topics of research are multiply classified, their total is not likely to match the grand total*

There appears to be a mismatch between a search-engine extract on a list of journals dedicated to the publication of research articles on DL and the list of journals as found in this study (Table 2):

Search Engine Extracts	Present Study
1. Computers & Education	1. Computers & Education
2. Digital Literacy Studies	2. Disability & Society
3. Educational Technology Research and Development	3. Education & Information Technologies
4. International Journal of Digital Literacy and Digital Competence	4. Issues in Informing Science & Information Technology
5. Journal of Digital Literacy	5. Journal of Intellectual Disabilities
6. Journal of Educational Computing Research	6. Journal of Special Education Technology
7. Journal of Research on Technology in Education	7. Nordic Journal of Digital Literacy

Table 2. Rank list comparison of journals

Disability-Specific Studies

Individuals with limited mobility or physical disabilities often require hardware adjustments, accommodations, and adaptations more than software changes. Examples of these adjustments include adaptive keyboards, foot pedals, mouth sticks, or input devices that utilize eye tracking to navigate the virtual world. Voice recognition software is also beneficial for individuals with limited mobility [56]. Arslantas and Gul[57] conducted a study in Turkey to examine the DL skills of university students with **visual impairment**. They employed mixed methods, including an online survey, semi-structured interviews, and a DL Scale. The findings revealed that the participants had high levels of self-reported technical and cognitive DL skills, but low levels of social DL skills. While they possessed basic skills for accessing information and creating files, they lacked proficiency in information management, collaboration, communication, and digital content creation. To ensure accessibility for individuals with blindness, it is important to provide screen readers and other assistive devices that can read text aloud, as well as to design websites and navigation aids for the virtual world. In a separate study by Mardiana, Suminar, and Sugiana[58] involving 39 blind and low-vision students in an Indonesian Special School, it was observed that they were heavy internet users. They demonstrated good DL skills in terms of understanding responsible and polite behavior in digital communication. Around 40 percent of the students reported using the internet for more than four hours a day, with information search being the

primary purpose, followed by social media usage. Some students were even able to utilize digital media for creating creative content, such as tutorials uploaded on YouTube.

The DL skills in **people with intellectual disabilities** (PIDs) have received research attention for the levels, extent, depth, form, types, and content. A particular form of **functional DL is** noted to be relevant for these people. Just as Functional Literacy has to do with writing or signing one's name, reading street signs, preparing a grocery list, filling out forms related to government schemes, and many other such things to lead a productive life and participate fully in society, functional DL is to do with basics like sending and receiving email messages, scanning, photographing, uploading, and sharing documents. Functional DL for PWDs involves understanding how to advocate for their digital accessibility needs and rights in various contexts, such as in the workplace or in accessing online services. DL opened the door to possibilities for fostering social connections, pursuing personal interests, and organizing everyday life in PIDs[59].

Research has examined the DL skills of PIDs in terms of their levels, extent, depth, form, types, and content. Functional DL, in particular, has been identified as relevant for this population. Similar to how Functional Literacy encompasses skills such as writing or signing one's name, reading street signs, creating a grocery list, and completing government forms to lead a productive life and actively participate in society, functional DL involves basic tasks like sending and receiving email messages, scanning documents, taking photographs, uploading files, and sharing documents. For PIDs, functional DL also includes understanding how to advocate for their digital accessibility needs and rights in various contexts, such as the workplace or when accessing online services. DL has provided opportunities for PIDs to establish social connections, pursue personal interests, and effectively organize their daily lives[59].

Caton and Chapman[60] conducted a systematic review of ten primary studies published in English between 2000-2014 to examine the use of social media by PIDs. The studies were identified through electronic database searches, communication with experts, and citation tracking. The findings revealed several barriers that impede the access of PIDs to social media, including concerns related to safeguarding, difficulties arising from poor literacy and communication skills, cyber-language and cyber-etiquette, and the accessibility and design of equipment. Borgström, Daneback, and Molin[61] conducted a study that examined two peer-reviewed papers published between 2001-2017. They identified the studies through electronic database searches, Facebook, and communication with experts. The research focused on young PIDs and highlighted concerns related to online risks, vulnerability as

victims of cyber-crime, and the need for support based on their levels of sociability, loneliness, anxiety, depression, poor insight and judgment, discrimination, ability to detect deception, reduced experience, and limited life opportunities[62].

Social networks provide PIDs the opportunity to actively participate in society and enhance their self-determination. However, the question arises whether PIDs can effectively deal with unreliable information sources on the internet. According to an experiment, PIDs have a limited ability to evaluate recommendations in forums, which is attributed to atypical development rather than delayed development of these abilities[63]. An online research survey was conducted to examine the online experiences, challenges, and preferences of adults with ID who use Facebook. The study included 58 respondents who reported using Facebook as frequently as non-disabled users to connect with family and friends in the real world. However, the respondents also highlighted challenges such as privacy settings and literacy demands[64].

Observation and interviews of young adults aged 13-25 years with mild-moderate levels of intellectual disabilities revealed that they preferred using icons, pictures, voice-based strategies, and videos when accessing the internet through smartphones, desktop devices, and tablets[65]. Studies have also been conducted on the use of everyday technology such as digital stoves, cell phones, and elevators by PIDs. The studies recorded completion time from start to end of the task, number of errors, and help requests[66]. Additionally, the use of smartphones to assist people with Down syndrome over seven recorded sessions through task sequencing found that they learned and performed better or faster when using AssisT-Task than traditional methods[67].

The digital participation of PIDs is not on par with that of individuals with other disabilities. This is influenced by various factors, including limited access to technology, inadequate digital literacy skills, and inaccessible online content. Additionally, social and economic barriers hinder the engagement of these individuals with digital technologies. Unfortunately, there are misconceptions that they are incapable of using digital technologies or that such technologies are irrelevant or unbeneficial for them. However, many PIDs can effectively use digital technologies with the right support and accommodations. Fortunately, there has been a steady increase in the digital skills of PIDs in recent years ([68][69]). A study by Li-Tsang et al.[70] found that only about 6% of respondents with ID knew how to use a keyboard, mouse, and access the internet, while approximately 33% were unable to operate a computer system at all. Despite 93% of them having a computer at home or in the workplace, they were not allowed to use it.

The study also highlighted difficulties in training PIDs to use information technology due to insufficient knowledge of training techniques and a lack of suitable software for training. Furthermore, the views of parents and teachers played a significant role in shaping their use of social media, as demonstrated by a Swedish study ([71][72]).

Khanlou et al.[73] conducted a scoping review of 29 peer-reviewed journal articles to explore the barriers faced by young adults with developmental disabilities in accessing and utilizing digital technology, as well as their transition needs in education, daily living, community integration, and employment. The study identified barriers such as affordability, availability, infrastructure, design, lack of alignment with individual needs, limited access to community activities, low literacy levels, and the need for accommodations. McMohan et al.[74][75] successfully trained individuals with developmental disabilities to use a mobile device with the Red Laser application to identify potential food allergens. The participants maintained their health, fitness, and wellness skills even six weeks later. In another study, McMohan et al.[76] explored the use of location-based augmented reality navigation, comparing Google Maps and paper maps as aids for navigation in individuals with developmental disabilities. The results showed that participants were more successful in navigating to unknown business locations in a city using augmented reality compared to Google Maps and a paper map.

Several studies have focused on examining a modified or condensed version of functional digital literacy (DL) skills suitable for PIDs. These studies have specifically looked at basic skills such as sending and receiving email messages, organizing social bookmarking, and accessing useful websites for downloading, revising, and uploading documents. The research has been conducted on various devices, including Windows desktop computers, laptops, and iPad tablets[77][78]. In order to enhance the life skills and independence of students with moderate/severe ID and/or autism spectrum disorders, integrating mobile technology with instructional practices has been recommended. This involves providing direct support and customization to meet the specific needs of these students[79]. It is crucial to incorporate DL skills into the curriculum for PIDs to equip them with the ability to navigate online risks and safely handle potential dangers encountered in virtual settings[80].

DL can be a valuable tool for PIDs. It can support their skill development and enhance their communication and social interaction abilities. However, they face specific challenges when it comes to accessing and using digital technologies. They require appropriate support and training to ensure they have the necessary skills and knowledge to use technology effectively and safely as responsible digital

citizens. Regarding the effects of serious games on PIDs or autism spectrum disorders (ASD), a review of 54 studies demonstrated that the majority of these games had a positive impact. They were found to be particularly effective in improving social and communication skills, rather than conceptual and cognitive skills[81]. Individuals with autism encounter difficulties with fine motor skills, making it challenging for them to use traditional keyboards or mice. They require adaptive input devices such as touch screens, alternative keyboards, visual aids, or other forms of assistive technology to support their learning and communication. Visual schedules or social stories can be beneficial in helping them understand and navigate digital tools and online environments. Overall, a personalized approach that considers the unique needs and strengths of each individual with autism is crucial for promoting DL and maximizing the benefits of technology[82].

As inclusive post-secondary education for students with ID becomes more prevalent in colleges and universities, there is a growing emphasis on academic enrichment, socialization, independent living skills, integrated work experiences, and career skills. Consequently, there is an increasing need to integrate digital skills into their education to enable them to effectively use various technology devices such as computers, tablets, smartphones, and pads for various purposes[83][84]. In addition, Keeley & Bernasconi[85] emphasized the importance of incorporating fun and practical content in DL training for individuals with multiple disabilities.

While there is confusion about the definition of **learning disabilities (LD)** between British and American versions, studies have focused on the television viewing habits and preferences of individuals with LD. The Talking Mats interview, which is a visual communication tool that uses symbols and pictures to help people with communication difficulties express their thoughts and feelings, has been used with individuals with aphasia, learning disabilities, dementia, and autism. Reviewing the video recordings of these interviews revealed areas of difficulty, such as the time duration of the interview, the tangibility of symbols, and the currency of vocabulary. This information helped to develop a tool that is fit for purpose[86][87]. However, little is known about the DL skills of individuals with LD. Research findings indicate that 74.5% of PWDs have very low to low DL levels, while 8.5% are average, and 17% are highly digitally literate. Adults with LD have lower mean DL scores than adults in the general population. The use of DL skills at home or work adds to the variance explained in DL skills. These findings have implications for adult educators and policymakers[88]. In this age of increasing digitization, teachers can improve the attention and academic performance of all students with ADHD by incorporating targeted

environmental, organizational, instructional techniques, and tech apps into their everyday instructional/classroom management practices[89].

The lives of individuals who are **deaf or hard of hearing (DHH)** have been significantly impacted by the digital revolution[90]. DHH individuals have embraced various forms of electronic communication in their social and professional lives. This includes using Short Message Services (SMS) for personal interactions, telephone typewriters (TTY) or voice/TTY relay services for longer communications, fax for business and social contacts, and engaging in activities such as email, web browsing, accessing chat rooms, word processing, games, and studying[91]. While there are several DL resources available for educational purposes, none of them specifically cater to the needs of DHH learners. This highlights a gap in Deaf education where technology resources are not aligned to meet the requirements of DHH individuals.

Research indicates the importance of DL training for DHH students as well as their teachers. However, teachers of DHH students often rely on traditional methods when designing and delivering academic content-based learning activities. There is a lack of guidelines or frameworks for software developers or designers to create accessible resources. There are unique challenges in addressing how organizations, digital device designers, and service providers can support the use of digital tools for PWDs. They include ensuring accessibility and usability for these people, addressing their diverse needs, providing adequate support and training, and navigating legal and regulatory requirements related to accessibility. Organizations and designers need to consider factors such as assistive technology compatibility, inclusive design principles, and the need for customization to accommodate different disabilities. Service providers must also prioritize user experience and provide comprehensive support for PWDs to effectively use digital tools. Additionally, all stakeholders must be aware of and comply with accessibility standards and regulations to ensure equal access to digital tools for PWDs. Some of these issues are indeed already raised in the paragraph preceding the measures of DL. However, it is agreed that this topic or theme can by itself be a separately specialised and focused review article in the forthcoming future.

As a result, strategies need to be invented or adapted to effectively reach these learners. Consequently, the potential benefits that technology offers in terms of accessible communication solutions for DHH individuals are not fully realized[92]. Various technological tools have proven useful for DHH individuals in terms of communication and access to information. These include electronic books, high-quality illustrated digital stories or websites with user-friendly closed captioning or subtitles for videos, text-

based communication tools, and visual cues and alerts for notifications. These tools also serve as therapy aids for speech, language, and literacy development among DHH individuals[93][94][95][96].

Measures of Digital Literacy

An increasing body of research indicates that DL is a significant obstacle to the adoption or use of digital devices and technologies by PWDs. As mentioned, the DL of PWDs can expand opportunities, increase independence, or ameliorate their QOL. Even as DL in PWDs is being increasingly valued, unfortunately, there is a dearth of exclusively validated measurement tools for capturing the levels of DL in PWDs. Items at a basic level covering DL skills in connecting to a WiFi network, searching for a term or phrase on Google.com, opening a mobile browser, looking up information, opening a new tab in the browser, looking at a news headline on social media and finding information, bookmarking a web page, clearing all cache and cookies from the browser, replying to a chat, deleting and forwarding a message, recording audio messages, reporting, and blocking a user are themselves missing. The need, rationale, and justification for using measures of DL are evident if one proposes to undertake ICT literacy initiatives or plans or plans a curriculum for PWDs[97].

A few DL-related assessment tools or the theories on which they are based are available online through open source or published offline. Mostly, they target college students, teachers, employers, and employees by using simulated situations, multiple-choice items, or right/wrong answers. Note that measuring digital skills or competencies is different from measuring DL. The Digital Literacy Scale (DLS; [98]) based on Chen's theory, Digital Literacy Assessment Test (DLAT; [99]), Internet Literacy Scale (ILS; [100]), Digital Literacy Scale (DLS; [101][102]), and New-Digital Literacy Scale (N-DLS; [103]) are among the few examples of DL measurement tools that are reported to be psychometrically sound, reliable, and valid. Greene, Seung, and Copeland[104] measured the critical components of DL for college students. Sivrikaya[105] examined the DL level of the students in sports science using a 17-item Digital Literacy Scale (DLS; [106]). **Baro, Obaro,** & **and Aduba** [107] attempted to assess DL skills in library and information professionals. A systematic review on the measurement of DL among older adults[108] and the eHealth Literacy Scale (eHEALS; [109]) is available for measuring DL among older adults. Other specialised measures include tools for measuring web-oriented DL[110][111] or another instrument that captures digital training experiences and uses a novel data collection method in the

form of a graphic questionnaire[112]. In sum, DL measurement tools with a focus exclusive to PWDs are found to be lacking [113][114][115].

The need, rationale, and justification for the **choice of a specific tool for the measurement of DL** of PWDs must be taken into account, whether it is for enabling individual or collective institutional decisions, at what level, or whether it is for framing a curriculum for learning. The validity, reliability, feasibility, context, utility, fairness, consistency, and precision of the instrument are important. The choice of targeted group, viz., children, teens, adults, or the aged, gender, socio-economic and health status, occupation (teachers, doctors, architects, sports persons, labor markets, or others) is also important[116] [117]. The measurement of DL as an essential life skill in research scholars of Law School is also available [118][119]. Other populations addressed by studies include school students[120][121], and emergent literacy skills alongside conventional literacy skills in young children using e-books and digital games[122]. The problems reported were delays in internet connectivity, difficulties in finding relevant information, high cost of access, irregular power supply, too long to view/download pages, and slow access speed. The reported purposes for using the internet by the respondents were to gather information, prepare class notes, for entertainment, solve question papers, and generate an online question bank

The **theories of DL for PWDs** often focus on concepts like Universal Design for Learning (UDL), where website developers incorporate features like alternative text for images and video captions to support users with visual or hearing impairments. UDL emphasizes the importance of providing multiple means of representation, expression, and engagement to support diverse learners. These theories align with the Social Model of Disability, which states that PWDs are not disabled by their impairments but by the disabling barriers they face in society. Therefore, the aim is to remove societal barriers for PWDs when they engage in the digital realm [123][124]. Additionally, they incorporate the Assistive Technology Model, which involves utilizing tools such as screen readers, Braille displays, and voice recognition software to assist individuals with visual or motor impairments. The compensation model[125] postulates that PWDs are isolated and have low levels of social interaction. Creating social interaction which is online can compensate to overcome 'limitations' in their body to improve their life chances. People who are socially inactive or dissatisfied with their social interactions in the physical non-ITC world tend to use the Internet more frequently, and hence benefit from it more.

The research on DL still lacks a well-established theoretical framework. A skills-based theoretical framework was first published by Eshet[126]. It covered a variety of complex cognitive, motor, sociological, and emotional skills needed to function effectively in digital environments. A holistic, refined conceptual framework for DL, which includes photo-visual literacy (understanding messages from graphical displays), reproduction literacy (utilizing digital reproduction to create new, meaningful materials from preexisting ones), branching literacy (constructing knowledge from non-linear, hypertextual navigation), information literacy (critically evaluating the quality and validity of information), and socio-emotional literacy (understanding the "rules" that prevail in cyberspace and applying this understanding in virtual communication)[126]. A sixth skill, the ability to think or process large volumes of stimuli at the same time, as in video games or online teaching, was added later[127][128][129][130]. The pedagogical usability, context of use, and implications of the framework for the design, evaluation, and training of DL skills using task analysis, shaping, modeling, guided practice, reinforcement, and prompting techniques are shown in school education[131].

Chen's theory of DL includes nine dimensions: communication, collaboration, critical thinking, creativity, citizenship, character, curation, copyright, and connectedness. Ibraimkulov et al.[132] developed a **two-component model of DL** viz., operational skills and informational and strategic skills to assess the level of development of DL in students with hearing impairment from special (correctional) schools in Kazakhstan. Later, validation of tools for measuring DL[133] based on archaic models (Gilster[11] and the **Technology Acceptance Model** (TAM), **The DL Skills Conceptual Model**[134], or the recent **South Pacific Digital Literacy Framework** (SPFLF) were developed[135][136][137]). In sum, there is still **no model or theory of DL exclusive for PWDs**[138].

Digital Literacy Empowerment Programs (DLEPs)

DLEPs are initiatives that provide individuals with the skills and knowledge they need to navigate and use digital technologies effectively. These programs usually focus on teaching fundamental computer skills, internet use, online safety, and digital communication. These programs aim to close the digital divide and allow people to fully participate in the digital space. DLEP programs, provided by educational institutions, NGOs, and government agencies, often include training workshops and online courses, as well as resources to help learners develop their digital skills. Vulnerable groups in society that have benefitted from DLEPs include seniors/older adults; low-income individuals; immigrants; women from

low socio-economic backgrounds; the marginalized and refugees; PWDs; people with physical or mental disabilities; and people living in rural or remote areas who lack access to digital technologies because of infrastructure constraints [139][140][141].**The National Digital Literacy Mission (NDLM)** initiated by the Government of India and launched in August 2014, targets key village-level workers to become digitally literate persons. Pallampara village, near Thiruvananthapuram city in Kerala, is recorded as India's first fully digitally literate panchayat[142][143][144][145].

The recent COVID-19 pandemic affected digital participation and inclusion in the lives of PWD. The issues were further aggravated by their loneliness and impoverished daily lives during the pandemic[146]. Software developers themselves needed training to incorporate the required design features, interface, and structure in the context of special educational needs [147][148]. Their carers and parents also needed training before they could develop the DL or skills of their wards[149]. They needed navigation indicators and contextual aids, simplification of screen pages both graphically and textually, simplification of game features, the predominant use of video-based content, and the use of individual interviews[150][151] even during adverse times such as the Covid-19 pandemic[152][153].

COVID-19 has had a significant impact on the digital participation and inclusion of PWDs in society. The problems were exacerbated by their isolation and poor living conditions during the pandemic [146]. Software developers needed training to incorporate the necessary design features, interface, and structure in relation to special educational needs[147][148]. Their carers and parents needed training to foster DL skills in their wards[149]. They needed navigation indicators and contextual aids, simplification of screen pages (graphically and textually), or game features, the predominant use of video-based content, and the use of individual interviews [150][151] even during adverse times such as the Covid-19 pandemic[152][153].

There are various formal or standardized DL empowerment programs that are often initiated by non-profit organizations. Some examples include the Digital Literacy Corps [154], Microsoft Digital Literacy [155], Google Digital Garage [156], Digital Promise, and TechSoup [157]. These programs offer courses on basic computer skills, internet safety, digital citizenship, digital marketing, data analytics, and other digital skills. Additionally, Microsoft's Disability Answer Desk provides technical support to PWDs who use Microsoft products, WebAIM's Training offers online training courses on web accessibility for PWDs, and The National Federation of the Blind's Access Technology Institute Program provides training on assistive technology for people who are blind or visually impaired. The American Foundation for the

Blind's eLearning Center Program is another program that offers training on assistive technology for PWDs [158].

There are several DL programs that focus on PIDs, including Project UNITE, The Arc's Tech Toolbox Program, The National Center on Disability and Access to Education Program, and The Digital Literacy Alliance Program. These programs typically cover topics like basic computer skills, internet safety, and social media. They use various technologies such as online courses, webinars, email, and social media to teach about accessing educational technology, assistive technology, instructional materials, universal design for learning, and online communication. Several independent studies and projects have attempted to evaluate the impact of short- or long-term DL initiatives on different segments of the population. Martin & Grudziecki[29] undertook a DigEuLit Project to define and develop a framework and tools to measure DL in educational settings.

Literacy Enrichment and Technology Integration in Pre-Service Teacher Education examines the various strategies to resolve the challenges of technology integration for teachers while offering best practices for transforming education. Some key questions asked are: What is the needed set of best practices for teaching DL to teachers? Where should teachers begin? What are the essentials to be covered? K-12 contexts? How to optimally prepare teachers to achieve their agenda?[159]

What are the best practices in teaching DL to PWDs? This is done by integrating or incorporating technology tools and resources into lesson plans to enhance students' digital skills and literacy development, providing them with authentic real-world, hands-on activities or learning experiences that allow students to apply their DL skills in meaningful ways. Teach students how to critically evaluate digital information, including fact-checking, identifying bias, and assessing credibility. Encourage collaborative projects and online discussions to foster digital communication skills and teamwork. Promote responsible and ethical use of technology, including online safety, privacy, and respectful online behavior. Teach students how to create and interpret various forms of digital media, such as videos, podcasts, and presentations. Tailor instruction to meet individual students' needs and interests, allowing them to explore DL at their own pace. Provide continuous support and training for teachers to stay updated on the latest digital tools and pedagogies. In a widely acclaimed book, Hobbs[160] demonstrated how to incorporate media literacy into the secondary classroom, providing the tools teachers need to: (i) Effectively foster students' critical thinking, collaboration, and communication skills; (ii) Integrate media literacy into every subject; (iii) Select meaningful media texts for use in the classroom; and (iv) Recognize the "teachable moment" in dialogue about popular culture. The book includes vignettes of Grade 6-12

teachers who are connecting their classroom subjects to media culture. A companion website offers video clips and discussion questions related to the sample lesson plans in each chapter. The book offers a wealth of ideas that can be implemented immediately to prepare students for college and the workforce. A preface, a bibliography, and an index are included.

Individual DL enrichment programs are shown to have positive impacts on performance through the use of digital tools like podcasts, blogs, and wikis[161]. Kaeophanuek, Na-Songkhla, and Nilsook[162] used self-assessment and in-depth interviews to obtain information about their teaching environments, problems, and obstacles to deriving alternative methods for DL development among information sciences students.

DL and PWDs

Inclusive education for PWDs requires a reflection on their digital lives. Does disability limit their access to ICT? What factors affect their use and experience of ICT? What is the minimum ICT skills or abilities that need to be developed? How can PWDs remain secure in the digital space? Research on digital technologies vis-a-vis PWDs remains largely unexplored. If any accounts exist, they are based on the views of parents, caregivers, and teachers rather than the PWDs themselves. Annual Social Surveys have shown a continuous increase in ICT usage among PWDs in some countries, particularly after the turn of the century. The dualism of 'normal-disabled' and 'disabled-abled' is to be rejected to strongly favour promoting DL for PWDs[163][164].

For PWDs, it has to be ensured that all digital materials used in teaching are accessible, such as screen readers, magnifiers, speech-to-text software, closed captions, and alt text for images. PWDs have different learning styles and abilities. Therefore, the use of a variety of teaching methods, such as visual aids, hands-on activities, and group work, to accommodate different learning needs is recommended. A supportive and inclusive learning environment that encourages participation and engagement from all learners by encouraging collaboration and peer support is suggested. Provision for assistive technology tools and software to help PWDs access and use digital resources is essential. Encourage self-advocacy in learners with disabilities to advocate for themselves and their needs. Teach them how to communicate their needs effectively and seek out resources and support. Overall, teaching DL to PWDs requires a flexible and inclusive approach that takes into account the unique needs of each learner[165][166].

Based on six case studies, the authors advocate against dualism like "normal-deviant" or "disabled-abled" by interpreting the cases from a social practice perspective before advocating fervently in favor of

promoting DL for PWDs[163]. Baek and Aguilar[167] examined the learning analytics literature over the past ten years (2011-2020). Their results showed that only 33% of the articles they retrieved focused on PWD, and 67% of the articles retrieved engaged with PWDs tangentially on several themes: detecting difficulties, providing early intervention, promoting learning, addressing accessibility issues and challenges, and discussing ethics and privacy concerns.

Ethical Issues of Digital Literacy in PWDs

The promotion of DL and AI for PWDs gives rise to ethical concerns regarding the cost and availability of AT, and the responsibility of content creators and platform providers to ensure accessibility. PWDs are vulnerable to online threats such as cyberbullying, identity theft, and harassment, making it crucial to provide them with guidance on protecting their personal information and devices. They may also face challenges in understanding online activities, giving and obtaining informed consent, and adhering to the law[168]. PWDs have the same digital rights as everyone else, but they often encounter additional barriers that prevent them from accessing digital content and services without discrimination. It is essential to create avenues for them to exercise their right to privacy and data protection, participate in the digital economy on an equal basis, and express themselves freely. This can be achieved by making websites and apps accessible and promoting digital inclusion. As digitalization advances, new digital rights have emerged due to the development of Internet and Communication Technology (ICT), the Internet of Things (IoT), and innovative smart technologies, applications, and software. Unfortunately, there has also been an increase in cybercrimes and fraudulent activities, leading to terms like cyber-terrorism, cyber-bullying, cyber-stalking, hacking, phishing, and spamming. PWDs are particularly vulnerable to privacy invasions, surveillance, restrictions on digital access, and other forms of discrimination and harm in the digital realm [169].

Recent Research

A recent publication uses Bourdieu's critical theory to explore how the unequal distribution of resources shapes processes of digital inclusion for young PWDs. The study was based on interviews in South Australia with 18 young people aged 10–18 years with a physical disability (such as cerebral palsy) or acquired brain injury and their family members. It was concluded that digital inclusion for young PWDs requires intensive, personalised, and long-term support from within and beyond the family to 'get online'[170]. Discussions on DL in PWDs in recent times hover on issues like internet safety, online

radicalisation of PWDs, their experiences on social networking sites, community building, and knowledge sharing[171], leveraging their social capital through participation in Facebook[172], investigating their expressed barriers to digital inclusion and online social networking[170], their digital inclusion and participation during the period of COVID-19[146], interactional power and supports in digital inclusion[173], measuring DL among students with visual impairments[58], and so on.

Limitations

Admittedly, this review paper is caught between the dilemma of opting between a generalist or specialist approach. If a generalist approach is adopted, it would necessitate including as many topics as possible related to DL and PWDs within its coverage. If a specialist approach is taken, there can be greater focus and in-depth analysis of various themes and sub-themes with a reduced risk of deviations or digression. When the breadth of the topics is widened, in-depth analysis would have to take a back seat.

Recommendations and Future Directions

Concrete recommendations and practical observations with value for PWDs include accessibility training programs, promoting inclusive design principles among digital designers and developers, and developing user-friendly resources such as guides, videos, and tutorials that cater to their specific needs, such as navigating digital interfaces. Additionally, collaborative workshops and sessions can facilitate the sharing of knowledge and best practices among PWDs, digital literacy experts, and technology providers. Personalized support and tailored assistance can aid PWDs in overcoming specific challenges related to DL. Peer support networks enable PWDs to share experiences and learn from each other in effectively utilizing digital tools. It is also advisable to create accessible content by considering screen readers, captions, and alternative formats.

There is a need to strengthen the DL component in preparing future preschool educators in areas like interactive didactic games, basics of animation and programming, as well as network technologies, a growing need in the immediate future[174]. There is a **need to introduce new learning models** in the educational system based on the use of modern innovative technologies and DL methods[175]. There are several potential directions in DL for PWDs for the future. Aspects such as **inclusive design** by incorporating considerations such as screen reader compatibility, smart boards, keyboard navigation, and alternative input methods are required. **Advances in assistive technologies** will continue to enhance

DL for PWDs through innovations in speech recognition software, eye-tracking devices, and other tools that facilitate their access to digital content. DL programs will likely become more personalized to cater to the specific needs and abilities of PWDs. **Adaptive learning platforms and individualized instruction** to help them acquire digital skills at their own pace and in ways that suit their unique learning styles is the need of the times. **Online platforms and communities** will play a crucial role in fostering collaboration and peer support among PWDs in the times to come. They will provide opportunities for knowledge sharing, skill development, and networking, empowering PWDs to enhance their DL collectively. Above all, governments and organizations will continue to recognize the importance of digital inclusion for PWDs and **implement policies to promote accessibility and equal opportunities** in the digital realm[176].

Some degree of generational digital divide is inevitable for PWDs or others too. This divide refers to differences in access to and use of digital technology among different age groups, affecting all people. This occurs due to limited access to assistive technologies, lack of inclusive design in digital interfaces, and insufficient training tailored to their needs. The generational digital divide for PWDs may be more pronounced, requiring special attention to empower individuals across generations and abilities. Addressing the divide involves using alt text, providing video captions, using clear language, and ensuring navigability with assistive technologies, roping PWDs in product testing, eliminating accessibility barriers, providing employee training, raising awareness, advocating for accessibility policies, collaborating with disability rights organizations, and supporting technology adoption. These strategies aim to bridge the digital divide and ensure their digital inclusivity.

Advocacy efforts will strive to raise awareness about the digital divide and work towards bridging it for PWDs. The future of DL for PWDs holds great potential for increased accessibility, inclusivity, personalized learning, collaboration, and policy advancements[177]. Addressing these limitations requires a comprehensive approach that considers accessibility, technology access, personalized learning, content diversity, and robust support systems. By addressing these challenges, DL programs can become more inclusive and effective for PWDs.

Statements and Declarations

Data Availability

This review is based on publicly available data from published articles and books cited in the reference list. No new primary data were generated or analyzed in support of this publication.

Author Contributions

The sole author confirms responsibility for the following: study conception and design, literature search and analysis, manuscript preparation.

References

1. ^*Becker BW (2018). "Information literacy in the digital age: Myths and principles of digital literacy." School of Information Student Research Journal. **7**(2):2.*
2. ^*Dobson T, Willinsky J (2009). "Digital literacy." In: The Cambridge handbook of literacy. pp. 286-312.*
3. ^*Cranmer S (2021). Disabled children and digital technologies: learning in the context of inclusive educatio n. New York: Bloomsbury Academic.*
4. ^*Venkatesan S (2004). "Introduction." Chapter 1. In: Children with developmental disabilities: A training gu ide for parents, teachers and caregivers. California/London/New Delhi: Sage. p. 19–48.*
5. ^*Harris D, Harris D, Sally B (1998). A link to learning: The use of computers by children with disabilities. Wellington: New Zealand Council of Education Research.*
6. ^*Kolotouchkina O, Barroso CL, Sánchez JLM (2022). "Smart cities, the digital divide, and people with disabil ities." Cities. **123**:103613.*
7. ^*Scanlan M (2022). "Reassessing the disability divide: unequal access as the world is pushed online." Univer sal Access in the Information Society. **21**(3):725–735.*
8. ^*Cho M, Kim KM (2021). "Exploring the disparity in tangible outcomes of internet use between persons wit h disabilities and persons without disabilities in South Korea." Disability and Health Journal. **14**(3):101101.*
9. a, b*Rogers EM (2003). Diffusion of innovations. 5th ed. New York: Free Press.*
10. ^*Compaine BM, editor (2001). The digital divide: Facing a crisis or creating a myth?. London: The MIT Pres s.*
11. a, b*Gilster P (1997). Digital Literacy. New York, NY: John Wiley & Sons, Inc.*
12. ^*Berge O (2017). "Rethinking digital literacy in Nordic school curricula." Nordic Journal of digital literacy. **12** (1-2):5-7.*
13. ^*Treglia E, Magnanini A, Caione G, Lungu MA (2019). "Assistive Technologies, Digital Literacy and Didactic for Inclusion." International Journal of Digital Literacy and Digital Competence (IJDLDC). **10**(3):1–9.*
14. ^*McDougall J, Readman M, Wilkinson P (2018). "The uses of (digital) literacy." Learning, Media and Techno logy. **43**(3):263–279.*

15. ^Hartley J (2017). The uses of digital literacy. Routledge.
16. ^Chase Z, Laufenberg D (2011). "Embracing the squishiness of digital literacy." Journal of Adolescent & Adult Literacy. **54**(7):535–537.
17. ^Mengual-Andrés S, Chiner E, Gómez-Puerta M (2020). "Internet and people with intellectual disability: A bibliometric analysis." Sustainability. **12**(23):10051.
18. ^Beliveau R, Wiesnger S (2023). Digital literacy: A primer on media, identity, and the evolution of technology. 2nd ed. Bern, Switzerland: Peter Lang AG International Academic Publishers.
19. ^Parker J, Reddy K (Eds.) (2019). Digital literacy unpacked. Chicago, Illinois: American Library Association.
20. ^Julien H (2018). "Digital literacy in theory and practice." In: Encyclopedia of Information Science and Technology, 4th Edition. IGI Global. pp. 2243–2252.
21. ^Wempen F (2014). Digital literacy for dummies. Hoboken, New Jersey: John Wiley & Sons.
22. a, bMartin A, Madigan D (Eds.) (2006). Digital literacies for learning. London: Facet Publishing.
23. ^Knobel M, Lankshear C (2006). "Digital literacy and digital literacies: Policy, pedagogy and research considerations for education." Nordic Journal of digital literacy. **1**(1):12–24.
24. ^Bawden D (2001). "Information and digital literacies: a review of concepts." Journal of Documentation. **57**(2):218–259.
25. ^Bawden D (2008). "Origins and concepts of digital literacy." In: Digital literacies: Concepts, policies and practices. Vol 30. pp. 17–32.
26. ^Bawden D, Robinson L (2002). "Promoting literacy in a digital age: approaches to training for information literacy." Learned Publishing. **15**(4):297–301.
27. ^Kope M, editor (2006). "Understanding e-literacy." In: Martin A, Madigan D, editors. Digital literacies for learning. London: Facet Publishing. pp. 68–79.
28. ^Willams P, Minnian A (2007). "Exploring the challenges of developing digital literacy in the context of special educational needs communities." In: Andretta S (Ed.). Change and challenge: information literacy for the 21st century. Adelaide: Auslib Press. p. 115–144.
29. a, bMartin A, Grudziecki J (2006). "DigEuLit: Concepts and tools for digital literacy development." Innovation in Teaching and Learning in Information and Computer Sciences. **5**(4):249–267.
30. ^Tinmaz H, Lee YT, Fanea-Ivanovici M, Baber H (2022). "A systematic review on digital literacy." Smart Learning Environments. **9**(1):1–18.

31. ^ Bulger ME, Mayer RE, Metzger MJ (2014). "Knowledge and processes that predict proficiency in digital literacy." Reading and Writing. **27**:1567-1583.
32. ^ Ba H, Tally W, Tsikalas K (2002). "Investigating children's emerging digital literacies." The Journal of Technology, Learning, and Assessment. **1**(4):5-48.
33. ^ Alsalem MA (2016). "Redefining literacy: The realities of digital literacy for students with disabilities in K-12." Journal of Education and Practice. **7**(32):205-215.
34. ^ Datta A, Bhatia V, Noll J, Dixit S (2018). "Bridging the digital divide: Challenges in opening the digital world to the elderly, poor, and digitally illiterate." IEEE Consumer Electronics Magazine. **8**(1):78-81.
35. ^ Fernando JG, Jain SK (2022). "Digital illiteracy of teachers and its impact on online learning." Technoarete Transactions on Applications of Information and Communication Technology (ICT) in Education. **1**(3):1-6.
36. ^ Spanakis P, Wadman R, Walker L, Heron P, Mathers A, Baker J, et al. (2022). "Measuring the digital divide among people with severe mental ill health using the essential digital skills framework." Perspectives in Public Health. **144**(1):21–30. doi:10.1177/17579139221106399.
37. ^ Camacho E, Torous J (2023). "Impact of digital literacy training on outcomes for people with serious mental illness in community and inpatient settings." Psychiatric Services. **74**(5):534-538.
38. ^ Venkatesan S (2021). "Is it Specific Learning Disability or Teaching Inability? Revisiting the Basics of a Socio-Political Diagnostic Entity." Chapter 3. In: Pandey A (Ed.). Educational Developments-Volume 2. Bhopal, India: Innovare Academics Sciences. p. 42–63.
39. ^ Combi M (2016). "Cultures and technology: an analysis of some of the changes in progress—digital, global and local culture." In: Borowiecki K, Forbes N, Fresa A, editors. Cultural Heritage in a Changing World. New York: Springer.
40. ^ Isin E, Ruppert E (2015). Being digital citizens. London: RLI.
41. ^ Selwyn N, Facer K (2013). The politics of education and technology: Conflicts, controversies, and connections. New York: Palgrave Macmillan.
42. ^ Murray MC, Pérez J (2014). "Unraveling the digital literacy paradox: How higher education fails at the fourth literacy." Issues in Informing Science and Information Technology. **11**:85.
43. ^ Nelson K, Courier M, Joseph GW (2011). "An investigation of digital literacy needs of students." Journal of Information Systems Education. **22**(2):95–110.
44. ^ Sung W, Kim S (2020). "Can people with disabilities use the mobile Internet if they want to?." In: The 21st Annual International Conference on Digital Government Research. p. 147–154.

45. ^Utaminingsih S (2022). "Implementation of Digital Literacy in the Learning Module in Class VI Primary School." ANP Journal of Social Science and Humanities. 3(2):7–10.

46. ^Koppel I, Langer S (2020). "Basic digital literacy—requirements and elements." Práxis Educacional. 16(42):326-347.

47. ^Uršej K (2019). "Digital literacy in the first three years of primary school: Case study in Slovenia." International Journal of Management, Knowledge and Learning. 8(1):61–77.

48. ^Kimbell-Lopez K, Cummins C, Manning E (2016). "Developing digital literacy in the middle school classroom." Computers in the Schools. 33(4):211-226.

49. ^Ayyildiz P, Yilmaz A, Baltaci HS (2021). "Exploring digital literacy levels and technology integration competence of Turkish academics." International Journal of Educational Methodology. 7(1):15-31.

50. ^Park EY, Nam SJ (2014). "An analysis of the digital literacy of people with disabilities in Korea: verification of a moderating effect of gender, education and age." International Journal of Consumer Studies. 38(4):404–411.

51. ^Tohara AJT (2021). "Exploring digital literacy strategies for students with special educational needs in the digital age." Turkish Journal of Computer and Mathematics Education (TURCOMAT). 12(9):3345–3358.

52. ^Venkatesan S (2009). "Ethical guidelines for bio-behavioral research involving human subjects." All India Institute of Speech and Hearing, Mysore.

53. ^Pallant J (2020). SPSS survival manual: A step-by-step guide to data analysis using IBM SPSS. Abingdon, Oxfordshire: Routledge.

54. ^Cohen J (1992). "Quantitative methods in psychology: A power primer." Psychological Bulletin. 112:1155-1159.

55. ^Farias-Gaytan S, Aguaded I, Ramirez-Montoya MS (2022). "Transformation and digital literacy: Systematic literature mapping." Education and Information Technologies. 27(2):1417-1437.

56. ^Lowenthal PR, Persichini G, Conley Q, Humphrey M, Scheufler J (2022). "Digital literacy in special education: Preparing students for college and the workplace." In: Research Anthology on Inclusive Practices for Educators and Administrators in Special Education. IGI Global. p. 524–537.

57. ^Arslantas TK, Gul A (2022). "Digital literacy skills of university students with visual impairment: A mixed-methods analysis." Education and Information Technologies. 27(4):5605-5625.

58. ^a, ^bMardiana S, Suminar JR, Sugiana D (2019). "Measuring Digital Literacy for Students With Visual Impairments." Library Philosophy and Practice DigitalCommons@ University of Nebraska-Lincoln. 43(12):2–14.

59. ^a, ^b*Barlott T, Aplin T, Catchpole E, Kranz R, Le Goullon D, Toivanen A, et al. (2020). "Connectedness and ICT: Opening the door to possibilities for people with intellectual disabilities." Journal of Intellectual Disabilities.* ***24****(4):503-521.*

60. ^*Caton S, Chapman M (2016). "The use of social media and people with intellectual disability: A systematic review and thematic analysis." Journal of Intellectual and Developmental Disability.* ***41****(2):125-139.*

61. ^*Borgström Å, Daneback K, Molin M (2019). "Young people with intellectual disabilities and social media: A literature review and thematic analysis." Scandinavian Journal of Disability Research.* ***21****(1):129-140.*

62. ^*Chadwick DD (2019). "Online risk for people with intellectual disabilities." Tizard Learning Disability Revi ew.* ***24****(4):180-187.*

63. ^*Salmerón L, Gómez M, Fajardo I (2016). "How students with intellectual disabilities evaluate recommenda tions from internet forums." Reading and Writing.* ***29****:1653–1675.*

64. ^*Shpigelman CN, Gill CJ (2014). "How do adults with intellectual disabilities use Facebook?." Disability & So ciety.* ***29****(10):1601–1616.*

65. ^*Alfredsson-Ågren K, Kjellberg A, Hemmingsson H (2020). "Access to and use of the Internet among adolesc ents and young adults with intellectual disabilities in everyday settings." Journal of Intellectual & Develop mental Disability.* ***45****(1):89-98.*

66. ^*Hällgren M, Nygård L, Kottorp A (2014). "Everyday technology use among people with mental retardation: Relevance, perceived difficulty, and influencing factors." Scandinavian Journal of Occupational Therapy.* ***21*** *(3):210-218.*

67. ^*Gomez J, Torrado JC, Montoro G (2017). "Using smartphones to assist people with Down syndrome in their labour training and integration: a case study." Wireless Communications and Mobile Computing.* ***2017****:1-15. doi:10.1155/2017/5062371.*

68. ^*Heitplatz VN, Bühler C, Hastall MR (2022). "Usage of digital media by people with intellectual disabilities: Contrasting individuals' and formal caregivers' perspectives." Journal of Intellectual Disabilities.* ***26****(2):420-441.*

69. ^*Heitplatz VN (2020). "Fostering digital participation for people with intellectual disabilities and their care givers: towards a guideline for designing education programs." Social Inclusion.* ***8****(2):201-212.*

70. ^*Li-Tsang C, Yeung S, Chan C, Hui-Chan C (2005). "Factors affecting people with intellectual disabilities in l earning to use computer technology." International Journal of Rehabilitation Research.* ***28****(2):127–133.*

71. ^*Molin M, Sorbring E, Löfgren-Mårtenson L (2015). "Teachers' and parents' views on the Internet and social media usage by pupils with intellectual disabilities." Journal of Intellectual Disabilities.* ***19****(1):22–33.*

72. ^Näslund R, Gardelli Å (2013). "'I know, I can, I will try': youths and adults with intellectual disabilities in Sweden using information and communication technology in their everyday life." Disability & Society. **28**(1):28–40.

73. ^Khanlou N, Khan A, Vazquez LM, Zangeneh M (2021). "Digital literacy, access to technology and inclusion for young adults with developmental disabilities." Journal of Developmental and Physical Disabilities. **33**:1-25.

74. ^McMahon DD, McMahon AK, Anglin M, Abrams K, Wilds K, Aumel A (2023). "Digital health, fitness, and wellness tools for students with disabilities." Journal of Special Education Technology. **38**(3):392–403.

75. ^McMahon DD, Cihak DF, Gibbons MM, Fussell L, Mathison S (2013). "Using a mobile app to teach individuals with intellectual disabilities to identify potential food allergens." Journal of Special Education Technology. **28**(3):21–32.

76. ^McMahon D, Cihak DF, Wright R (2015). "Augmented reality as a navigation tool to employment opportunities for post secondary education students with intellectual disabilities and autism." Journal of Research on Technology in Education. **47**(3):157–172.

77. ^Cihak DF, Wright R, Smith CC, McMahon D, Kraiss K (2015a). "Incorporating functional digital literacy skills as part of the curriculum for high school students with intellectual disability." Education and Training in Autism and Developmental Disabilities. **50**(2):155-171.

78. ^Cihak DF, McMahon D, Smith CC, Wright R, Gibbons MM (2015b). "Teaching individuals with intellectual disability to email across multiple device platforms." Research in Developmental Disabilities. **36**:645-656.

79. ^Ayres KM, Mechling L, Sansosti FJ (2013). "The use of mobile technologies to assist with life skills/independence of students with moderate/severe intellectual disability and/or autism spectrum disorders: Considerations for the future of school psychology." Psychology in the Schools. **50**(3):259-271.

80. ^Holzman P, Thompson W (2023). "Digital literacy for students with intellectual disabilities." In: Handbook of Research on Current Trends in Cybersecurity and Educational Technology. Hershey, Pennsylvania: IGI Global. pp. 233-249.

81. ^Tsikinas S, Xinogalos S (2019). "Studying the effects of computer serious games on people with intellectual disabilities or autism spectrum disorder: A systematic literature review." Journal of Computer Assisted Learning. **35**(1):61–73.

82. ^Lancioni GE, Singh NN (Eds.) (2014). Assistive technologies for people with diverse abilities. New York: Springer Science & Business Media.

83. ^ *Baxter A, Reeves LM (2022). "Inclusion of digital literacy skills in transition planning for students with inte llectual disabilities." Journal of Special Education Technology. **38**(3):384-391.*

84. ^ *Conley Q, Scheufler J, Persichini G, Lowenthal PR, Humphrey M (2019). "Digital citizenship for all: Empowe ring young learners with disabilities to become digitally literate." In: The Human Performance Technology: Concepts, Methodologies, Tools, and Applications. Hershey, PA: IGI Global. pp. 829-850.*

85. ^ *Keeley C, Bernasconi T (2023). "Digital participation and digital education for people with profound and multiple disabilities and complex communication needs." Frontiers in Communication. **8**:1229384.*

86. ^ *Bunning K, Alder R, Proudman L, Wyborn H (2017). "Co-production and pilot of a structured interview usin g Talking Mats® to survey the television viewing habits and preferences of adults and young people with l earning disabilities." British Journal of Learning Disabilities. **45**(1):1-11.*

87. ^ *Ryan G (1988). Computer literacy instruction for learning disabled students with reading disabilities. Mass achusetts, USA: Boston College.*

88. ^ *Patterson MB (2022). "Digital literacy skills and skill use of adults with learning disabilities." COABE Journ al: The Resource for Adult Education. **11**(1).*

89. ^ *Barnett JEH (2017). "Helping students with ADHD in the age of digital distraction." Research, Advocacy, an d Practice for Complex and Chronic Conditions. **36**(2):1-7.*

90. ^ *Kritzer KL, Smith CE (2020). "Changing perspectives for the 21st century: digital literacy and computation al thinking for deaf/hard of hearing learners." Chapter 21. In: The Oxford handbook of deaf studies in learni ng and cognition. Oxford: Oxford University Press, USA. p. 332–346.*

91. ^ *Power MR, Power D, Horstmanshof L (2006). "Deaf People Communicating via SMS, TTY, Relay Service, F ax, and Computers in Australia." Journal of Deaf Studies and Deaf Education. **12**(1):80–92.*

92. ^ *Flórez-Aristizábal L, Cano S, Collazos CA, Benavides F, Moreira F, Fardoun HM (2019). "Digital transformat ion to support literacy teaching to deaf children: From storytelling to digital interactive storytelling." Telem atics and Informatics. **38**:87-99.*

93. ^ *Alshawabkeh AA, Woolsey ML, Kharbat FF (2021). "Using on-line information technology for deaf student s during COVID-19: A closer look from experience." Heliyon. **7**(5).*

94. ^ *DeForte S, Sezgin E, Huefner J, Lucius S, Luna J, Satyapriya AA, et al. (2020). "Usability of a Mobile App for I mproving Literacy in Children With Hearing Impairment: Focus Group Study." JMIR Human Factors. **7**(2):e1 6310.*

95. ^ *Harris M (2015). "The impact of new technologies on the literacy attainment of deaf children." Topics in L anguage Disorders. **35**(2):120-132.*

96. ^ Luft P, Bonello M, Zirzow NK (2009). "Technology skills assessment for deaf and hard of hearing students in secondary school." American Annals of the Deaf. **154**(4):389–399.

97. ^ Chetty K, Qigui L, Gcora N, Josie J, Wenwei L, Fang C (2018). "Bridging the digital divide: measuring digital l iteracy." Economics. **12**(1):20180023.

98. ^ Amin H, Malik MA, Akkaya B (2021). "Development and validation of digital literacy scale (DLS) and its i mplication for higher education." International Journal of Distance Education. E-Learn. **7**:24-43.

99. ^ Bansal C, Mishra PK (2021). "Digital literacy skills of secondary level students: an assessment." Journal of E merging Technologies and Innovative Research. **8**(6):430-436.

100. ^ Ma S, Wang Y, Shu Z, Duan Z, Sun L (2023). "Development and validation of internet literacy scale for high school students." Education and Information Technologies. **28**(9):1–28.

101. ^ Bayrakci S, Narmanlioğlu H (2021). "Digital literacy as whole of digital competences: Scale development st udy." Thought and Society Social Sciences Journal. (4):1-30.

102. ^ Park EY (2022). "Digital competence and internet use/behavior of persons with disabilities in PC and smar t device use." Universal Access in the Information Society. **21**(2):477–489.

103. ^ Reddy P, Chaudhary K, Sharma B, Hussein S (2023). "Essaying the design, development and validation pro cesses of a new digital literacy scale." Online Information Review. **47**(2):371–397.

104. ^ Greene JA, Seung BY, Copeland DZ (2014). "Measuring critical components of digital literacy and their relat ionships with learning." Computers & Education. **76**:55-69.

105. ^ Sivrikaya MH (2020). "An analysis on digital literacy level of faculty of sports science students." Asian Jour nal of Education and Training. **6**(2):117–121.

106. ^ Ng W (2012). "Can we teach digital natives digital literacy?." Computers & Education. **59**(3):1065–1078.

107. ^ Baro EE, Obaro OG, Aduba ED (2019). "An assessment of digital literacy skills and knowledge-based compe tencies among librarians working in university libraries in Africa." Digital Library Perspectives. **35**(3/4):172-192.

108. ^ Oh SS, Kim KA, Kim M, Oh J, Chu SH, Choi J (2021). "Measurement of digital literacy among older adults: sy stematic review." Journal of Medical Internet Research. **23**(2):e26145.

109. ^ Norman CD, Skinner HA (2006). "eHEALS: the eHealth literacy scale." Journal of Medical Internet Researc h. **8**(4):e507.

110. ^ Hargittai E (2005). "Survey measures of web-oriented digital literacy." Social Science Computer Review. **2 3**(3):371-379.

111. ^ *Hargittai E (2009). "An update on a survey measures of web-oriented digital literacy." Social Science Com puter Review. **27**(1):130-137.*

112. ^ *Macevičiūtė E, Wilson TD, Manžuch Z (2019). "Assessing the graphic questionnaire used in digital literacy t raining." Issues in Informing Science and Information Technology. **16**:113–126.*

113. ^ *White EH, Pavlovic M, Poed S (2020). "Understanding and mapping digital literacy for students with disab ility." In: Griffin P, Woods K (Eds.). Understanding Students with Additional Needs as Learners. Cham: Sprin ger. p. 131–156.*

114. ^ *Yustika GP, Iswati S (2020). "Digital literacy in formal online education: A short review." Dinamika Pendidi kan. **15**(1):66–76.*

115. ^ *Covello S, Lei J (2010). "A review of digital literacy assessment instruments." Syracuse University. 1:31.*

116. ^ *Bejaković P, Mrnjavac Ž (2020). "The importance of digital literacy in the labour market." Employee Relati ons: The International Journal. **42**(4):921-932.*

117. ^ *Garcia-Martin J, Garcia-Sanchez JN (2017). "Pre-service teachers' perceptions of the competence dimensio ns of digital literacy and of psychological and educational measures." Computers & Education. **107**:54-67.*

118. ^ *Singh M (2018). "Digital literacy: An essential life skill in the present era of growing and global educational Society." Journal of Advances and Scholarly Researches in Allied Education. **15**(8):62–67.*

119. ^ *Pratap RV, Singh K (2018). "Digital literacy skills among students and research scholars of the law school, Banaras Hindu University, Varanasi, India: A Study." International Journal of Next Generation Library and Technologies. **4**(1):111.*

120. ^ *Kulkarni DR, Ramesha (2021). "An assessment of digital literacy skills among secondary school children: A study of Belgaum district, Karnataka." International Journal of Multidisciplinary Educational Research. **10** (5):33–40.*

121. ^ *Lazonder AW, Walraven A, Gijlers H, Janssen N (2020). "Longitudinal assessment of digital literacy in child ren: Findings from a large Dutch single-school study." Computers & Education. **143**:103681.*

122. ^ *Neumann MM, Finger G, Neumann DL (2017). "A conceptual framework for emergent digital literacy." Earl y Childhood Education Journal. **45**:471–479.*

123. ^ *Oliver M (2013). "The social model of disability: Thirty years on." Disability & Society. **28**(7):1024–1026.*

124. ^ *Guo B, Bricout JC, Huang J (2005). "A common open space or a digital divide? A social model perspective o n the online disability community in China." Disability & Society. **20**(1):49-66.*

125. ^ *Cummings JN, Sproull L, Kiesler SB (2002). "Beyond hearing: Where the real-world and online support me et." Group Dynamics: Theory, Research, and Practice. **6**(1):78.*

126. ^a, b *Eshet Y (2004). "Digital literacy: A conceptual framework for survival skills in the digital era." Journal of Educational Multimedia and Hypermedia. **13**(1):93-106.*

127. ^ *Osterman MD (2012). "Digital literacy: Definition, theoretical framework, and competencies." In: Plakhotnik MS, Nielsen SM, Pane DM (Eds.). Proceedings of the 11th Annual College of Education & GSN Research Conference. Miami: Florida International University. p. 135–141.*

128. ^ *Eshet Y (2012). "Thinking in the digital era: A revised model for digital literacy." Issues in informing science and information technology. **9**(2):267-276.*

129. ^ *Nawaz A, Kundi GM (2010). "Digital literacy: An analysis of the contemporary paradigms." Journal of Science and Technology Education Research. **1**(2):19–29.*

130. ^ *Sefton-Green J, Nixon H, Erstad O (2009). "Reviewing approaches and perspectives on "digital literacy"." Pedagogies: an international journal. **4**(2):107–125.*

131. ^ *Hadjerrouit S (2010). "A Theoretical Framework to Foster Digital Literacy: The Case of Digital Learning Resources." In: Reynolds N, Turcsányi-Szabó M, editors. Key Competencies in the Knowledge Society. KCKS 2010. IFIP Advances in Information and Communication Technology, vol 324. Berlin, Heidelberg: Springer.*

132. ^ *Ibraimkulov A, Khalikova K, Yerimbetova A, Gromaszek K (2022). "Enhancement of digital literacy of students with disabilities." European Journal of Contemporary Education. **11**(2):388-407.*

133. ^ *Peled Y, Kurtz G, Avidov-Ungar O (2021). "Pathways to a knowledge society: A proposal for a hierarchical model for measuring digital literacy among Israeli pre-service teachers." Electronic Journal of e-Learning. **19**(3):118–132.*

134. ^ *Alkali YE, Amichai-Hamburger Y (2004). "Experiments in digital literacy." CyberPsychology & Behaviour. **7**(4):421-429.*

135. ^ *Reddy P, Chaudhary K, Hussein S (2023). "A digital literacy model to narrow the digital literacy skills gap." Heliyon. **9**(4):e14878.*

136. ^ *Reddy P, Chaudhary K, Sharma B (2020). "Digital Literacy: A Review of Literature." International Journal of Techno-ethics (IJT). **11**(2):65–94. doi:10.4018/IJT.20200701.oa1.*

137. ^ *Reddy P, Chaudhary K, Sharma B, Chand R (2022). "Talismans of digital literacy: A statistical overview." Electronic Journal of e-Learning. **20**(5):570–587.*

138. ^ *Ali A, Raza AA, Qazi IA (2023). "Validated digital literacy measures for populations with low levels of internet experience." Development Engineering. **8**:100107.*

139. ^ *Njenga JK (2018). "Digital literacy: The quest of an inclusive definition." Reading & Writing-Journal of the Reading Association of South Africa. **9**(1):1–7.*

140. ^Bühler C, Pelka B (2014). "Empowerment by digital media of people with disabilities: Three dimensions of support." In: Computers Helping People with Special Needs: 14th International Conference, ICCHP 2014, Paris, France, July 9-11, 2014, Proceedings, Part I 14. New York: Springer International. pp. 17-24.

141. ^Lee SH (2014). "Digital literacy education for the development of digital literacy." International Journal of Digital Literacy and Digital Competence (IJDLDC). **5**(3):29–43.

142. ^Gahlot A, Gahlot S (2020). "Changing the state of literacy in the Digital Age in India." EPiC Series in Education Science. **3**:98-107.

143. ^Babu R, Kalaivani S, Saileela K (2019). Empowering India Through Digital Literacy. Vol. 1. North Carolina: Lulu Press.

144. ^Joseph N, Kar AK, Ilavarasan PV (2017). "A model for prioritization and rediction of impact of digital literacy training programmes and validation." In: Conference on e-Business, e-Services and e-Society. Cham: Springer International Publishing. pp. 227-238.

145. ^Rajeev VR, Pillai NM, Radhakrishnan A, Bhavani RR (2018). "Evaluating digital India through national digital literacy mission in Kalliyoor panchayath." International Journal of Pure and Applied Mathematics. **119**(15):1943–1954.

146. a, b, cChadwick D, Ågren KA, Caton S, Chiner E, Danker J, Gómez-Puerta M, et al. (2022). "Digital inclusion and participation of people with intellectual disabilities during COVID-19: A rapid review and international bricolage." Journal of Policy and Practice in Intellectual Disabilities. **19**(3):242-256.

147. a, bHobbs R, Coiro J (2019). "Design features of a professional development program in digital literacy." Journal of Adolescent & Adult Literacy. **62**(4):401-409.

148. a, bWilliams P (2006). "Exploring the challenges of developing digital literacy in the context of special educational needs communities." Innovation in Teaching and Learning in Information and Computer Sciences. **5**(1):1–16.

149. a, bPromrub S, Sanrattana W (2022). "Online program to empower teachers learning to develop students' digital literacy skills." Education Quarterly Reviews. **5**(2).

150. a, bSauvé L, Plante P, Mendoza GAA, Brassard C, Desjardins G (2023). "Developing the Digital Literacy of People with Cognitive Limitations in the Workplace." SN Computer Science. **4**(2):143.

151. a, bSeok S, DaCosta B (2017). "Digital literacy of youth and young adults with intellectual disability predicted by support needs and social maturity." Assistive Technology. **29**(3):123–130.

152. a, bKaragul IB, Seker M, Aykut C (2021). "Investigating students' digital literacy levels during online education due to COVID-19 pandemic." Sustainability. **13**(21):11878.

153. ^a, ^b*Saribanon N, Siregar MAP, Joshi LK, Zuhriansyah Z, Rubyawan R (2020). "Digital Literacy And Access To Technology In The Empowerment Program For Persons With Disabilities During The Covid-19 Pandemic." J ournal of Social Political Sciences.* ***1****(2):129–143.*

154. ^*Clark L, Visser M (2011). "Digital literacy takes center stage." Library Technology Reports.* ***47****(6):38-42.*

155. ^*Kusumo FA, Subali B, Sunarto S (2022). "The Analysis of Student's Digital Literacy with Microsoft E-Learni ng Media." Journal of Primary Education.* ***11****(2):165–177.*

156. ^*Jaison J (2020). "The impact of technology in 2020." XRDS: Crossroads, The ACM Magazine for Students.* ***2 7****(2):74-76.*

157. ^*Mallery M (2013). "Tech services on the web: TechSoup for nonprofits disaster planning and recovery Tool kit." Technical Services Quarterly.* ***30****(1):121–122. http://www.techsoup.org/toolkits/disasterplan.*

158. ^*Darvishy A, Eröcal D, Manning J (2019). Delivering together for inclusive development: digital access to Inf ormation and knowledge for persons with disabilities. Paris, France: UNESCO Publishing.*

159. ^*Keengwe J, Onchwari G, Hucks D (2013). Literacy enrichment and technology integration in pre-service tea cher education. Hershey: IGI Global.*

160. ^*Hobbs R (2011). Digital and media literacy: Connecting culture and classroom. Thousand Oaks, California: Corwin Press.*

161. ^*Mohammadyari S, Singh H (2015). "Understanding the effect of e-learning on individual performance: Th e role of digital literacy." Computers & Education.* ***82****:11–25.*

162. ^*Kaeophanuek S, Na-Songkhla J, Nilsook P (2018). "How to enhance digital literacy skills among informatio n sciences students." International Journal of Information and Education Technology.* ***8****(4):292-297.*

163. ^a, ^b*Ozman M (2019). "Digital platforms and disability in France." SSRN.*

164. ^*Lissitsa S, Madar G (2018). "Do disabilities impede the use of information and communication technologie s? Findings of a repeated cross-sectional study–2003-2015." Israel Journal of Health Policy Research.* **7***(1):1–1 7.*

165. ^*Ortlieb E, Cheek EH Jr, Semingson P (Eds.) (2018). Best Practices in Teaching Digital Literacies. (Literacy Re search, Practice and Evaluation; vol 9). Emerald Publishing.*

166. ^*Ortlieb E, Cheek EH Jr (Eds.) (2013). Advanced literacy practices: From the clinic to the classroom. Bingley, UK: Emerald Group Publishing.*

167. ^*Baek C, Aguilar SJ (2022). "Past, present, and future directions of learning analytics research for students with disabilities." Journal of Research on Technology in Education.* ***55****(6):931-946. doi:10.1080/15391523.202 2.2067796.*

168. ^Joamets K, Chochia A (2021). "Access to artificial intelligence for persons with disabilities: Legal and ethica l questions concerning the application of trustworthy AI." Acta Baltica Historiae et Philosophiae Scientiaru m. **9**(1).

169. ^Peng D, Yu Z (2022). "A literature review of digital literacy over two decades." Education Research Internat ional. **2022**:1–8. doi:10.1155/2022/2533413.

170. a, bNewman L, Browne-Yung K, Raghavendra P, Wood D, Grace E (2017). "Applying a critical approach to inv estigate barriers to digital inclusion and online social networking among young people with disabilities." In formation Systems Journal. **27**(5):559–588.

171. ^Sweet KS, LeBlanc JK, Stough LM, Sweany NW (2020). "Community building and knowledge sharing by in dividuals with disabilities using social media." Journal of computer assisted learning. **36**(1):1–11.

172. ^Shpigelman CN (2018). "Leveraging social capital of individuals with intellectual disabilities through parti cipation on Facebook." Journal of Applied Research in Intellectual Disabilities. **31**(1):e79–e91.

173. ^Chadwick DD, Buell S (2023). "Interactional power and support in digital inclusion of an adult with intellec tual disabilities: a case study analysis." Journal of Research in Special Educational Needs. **23**(3):251-261.

174. ^Anisimova E (2020). "Digital literacy of future preschool teachers." Journal of Social Studies Education Res earch. **11**(1):230-253.

175. ^Liu ZJ, Tretyakova N, Fedorov V, Kharakhordina M (2020). "Digital literacy and digital didactics as the basi s for new learning models development." International Journal of Emerging Technologies in Learning (iJE T). **15**(14):4–18.

176. ^Buckingham D (2015). "Defining digital literacy-What do young people need to know about digital medi a?." Nordic journal of digital literacy. **10**:21-35.

177. ^Sá MJ, Santos AI, Serpa S, Ferreira CM (2021). "Digital Literacy in Digital Society 5.0." Academic Journal of I nterdisciplinary Studies. **10**(2):1–9.

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