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Bridging the digital divide for people with intellectual disability

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Abstract

Recent data from several studies and surveys confirm that our society has entered the digital and information age. Some authors mention that information and communication technologies (ICT) have the potential to enhance people's power to act and promote equal citizen participation. These elements are particularly important for people living with intellectual disability (ID). However, it seems that the use of ICT is challenging for these people and that a digital divide has gradually formed between them and the connected citizen. The general objective of this theoretical article is to identify and illustrate the dimensions that must be taken into account to promote the digital participation of people with ID. The model is based on a qualitative analysis of scientific publications using a conceptual-style matrix (Miles & Huberman, 2003). The coding categories were derived from two main sources: the accessibility pyramid and the Human Development Model - Disability Creation Process. Five challenges or conditions associated with digital inclusion were identified: access to digital devices, sensorimotor, cognitive and technical requierements and the comprehension of codes and conventions. For each one, the obstacles and facilitators identified in the literature are described. These reflections and principles led us to propose a model in the shape of a gear. The proper operation of the gear system depends on the fit between individual resources and environmental support. The model is a first step to understand the digital inclusion of people with ID.

Keywords: intellectual disability; information and communication technologies; Internet; digital divide

Introduction

Recent data from several studies and surveys confirm that our society has entered the digital and information age (Licoppe, 2009). By definition, the digital society is one where information and communication technologies (ICT) are the cornerstone of interactions between individuals (Compiègne, 2011). For citizens, this shift has several advantages, including almost unlimited access to information and entertainment as well as a proliferation of opportunities to socialize through digital media. Some authors mention that ICT have the potential to enhance people's power to act and promote equal citizen participation (Allard, 2007; Jenkins, 2006). These elements are particularly important for people living with intellectual disability (ID) (Lachapelle & Wehmeyer, 2003; Watkins, 2014). However, it seems that a gap has gradually emerged between them and the connected citizen (Chadwick, Wesson, & Fullwood, 2013). This could be explained in part by the perceived risks

of Internet access and use (Chadwick, Quinn, & Fullwood, 2016; Seale, 2014) as well as evidence of online victimization (Buijs, Boot, Shugar, Fung, & Bassett, 2016; Sallafranque St-Louis, 2015) for people with ID.

The article is a theoretical essay based on a literature review. It identifies the dimensions associated with the digital inclusion of people with ID. The first part presents the use of ICT by people with ID, as well as the benefits identified. Then it describes the phenomenon of digital exclusion (also known as digital divide or digital gap) observed among these people. The research method used to identify the dimensions is then presented. The results section describes each of the dimensions associated with the digital inclusion of these people and the dynamics underlying their relationships. The last part presents our conclusions, a discussion about the model as well as some perspectives for future development.

Intellectual Disability

In the 11th edition of its *Definition and Classification Manual*, the American Association on Intellectual and Developmental Disabilities (AAIDD, 2010) defines intellectual disability as a condition "*characterized by significant impairments both in intellectual functioning and in adaptive behavior as expressed in conceptual, social, and practical adaptive skills*" (p.1), that is present before the age of 18 years. The literature mentions that the prevalence of this condition varies from 1% to 3% in the general population (Tassé & Morin, 2003). Nonetheless, the simple presence of these three criteria should not justify a diagnosis of ID; it is also important to consider five postulates that take into account the great complexity of a multidimensional assessment including sensorimotor, behavioural and communication differences as well as the co-existence of limits and strengths within an individual (AAIDD, 2010). The AAIDD has further established that intellectual disability no longer stems only from the person, but also from the person's interactions with his or her environments. Given this conceptualization, it becomes obvious that specific means must be implemented to adapt the environment to these people's individual abilities so they can express and improve them or develop new ones, as well as participate and exercise a valued role in society and have a better quality of life (AAIDD, 2010).

Lachapelle and Wehmeyer (2003) mention that exercising this role and promoting quality of life entails the power to act and the self-determination of people with ID. Indeed, for these people, the concept of social participation underlies the complete realization of a lifestyle that includes, notably, everyday activities and social roles (Fougeyrollas, Cloutier, Bergeron, Côté, & St-Michel, 1998). Furthermore, some models suggest that the disability situation and social participation are at opposite ends of a same continuum where the positioning depends on the interaction between personal and environmental factors (Fougeyrollas et al., 1998). In sum, an increase in the power to act goes hand in hand with the notion of self-determination and social participation (Lachapelle & Wehmeyer, 2003). Moreover, this notion of social participation is a central component of various reference frameworks and government policies in several countries (AAIDD, 2016; Fédération québécoise des Centres de Réadaptation en Déficience intellectuelle [FQCRDITED], 2013; Office des personnes handicapées du Québec [OPHQ], 2009; United Nations, 2006; World Health Organization [WHO], 2010).

Recently, this notion of social participation was enhanced by a new component: social participation through ICT, or digital participation (Lussier-Desrochers, Normand et al., 2016). This new area of interest is based on two main elements: on the one hand, results from studies showing the benefits associated with the use of technologies by people with ID (Lachapelle, Lussier-Desrochers, & Pigot, 2007; Lachapelle & Therrien-Bélec, 2013; Näslund & Gardelli, 2013; Seale, 2014) and, on the other hand, the literature showing the presence of a digital divide limiting access of people with ID to these technologies (Chadwick et al., 2013; Hoppestad, 2013). These elements are presented in turn in the upcoming subsections.

Benefits Associated With the Use of Technologies by People With ID

In recent years, several adapted software programs, applications and interfaces have been created to meet the needs of people with ID and to promote their self-determination and social participation (Ayres, Mechling, & Sansosti, 2013; Davies et al., 2015). This interest stems notably from the results of studies showing that the use of ICT by these people has certain benefits, such as communication; social interaction and interactions within the community (Reichenberg, 2016), like making purchases at the grocery store or restaurant (Allen, Vatland, Bowen, & Burke, 2015; Burckley, Tincani, & Guld Fisher, 2015); travelling around the community (Ayres et al.,

2013; Mechling & Seid, 2011); and performing tasks in residential areas (Lachapelle, Lussier-Desrochers, Caouette, & Therrien-Bélec, 2011; Taber-Doughty, Shurr, Brewer, & Kubik, 2010). In sum, technology helps to raise the level of autonomy in performing daily activities as well as learning new skills (Davies, Stock, & Wehmeyer, 2002; Sigafoos et al., 2005; Wu, Cannella-Malone, Wheaton, & Tullis, 2016). It is important, however, to point out that the majority of studies show that there is great variability among individuals and that their needs must be analyzed accurately (Lussier-Desrochers, Caouette, & Godin-Tremblay, 2015; Lussier-Desrochers et al., 2014).

People with ID are currently using several types of technological solutions, including tablets (Allen et al., 2015; Burckley et al., 2015), smartphones (Lachapelle et al., 2011), portable digital players like the iPod Touch (Wu et al., 2016) or other similar devices (Mechling & Seid, 2011), desktop and laptop computers (Davies et al., 2002; Sigafoos et al., 2005), as well as telehealth cameras (Taber-Doughty et al., 2010). Optimal use of many ICT require an Internet connection. This is the case notably for such mobile technologies as smartphones or tablets, which are of very limited use if not connected to the Internet. Therefore, a more detailed analysis of the Internet use patterns of these people is needed to clearly understand the issues involved in their use of ICT.

There is little data on this population's Internet use patterns (Hoppestad, 2013; Lussier-Desrochers, Dupont, Lachapelle, & Leblanc, 2011; Normand, Rodier, Lussier-Desrochers, & Giguère, submitted; Sallafranque St-Louis, 2015). Nonetheless, some authors from different countries (United States, Sweden, Canada, Israel) note that when these people use the Internet, they do so primarily for the purpose of communicating with other users, strangers or not, through social media (Löfgren-Mårtenson, Sorbring, & Molin, 2015; Molin, Sorbring, & Löfgren-Mårtenson, 2015; Normand et al., submitted; Sallafranque St-Louis, 2015; Shpigelman & Gill, 2014). Using this new form of social interaction allows them to define themselves "like everyone else" and to create a sense of belonging to a "normal" community (Löfgren-Mårtenson et al., 2015; Shpigelman, 2016). Video or picture entertainment is also very popular (Sallafranque St-Louis, 2015). However, online browsing or communication that requires a great deal of reading or writing poses problems (Harrysson, Svensk, & Johansson, 2004; McClimens & Gordon, 2009; Molin et al., 2015; Shpigelman & Gill, 2014; Wong, Chan, Li-Tsang, & Lam, 2009). And although, compared with the rest of the population, fewer of these people use the Internet and spend less time on it (Parsons, Daniels, Porter, & Robertson, 2008; Wells & Mitchell, 2014), they seem to be more at risk of online sexual victimization or extortion (Löfgren-Mårtenson et al., 2015; Normand & Sallafranque St-Louis, 2015, 2016; Wells & Mitchell, 2014). Consequently, it is not unusual for the people around them to attempt to control or limit their access to the Internet (Chadwick et al., 2013; Löfgren-Mårtenson et al., 2015).

In summary, ICT appear to be a very promising avenue for supporting social participation of people with ID. Be that as it may, it seems that not all people with ID use technologies daily and that there are issues specifically related to their use by these people. This phenomenon of digital divide is currently a concern for several actors evolving in the field of ID.

The Phenomenon of Digital Divide for the Population with ID

Some authors mention that instead of an increase in social participation, the reverse is occurring: a widening gap between people with ID and the connected citizen (Attour & Longhi, 2009; Batey & Waine, 2015; Dagenais, Poirier, & Quidot, 2012; Eveno, 1998). Moreover, the majority of people with ID are unable to take full advantage of the digital and information society (Carey, Friedman, & Bryen, 2005; Palmer, Wehmeyer, Davies, & Stock, 2012; Wehmeyer, Palmer, Smith, Davies, & Stock, 2008). This gap translates more precisely into a feeling of exclusion called "digital divide" (Organisation for Economic Co-operation and Development [OECD], 2004; Vodoz, 2010). This situation goes against social and government policies underscoring the importance of ensuring these people's full and complete participation in all areas of social life, which include employment, schooling and recreation (OPHQ, 2009). Therefore, a number of people with ID can neither contribute to, nor benefit from, the digital society, because their access is obstructed by several elements. This is due notably to the fact that the digital environment in which they must interact is common to all citizens and thus not adapted to their abilities and needs for support (Dagenais et al., 2012; Rocha et al., 2012).

Several authorities have rallied to identify measures for supporting the digital inclusion of these people (Coleman Institute for Cognitive Disabilities, 2013; President's Committee for People with Intellectual Disabilities

[PCPID], 2015). According to Compiègne (2011), this is the type of reflection that should be given priority. In Canada, many social actors are preoccupied by this phenomenon and try to find solutions to resolve this issue. For example, in the province of Quebec, a Charter for digital inclusion of people with ID was launched in 2016; it presents 10 actions that must be prioritized in order to reduce the gap between people with ID and the connected citizens (#CTI, 2016). This action is consistent with similar initiatives in other countries (e.g. *The Rights of People with Cognitive Disabilities to Technology and Information Access* produced in the United States).

Objectives of the Theoretical Essay and Method Used to Identify the Dimensions of Digital Inclusion

Objective of the theoretical essay. The general objective of this theoretical essay is to identify the dimensions associated with the digital inclusion of people with ID. This identification will make it possible to propose an integrative model of the dynamics underlying the relationship between these dimensions.

Method

A two-phase process was used to identify the dimensions associated with digital inclusion. First, a search of peer-reviewed articles was performed via the PsycINFO and ERIC databases. The first phase of the review aimed to draw an accurate picture of technology use by people with ID. To do so, keywords relating to the three following concepts were used: (a) intellectual disability; (b) Internet and technologies and (c) usage (Table 1). This first search resulted in 303 articles. The article abstracts were read to see if they met the inclusion criteria (present an experience with ICT usage by people with ID and be published in French or in English). For this phase, a total of 161 scientific articles were retained (Table 2).

This first review was combined with a second one, which aimed, this time, at better defining the phenomenon of digital exclusion experienced by people with ID. The concept of exclusion was added to the initial concepts in the literature search conducted in PsycINFO and ERIC. From this second search, 20 articles were retained, on a total of 39 found. Finally, a complementary Google search was performed to document dimensions that may not have been identified in the scientific literature. However, in an effort to simplify the process, this complementary component included initiatives offered in Québec only. This focus allowed the authors to produce a model close to their social reality.

Further to this first literature search, the contents of the documents retained were analyzed qualitatively using a conceptual-type matrix to organize the information coherently (Miles & Huberman, 2003) (Table 3). The coding supra-categories and sub-categories used were derived from two main sources: the accessibility pyramid (Lussier-Desrochers, Normand et al., 2016) and the Quebec Classification: Disability Creation Process (QC:DCP) (Fougeyrollas et al., 1998). The accessibility pyramid is a conceptual model created by the authors in order to understand digital inclusion of people with ID and autism spectrum disorder. It comprises five dimensions (see Table 3), and was created to support front-line workers in the implementation of technologies in clinical settings. Another theoretical framework used in our analyses is the Quebec Classification: Disability Creation Process (Fougeyrollas et al., 1998). It states that handicapping situation, on the one hand, and social participation, on the other, result from an interaction between environmental and personal factors throughout a lifetime. Facilitators and obstacles are present in both the personal and the environmental conditions in which a person engages in daily activities and social roles (life habits).

The sections below present the results of the analysis according to the dimensions of the matrix.

Table 1. *Keywords Used to Search the Articles*.

(a) intellectual disability	
Multiple Disabilities	Intellectual* Development* Disorder*
Delay Development	Down's Syndrome
(b) Internet and technologies	
Cellular Phone*	Online Community
Text Messag*	Social Media
Blog*	Computer Application*
Internet	Computer* Mediated Communication
Microcomputer*	Computer Peripheral Device*
Electronic Communication	Websites
Mobile Device*	Social Network*
Augmentative Communication	Online Social Network*
Assistive Technolog*	Computer Software
Information Technology	Computer*
Technolog*	
(c) usage	
Activities of Daily Living	Spatial Orientation (Perception)
Food	Finance
Household Management	Shopping
Food Preparation	Internet Addiction
Communication	Internet Usage
Socialization	Interpersonal Communication
Interpersonal Relationships	Hygiene
Family Relations	Self-Care Skills
Social Interaction	Clothing
Social Dating	Health
Interpersonal Interaction	Physical Health
Friendship	Mental Health
Cyberbullying	Learning
Cybersex	Computer Simulation
Daily Activities	Computer Searching
Hobbies	Education
Games	Employee Skills
Computer Games	Task
Recreation	Job Performance
Help Seeking Behavior	Electronic Commerce
Safety	Electronic Communication
Transportation	Electronic Learning
Wayfinding	
d) exclusion	
Computer Literacy	Access to Information*
Information Literacy	Technological Literacy
Digital Divide	Barrier*
Social Deprivation	Problem*
Disadvantaged	Access to Computer*
Deprivation	Autoinstructional Aid*
Accommodation (Disabilities)	Appropriate Technology
Marginalization	

Table 2. *Articles Retrieved and Excluded From the Databases.*

	N retrieved	N excluded	N retained
PsycINFO	101	41	60
ERIC	202	87	115
Total	**303**	**128**	**175**
Duplicates			14
N of article analyzed			**161**

Table 3. *Conceptual Matrix Created For the Qualitative Analysis.*

Supra-categories (accessibility pyramid)	Categories (QC-DCP)	Sub-categories (QC-DCP)	Code
Access	Environmental factors	Obstacles	AEO
		Facilitators	AEF
	Personal factors	Obstacles	APO
		Facilitators	APF
Sensorimotor	Environmental factors	Obstacles	SEO
		Facilitators	SEF
	Personal factors	Obstacles	SPO
		Facilitators	SPF
Cognitive	Environmental factors	Obstacles	CEO
		Facilitators	CEF
	Personal factors	Obstacles	CPO
		Facilitators	CPF
Technical	Environmental factors	Obstacles	TEO
		Facilitators	TEF
	Personal factors	Obstacles	TPO
		Facilitators	TPF
Codes and conventions	Environmental factors	Obstacles	VEO
		Facilitators	VEF
	Personal factors	Obstacles	VPO
		Facilitators	VPF

Results

Dimensions Associated with the Digital Inclusion of People With ID

Five digital access dimensions or conditions were identified. This section presents the information relating to the dimensions found in the literature (internet access, sensorimotor, cognitive, technical, social conventions). For each one, the obstacles and facilitators identified in the literature are presented for the personal and the environmental factors.

Dimension relating to devices and Internet access. One of the digital inclusion dimensions is, of course, access to technological devices by people with ID. To access the Internet, its content and digital services, people must necessarily go through technological devices (computer, digital tablet, smartphone, router) that are connected to this network. The literature analysis shows two main ways that people with ID can access these devices: (a) personal ownership of the technology through a purchase, a technology-access program or a

donation; or (b) an equipment loan from a friend or family member, from an organization or through an equipment-lending program.

For the first option, people's financial resources are a major barrier. In fact, the Institut de la statistique du Québec (2013) advances that participating in the digital society requires a certain financial investment for the purchase of equipment (computer, smartphone, digital tablet, router). Furthermore, there are costs involved in connecting to the Internet. That said, low income is a major risk factor inherent to the population with ID. Indeed, provincial and national data show that these people's living environment is often affected by poverty (Canadian Association for Community Living, 2013; OPHQ, 2013). It is thus clear that access to technologies is compromised by their financial resources. Moreover, the analysis shows that additional costs are often involved in obtaining technological devices adapted to the person's specific needs (e.g., purchase of adapted peripherals or specialized applications).

Concerning this first element, the environment might provide support and compensation. Indeed, the purchase option is not the only possibility. The review shows that access programs offered by such organizations as the government or private foundations enable some people to acquire their own device. However, several of the initiatives identified make the hardware available but do not cover the cost of owning the technologies (Internet connection, purchase of applications or specialized peripherals, carrying case, etc.). In this regard, the total cost of owning a digital tablet (including direct and indirect costs, such as network connection, security software or maintenance) is often twice the initial cost of the tablet itself (Morphy, 2010; Principled Technologies, 2013). Therefore, although people may have a technological device donated to them, it is very probable that they will not have the financial means to pay the additional usage costs. Moreover, Dagenais et al. (2012) specifies that the equipment given to these people is often obsolete and prone to technical problems, which could lead to their underusing, if not completely giving up on, the technology.

Therefore, the second option appears more promising. First, there is the possibility of a short-term loan, like a digital tablet borrowed from a municipal library (e.g., Ville de Trois-Rivières, 2015). However, this method of borrowing remains complex for people who have difficulties travelling. It also carries a number of risks related to divulging personal information. Motor problems put the device at risk of being dropped, and the absence of adapted peripherals make regular loans less appealing. In Québec, some government agencies have also created equipment-lending programs (Association québécoise des troubles d'apprentissage [AQETA], 2016 ; OPHQ, 2011; Projet ministériel d'aide technique à la communication [PMATCOM], 2015), but a survey revealed that they do not seem to adequately meet all the needs of these people (Lussier-Desrochers, Caouette, & Godin-Tremblay, 2016), nor do they include Internet access or cover indirect usage costs. Therefore, a last option for these people is seemingly to share a device with friends or family members (e.g., family computer), which can significantly reduce the number of hours of use. In short, the dimension relating to physical access to adapted devices constitutes an obstacle to the digital inclusion of people with ID, adding to the challenges of connecting to the Internet. Finally, despite the importance of this element, there is little documentation on the subject in the scientific literature, compared with the other dimensions presented below. This situation was previously noted by Chadwick et al (2013) and by Palmer et al. (2012).

Sensorimotor dimension. A second dimension of accessibility concerns the user's sensorimotor skills in relation to ICT handling demands. In fact, several studies show that the use of technological devices requires a certain minimum of sensorial (mainly tactile, visual, auditory and proprioceptive) and motor (fine and gross motor) abilities (Dagenais et al., 2012).

Therefore, with respect to person-related risk factors, the co-occurrence of ID and of sensorimotor limits is scientifically documented (Cleaver, Ouellette-Kuntz, & Hunter, 2009; Chadwick et al., 2013 ; Crow, 2008; Dagenais et al., 2012; Michel, Masson, & Sperandio, 2006; Wong et al., 2009). They represent a major obstacle to using the Internet notably because they have direct repercussions on the performance of basic actions required to operate the technological devices that connect to this network. For example, a lack of upper-limb coordination, prehension or dexterity can make it difficult to use a keyboard or a mouse (Cleaver et al., 2009; Dagenais et al., 2012; Wong et al., 2009). Additionally, motor constraints often limit reaction time and execution speed, making certain activities difficult to perform because of time restrictions, when filling out a form or shopping online, for

example (Carmeli, Bar-Yossef, Ariav, Levy, & Liebermann, 2008; Dagenais et al., 2012). Furthermore, people with ID may also have sensorial (visual, auditory) difficulties when browsing the Internet (Dagenais et al., 2012).

These difficulties in an individual also collide with environmental obstacles related to the ergonomics of the devices and the software, which can impede access to online content. For instance, the presence of little tabs on Internet sites or the small size of the devices (e.g., cellphones) make them complicated to handle for people with ID (Dagenais et al., 2012; Tanis et al., 2012). Moreover, a growing number of Internet sites use multimedia to transmit information, which represents a hindrance for people with visual and auditory limits (Michel et al., 2006). That said, nearly 80% to 90% of Internet sites would not be navigable by people with these types of difficulties (Michel et al., 2006).

The analysis of the studies found revealed that a number of environmental facilitators can compensate for the obstacles encountered. Among the solutions identified, the most interesting avenue appears to be the installation of technological devices adapted to the person's specific needs (Danial-Saad, Weiss, & Schreuer, 2012; Grace, Raghavendra, Newman, Wood, & Connell, 2014). Several peripherals are currently available on the market, including alternative mice (Danial-Saad et al., 2012), enlarged keyboards (Abilities expo, 2015), touch screens (Stephenson & Limbrick, 2015), software for operating a computer by pupillary motion (Dube & Wilkinson, 2014; Light & Mcnaughton, 2014), as well as voice synthesis and recognition systems (Grace et al., 2014). The studies conducted thus far indicate that this type of peripheral helps improve Internet access for people with these sensorimotor limits (Raghavendra, Newman, Grace, & Wood, 2013). However, given the heterogeneity of the people's sensorimotor profiles, the authors tend to favour a personalized approach to adapting devices (Cleaver et al., 2009; Crow, 2008).

Cognitive dimension. The cognitive requirements of the digital world represent another accessibility dimension. This dimension was previously adressed by Chadwick et al. (2013). Compiègne (2011) mentions that *[Translation]* "people's initial cognitive abilities remain determinant and discriminant" in ensuring the efficient use of digital technologies (including Internet access). To date, the studies' results suggest that interacting with technologies and digital content requires the mobilization of several cognitive components, like inductive reasoning, problem-solving skills, short- and long-term memory, reasoning, planning, reflection and deduction (Chevalier & Tricot, 2008; Dagenais et al., 2012; Tanis et al., 2012; Tricot, 2007; Rivas-Costas et al., 2014). Reading and writing skills also influence Internet use (Michel et al., 2006; Rivas-Costas et al., 2014). Yet, the vast majority of these functions are posing a problem in people with ID, who thus have difficulty understanding how the devices work, as well as how to decipher the symbols, formulate a query in a search engine, select relevant content or even understand the information provided (Danielsson, Henry, Messer, & Rönnberg, 2012; Harrysson et al., 2004). Furthermore, Williams and Nicholas (2006) noted that people with cognitive limitations do not use the mouse efficiently even if they have the necessary motor abilities. For instance, they click excessively, point to the screen instead of using the mouse, pull their hand back after each action with the mouse, and drag the cursor randomly across the screen. Moreover, they often react hastily and select the first option by default, which represents a major obstacle to browsing the Internet (Lussier-Desrochers et al., 2011; Williams & Nicholas, 2006).

The studies' results show also that the digital environment makes it complicated to access information due to the quantity, variety and way it is fragmented (Bunning, Trapp, Seymour, Fowler, & Rollett, 2010; Tricot, 2007). Nonetheless, this domain is only in its infancy and few studies have yet looked into the issue (Hoppestad, 2013). Meanwhile, Chen (2010) stresses that reading hypertext requires more cognitive efforts than reading text on paper. Additionally, Wong and colleagues (2009) show that the more steps involved in a technology, the greater the difficulties for people with cognitive limitations. In short, the basic actions involved in browsing the Internet solicit a vast set of cognitive skills (Harrysson et al., 2004; Lussier-Desrochers et al., 2011; Tanis et al., 2012; Wong et al., 2009). Finally, several authors say that using technologies is often complicated by confusing elements, such as only one button to turn a cellphone both on and off (Williams & Nicholas, 2006).

To overcome cognitive limits, many solutions can be set up in a person's environment. However, no consensus emerged from the scientific literature regarding which ones to favour. First, adapted applications, Internet sites and web browsers have been developed in recent years to help reduce the cognitive load associated with the use of digital tools (Hall, Conboy-Hill, & Taylor, 2011; Moisey & van de Keere, 2007; Perkins & LaMartin, 2012;

Rocha et al., 2012; Stock, Davies, Davies, & Wehmeyer, 2006; Williams & Hennig, 2015; Wong et al., 2009). Other authors suggest instead to remedy some difficulties by configuring certain parameters through the control panel, for instance, modifying the mouse settings or enlarging the font (Rivas-Costas et al., 2014; Williams & Nicholas, 2006). Finally, some believe that the solution would be to take into account universal accessibility rules, so that everyone in the community could access the same digital environment (Blanck, 2014; Harrysson et al., 2004; Karreman, van der Geest, & Buursink, 2007; Tanis et al., 2012). Unfortunately, designers give very little consideration to these rules (Bunning, et al., 2010; Harrysson et al., 2004; Kennedy, Evans, & Thomas, 2011; Tanis et al. 2012). That said, Brangier and colleagues (2010) believe that the main problem with these rules is that there are far too many (between 944 and 3000 rules). To overcome the problem, researchers (Hoppestad, 2013; Langevin, Rocque, Ngongang, & Chalghoumi, 2012) recommend that the reference group for designing technological tools consist of people with ID, given their major cognitive difficulties.

Technical dimension. A fourth dimension emerged from the literature: technical skills. This one refers to the skills that technology and Internet users need to keep their devices in working order. So, to ensure the efficiency and sustainability of the computer equipment, preventing the risks that can jeopardize its proper functioning is essential. Some technologies, notably those connected to the Internet, often expose the user's computer equipment to potential risks. Indeed, if preventive measures are not taken (e.g., antivirus software), viruses, spyware, Trojan horses or other malware may temporarily or permanently damage the user's computer equipment and thus necessitate repairs or even replacement of some components (Newman, 2009). This situation is even more worrisome given the limited financial resources of people with ID. In the scientific literature, few studies deal specifically with the technical difficulties encountered by Internet users with ID. Yet, a study by Lussier-Desrochers and colleagues (2011) reports that some people mention having contracted, on the Internet, computer viruses that affected the functioning of their computer. Dagenais and colleagues (2012) add that several people with disabilities do not have the knowledge and know-how to solve the technical difficulties encountered, thus illustrating the interdependence of technical skills and cognitive functions.

Moreover, the use of technological devices requires periodic solving of technical issues, such as connecting to public or private networks, installing new peripherals, updating applications, Internet searching or devices and repairing software failures (Perriault, 2006 ; Zisimopoulos, Sigafoos, & Koutromanos, 2011). These basic actions can quickly become complex for people with ID. Consequently, a person who does not have the necessary technical skills will have to turn to other users or to technical-assistance Internet sites.

The environment can play a determining role in providing technical support. The literature indicates that prevention of technical failures is predominant. Therefore, configuring device security, securing the wireless network, installing an antivirus program, setting up the firewall as well as updating the operating system and software are all concrete actions that must be performed (Government of Canada, 2015; HabiloMédias, 2015). However, people with ID need guidance with these processes, which are often cognitively complex (Dagenais et al., 2012). There are currently some sites that provide guidance regarding digital technologies (e.g., Habilomedia.ca addresses several themes, including the risks associated with cybersecurity and what to do to protect oneself). Unfortunately, though, they are not adapted to the cognitive limits of people with ID. In sum, although acquiring technical skills is an important step in promoting access to digital technologies, few concrete actions intended specifically for people with ID have been performed to date.

Dimension relating to social codes and conventions. Access to and participation in the digital society require an understanding of new social interaction rules and conventions. Indeed, there are specific ways to behave or present oneself in this new universe populated with countless individuals and contents that are more or less trustworthy. In fact, prudence is in order with respect to certain forms of personal or promotional solicitation. A good understanding of these codes requires conceptual adaptive abilities, such as abstraction, reasoning and social skills (Chevalier & Tricot, 2008; Dagenais et al., 2012). People who do not understand these rules could expose themselves to new forms of victimization or exclusion, such as sexual solicitation online, identity theft, impulse buying, harassment, and exposure to unwanted content (Government of Canada, 2015; Holtfreter, Reisig, Pratt, & Holtfreter, 2015). They may even go as far as jeopardizing their health and safety, for example, by accepting to meet and have unsafe sex with strangers found on the Web (Normand & Sallafranque St-Louis, 2015; Sallafranque St-Louis, 2015).

The credulity, tendency to agree, desire to please and impulsivity typical of many people with ID puts them at risk of phishing and fraud (Holtfreter et al., 2015; Wehmeyer, Abery, Mithaug, & Stancliffe, 2003). Furthermore, it seems that these people have a tendency to immediately accept offers made through pop-up windows on the Internet (Lussier-Desrochers et al., 2011).

When it comes to potential solutions from the environment, few recommendations have been tested, but several have been suggested, including educational programs and individualized support (Dowdell, Burgess, & Flores, 2011; Holmes & O'Loughlin, 2014; Raghavendra et al., 2013). Also suggested are computerized, policy-based or legal solutions designed to increase data and user security (Charlotte, 2010). For example, Facebook has changed one of its default settings that used to automatically make certain posts public. It is also interesting to note that dating sites now do background checks (e.g., criminal records) on their members. Additionally, in 2011, to promote safe use of social media sites, Autism Speaks issued ten recommendations for adolescents and young adults with autism spectrum disorders (ASD), which are also relevant for people with ID. Notably, they include warnings about sharing personal data (home address, phone number, bank account number, photos), controlling shared information (private groups, open-access Web sites) and meeting with virtual friends in person (meeting in public locations, informing people in their circle, being accompanied).

Model of the Dimensions Relating to Digital Inclusion of People With ID

In a previous paper, our team proposed a model in the shape of an accessibility *pyramid* that illustrated the issues relating to digital inclusion (Lussier-Desrochers, Normand et al., 2016). The preliminary presentation of this model at several conferences for caseworkers and researchers triggered various reactions. Caseworkers found that this pyramid-shaped representation provided a simple way to understand and define the dimensions of digital accessibility. Several suggestions were made to improve this first model, including: (a) present the dimensions in a more flexible manner by avoiding a multi-level progression; (b) attribute equal weight to the various dimensions and avoid a presentation mode suggesting that some dimensions are more important; (c) illustrate the dynamic links between the various dimensions; (d) distinguish personal and systemic (environmental) issues; and (e) favour a simple and easy-to-understand presentation.

The results of the review presented here attempt to provide an enhanced model that responds to these proposed improvements. In fact, they are the product of a reflection and numerous debates by the authors. Further to this analysis, our team rejected the idea of a linear-level pyramid model. We felt that a better graphical representation of the digital access dimensions described here and of their interactions was desirable.

These reflections and principles led us to propose a model in the shape of a gear, which is presented in Figure 1.

The centre gear (hub) represents the personal and environmental resources that generate a movement of dynamic interaction with the five peripheral gears, which represent the requirements of the digital world: (a) sensorimotor, (b) cognitive, (c) technical, (d) access to technological devices and (e) codes and conventions. The arrow, for its part, encircles all these dimensions and illustrates that the continuous, dynamic motion is conducive to a person's participation in the path towards digital inclusion. The first advantage of this model is that the hub includes the individual's personal resources and the systemic resources found in his or her environment, which influence the motion of each peripheral gear. These two factors complement each other to ensure the proper operation of the gear system. Some people will be able to attenuate the obstacles to accessibility with individual resources, such as good dexterity or good visual memory. They will then not need to turn to external resources to overcome potential obstacles to manipulating devices or certain Internet browsing components. Conversely, personal factors—such as restricted sensorimotor skills—could limit the use of a computer mouse for others. Resources available in the person's environment could then be helpful. For example, the purchase of an alternative mouse or of a touch screen would help achieve a higher level of accessibility and, potentially, greater digital participation and inclusion. Consequently, as shown by the review, digital inclusion of people with ID is a dynamic process that draws on personal resources and systemic resources from the environment. For instance, the person's cognitive and sensorimotor abilities may be confronted with complex interfaces or unsuitable peripherals, like stones in the gears, that will prevent the person from meeting the requirements of and participating in the digital society.

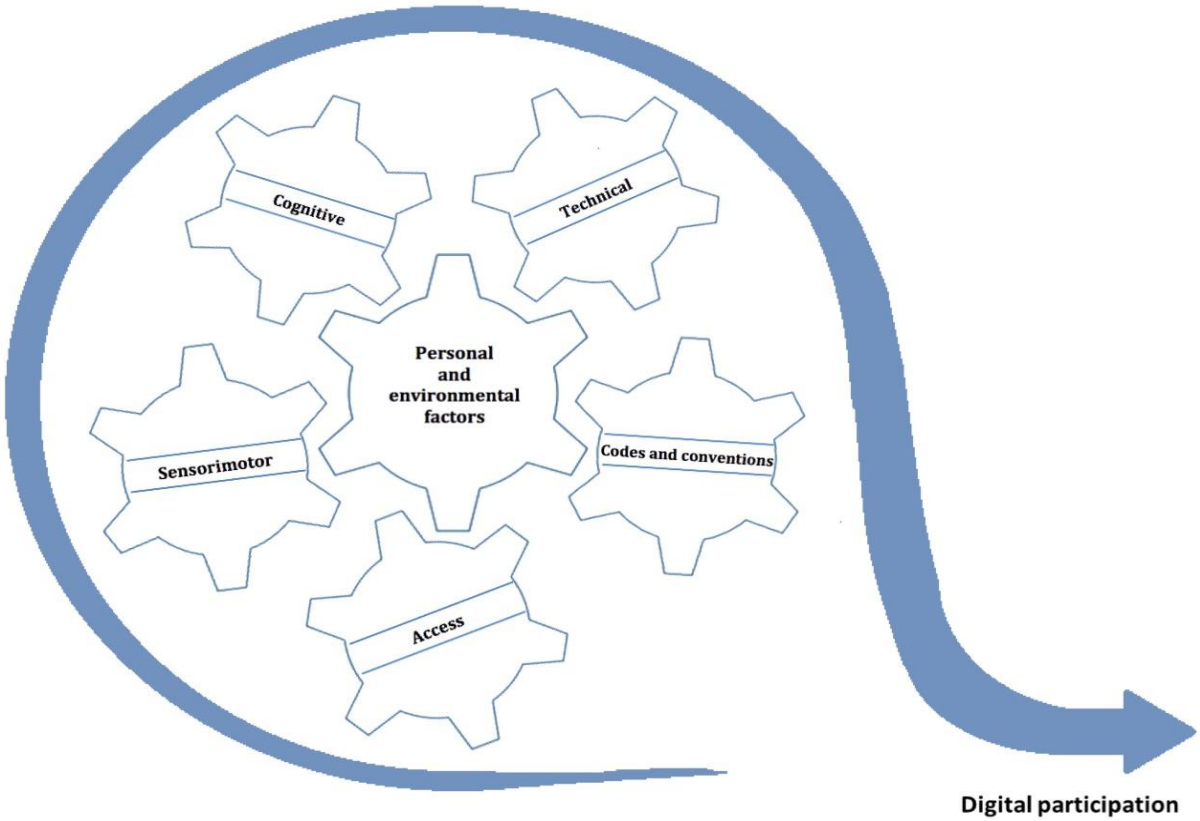

Figure 1. Model of the dynamic links between the digital inclusion dimensions for people with ID.

Basically, this hub, which consists of the person's resources and those from his or her environment influences the opportunities offered to the person to meet the five main requirements of the digital society (the five dimensions documented in the review). A person with good capacities and appropriate environmental support will find it easier to generate an activity on peripheral components and thus advance along the path to digital participation. Conversely, a person facing several obstacles of the digital environment will have difficulty making the gears move along the path to social participation. The hub will thus need to exert greater force, drawing further from the personal or environmental resources, to meet the requirements of the digital society, and overcome the obstacles that may block its path.

This gear model illustrates the efforts required to ensure digital access. The proper operation of the gear system depends on the complementarity of the five dimensions. Nonetheless, this operation will encounter the obstacles identified in the literature. The synergy between individual resources and support from the environment at the centre of the five dimensions must be powerful enough to literally overcome the obstacles—like stones in its path—to participation in the digital world.

Discussion and Conclusion

The objective of this article was to present the dimensions to consider in order to bridge the digital inclusion gap for people with ID. Based on a literature review, the paper also illustrates how the dimensions interact with one another. This model was intended as a first step in better understanding the issues associated with social participation in the digital society. Although this process is relevant, it has some limits. First, in terms of method, the literature review included only English- and French-language scientific papers. Moreover, research in literature has focused almost exclusively on documentation produced in North America and the generalization of the model is not possible. Also, the concepts and keywords used in the databases are narrow and historical terms may have fallen out of favour.

It is possible that initiatives to promote digital inclusion exist in other countries and that the results were published in other languages. Moreover, the complementary Google search targeted only Québec initiatives. In the future, it would be relevant to examine international initiatives when performing this step, to obtain a more complete portrait. In brief, the model proposed is limited to the authors' social context and thus limits the possibilities of generalization. Nonetheless, the elements identified in the literature review cover a broader range and help offset this shortcoming to some extent. On the other hand, the article didn't fully covered gatekeeping and the interaction between risk perceptions and permissions for access. Therefore it represents another limit of our work.

Meanwhile, the model itself is derived simply from the authors' reflections based on their experiences and their consultation of the elements found in the literature. In future studies, it would be interesting to compare this model with other authors' proposed models. For example, Beukelman and Mirenda (2013) propose an evaluation model in the field of communication aids that include several of the components identified in our model and overlap the factors identified in the review by Chadwick et al. (2013). They also present it in the form of a decision tree. While these authors focus only on communication assistance, the model proposed could motivate the continuation of the reflection by research teams interested in the subject.

Still regarding the method, it would be interesting to conduct a study of an *in situ* application of the model with people with ID. In this type of study, the model could be compared with the people's reality and a social validation could be performed. Quantitative studies involving correlational and factorial designs should also be used to examine the validity and fidelity of the model proposed. The weight of the various factors could then be determined. Indeed, our review showed that certain dimensions are extensively documented while others are just emerging. Studies of this nature would thus enable us to find out whether the low level of documentation of a component is linked to its emerging nature or rather to its relative weight compared with other variables.

Finally, the new model does not include the ethical or psychosocial issues identified in the previous pyramid model. This omission is intentional; ethical issues are a cross-sectional theme and psychosocial issues appear to result from a digital inclusion process. This does not mean, however, that these elements should be dismissed. On the contrary, ethical issues related to the use of technologies with these people could constitute, on their own, the content of a scientific publication. In short, our team stresses the importance of considering this dimension at every step of the way, when technologies are used with people with ID. Meanwhile, psychosocial issues has been considered extensively in the review by Chadwick et al. (2013) and in the review by Caton and Chapman (2016). It is recommended that this area of research be actively developed over the next few years.

Nonetheless, this first model helps to further the reflection on the subject. We hope that it will contribute to the advancement of knowledge in this sector and that collective actions will ultimately reduce the risks of exclusion, increase accessibility and promote social participation and inclusion of these people in the digital world.

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