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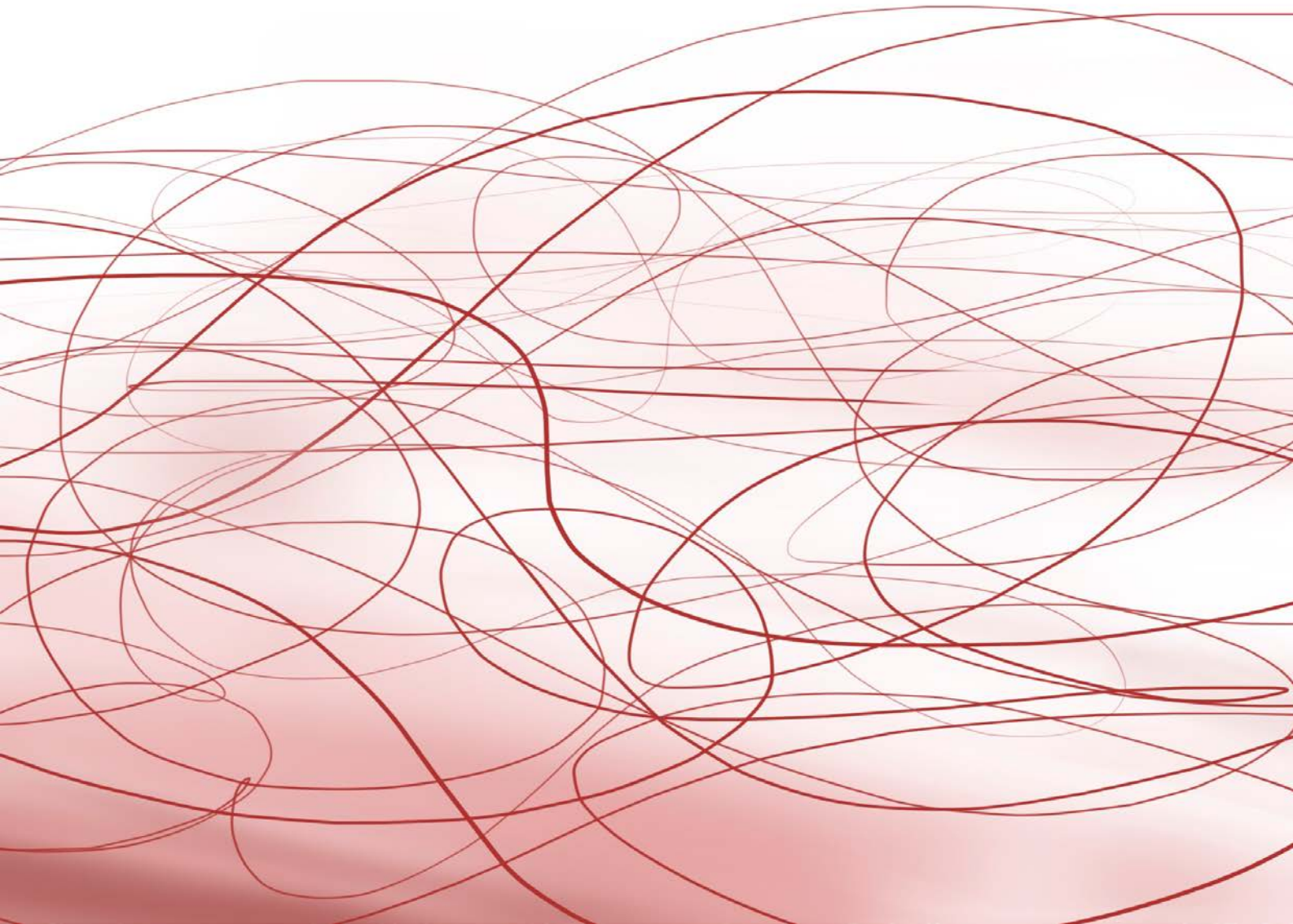

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MEASURE OF ENVIRONMENTAL ACCESSIBILITY (MEA): DEVELOPMENT AND INTER-RATER RELIABILITY

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***Abstract*:** The Measure of accessibility to urban infrastructures for adults with physical disabilities was first published in 2012 and proved to have good inter-rater reliability. Yet, the format (more user-friendly) and content (updated references and labels) of this instrument needed to be improved. Therefore, a new version, now entitled Measure of Environmental Accessibility (MEA), was developed to provide professionals and individuals defending the rights of persons with disabilities with a more user-friendly, objective measure of accessibility of exterior and interior urban infrastructure for individuals with motor, visual, hearing, cognitive and intellectual disabilities. The aim of this paper is to present the improvements made in this new version and to evaluate its inter-rater reliability. This cross-sectional study for inter-rater reliability was conducted by a student in occupational therapy and a student in architecture who performed 30 MEA evaluations of public infrastructures. Inter-rater reliability was evaluated using Gwet's AC1 statistic. Most items (71%, 626/882) had AC1 values ranging from good to excellent. Some items had lower inter-rater reliability coefficients (12%, 108/882, p-value <0.05) and a few had non-significant coefficients (6%, 52/882, p-value ≥0.05). These items are distributed unevenly in the MEA. Thus, it

Gamache, S., Morales, E., Noreau, L., Dumont, I., & Leblond, J. (2018). Measure of environmental accessibility (MEA): development and inter-rater reliability. Journal of Accessibility and Design for All, 8(1), 1-32. doi:http://dx.doi.org/10.17411/jacces.v8i1.141

is impossible to predict which items are less appropriate. Another 96 items (11%) did not have a Gwet's AC1 value since both raters did not observe the evaluated element. The MEA is a reliable accessibility measure for urban built environments. Its new content and format make it a useful tool for individuals involved in the design or renovation of the built environment to improve accessibility and, therefore, inclusion of individuals with disabilities.

Keywords: accessibility; assessment; motor disabilities; visual disabilities; hearing disabilities; intellectual disabilities; cognitive disabilities.

Introduction

It is not uncommon for able-bodied individuals to have problems getting to a particular place because of the configuration of the environment, whether because there is insufficient space to manoeuvre, the information provided for orientation purposes is unclear, or it is too strenuous to interact with the environment to take part in activities. For people with disabilities, this can be an everyday situation. Individuals with physical disabilities (IPD), including motor, visual and hearing disabilities, experience various well-documented disabling situations when accessing public environments, whether outdoors (Clarke, Ailshire, Nieuwenhuijsen, & Vrankrijker, 2011; Giesbrecht, Ripat, Cooper, & Quanbury, 2011; Jenkins, Yuen, & Vogtle, 2015; Rosenberg, Huang, Simonovich, & Belza, 2013) or indoors (Dos Santos & de Carvalho, 2012; Martins & Gaudiot, 2012; Mcintyre & Hanson, 2014). For IPD, the environment is an essential component of actions to improve health conditions, prevent impairments, and improve their outcomes (World Health Organization & The World Bank, 2011). Thus, inaccessibility of public environments can have very damaging social, emotional and financial consequences (Deliot-Lefevre, 2006; McClain, Medrano, Marcum, & Schukar, 2000; Shumway-Cook et al., 2005) because it limits social participation. Everyone who wishes to should have equal opportunities to access public environments. Laws and recommendations are present in many countries to ensure access but are not always applied. As mentioned previously, obstacles

are present and their removal requires a thorough assessment to ensure accessibility.

When assessing public environments, particular attention should be paid to the conflicting needs of different groups of individuals to ensure access for the greatest number. For example, individuals with visual disabilities interpret the environment more easily if tactile information is provided on the ground (e.g. distinct lip between the road and the sidewalk). On the other hand, wheelchair users prefer uniform surfaces that are easier to travel on. A compromise, a way to accommodate for the varying needs of IPD, should be reached to ensure that all groups, which have different preferences and needs, can use the environment efficiently and safely. Moreover, both exterior and interior environments should be assessed to ensure that the entire mobility chain for performing a task/activity is considered. Such an assessment tool has been developed, the *Measure of accessibility to urban infrastructures for adults with physical disabilities* (MAUAP), the content of which was validated by experts (users, clinicians, municipal representatives) and proved to have good inter-rater reliability indicators (Gamache et al., 2016a, 2016b). However, the format of this tool needed to be improved to make it shorter and more user-friendly. Moreover, its content, dating from a literature review performed in 2010 (Gamache et al., 2016a), needed to be reviewed to better represent the advancements in the field of accessibility for IPD. In addition, several partners interested in the use of the MAUAP mentioned certain difficulties in implementing it, which limited its integration into good practices. Thus, the objective of this study was to update the MAUAP's content and format and to evaluate the inter-rater reliability of the updated version. The research protocol was reviewed and approved by the ethics committee of the Institut de réadaptation en déficience physique de Québec (Quebec City, Canada, project #2010-218).

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Methodology

Content modification

The content of the first version of the MAUAP was not underpinned by a standardized vocabulary and conceptual model. A choice needed to be made in that regard to provide a stronger, more logical basis for the MAUAP. After an in-depth reflection process by the research team regarding the format and the content of the MAUAP for its conviviality, the new *Measure of Environmental Accessibility* (MEA) is now based on two concepts: universal accessibility and the *Human Development Model - Disability Creation Process* (HDM-DCP). *Universal accessibility* aims to eliminate artificial restrictions on opportunities to use the environment.(Steinfeld & Maisel, 2012) Hence, the goal is to create accessible environments which can include additions or adaptations.(Steinfeld & Maisel, 2012) The HDM-DCP maps out the interaction between personal factors (identity factors, organic systems, capabilities), environmental factors (social and physical, considered as either facilitators or obstacles at various scales (micro, meso, macro)) and life habits (daily activities and social roles).(Fougeyrollas, 2010) This interaction can result in either a disabling situation or social participation, depending on the level of adequacy and congruence between these factors. As an explanatory model of disability and scientific classification of personal and environmental factors, the HDM-DCP provides a nomenclature ensuring a mutually exclusive conceptualization of what belongs to the person and to the environment. It is formulated in positive terms and attributes the responsibility of accomplishing or not life habits to the interactions with environmental factors, rather than to people and their disabilities.(Fougeyrollas, 2010) This nomenclature provides a common language for professionals in various domains. As an anthropological model of human development, it makes it possible to conduct an analysis of interactions between the person and the encountered environments that is applicable to everyone whether or not the person has disabilities, and regardless of the person's life context. Since it is

impossible to develop an environmental measure of existing environments that respects the principles of universal design, the concept of universal accessibility has been identified as adequate. However, if possible, the principles of universal design should be respected when improving environments, and the consideration of all users in the concept remains present in the proposed labels. Finally, the HDM-DCP provides a nomenclature; the vocabulary used ensures uniform terminology, with the objective of facilitating exchanges with all groups of individuals who can benefit from the use of this new measure.

In order to update the MAUAP's labels and improve its content, a literature review was carried out. In December 2012, a first review of the scientific literature regarding accessibility for individuals with cognitive and intellectual disabilities was performed using the keywords presented in table 1. This was a main concern because the authors wanted to provide a more inclusive assessment of accessibility by considering the highest number of users possible. The MAUAP lacked this information.

Table 1. Scientific literature review regarding accessibility for individuals with cognitive and intellectual disabilities

Databases	Keywords
Pubmed	Cognitive impairment; Assessment tool, assessment instruments; Accessibility; Information access
Pubmed	MeSH : Architectural accessibility; Access to information; Mental disorders / Intellectual disability / Cognition disorder
Cinahl	Cognitive impairment, Intellectual disability, Accessibility, Access, Assessment, Environment, Service utilization, Information
Cinahl	Others : Community assessment, Clinical assessment tools, Research instruments

Databases	Keywords
Psychological abstracts	Intellectual disability, Cognitive impairment, Accessibility
Psychological abstracts	Descriptors : Cognition, Intelligence, Mental health, Access, Information technology/sources/society
PsycINFO	Cognitive impairment, Intellectual development disorder, Access, Access to information, Accessibility, Assessment tool
PsycINFO	Descriptors : Cognitive impairment, Intellectual development disorder, Community facilities/involvement/services, Information

In addition, from September 2012 to September 2015, the MAUAP's labels were continuously updated via the consultation of varied online sources and regular updates from the databases consulted in the development of the first version of the MAUAP (Gamache et al., 2016a). To facilitate the analysis of the information we collected, a document summarizing the information according to environmental element was developed to link the existing content of the MAUAP with new elements. The objectives of this process were to:

- **Identify information** (new or complementary) that could improve the MAUAP. Such information could add precision to an already-considered aspect or represent an entirely new element to be considered. Elements on accessibility for individuals with cognitive and intellectual disabilities (ICID) were added.
- **Confirm the validity** of certain already-proposed elements. The presence of a recommended element in many sources represented a certain level of agreement in the scientific literature.
- **Confront certain elements**. A great diversity of recommendations indicates a lack of certainty or consensus in the literature.

All the proposed accessibility practices identified in the literature review were analyzed to determine which ones were the most applicable and/or represented a good compromise to enable IPD of all types (motor, visual, hearing), as well as ICID, to access the environment. Each section's content was validated by the authors through work discussions, working in the fields of architecture, rehabilitation and access for IPD.

Format modifications

Since the first version was not particularly accessible in terms of presentation, as some partners willing to include the MAUAP in their practice pointed out, the format had to be completely rethought. The levels of information presented in the first version were complex and contributed to the lengthiness of the assessment. Levels of information were created to shorten labels, by creating categories or groups of elements to consider and placing the emphasis on specific words. As for the rating scales, it was found that the four-level rating scale for accessibility in the MAUAP, which proposes percentage ranges of checked characteristics to accommodate the varying numbers of labels per item, was not user-friendly. It did not provide a meaningful and representative evaluation of accessibility. Therefore, the rating scales were also rethought.

Inter-rater reliability study

Sample

A convenience sample of public infrastructures was identified to evaluate all types of environments evaluated in the MEA (pedestrian, public, commercial, financial, health care, learning (educational), leisure, etc.). A diversified sample of infrastructures was chosen and buildings of various types and styles were visited. The number and types of assessed infrastructures are presented in table 2.

Table 2. Convenience sample of evaluated infrastructure

Types of infrastructures	Specific types of infrastructures	n
Learning (educational) infrastructures for adults	Professional training center	1
Learning (educational) infrastructures for adults	CEGEP (non-university postsecondary institutions)	5
Learning (educational) infrastructures for adults	University building	19
Leisure infrastructures for adults	Sports center	6
Leisure infrastructures for adults	Community and leisure center	9
Leisure infrastructures for adults	Library	18
Commercial infrastructures	Shopping center	5
Financial institutions	Credit union or bank	6
Health care institutions	Hospital or rehabilitation institute	2
Pedestrian facilities	Curb ramps, crosswalks, sidewalks	30

Procedure for inter-rater reliability evaluation

To evaluate the MEA's inter-rater reliability, a student in occupational therapy (master's level) and a student in architecture (undergraduate, one year

completed) performed the MEA evaluations in the same infrastructure at the same time but without consultation. After taking a one-hour training session with the first author (SG) and watching a tutorial about the MEA (including practical exercises validated with the first author (SG)), they independently performed 30 evaluations of public infrastructure in the summer of 2016 (there was an overlap in the infrastructures evaluated to complete the 30 evaluations). The infrastructures were chosen randomly through the list of municipal and educational infrastructures of Quebec City which present the elements that can be evaluated with the MEA (e.g., library, cafeteria, locker room). If these infrastructures did not prove to be sufficient to evaluate sections of the MEA, other public infrastructures close to those evaluated were targeted. The material used included a measuring tape, an inclinometer, a measuring wheel, a luxmeter, a sonometer, a chronometer, a calculator and the electronic version of the MEA on an electronic tablet.

Data analysis

Inter-rater reliability for each of the MEA's items, being each element to be evaluated described through the use of an element, a component and a criteria in the MEA, was analyzed. On the other hand, the MAUAP items were a checklist of many criteria. In a previous study, the Gwet's AC1s were therefore calculated according to the four-level rating scale which provided less precise results.(Gamache et al., 2016b) To make things simpler, more structured and precise, the MEA items are now more condensed and specific. What was considered a label in each MAUAP item is now an item in itself in the MEA. Gwet's AC1 statistic was used, which represents the conditional probability that two randomly selected raters will agree, given that no agreement will occur by chance (Jenkins et al., 2015; Wongpakaran, Wongpakaran, Wedding, & Gwet, 2013). Unweighted Gwet's AC1s were calculated for all items (dichotomous score). Gwet's AC1 values were interpreted as representing poor (0.00 to 0.40), moderate (0.41 to 0.60), good (0.61 to 0.80) or excellent (0.81 to 1.00) agreement between the raters. The higher the value, the higher the percentage

of agreement between raters is compared to the chance level (DeVellis, 2003). Data were analyzed with the Gwet's inter-rater reliability functions designed for the R statistical environment (http://www.agreestat.com/r_functions.html, R software version 3.3.2). Our objective was that all Gwet's AC1 values should be high (≥0.61; i.e., good or higher).

Results

Content and format modifications

In the literature review regarding accessibility for ICID, a total of 47 articles were identified as relevant. They covered topics such as visual barriers to prevent wandering, electronic technologies (e.g., web accessibility, computers, content), assistive devices, environmental barriers, physical access and information in the community, and the *Environmental Restriction Questionnaire* (tool). To update the labels, other references were added to the existing ones (first version of the MAUAP) in a document summarizing the information according to environmental element in order to link the existing content of the MAUAP to new elements. Here are the gathered references:

From the literature review regarding accessibility for ICID:

- Bartfai & Boman. (2011). Policies concerning assistive technology and home modification services for people with physical and cognitive disabilities in Sweden
- Boyden, Esscopri, Ogi, Brennan, & Kalsy-Lillico. (2009). Service users leading the way: focus group methodology in developing accessible information DVDs with people with learning disabilities
- Buchner. (2009). Deinstitutionalisation and community living for people with intellectual disabilities in Austria: history, policies, implementation and research

- Carey, Friedman, & Bryen. (2005). Use of electronic technologies by people with intellectual disabilities
- Casado & Lee. (2012). Access barriers to and unmet needs for home and community-based services among older Korean Americans
- Davies, Stock, King, & Wehmeyer. (2008). ‘‘Moby-Dick is my favorite:’’ Evaluating a cognitively accessible portable reading system for audiobooks for individuals with intellectual disability
- Diamond, Shreve, Bonilla, Johnston, Morodan, Branneck. (2003). Telerehabilitation, cognition and user-accessibility
- Felicetti. (2005). Barriers to Community Access: It’s About More Than Curb Cuts
- Feliciano, Vore, Leblanc, & Baker. (2004). Decreasing entry into a restricted area using a visual barrier
- Fichten, Barile, Asuncion, & Fossey. (2000). What government, agencies and organizations can do to improve access to computers for postsecondary students with disabilities: recommendations based on Canadian empirical data
- Ficocelli & Nejat. (2012). The design of an interactive assistive kitchen system
- Fortney, Chumbler, Cody, & Beck. (2002). Geographic access and service use in a community-based sample of cognitively impaired elders
- Fox, Moore, Ficka, Lemoncello, & Prideaux. (2009). Public computing options for individuals with cognitive impairments: Survey outcomes
- Garbutt. (2009). Is there a place within academic journals for articles presented in an accessible format?

- Godsell & Scarborough. (2006). Improving communication for people with learning disabilities
- Hammel. (2003). Technology and the environment: supportive resource or barrier for people with developmental disabilities?
- Hammel, Jones, Smith, Sanford, Bodine, & Johnson. (2008). Environmental barriers and supports to the health, function, and participation of people with developmental and intellectual disabilities: report from the State of the Science in Aging with Developmental Disabilities Conference
- Henderson & Fuller. (2011). Problematising' Australian policy representations in responses to the physical health of people with mental health disorders
- Hochhausen, Le, & Perry. (2011). Community-based mental health service utilization among low-income Latina immigrants
- Hornung. (2011). Towards a Design Rationale for Inclusive eGovernment Services
- Johnson, Douglas, Bigby, & Iacono. (2009). Maximizing community inclusion through mainstream communication services for adults with severe disabilities
- Kelly, Sloan, Brown, Petrie, Lauke, Ball, & Seale. (2007). People, policies and processes
- Kennedy, Evans, & Thomas. (2011). Can the web be made accessible for people with intellectual disabilities?
- Lubinsky. (2010). Communicating effectively with elders and their families
- Luedtke, Goldammer, & Fox. (2012). Overcoming communication barriers: navigating client linguistic, literacy, and cultural differences

- Namazi, Rosner, & Calkins. (1989). Visual barriers to prevent ambulatory Alzheimer's patients from exiting through an emergency door
- Nind & Seale. (2009). Concepts of access for people with learning difficulties: towards a shared understanding
- O'Regan & Drummond. (2008). Cancer information needs of people with intellectual disability: a review of literature
- Poncelas & Murphy. (2007). Accessible information for people with intellectual disabilities: Do symbols really help?
- Porter. (2005). Foreword
- Price, Hermans, & Evans. (2009). Subjective barriers to prevent wandering of cognitively impaired people (Review)
- Reagan. (2004). Perceived Mental and Physical Health: How Is It Influenced by Demographics, Health Behaviors, and Access to Health Care Resources?
- Rochette & Loiselle. (2012). Successfully performing a university student's role despite disabilities: challenges of an inclusive environment and appropriate task modification
- Rosenberg, Ratzon, Jarus, & Bart. (2010). Development and initial validation of the environmental restriction questionnaire
- Solway, Estes, Goldberg, & Berry. (2010). Access barriers to mental health services for older adults from diverse populations: perspectives of leaders in mental health and aging
- Spandler. (2007). From social exclusion to inclusion? A critique of the inclusion imperative in mental health

- Stock, Davies, Wehmeyer, & Lachapelle. (2011). Emerging new practices in technology to support independent community access for people with intellectual and cognitive disabilities
- Swedberg. (2001). Facilitating accessibility and participation in faith communities
- Thorpe, Houtven, & Sleath. (2009). Barriers to outpatient care in community-dwelling elderly with dementia : The role of caregiver life satisfaction
- Todis, Sohlberg, Hood, & Fickas. (2005). Making electronic mail accessible: Perspectives of people with acquired cognitive impairments, caregivers and professionals
- Torres & Berg. (2008). Effects of two applications on the success of E-mail access for an individual with acquired cognitive impairment [dissertation]
- Townsley, Rodgers, & Folkes. (2003). Getting informed: Researching the production of accessible information for people with learning disabilities
- Verdonschot, Witte, Reichrath, Buntinx, & Curfs. (2009). Impact of environmental factors on community participation of persons with an intellectual disability: a systematic review
- Vilar, Filgueiras, & Rebelo. (2007). Integration of people with disabilities in the workplace: A methodology to evaluate the accessibility degree
- Walsh, Scaife, Caitlin, Dodsworth, & Schofield. (2011). Perception of need and barriers to access: the mental health needs of young people attending a Youth Offending Team in the UK

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- Wennberg & Kjellberg. (2010). Participation when using cognitive assistive devices from the perspective of people with intellectual disabilities
- Williams & Nicholas. (2006). Testing the usability of information technology applications with learners with special educational needs

From existing MAUAP references:

- Adaptive Environments Center & Barrier Free Environments. (1995). ADA accessibility checklist for existing facilities
- Arizona State University & Herberger Center for Design Excellence. (2005). The community survey. Liveable communities : an evaluation guide
- Bennett, Kirby, & Macdonald. (2009). Wheelchair accessibility: descriptive survey of curb ramps in an urban area
- Don MacDowall of Bass International Consulting for People Outdoors. (2004). Accessibility checklist – a self-assessment tool
- Greater Toronto Hotel Association. (2003). Greater Toronto hotel association hospitality checklist
- Kerr & Rosenberg. (2009). Walking route audit tool for seniors [WRATS]
- McClain & Todd. (1990). Food store accessibility
- Measuring up program-2010 Legacies Now- Accessible Tourism Strategy. (2008). Non-accommodation checklist. Measuring up built environment self-assessment guidelines
- Research Alliance for Children with Special Needs. (2003). Physical accessibility measure for schools (PAMS)

- Research Alliance for Children with Special Needs and the School of occupational therapy & the University of Western Ontario. (2010). University campus accessibility measure (UCAM)
- Service de l'aménagement du territoire de la Ville de Québec. (2010). Guide pratique d'accessibilité universelle
- Stark, Hollingsworth, Morgan, & Gray. (2007). Development of a measure of receptivity of the physical environment
- U.S. Department of Justice. (2001). ADA checklist for new lodging facilities
- U.S. Department of Justice. (2004). ADA checklist for polling places

From other added references:

- Absolu System. Guide pratique couleur & accessibilité
- ArgoServices. (2011). Fiches pratiques
- Association des malentendants canadiens. (2008). Conception universelle et accès facile: lignes directrices pour les personnes malentendantes
- Canadian Heritage Parks Canada. (1994). Design guidelines for accessible outdoor recreation facilities
- CERTU. (2007). Une voirie accessible
- CERTU & CETE de Lyon. (2010). Zone de rencontre: Quels dispositifs repérables et détectables par les personnes aveugles et malvoyantes?
- Christiaen. (2004). Vivre mieux dans un environnement visuel adapté
- Comité régional du Tourisme Paris Ile-de-France - Maison de Victor Hugo. (2013). Accessibilité: Qualité de l'accueil à Paris Ile-de-France:

Concevoir un guide adapté pour les personnes en situation de handicap mental

- Commission canadienne des droits de la personne. (2007). Pratiques exemplaires de conception universelle à l'échelle internationale : examen général [International best practices in universal design]
- Confédération Française pour la Promotion Sociale des Aveugles et Amblyopes. (2010). Les besoins des personnes déficientes visuelles: Accès à la voirie et au cadre bâti
- Cunningham, Michael, Farquhar, & Lapidus. (2005). Developing a reliable Senior Walking Environmental Assessment Tool
- Davies, Stock, King, & Wehmeyer. (2008). ''Moby-Dick is my favorite:'' Evaluating a cognitively accessible portable reading system for audiobooks for individuals with intellectual disability
- Fédération française du bâtiment. (2009). Guide des bonnes pratiques de mise en couleur
- Figoni, McClain, Bell, Degnan, Norbury, & Rettele. (1998). Accessibility of physical fitness facilities in the Kansas City metropolitan area
- Godsell & Scarborough. (2006). Improving communication for people with learning disabilities
- ILSMH Association Européenne. (1998). Le savoir-simplifier: Directives européennes pour la Production d'Information en langage clair à l'usage des Personnes Handicapées Mentales
- Institut Nazareth et Louis Braille & Société Logique. (2003). Critères d'accessibilité répondant aux besoins des personnes ayant une déficience visuelle
- Kelly, Sloan, Brown, Petrie, Lauke, Ball, & Seale. (2007). People, policies and processes

- Ministère de l'écologie, Ministère du travail et des relations sociales et de la solidarité, & Ministère du logement et de la ville. (2008). Circulaire interministérielle no 2007-53 DGUHC du 30 novembre 2007 relative à l'accessibilité des établissements recevant du public, des installations ouvertes au public et des bâtiments d'habitation

- Ministère des Transports de l'écologie du Tourisme et de la Mer. (2012). Prescriptions techniques pour l'accessibilité de la voirie et des espaces publics

- ONIP, FAF, & Argos-Service. (2011). Contrastes & Harmonies

- OPHQ. (2009). À part entière : pour un véritable exercice du droit à l'égalité », Politique gouvernementale pour accroître la participation sociale des personnes handicapées

- Pôle ressources national sport et handicap. (2012). Accessibilité des équipements, espaces, sites et itinéraires sportifs: Les gymnases: Guide d'usage conception et aménagements

- Transports Québec. (2007). Normes de la construction routière MTQ – Normes

- UNAPEI. (2009). Guide pratique de l'accessibilité: Pour vous accompagner dans vos démarches en matière d'accessibilité en faveur des personnes en situation de handicap mental

- UNAPEI. (2012). Guide pratique de la signalétique et des pictogrammes

The seven existing sections (Gamache et al., 2016a) were reorganized to eliminate any redundant information and shorten the assessment. The *Canadian Standards Association*'s recommendations (CSA Group, 2012) were selected as the principal source of information since they are most representative of the possible progress in accessibility and of Canadian practices which can be applied in Nordic countries. Moreover, ISO recommendations (International Organization for Standardization [ISO], 2011) were also used, because of their influence and the

fact that they are produced by an issuer of controlled norms developed by a group of experts from different fields. Even so, all data gathered from other sources were considered in the development of the MEA and were added if relevant.

As in the first version, the MEA includes an introduction presenting the theoretical conceptualization and development of the assessment, a description of what can be evaluated with the MEA, instructions, measurement conversion tables and the use of colour and contrast. It is followed by the evaluation per se. So that each section can remain independent and be used only if necessary, each existing section was separated into smaller but more structured sections, each of which represents an environmental element, resulting in 29 sections in the MEA (see table 3).

Staircases have been added in the new version. Even though they are not inherently universally accessible structures (wheelchair users and severely mobility-impaired individuals do not usually use them), some IPD who use mobility-assistive devices (e.g. cane, walker) use them, and so they need to be accessible. As can be seen in table 3, the MEA contains a more significant number of items, most of the MAUAP items were modified or adapted.

As for the format, to shorten the presentation of the information, labels were deconstructed to form three categories of information: elements, components and criteria. Elements are the categories of information that are covered in the criteria that form the evaluated environmental element. For example, the first section regarding curb ramps includes elements such as surface, landing (top), transition, running slope, etc. The components are the subcategories that refine the elements' descriptions. Again in the curb ramps section, if we consider the element SURFACE, the related components are ground, obstacles, joints and alignment; they allow further deconstruction of the concept. Finally, the criteria indicate what needs to be measured precisely and objectively and which need to be rated. The presentation was therefore standardized to ensure that all sections are constructed in the same way so the information can easily be found. All the

items regarding the configuration of the evaluated element are presented first, followed by those related to signage, lighting and specific features. In order to better understand the origin and choices made for each of the proposed items, all references used are presented. Moreover, in the MAUAP, some items were identified as key points without which accessibility would be impossible or greatly hindered and which needed to be analyzed very carefully (indicated in bold). In the MEA, this feature was not replicated. Each item is considered to contribute to an interrelated assemblage of necessary characteristics that must be considered as a whole. Moreover, elements that cannot be objectively evaluated are presented in an ADDITIONAL INFORMATION section at the beginning of each section. This provides a better understanding of IPD and ICID's needs and improves access to the environment, but the items in question are not deemed necessary or objective enough to be evaluated. An example of the resulting format can be found in figure 1 (image provided: example of evaluated environment).

As for the rating scales, it was found that the MAUAP's four-level accessibility rating scale, which proposed percentage ranges of checked characteristics to accommodate the varying number of labels per item, was not very useful. It did not provide a meaningful, representative evaluation of accessibility. Since the content of this measure focuses on the acceptable middle-ground between the needs of individuals with motor, visual, hearing, cognitive and intellectual disabilities, the absence of a particular accessibility criterion might hinder access for some people but not for others. Priority should not be given to certain types of individuals; all have the right of access. Therefore, the rating scales were also changed. The first rating element is presented under ACTUAL MEASURES. This provides a specific space for the rater to compare the accessibility criterion for each item with what can actually be observed. In the previous version, this information could be entered in the OBSERVATIONS sections, but it seemed easier for raters to distinguish the measures from other observations. Another rating scale concerns the COMPLIANCE of the observed measure with the criterion found in each item. There are three options; the element presented in the item is

absent, it is there and is compliant or it is there but it is not compliant with the criterion. Finally, the last rating element provided is the OBSERVATIONS AND MODIFICATIONS section where the rater provides further explanations of the observations made and information on possible modifications to be implemented to improve accessibility.

The material required to perform the evaluation objectively was added for each section of the MEA to make it more user-friendly. At the top of each page, the required measurement instruments are listed (stopwatch, level, luxmeter, measuring wheel, measuring tape, sonometer, thermometer). Before completing an assessment, raters can therefore select the required sections concerned with the desired environmental elements. They can then identify the measuring instruments they need to perform the assessment and thus complete it by providing the objective actual measure, the actual measure's compliance with the proposed assessment criterion, and the observations and modifications they propose. Therefore, each section can be used independently and quite intuitively.

Table 3. Comparison of sections in the MAUAP and the MEA

MAUAP			MEA			
Sections	**Content**	**# items**	**Groups**	**Sections**	**Content**	**# items**
1. Parking lot		11	**Parking**	5. Designated parking		26
				6. Parking meter, Ticket machine or Toll station		25
2. Pedestrian facilities	Curb cut or sloped curb to access the sidewalk	11	**Pedestrian infrastructures**	1. Curb ramps/Curb cuts		23
	Sidewalk and pedestrian path			4. Sidewalk and pedestrian path		21
	Curb cut or sloped curb to leave the sidewalk					
	Pedestrian traffic light			3. Pedestrian signal		15
	Crosswalk			2. Pedestrian crossing		11
	Curb cut or sloped curb to access the sidewalk after crossing the street					
3. Building access from the exterior	Curb cut or sloped curb to access the building	17				
	Sidewalk or pedestrian path to access the building					
	Ramps to access the building					
	Exterior signage			7. Signage and outdoor access		6
	Entrance			8. Doors		44
4. Interior manoeuvring area	Global signage for the building	12		10. Signage		37
	Floor, walls and lighting		**Circulation**	14. Walls		9
				15. Obstacles		3
	Hallway			13. Accessible routes		42
	Environmental control			21. Manoeuvring devices		8
	Ramp		**Circulation**	17. Access ramp		21
				18. Handrails and guardrails		12

MAUAP			MEA			
	Elevator			19. Elevator		64
	Platform lift			20. Platform lift		17
				16. Staircase		35
5. Places for learning and leisure	Classroom, meeting room, multipurpose room, community hall and auditorium	33	**Learning and leisure facilities**	26. Room and auditorium		10
				29. Accessible seats		11
	Library/Resource center			27. Library and resource center		5
	Locker room entrance		**Locker rooms and toilets**	23. Locker rooms		39
	Dressing room			24. Toilet, changing and shower stalls		121
	Locker					
	Shower stall					
6. Services	Functional security of the building	26	**Learning and leisure facilities**	9. Security		29
	Reception desk at the entrance of the building			11. Desks		18
	Service signage					
	Door					
	Environmental control					
	Area with chairs and tables			12. Tables and chairs		24
	Cafeteria/snack bar			28. Cafeteria		18
	Phone			22. Equipment	Telephone	27
	Water fountain				Drinking fountain	19
	Automatic teller machine				Automatic teller machine	30
					Trashcans, bins	11
7. Public restroom	With stalls	23	**Locker rooms and toilets**	25. Washrooms		101
	Accessibility					

MAUAP	MEA
Stall Use of the toilet Counter, sink and mirror Without stalls Accessibility Toilet without stalls Use of the toilet	

Note: Items of the MAUAP represent checklists of environmental characteristics (n=3 to 16 per item). Items in the MEA represent an environmental characteristic each.

Figure 1. Example of the MEA's format

1

1. Pedestrian infrastructures – Curb ramps/Curb cuts

#	Elements	Components	Criteria	Actual measures	Absent	Compliance		Observations and modifications
1.	Surface	Ground	Level, continuous and slip-resistant even if wet[1]			☐	☐	
2.		Obstacles	No unevenness nor hole in front			☐	☐	
3.		Joints	Type: saw cuts[1]			☐	☐	
4.		Alignment	With the unimpeded pedestrian corridor on the sidewalk and guiding pedestrians to their reserved circulation area[1, 2]			☐	☐	
5.	Landing (top)	Depth	≥ 1200mm[2]			☐	☐	
6.	Transition	At the centre	Running length ≥ 1500mm[1, 3]			☐	☐	
7.	Running slope		≤ 6.66% (1:15)[2] • Where the curb ramp has flared sides: 6.66-10% (1:15-1:10)[2]			☐	☐	
8.	Cross slopes		• At junctions, intersections: < 2% (1:50)[2] • Where pedestrians are likely to walk across the curb ramp on vehicle traffic area: < 5% (1:20)[2]			☐	☐	
9.		Where there is a counterslope > 11% (sideways)	Transition starting at the ramp base and running over the entire width (sideways) on a distance ≥ 600mm in a street[2] and with a counterslope ≤ 2% (1:50)[2]			☐	☐	
10.	Curb cut width	Excluding flare sides	1200-1500mm[2]			☐	☐	
11.	Edge (lip)	Shape	Bevelled or round[1]			☐	☐	
12.		Height	≤ 20mm[4] with the pavement (≤ 13mm ideally) without being reduced to 0 to remain detectable[1]			☐	☐	
13.		Marking	Motif of contrasting colours (≥ 70%), decorative strip or granite curb[1]			☐	☐	
14.		Distance between 2 lowerings	> 2500mm[5, 6]			☐	☐	
15.	Tactile tiles	Distance from the edge	150-200mm[2]			☐	☐	
16.		Length	600-650mm[2]			☐	☐	
17.	Lighting		Directed toward the curb ramp or cut: ≥ 50 lux			☐	☐	
18.	Obstacles	Distance	≥ 900mm[7]			☐	☐	
19.	Bollards (if any)	Location	On both sides of the roadway[7]			☐	☐	
20.		Width	≥ 1400mm[2]			☐	☐	
21.		Height	1200mm[7]			☐	☐	
22.		Contrast	Contrasting top (≥ 70%)[7]			☐	☐	
23.		Chains	Bollards should not be linked with chains[8, 9]			☐	☐	

1. Pedestrian infrastructures – Curb ramps/Curb cuts

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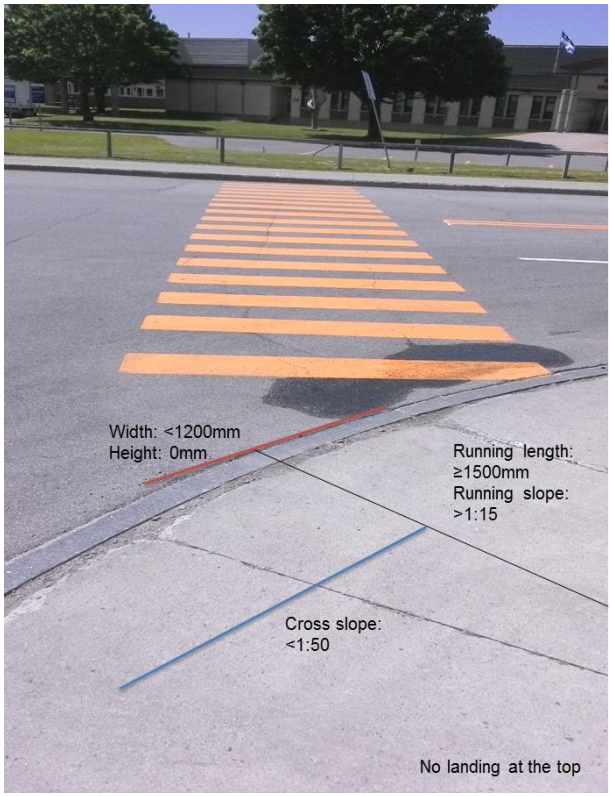
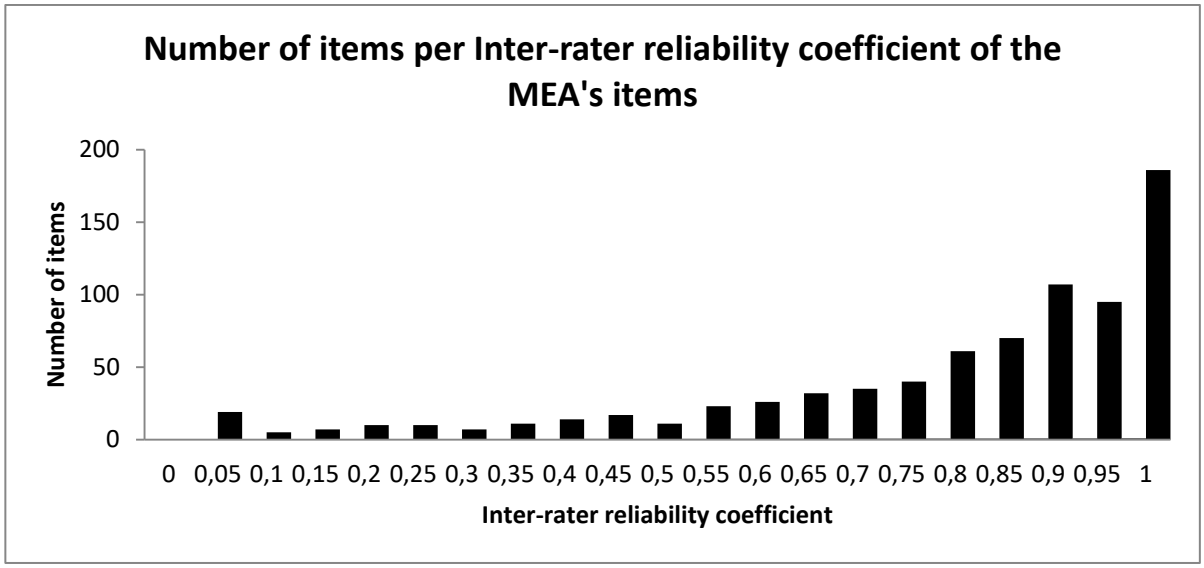
2



Inter-rater reliability study

Figure 2 shows the distribution of inter-rater reliability coefficients Gwet's AC1 values for all items. Most items (n=458/882) have a Gwet's AC1 greater than 0.80, meaning excellent agreement between raters beyond the chance level. Many others have good Gwet's AC1 values (0.61 to 0.80) (n=168/882). Some items have lower inter-rater reliability coefficients (n=108/882, p-value <0.05 significantly different from 0) and a few have non-significant coefficients (n=52/882, p-value ≥0.05). Another 96 items did not have a Gwet's AC1 value since both raters did not observe the evaluated element since the accessibility feature has not been observed within the sample.

Figure 2. Distribution of inter-rater reliability coefficients of the MEA's items



Note: A few items have non-significant coefficients (n=52/882, p-value ≥0.05 – items 1.07, 1.09, 1.12, 1.17, 1.18, 4.07, 4.12, 5.09, 5.25, 6.15, 6.25, 8.16, 8.37, 8.43, 10.15, 10.16, 11.08, 12.08, 12.10, 12.13, 12.16, 12.17, 12.18, 13.09, 15.02, 16.01, 16.03, 16.08, 16.13, 16.19, 16.25, 16.26, 16.27, 16.31, 19.24, 19.37, 19.61, 21.02, 22.21, 22.25, 22.34, 22.35, 22.39, 22.43, 24.117, 24.121, 22.67, 25.93, 26.03, 26.10).

Discussion and conclusion

The objectives of this study were to update the content and format of the *Measure of accessibility to urban infrastructures for adults with physical disabilities* and to

evaluate the inter-rater reliability of the updated version. The new version of this measure, the *Measure of Environmental Accessibility*, is based on the concepts of universal accessibility, and the HDM-DCP. A literature review was performed to update labels, and ICID were also considered as part of the target user population. As for the format modifications, the seven existing sections were reorganized to create 29 independent sections. The new version allows the evaluation of staircases, which the MAUAP did not allow. The labels were also deconstructed to create three categories of information: elements (what is going to be evaluated), components (subcategories refining the description) and criteria (what needs to be measured). Items are now better defined; one item is one criterion in the MEA, contrarily to the MAUAP items which are checklists of criteria. The references to the publications used to establish the evaluation criteria are provided for each label in the MEA. Key points (in bold in the first version to indicate essential elements) have been eliminated, since these points depended on the type of disability and thus may significantly vary from one person to the other. Elements that cannot be objectively evaluated are now presented in an ADDITIONAL INFORMATION subsection at the beginning of each section, which provides additional indications for people who wish to better understand the needs of IPD and ICID and improve access to the environment. As for the rating scales, the four-level rating scale of accessibility in the MAUAP, which proposed percentage ranges of checked characteristics to accommodate the varying number of labels per item, was changed to three types of rating: ACTUAL MEASURES (observable measures in the environment), COMPLIANCE (of an observed measure with the criterion provided for each item – absent, compliant, not compliant), and OBSERVATIONS AND MODIFICATIONS (explanations of the observations made and information on possible modifications to be made to improve accessibility). Additional information has been provided in the presentation of each section on the material required to perform the evaluation objectively (pictograms at the top of each page). Each section takes from two to ten minutes to complete, the rater only uses the sections concerned with the environmental elements he/she wishes to evaluate.

Inter-rater reliability was assessed using Gwet's AC1. Most items have good to excellent inter-rater reliability indicators (71%, 626/882), which meets our objective that the MEA items should have Gwet's AC1 values that are good or better. Another 96 items did not have a Gwet's AC1 value since both raters did not observe the

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evaluated element. Overall, the MEA is a promising measure for evaluating the accessibility of public environments for IPD and ICID. Nevertheless, some items have lower inter-rater reliability coefficients (n=108/882, p-value <0.05 significantly different from 0) and a few have non-significant coefficients (n=52/882, p-value ≥0.05). These items are distributed unevenly in the MEA, so it is impossible to predict which items are less appropriate. Many of the disagreements found within the judges' ratings for these items seem to relate to their ability to classify whether an item was absent or non-compliant; in either case, the item represents an inaccessible situation. The MEA allows a better understanding of what needs to be considered in the environment to provide one that is more congruent with the person's characteristics and the activity taking place in the environment.

Limits of the study

The sample size (infrastructure) used for evaluating inter-rater reliability was limited and extreme levels of accessibility (e.g., exemplary cases) may not have been observed. However, it respected the requirements for obtaining statistically significant results. All evaluations were performed in Quebec City and therefore might not have provided enough diversity. Even so, a variety of types of structures were evaluated which had been built at different times and in different contexts. Moreover, the number of evaluators (n=2) was small and might not have been representative of all possible types of users; still, the evaluators came from different backgrounds and this brought a certain diversity among raters.

Statistically speaking, a high agreement was obtained when both raters believed that a characteristic was not present. This does not necessarily mean that their judgment was accurate. With the current MEA instructions, the characteristic may have been hard to detect, rather than absent. Moreover, when both raters detected a characteristic, we did not check to make sure their assessment was based on the observation of the same elements. Thus, the nature of the agreement between raters might be questioned.

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Future research

The format of the MEA could be further adapted to make it more accessible and usable by individuals with visual disabilities and other professionals concerned with accessibility (e.g., architects, groups defending the rights of IPD and of ICID). A co-design approach to the development of a new version by meeting with individuals with disabilities should also be considered. Inter-rater reliability should also be evaluated with more evaluators as well as with other professionals such as urban planners or individuals who are not experts in construction or rehabilitation (e.g. representatives groups of IPD or ICID). These individuals will then have access to a tool that can be used before renovations or at the beginning of a construction project to ensure that existing and future urban infrastructures are accessible. Future research could, therefore, include the use of the MEA by any individual wanting to improve the accessibility of public infrastructures for individuals with physical, cognitive and intellectual disabilities in order to create a common ground and vocabulary with which to work in urban projects.

Final remarks

The results of this paper show that the MEA is a promising measure of accessibility of exterior and interior urban infrastructures for individuals with motor, visual, hearing, cognitive and intellectual disabilities. Compared to the previous version (MAUAP), the MEA's content has been updated, the format has been improved to favor user-friendliness, and the rating scales have been modified to provide more adequate conclusions. Moreover, this measure showed good inter-rater reliability indicators in this study, with two evaluators from different backgrounds. It is available both in English and in French. This tool can highlight potential adaptations for improving accessibility; thus, it will promote the exchange of accessibility solutions with architects, urban planners, and decision makers. As of now, the MEA is intended for professional use by health clinicians and construction workers/planners. However, it could be envisioned that users with disabilities be involved in data collection to

provide feedback. The introduction of the MEA provides enough information to ensure its use. Nevertheless, further training is recommended.

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EVALUATING THE ACCESSIBILITY OF ONLINE LIBRARY GUIDES AT AN ACADEMIC LIBRARY

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***Abstract*:** This article describes an exploratory research study assessing the level of Americans with Disabilities Act (ADA) compliance and general accessibility of online information resources at a mid-sized, 4-year, public institution in the state of Ohio. A rubric, available freely online as a living document, was developed based on the Web Content Accessibility Guidelines (WCAG) 2.0, Section 508 of the Rehabilitation Act of 1973, and web design best practices. From 2015-2016, the authors used the rubric containing 14 criteria (12 criteria from the WCAG 2.0, a criterion from Section 508, and a criterion related to universal web design best practices) to assess a random sample of online library guides (18 guides) at this institution.

The authors found that the template developed by the administrator and used by all library guides at the study institution caused 70% of the applicable criteria to fail. The content contributed by individual library guide authors did not pass all of the criteria, but generally performed better than the template. Library guide author contributed content failed an average of seven rubric criteria. Many of the common library guide author errors in this study coincide with those reported by other institutions.

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Combining the WCAG 2.0 criteria with additional universal web design best practices criteria within the rubric eliminated most of the universal accessibility concerns that remained after applying the WCAG 2.0; a concern that had been identified in previous literature examining WCAG 2.0 applications to online information resources. It was concluded that the rubric was sufficiently comprehensive and that further exploration of its utility was warranted. This includes asking a heterogeneous group of users to assess the usefulness of the rubric by applying it to library guides outside of this study.

Keywords: Online accessibility, universal design, Americans with Disabilities Act.

Introduction

This article explains and describes a 2015-2016 exploratory research study that examined the efficiency of using a comprehensive rubric to assess Americans with Disabilities Act (ADA) Amendments Act (2008) compliance in online, university library-created information resource guides (hereinafter referred to as LibGuides).

The study was conducted at a 4-year, public university in the state of Ohio by the article's authors (hereinafter referred to as the authors) to examine the utility of the author-compiled, comprehensive accessibility standards/guidelines rubric when applied to a fully online information resource. Once the study was complete, appropriate amendments were made to the rubric to make it clearer and easier to use for those assessing the ADA and universal design compliance of their web materials, particularly those in higher education.

The comprehensive accessibility standards/guidelines rubric (hereinafter referred to as the rubric) is a compilation of standards and guidelines from numerous organization's resources that provide best practice guidance for making web content accessible to those with disabilities. In addition, the rubric provides suggestions related to universal design of online resources to

promote ubiquitous access. The standards and guidelines used to create the rubric include the Web Content Accessibility Guidelines (WCAG) 2.0, created by the World Wide Web Consortium (W3C)'s Web Accessibility Initiative; Section 508 of the Rehabilitation Act of 1973; and web design best practices.

The rubric includes three levels of conformance, based on WCAG 2.0 guidance. Level A is viewed as the minimum conformance standard. To meet Level A conformance, "the web page [must satisfy] all the Level A Success Criteria, or a conforming alternate version is provided" (World Wide Web Consortium [henceforth W3C], 2016, Understanding Requirement 1). Levels AA and AAA have higher-level conformance requirements that must be met, and must also meet the level conformance standards for the lower levels. The rubric explains how criteria are met for each level described above.

The rationale for creating the rubric is explained in the next section.

Statement of the problem

Although legally required, ensuring ADA/accessibility compliance in online materials is incredibly challenging. Many of the requirements providing guidance on how to comply with the law when creating accessible online information materials are not in one place. Also, updates that have been made to the law are not always reflected in online resources. Consequently, the authors discussed creating a central hub of information they could use when designing their online materials, both out of frustration with the lack of an available comprehensive resource, and because of their need for a web design resource they could consult to save time and error in the creation process. To that end, to maximize their own efficiency and create a less frustrating and more reliable assessment tool, the authors created the rubric (available in the Appendix).

Specifically, the authors believe the rubric provides time-crunched information technology and library staff members with a simple yet comprehensive resource to consult when creating and designing ubiquitously accessible materials. Designers and others can also consult the rubric when evaluating

ubiquitous accessibility compliance in currently available web materials. As the authors began researching the literature on the matter, they realized they were not alone in struggling to create and maintain ADA-compliant and universally designed online materials. In a national study investigating various information available online to students with disabilities at degree-granting postsecondary institutions, Raue, Lewis, and Coopersmith (2011) found:

A few of the barriers cited by institutions as hindering implementation of universal design to a moderate or major extent were limited staff resources to provide faculty and staff training on accessibility issues … costs associated with purchasing appropriate technology … and other institutional priorities (p. 4).

The authors also discovered during their research that more than 30 higher education institutions across the United States had been subject to complaints and legislative actions due to lack of ADA compliance within their online materials (Carlson, 2017). It is speculated herein that lack of compliance has more to do with lack of funding and personnel able to make these updates and changes at these institutions rather than a willful dismissal of the need for accessible content. However, as Providenti (in Seale, 2014) states:

Institutions need to take accessibility issues more seriously. While the impetus to do so should fall under the rubric of professional ethics rather than avoiding a legal threat, either reason will suffice. … Ethics may be important but they are also cheap. Litigation, on the other hand is expensive. … Can we afford to ignore web standards when doing so impacts accessibility? (2004, p. 34).

Indeed, the number of U.S. higher education students who report having a disability has increased steadily over the last decade. Explanations for this include expanded access to distance education options (Caldwell, 2006; Seale, 2014), and legislation which provided broader access to higher education for students with disabilities, e.g. the ADA Amendments Act of 2008, and the 2008 Higher Education Opportunity Act (Raue et al., 2011). Additionally, there has been an increase in veterans and adult/non-traditional learners attending U.S. higher education institutions, and these specific populations have a higher-than-average disability registration rate than traditional undergraduate

students (U.S. Department of Education, National Center for Education Statistics [henceforth USDE NCES], 2016).

Based on the most currently available statistics, approximately 11% of enrolled undergraduate students reported having a learning, visual, auditory, or speech disability; or an orthopedic or health impairment (USDE NCES, 2014a). This statistic does not include students who do not report their disability or students who are unaware they have a disability; therefore, this statistic is likely to be much higher than reporting averages can determine. Regardless, 11% is a significant portion of the undergraduate student population in U.S. higher education institutions and one which must be provided with equal access to education therein.

In many countries, there is legislation to protect the rights of persons with disabilities. In the United States, Sections 504 (1973) of the Rehabilitation Act and the ADA Amendments Act (2008) are used in litigation against U.S. higher education institutions when they fail to provide reasonable accommodations to students with documented disabilities (U.S. Department of Education, 2014a, 2014b; U.S. Department of Justice, 2016). DeMaine (2014) defines reasonable accommodations as "those that ensure equal opportunity for participation and access to the benefits of the institution's programs without causing undue hardship for the institution" (p. 538). The authors agree that such legislation ensures that students with documented disabilities are given equal access to education through appropriate accommodations and physical, technological, and other assistance measures.

Although many U.S. institutions have focused a great deal on physical access to education while on campus for students with disabilities, there are many who have not paid as much attention to their web-based resources, as evidenced by the litigation discussed earlier. As the authors recognized in their preliminary research into this topic, there are many institutions who need assistance in complying with web accessibility standards. This led to the creation of the rubric, providing for a central repository of all reasonable standards.

Legal requirements notwithstanding; those who work in higher education have an ethical responsibility to educate all qualified students enrolled in programs of study, no matter the format through which the education is delivered. In the last 10 years, it has become more commonplace in the United States to apply, enroll, and complete a college degree using distance education methods, as well as to use associated tools to support incremental learning in online environments, sometimes referred to as badging (Educause, 2017). The number of students taking online classes is increasing rapidly, as well (USDE NCES, 2014b). Because of the increasing number of online services and born-digital educational materials available in the U.S. higher education environment, it is crucial for these institutions to ensure they provide accessible and compliant online material for a wide variety of users and usage capabilities. The ability to educate oneself is a basic human right and this right should be ubiquitously extended.

At this juncture, it is crucial to state that the authors recognize that similar challenges related to web accessibility of online resources are faced by higher education institutions abroad as well as in the United States (as detailed in the report by Altbach, Reisberg and Rumbley, prepared for the UNESCO 2009 World Conference on Higher Education). However, as stated previously, ADA compliance has become a pressing concern for many U.S. higher education institutions that wish to expand access to materials and avoid federal censure for failing to comply. It is for this reason this article focuses primarily on the needs of U.S. higher education institutions and studies completed therein in this regard, while acknowledging the global availability and importance of the guidelines and standards presented in the WCAG 2.0 in helping U.S. institutions improve compliance and access.

Purpose and aims of the study

Primarily, online academic library materials are created for higher education students, faculty, and university community members to support their information needs and academic requirements. Because it is almost impossible to determine the characteristics of people using this material beyond

incidental data gathering, it is imperative that all library material is created to be universally accessible prior to its availability online. The authors believe this standard should apply to all online materials created for higher education purposes. Consequently, the rubric was compiled from a variety of web accessibility and universal design best practice guides and related resources to assist librarians and others in this endeavor.

The aims of the study included:

- The creation of a rubric to test for accessibility of online resources which provides simpler evaluation criteria by co-locating important points of inspection;
- The evaluation of library subject guides (i.e. LibGuides) at a university that uses Springshare software tool LibGuides 2.0, to determine the accessibility of the online material provided within the LibGuides; and
- The identification of common accessibility mistakes and provision of suggestions to improve accessibility and create a basis for best practices in future design efforts.

A brief review of relevant literature is provided next and presents scholarly support for the authors' conducted study and created rubric. The remainder of this article includes:

a) The methodology section, which explains the theoretical underpinnings of the study, its research methods, and the rubric's creation;

b) The results section, which explains the study's findings and situates these findings in the broader concept of accessibility of online materials, and

c) The conclusion, which reflects on what was learned during and after the study by its authors and discusses future directions for research regarding universal accessibility design in online information materials.

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Review of relevant literature

In 2001, the American Library Association (ALA) Council approved the Library Services for People with Disabilities Policy to improve library services to patrons with disabilities (ALA, Americans with Disabilities Act Assembly, 2001). This policy outlines the responsibility of libraries under U.S. disability legislation regarding services, facilities, collections, and other areas. It discusses technological considerations that would align with existing accessibility standards and best practices; therefore, this section will discuss applicable U.S. legislation, accessibility standards, and best practices which are relevant to the study described herein. In addition, it will outline existing studies testing the accessibility of higher education websites and how results of these studies have impacted change in this area.

U.S. legislation

Section 504 of the Rehabilitation Act of 1973 was crucial legislation regarding the civil rights of persons with disabilities in the United States. Unless an undue hardship to the institution would result from compliance, court rulings have enforced that higher education institutions that receive federal funding must provide reasonable accommodations for students with disabilities (deMaine, 2014). The ADA extends the coverage to private higher education institutions, as well.

Because these Acts were written before the modern Internet, they primarily focused on physical spaces (deMaine, 2014). To address the needs created by the Information Age, the Rehabilitation Act was amended in 1998 (Section 508) to cover website accessibility explicitly; however, it pertained to U.S. government websites only (deMaine, 2014). In part, the amendment was based on the WCAG 1.0 written in 1999 (deMaine, 2014). Due to its age, the original Section 508 was antiquated and could not deal with the realities of the modern web. In 2015, there was a Notice of Proposed Rulemaking (NPRM) to update the legislation and language regarding Section 508 (Proposed

Information and Communication Technology, 2015). The update was proposed based on the newer WCAG 2.0 standards because the criteria in Section 508 were covered by the WCAG 2.0. By 2018, the updated Section 508 will require government websites to comply with WCAG 2.0.'s level A and level AA accessibility criteria. Due to changing legislation, studies such as the one presented in this article are critical for those seeking to make online information resources accessible and legally compliant.

Standards, best practices, and concerns related to WCAG 2.0 application

The WCAG 2.0 is based on the principles that information should be perceivable, operable, understandable, and robust (W3C, 2008). The WCAG 2.0 has 12 guidelines containing anywhere from one to ten criteria within each guideline. These guidelines are not reliant on specific technology, thereby accounting for future web design technologies (W3C, 2008). Countries like Canada and Australia have used the WCAG 2.0 to evaluate all government websites (deMaine, 2014). Also, Web Accessibility in Mind (WebAIM), which is known for its expertise in accessibility assessment, uses the WCAG 2.0 and Section 508 of the U.S. Rehabilitation Act of 1973 as evaluation criteria (Web Accessibility in Mind, 2017).

Not everyone is convinced that the WCAG 2.0 adequately meets the needs of persons with disabilities, particularly as it pertains to end-user accessibility. Kelly et al. (2009) provide examples pertaining to WCAG 1.1.1, which requires providing a text alternative for non-textual content. The examples consist of visual advertisements and artwork, which would be part of the sensory exception that states "text alternatives at least provide descriptive identification of the non-text content" (W3C, 2008). Kelly et al. (2009) argue that there should be a 'user-focused approach' embedded in accessible design, especially in online classes, but do not describe how comparable accommodations would be provided for classes that are not online, which would essentially have the same problem. According to Kelly et al. (2009), the WCAG 2.0 is followed without a thought to the context of use by the end user.

However, if the guidelines are followed in this manner (i.e. without thinking about use by end users), the web author is not applying the criteria correctly from a broader accessibility perspective.

Power, Freire, Petrie, and Swallow (2012) conducted a usability test with 32 legally blind participants who ranged from totally blind to very little central vision. They found that 49.6% of the level A or AA compliant websites had accessibility problems. However, many of the errors stated in the Power study would be eliminated by following universal web design and writing best practices. Some of these errors are addressed in the level AAA criterion, such as complicated language (WCAG 3.1.3-3.1.5) and an unclear link destination (WCAG 2.4.9). It was not clear why particular websites passed in the Power study when WCAG error failures were readily apparent. However, Power et al. (2012) suggested disregarding the problem-based approach of the WCAG 2.0 for broader principles until further study of the web use of this demographic was conducted. The authors found the WCAG 2.0 did not cover everything as well, making the suggestion in the Power study somewhat heavy-handed. To overcome this gap in coverage, the rubric contains a criterion requiring web design best practice. Horton and Quesenbery (2014) created a framework based on the WCAG 2.0 criteria, Universal Design theory, and the Design Thinking process, acknowledging the importance of the WCAG 2.0 and using other concepts to account for the gaps. Several of the WCAG 2.0 level AAA criteria were mapped to their framework, including the examples given by Power et al. (2012).

Intersections between WCAG 2.0 and universal design

As shown above, although WCAG 2.0 places a heavy focus on a variety of web design elements, it does not always do so with all users in mind. Implementing web design that persons with and without disabilities could use would not only make sites equitable for all users, but it would also simplify maintenance for web administrators. Enter the inclusion of universal design theory with WCAG 2.0 principles in web design, as suggested by previous researchers and implemented in the rubric included in this study.

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According to the Centre for Excellence in Universal Design (2014), universal design is a concept which requires designers to consider a wide variety of users throughout the design process. In theory, one creates web objects that can be used by everyone, in a variety of ways and for a variety of purposes. The principles of universal design align well with the accessibility principles and criteria provided in WCAG 2.0. The principles of universal design are equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance for error, low physical effort, and size and space for approach and use (Centre for Excellence in Universal Design, 2014).

When creating the rubric, the authors included criteria from both the WCAG 2.0 and web design best practice models (through the lens of universal design) toward consideration of all users of online information resources. Based on what they had learned by reviewing the current literature on the topic, the authors acknowledged that a web design which helps one user could be a barrier for another. Consequently, the rubric criteria establish a design process which promotes accessibility testing in conjunction with knowledge of the universal needs of users. When the end user is unknown, universal design principles, used in conjunction with WCAG 2.0 standards and web design best practices, can help make web content accessible to a wide range of users and consequently support a variety of needs.

Several conventions established by the WCAG 2.0 are effective for a mobile display supporting universal design. When using LibGuides, as many libraries do, the LibGuides are displayed as one column on mobile phones, so reading order (i.e. WCAG 1.3.2) becomes very important (Rosenthal, 2016). In the authors' study, some LibGuide creators provided sensory based instructions, such as "the directions are on the left," which violated WCAG 1.3.3 and was incorrect on a mobile phone. The criterion WCAG 1.4.4 requires that containers adjust their textual content when resized. Rosenthal (2016) found that a certain HTML class was needed for tables with many columns in LibGuides. If this class is not used, the table will overflow its container when using a mobile device (Rosenthal, 2016). As more students in higher education rely on mobile platforms as their primary information providers, it is essential

that display on multiple devices be considered within universal design and as a part of accessibility concerns when creating web content.

Rao (2013) found that many of the design mechanisms based on universal design were successful with students from vastly different cultures and primary languages. Particularly, Rao found that adult learners and students from rural and remote locations found information in multiple formats useful. Multiple formats, e.g. properly captioned video with a text alternative, as Rao created, would pass at least level A of the WCAG 2.0, providing access to students with disabilities as well. Poore-Pariseau (2013) and Rao (2013) found that a diverse group of students appreciated assignments when the students could choose the assignment's format. This practice supports different learning styles and enables students with disabilities to choose a format that best suits their needs.

Accessibility testing and evaluation

Studies have used a variety of samples for accessibility testing, where most were a sample of convenience. Comeaux and Schmetzke (2013) chose 56 universities that had the best library schools according to U.S. News and World Reports in 2001 to be used in their 10-year longitudinal study. The sample was dominated by large universities; therefore, the results would not necessarily be generalizable (Comeaux & Schmetzke, 2013). They examined the main library, the library school homepage, and the web pages contained in the homepage hyperlinks. Comeaux and Schmetzke (2013) claimed most studies up to 2001 tested the homepage only. According to Lazar and Greenridge (as cited in Comeaux & Schmetzke, 2013), the homepage is important as an entry point to the website to justify this practice. Homer and Parmanto (as cited in Comeaux & Schmetzke, 2013) found the homepage was not a measure of the accessibility of the website in its entirety. In 2007, Green and Huprich (2009) followed Comeaux and Schmetzke's lead by using the same sample methodology, where the only difference was choosing 12 sites instead of 56. Vojtech (2016) evaluated 114 websites of state and private universities and colleges in Slovakia and the Czech Republic.

Although Comeaux and Schmetzke (2013) discussed web accessibility policies for universities, a web accessibility policy does not guarantee adherence. The university and its employees must realize the importance of accessibility in expanding access to education, and make every effort to follow its own policies in this regard. One example of a university library accessibility policy provided by Comeaux and Schmetzke (2013) was Pennsylvania State University Libraries. Pennsylvania State University was sued for ADA violations, and the library was included in the complaint (Lush, 2015). Since then, Pennsylvania State University has created an updated accessibility policy and the library website became more accessible. Expanded training regarding online materials design helps authors of said materials comply with the new accessibility policy.

Despite the frequent replication of the Comeaux and Schmetzke (2013) study to assess accessibility in web design, the authors assert that randomly sampling pieces of the web 'whole' will not provide an accurate representation of elements related to accessibility within a website, per the standards listed in the WCAG 2.0. Additionally, it is worthwhile to note that some information would be invisible to researchers if they were not at an institution itself to see the information first-hand.

Some researchers appear to share this perspective. There are studies which have chosen to evaluate all the web pages of an organization, such as the 520 web pages at an unnamed university analyzed in a study by Solovieva and Bock (2014), all content within one online course through Coursera (Fadel, Kuntz, Ulbricht, and Batista, 2016), and the finding aids for online special collections at 68 public universities and colleges in the Association of Research Libraries (Southwell and Slater, 2013). In the authors' study, they were specifically seeking WCAG 2.0 compliance of the LibGuides at the institution selected as the study site, so the methodology in how they selected a sample differs. They chose to use quantitative random sampling methodology to select units of analysis for their study (i.e. individual LibGuides), due to the depth of the evaluation conducted through the use of the rubric, and to make the results

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generalizable to other LibGuides at this institution and possibly LibGuides designed using LibGuides 2.0 at comparable institutions.

The authors note again here that increasing accessibility and addressing universal design concerns in online higher education materials is a global concern. However, it is the case that many U.S. higher education institutions are facing increased challenges to ensure ADA compliance in their online materials without an increase in funding. Consequently, the authors focused the majority of their efforts in this exploratory study on U.S. institutions for guidance and clarity in their own work. The authors intend to pursue global considerations related to his area of research and in regard to examining the ubiquity of the rubric at a later date.

More information regarding how the authors' study was conducted and the study's findings will be discussed in the Methodology section.

Methodology

After obtaining Level I (exempt) approval from the study institution's Institutional Review Board (IRB), the authors began their study by collecting study data in fall, 2015, testing randomly selected LibGuides against the rubric through spring, 2016, and conducting statistical analysis and producing findings through fall, 2016. Per IRB requirements, the LibGuides and their authors were assigned unique identifiers within the study for the purposes of confidentiality. Although the LibGuides are publicly accessible, their authors were asked permission to use their LibGuides in the study as a professional courtesy.

The study pool included LibGuides from both the main and branch campus of the study institution. At the time of the evaluation, the branch campus was beginning to implement their instance of LibGuides, so all eight LibGuides that existed at that time were analyzed. During the analysis of the branch campus guides, the authors found that the LibGuides template (hereinafter referred to as template) was used differently by the branch campus; therefore, a direct comparison could not be made. Therefore, the branch campus analysis was

excluded from the study. For the main campus, all existing LibGuides were included in the original population pool, except:

- those that contained hyperlinks to other LibGuides or external websites using linked assets alone;
- one-page LibGuides represented in multiple LibGuides;
- LibGuides developed for testing purposes;
- LibGuides created for internal library use; or
- community LibGuides equally edited by multiple authors.

Twenty percent of the main campus LibGuides were selected by random sampling. To eliminate bias, no more than 20% of a single author's LibGuides were selected. During the analysis, the authors found that one author's LibGuides skewed the results disproportionately, so those LibGuides were eliminated from the original population. A total of 18 LibGuides were randomly selected from the population pool and included in the LibGuide analysis for the main campus.

As explained previously in this article, the rubric was created to analyze the LibGuides for accessibility compliance. Most criteria are based on the WCAG 2.0, where many criteria require good coding practices. However, there are several web design best practices that are not included. A criterion was added to the rubric to address this need. Anderson et al. (2010)'s book suggested many of the web design best practices considered in this study. One criterion of Section 508 of the Rehabilitation Act of 1973, effective 2015-2016, was kept because the authors thought that this criterion was not completely covered by the WCAG 2.0 (i.e. §1194m). Since this criterion was eliminated when the rubric was updated in 2017, it is not discussed in the article.

The levels A (minimum accessibility), AA (improved accessibility), and AAA (optimum accessibility) in the rubric were provided by the WCAG 2.0. When there are not violations of web design best practice, the rubric criterion meets

level A. The original study rubric appears in the Appendix. A hyperlink to the up-to-date version appears in the Appendix as well. Software and web-based tools were needed to analyze some of the criteria. These included Audacity, Colour Contrast Analyzer, JAWS, and Photosensitive Epilepsy Analysis Tool (PEAT). The web-based tools used were the WAVE tool and the W3C Code validator. Some HTML source code was examined manually.

In February 2016, before independent review and analysis, the authors selected three main campus LibGuides to analyze together in a normative session to ensure equal application of the rubric. From February to May 2016, each author evaluated a unique portion of the main campus LibGuides sample. From June to August 2016, the authors reviewed the other's notes to confirm equal application of the rubric. In fall 2016, the data were coded to perform the statistical analysis and elicit findings.

The research questions proposed for the study are:

- What accessibility level do the sample LibGuides pass for each criterion?
- What common errors do sample guide authors make?
- How many criteria do the sample LibGuides typically fail?
- Are some guide authors making consistent errors, or are consistent errors the result of non-author controlled LibGuide elements, such as master design and layout?

The research questions will be addressed in the Results section.

Results

Template and LibGuides failures of the rubric

As stated earlier, the authors of this study were examining the sample LibGuides from two perspectives: 1) non-author controlled failures of rubric criteria (i.e. institutional template and software/LibGuide failures), and 2)

author-controlled failures of rubric criteria. Non-author controlled failures of rubric criteria are discussed next.

Non-author controlled elements are two-fold. First, the authors noted that some failure issues were based on problems inherent to LibGuides. Springshare, the software company which created and maintains LibGuides, has corrected some accessibility issues in a recent update to its software tools. However, these corrections were made after this study concluded, so results discussed herein are those which were germane at the time of the study. Secondary failure issues included template problems and common widgets that could be corrected by the web administrator at the study's institution.

Template failures

For a LibGuide to pass the rubric at minimum and improved accessibility (i.e. Level A and AA), criteria items within the sections Text Alternatives, Adaptable, Distinguishable, Keyboard Accessible, Navigable, Input Assistance, Predictable, and Compatible needed to be met. Based on the analysis, every LibGuide in the study failed more than 70% of the applicable criteria of the accessibility rubric due to template issues.

The **Text Alternatives** criterion in the rubric pertains to text alternatives for non-text elements. Particularly, there must be text describing all images clearly, and the template did not pass this criterion because there was imprecise text describing template images. Specifically, the 'alt' attribute of the image tag of the two logos in the template did not contain all the text in the logo; therefore, sighted users would receive more information than users with visual impairments.

Here follow specific examples regarding failures for the abovementioned criteria. First, the alt attribute of the library's logo in the template should be "The institution name, University Libraries" instead of "University Libraries." In the navigation, there was text beside the glyphicons (icon fonts) used. This practice is appropriate because glyphicons can be helpful for people with print disabilities, such as dyslexia (Cunningham, 2012). However, the glyphicons did

not match the text well, limiting their helpfulness. Second, an image can be attached to a link asset using LibGuides, which assigns the alt attribute to "thumbnail." If the alt attribute is not configurable, guide authors should be advised not to use this feature in LibGuides. There were LibGuides that failed the Text Alternative criterion due to this issue.

The template did not pass the **Adaptable** criterion primarily because of structural problems. First, the heading tags in the footer (the line or block of text appearing at the end of a web page) of the template were not structurally sound. The footer begins with the level six heading tag and the subsequent heading tags were level three. According to the W3C, the heading tags should begin at heading level one in the type of footer used in the template. In addition, it could not be programmatically determined whether the hyperlinks in the footer were dropdown menus. It is essential for blind and low vision users to be aware of this functionality.

Hyperlink formatting caused the template to fail the **Distinguishable** criterion. Through historical use, underlining text has become a convention for hyperlinks; however, it is not inappropriate to underline the hyperlink only when the mouse hovers over it or the hyperlink has focus. To use hyperlink text color only, the hover and focus conditions must be distinguishable from the normal text. The hyperlinks in the body of the template had the appropriate contrast (greater than 3:1) for this scheme. However, this was not the case for one of the navigations menus because the normal condition, white text with a dark blue background, did not have greater than 3:1 contrast with the hover condition, gold text with a dark blue background. This change in color would not be noticeable for individuals with certain types of color blindness.

Many colors failed the specified contrast for the improved accessibility level. The most important examples of contrast failures were the hyperlinks in the body of all LibGuides, which were blue text with a grey background color, and a font smaller than 18 points. In addition, all the level two headings were white text with a green background. Although proper contrast might appear as

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improved accessibility for the **Distinguishable** criterion, it a crucial aspect of web design.

Another failure of the **Distinguishable** criterion of the rubric was that the breadcrumb trail occupies the same space as the navigation menu above it when the zoom was set to 200%. The navigation menu and the breadcrumb trail were difficult, if not impossible, to read.

A few items within the template were not accessible using the keyboard, so the template failed the **Keyboard Accessible** criterion. Often, guide authors used the title attribute to provide extra information about a hyperlink (otherwise known as a tooltip). However, the tooltip was not keyboard accessible. Amending code for the template could likely resolve this issue. Also, the LibGuides software uses a tooltip when the author selects the details about an asset to appear while the mouse hovers. Until Springshare makes this feature accessible, authors should be discouraged from its use in all cases except RSS feeds (made keyboard accessible in LibGuides 2.0 when the authors were writing this article). At the time this article was written, the other LibGuides "hover over" assets were not fixed.

The most significant failure of the **Navigable** criterion within the template was using the hyperlink text 'more' with the database assets. The purpose of this link was not obvious in context because it displayed a year when selected.

Additional footer issues outside of those discussed within the **Adaptable** criterion occurred. Specifically, because the footer headings were not descriptive, there was a failure of the **Navigable** criterion at the improved accessibility level. Additionally, it was not visually obvious when most items in the template itself had focus. Often, a thin, dashed black rectangle appeared. In some cases, the format of an element was consistent regarding focus by the keyboard or mouse pointer. In many of the navigation menus, hyperlink focus was not consistent. Some designers suggest consistency and others do not. Regardless, they all agree that focus must be distinct and this was not the case for the navigation menu, which had a dark blue background color. When using the keyboard for navigation, the focus was not visible whatsoever.

Within the study sample LibGuides, there were widgets commonly used by authors. Most of the time, no instructions or labels were provided for controls within the widget, particularly textboxes, which failed the **Input Assistance** criterion of the rubric. The missing labels caused the **Compatible** criterion of the rubric to fail as well. The administrator could provide uniform widgets regardless of their source (e.g. third party) that would help solve this problem. In addition, the Compatible criterion fails because there were many HTML errors that were exposed by using the W3C markup validation service. Template errors included, but were not limited to, obsolete attributes, attributes that contained white space when it was not permitted, and superfluous closing tags (i.e.). Multiple errors occurred when assessing other author-used widgets. Of the most concern was the finding that if more than one widget was used (third party or administrator created) on a web page, a duplicate ID caused a validation error.

The **Predictable** criterion did not pass because there were inconsistencies in hyperlink text and their URL within the template. For example, LibGuides names the landing page of the guide "home" by default and many guide authors do not change the name. At the study's institution, one of the navigation options in the template is "home," leading to the library's homepage. Guide authors should be advised to use more descriptive names for the default tab because "home" is ambiguous. The Interlibrary Loan link was called 'ILL' in the template header, and 'Interlibrary loan' in the secondary navigation, which caused failures in other criteria for optimum accessibility. The ILL hyperlink could be removed to solve both issues.

The **Web design best practice** criterion failed for many reasons. For example, the floating button that returns users to the top of the web page did not function when it appeared in the footer, and there were at least 26 broken URLs found throughout the template.

The template at the study's institution would not need to meet optimum accessibility as defined by the rubric; however, some criteria are essential important for accessibility. For example, all hyperlink text should describe the

hyperlink's meaning. Albeit optimum level criteria, this criterion should be met. Only the failures that should be corrected will be discussed next.

The **Readable** criterion of the rubric did not pass because of the template use of jargon, such as My Library and E-Reserves, without definition. Also, there are abbreviations that are not universally known. For example, some LibGuide users will not know the U.S. state abbreviations, particularly international students. State abbreviation should be replaced with the state name, which will improve screen reader pronunciation as well. Defining acronyms is required by the Readable criterion at this level. Future web design policy at the study's institution should provide a convention for authors regarding acronyms in reusable content to promote consistency.

The **Predictable** criterion did not pass because LibGuides launch new windows even when the user does not initiate it. LibGuides were configured such that all assets that were a hyperlink, such as databases or website links, launched in a new window without informing the user. This issue is particularly important for users with low or no vision. Either through policy or configuration, there should be a clear convention for guide authors when embedding hyperlinks into Rich Text/HTML, and this convention should be understood by the end user. For example, hyperlinks leading to the study institution's website open in the same window. Hyperlinks leading to external websites open in a new window and the user is informed about another window launching. Such solutions may cater to a wider variety of LibGuide users.

Most common non-template LibGuide rubric failures

Before beginning this section, it is worth noting that when each of the LibGuides in the study was evaluated using rubric criteria, the number of times a certain error was repeated in a LibGuide in the study was not counted. The number of unique errors was recorded only. Therefore, the total number of errors could be much more significant. The most common errors of the seven criteria that have over a 70% failure rate of minimum accessibility will be addressed in this discussion.

None of the LibGuide sample authors included labels or instructions for assets like textboxes, checkboxes, or other user input controls within their LibGuides; therefore, this common error fails the Input Assistance criterion. Since the screen reader would not read a label or instructions, screen reader users would not know what to do when they encountered the asset. Because there is a lack of visible textual instructions, it is possible that any user would be confused when encountering these assets. Not including a label accounted for half of the failures of the Compatible criterion, as well. Including a label would not completely solve the Compatible criterion problems, however, as code validation errors were the most common failure of the Compatible criterion. Figure 1 and Table 1 contain the most common errors of the Compatible criterion.

Figure 1. Compatible Criterion Failures

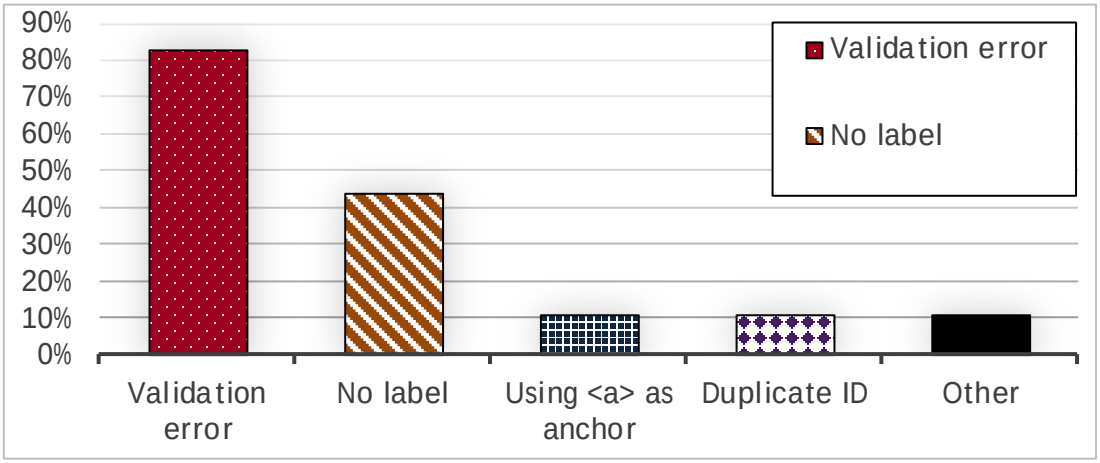

Table 1. Compatible Criterion Failures

Reason for failure	Percentage of Applicable LibGuides
HTML code validation error	83%
Control element without a label	44%

Reason for failure	Percentage of Applicable LibGuides
Using hyperlink tag (<a>) as an anchor	11%
Duplicate ID	11%
Other	11%

The most common error for the **Time-based Media** criterion was not providing a text or audio equivalent of time-based media content. If transcripts were included for this content, the LibGuides would pass this criterion. The content does not have to be an exact duplicate—it must only serve the same function. For example, if a student does not want to watch a video asset, providing a text alternative as informative as the video content that works with assistive technology is important. Designing content for a wide range of users is what makes content universally accessible.

There were many reasons that study LibGuides failed the **Adaptable** criterion. The most common error was using an HTML element to achieve a particular "look," rather than the purpose for which HTML is intended. The HTML element must be used for its intended purpose so it works correctly with assistive technology. For example, tables must contain tabular data. Using tables for layout is an archaic practice, made redundant 10 or more years ago, yet this was readily apparent in some of the study LibGuides. Figure 2 and Table 2 contain the most common errors of the **Adaptable** criterion.

Figure 2. Adaptable Criterion Failures

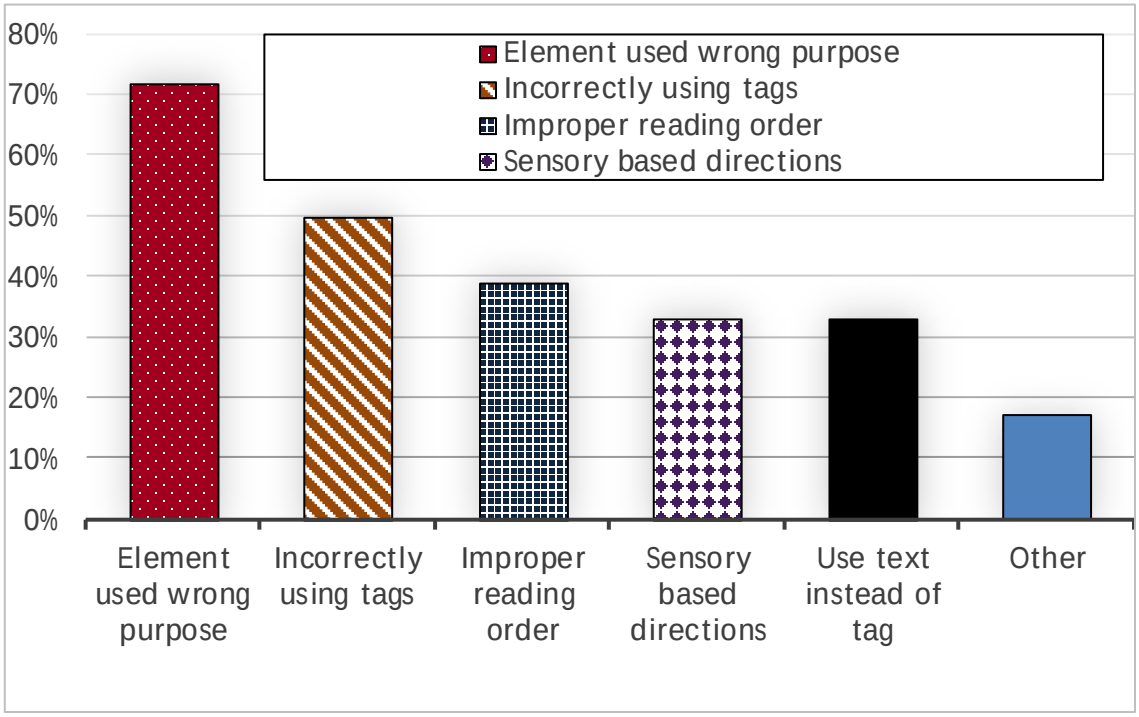

Table 2. Adaptable Criterion Failures

Reason for failure	**Percentage of Applicable LibGuides**
Element is used for display purposes, not its function	72%
Incorrectly using tags	50%
Improper reading order	39%
Sensory based directions require sight	33%
Used text when a tag for should be used	33%
Other	17%

Also, although some guide authors did not use the alt attribute for images, more LibGuides failed the Text Alternative criterion because the alternative text did not describe the function of the image well, if at all. Figure 3 and Table 3 contain the most common errors of the Text Alternative criterion.

The most common error for the Navigable criterion was providing a hyperlink that had no link text, which was surprising. The authors of this article postulate that this occurred when using the rich text editor because there is no functional purpose for a hyperlink that was invisible to the user. In addition, these hyperlinks were tab stops, so the hyperlink would receive focus when tabbing through the content. Because of this, when the user selected the enter key, it would lead the user to an unexpected location.

Figure 3. Text Alternative Criterion Failures

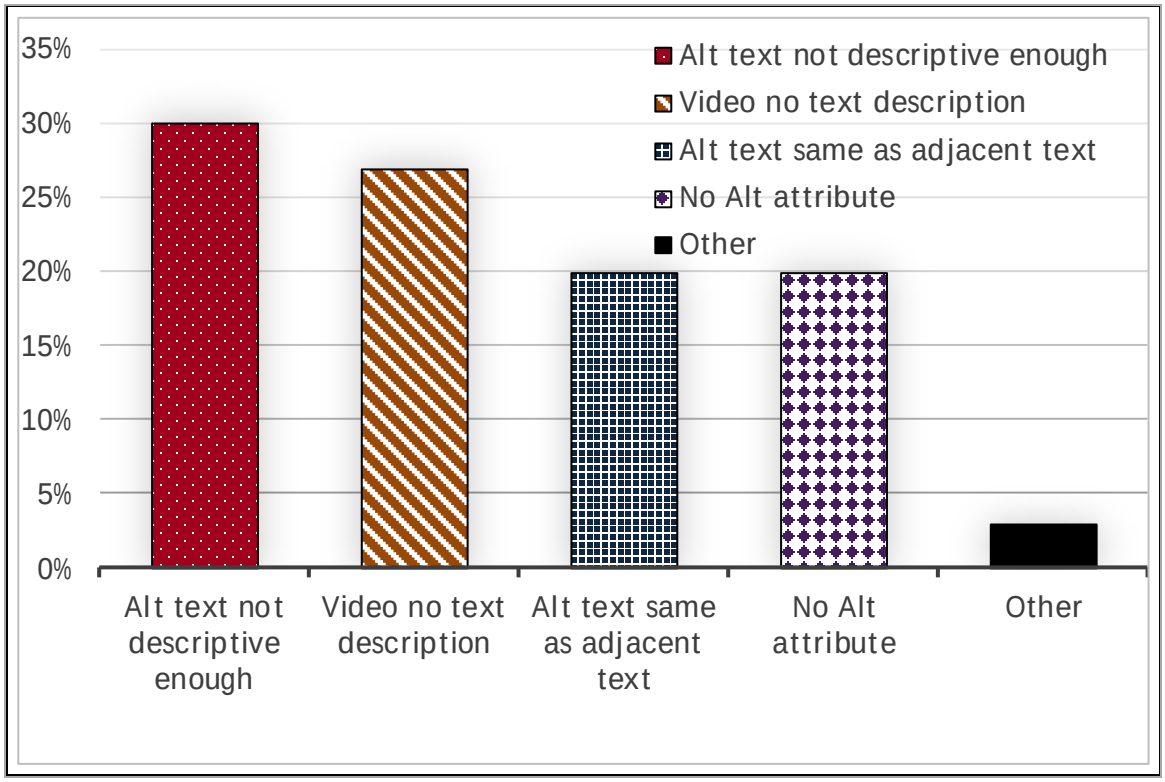

Table 3. Text Alternative Criterion Failures

Reason for failure	**Percentage of Applicable LibGuides**
Alt text is not descriptive enough about the function of the image	30%
Video needs a text description	27%
Alt text is exactly the same as the text next to it	20%
Alt attribute is not used for image tag	20%
Other	3%

Every LibGuide failed some established **Web design best practice**. The most common error was improper HTML source code due to using the rich text editor. If the rich text editor is used, it is best practice to type directly wherever possible and to use the paste buttons in the rich text editor when pasting text. When copying from HTML, it is best to paste content as plain text, then use the rich text editor to apply formatting to the text. Formats in the rich text editor that do not cause many problems include headings, bold and italic. However, fonts, text sizes, and line spacing should never be used. Many strange HTML errors can occur when editing existing HTML content. Often, the rich text editor adds unnecessary non-breaking spaces, which can cause the text to overflow its container when a user resizes his or her screen, particularly on a mobile device. When using the rich text editor, it is possible that the tags surrounding a sentence are not deleted when the text is deleted, causing empty span and heading tags.

Another common error was underlining text that was not a hyperlink. Underlining text is a well-known convention for hyperlinks, so users might find

non-clickable underlined text confusing. Other errors included using broken URLs and fixed sizes for images and inline frames (or iframe, an HTML document embedded within another HTML document – such as the HTML to a YouTube video embedded within the LibGuide page's existing HTML).

Web design errors for the LibGuides were grouped into 16 unique web design errors. Essentially, most LibGuides within the study had five unique web design errors. Six LibGuides had less than four unique web design errors. Two LibGuides had more than double the most common number of unique web design errors with a value of 12. Table 4 contains the most common errors of the Web Design criterion.

Table 4. Web Design Criterion Failures

Reason for failure	**Percentage of Applicable LibGuides**
Bad coding due to the rich text editor	72%
Bad URLs	56%
Underlined text that isn't a hyperlink	50%
Images and/or iframes are a fixed size	50%
Typos	44%
Obsolete tags are used	44%
Adjacent hyperlinks go to the same URL	44%
Text doesn't work well with a screen reader	39%

Reason for failure	Percentage of Applicable LibGuides
Hyperlink or heading text is the same as adjacent text	39%
Other	50%

Overall rubric compliance of the LibGuides (excluding the template)

There were rubric criteria where the LibGuides performed well. To illustrate, Table 5: Rubric Criteria for the Evaluated LibGuides by Level, show the number of LibGuides that pass the rubric criteria.

Table 5 provides specific detail on how many LibGuides did not pass, how many LibGuides passed for all three levels, and which classified as not applicable (N/A) for the criterion used for evaluation.

Table 5. Rubric Criteria for the Evaluated LibGuides by Level

Criterion	Does not Pass	Minimum Accessibility (Level A)	Improved Accessibility (Level AA)	Optimum Accessibility (Level AAA)	Criteria N/A
Text Alternative	15	3	N/A	N/A	0
Time-based Media	11	1	0	0	6
Adaptable	16	2	N/A	N/A	0
Distinguishable	3	11	2	2	0

Criterion	Does not Pass	Minimum Accessibility (Level A)	Improved Accessibility (Level AA)	Optimum Accessibility (Level AAA)	Criteria N/A
Keyboard Accessible	5	10	N/A	3	0
Enough Time	0	0	N/A	18	0
Seizures	4	5	N/A	3	6
Navigable	13	2	3	0	0
Readable	0	0	14	4	0
Predictable	0	7	10	1	0
Input Assistance	8	0	0	0	10
Compatible	16	2	N/A	N/A	0
Usable	6	7*	N/A	N/A	5
Web Design	18	0	N/A	N/A	0

* Would not pass for older Internet Browsers

As seen Table 5, the LibGuides performed well for the criteria: **Distinguishable**, **Keyboard Accessible**, **Enough Time**, **Readable**, and **Predictable**. Most of the items within the **Distinguishable** criterion pertained to the formatting of text and use of color. Many LibGuides contained color that was supplied by the template only; thus, did not use color in their LibGuides.

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The three failures of minimum accessibility were due to using color alone to convey meaning. Specific details regarding compliance with each criterion for the LibGuides in the study are provided below.

Eleven LibGuides had minimum accessibility regarding the **Distinguishable** criterion and lacked improved accessibility for many reasons. One common reason was that the inline CSS specified either a foreground or background color without specifying the other. In several cases, a contrast problem was observed. Another common reason was the use of images containing important text. Often in the evaluation, it was due to using screenshots instead of typing important text. Text should be presented as text whenever possible.

In general, images should be used in moderation. An important aspect of equitable access to web content is finding a compromise between many user groups. For example, images can be helpful to those with dyslexia; however, too many images are distracting to someone with attention deficit disorder (Cunningham, 2012). When images containing vital information without a textual description are used, the images are not accessible to multiple groups. Users with dyslexia might not be able to read the text in the image and cannot use their own CSS to amend this (Cunningham, 2012). Blind or low vision users will miss the information in the image entirely. When evaluating this criterion, the authors found two LibGuides had improved accessibility and two had optimum accessibility.

Ten LibGuides had minimum accessibility for the **Keyboard Accessible** criterion. Three LibGuides had optimum accessibility because the other LibGuides used the title attribute in one or more hyperlinks. Five LibGuides did not pass this criterion because the guide authors configured an asset in a way that was not keyboard accessible. There was no AA level or improved accessibility when assessing this criterion.

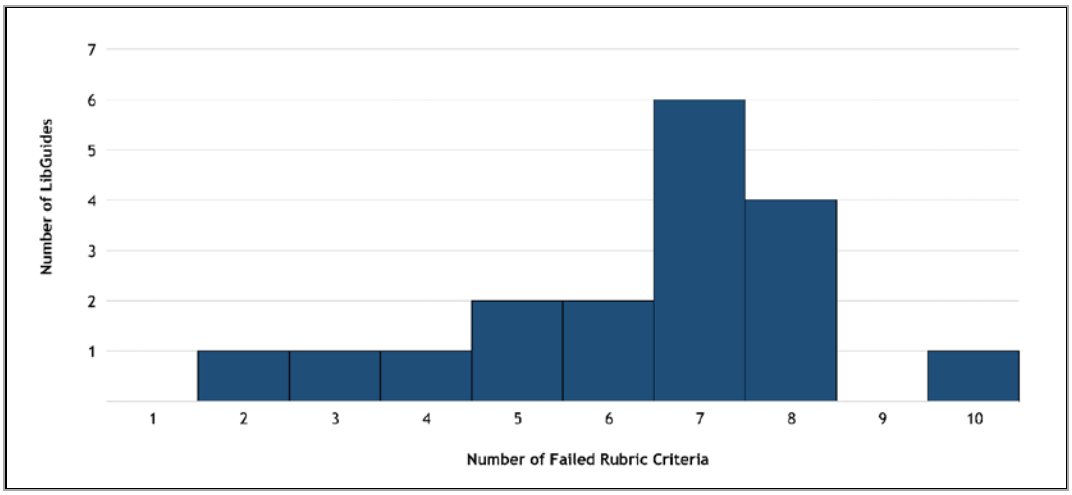
None of the functions of the LibGuides were time-dependent; therefore, all 18 LibGuides had optimum accessibility for the **Enough Time** criterion.

Fourteen LibGuides had improved accessibility for the **Readable** criterion. All LibGuides that were written in English only will pass this level because the template indicated the language. These LibGuides failed optimum accessibility for a variety of reasons. The most common reason was there were acronyms used throughout the LibGuides that were not defined. Four LibGuides had optimum accessibility for this criterion.

Seven LibGuides had minimum accessibility for the **Predictable** criterion. The most common reason for failing improved accessibility was inconsistent hyperlink text leading to the same URL. Ten LibGuides had improved accessibility and one LibGuide had optimum accessibility within this criterion.

The number of criterion that the LibGuides failed was plotted as a histogram (Figure 4. Number of Failed Rubric Criteria for the LibGuides). The mode and median of the data were 7 and the mean is 6.39 (SD = 1.92).

Figure 4. Number of Failed Rubric Criteria for the LibGuides



Most LibGuides failed seven rubric criteria (six LibGuides). Four LibGuides failed eight criteria. Two LibGuides failed five and two LibGuides failed six criteria. One LibGuide failed two, three, four, and 10 criteria, respectively.

The number of rubric criteria failures with respect to author did not lead to any statistically significant pattern when plotted within a histogram. There could be a vast difference in the number of errors made. Some authors created LibGuides that were short and simple, while other authors created

LibGuides that contained audiovisual content and were more complex. The authors speculate that short and simple LibGuides will have little to no errors introduced by the author.

Consider a LibGuide that contains assets that pass the rubric criteria and little or no HTML content supplied by the author. Any embedded HTML they provided had no formatting. If there were no images, videos, or text formatting, five rubric criteria and much of the **Distinguishable** criterion were not applicable. These LibGuides might be accessible to many groups; however, they might not be accessible to users with textual disabilities, like dyslexia, when these users could not use a screen reader. These LibGuides would also not cater to user preferences for audiovisual material, which could lead to the LibGuides not being used. It would be terribly boring if all LibGuides were absent of images, videos, or text formatting. The authors believe it is pertinent to point out that among the LibGuides, there was some sharing of content among guide authors within different LibGuides. Consequently, an error in a piece of content in one LibGuide can be propagated through the LibGuides of different authors reusing this content, and this could have contributed to the variability of the number of rubric failures for the authors as well.

General comments

In this study, the LibGuides usually passed minimum accessibility for the **Distinguishable** and **Seizure** criteria. The **Readable** and **Predictable** criteria usually passed improved accessibility and the **Enough Time** criterion usually passed optimal accessibility. The majority of LibGuides did not pass the remaining criteria.

Many of the common errors are those that are crucial to fix from both an accessibility compliance and a universal design theory perspective. For example, providing alternative textual content remains an issue for images. For more than a decade, it has been widely known that textual content must be in the alt attribute of the image tag or in the HTML text near the image

(Southwell & Slater, 2013). This error is not isolated to this study because it was mentioned in other studies discussed in this article. The text descriptions for images must contain the purpose of the image experience, which cannot be detected by automatic means. It requires human intervention.

Text descriptions and text alternatives must be provided for all multimedia content as well. Creating this content will take more time, but it will improve the educational material for all users (Poore-Pariseau, 2013; Rao, 2013). A common error was to embed text in an image when CSS could have been used instead. If library guide users must know the meaning of a textual phrase, sentence, or paragraph, it should be rendered as text. Using CSS would make the text accessible.

Proper HTML code is essential. Many errors related to this theme were found in the LibGuides. If the rich text editor is used, it must be used with an awareness of what is happening to the HTML in the background. Without such awareness, web design best practice and **Compatible** criteria will fail. Using the advanced formatting options in the rich text editor will cause **Adaptable** and **Distinguishable** criteria to fail as well. Although it is vital to use tags properly so that screen readers can interpret them correctly, improper use of HTML, including not using tags for their intended purpose, is a common error. The **Compatible** and **User Input** criteria require at least labels for user control inputs, which are extremely important to users with visual disabilities. The textual instructions described by the User Input criterion are important to everyone, yet the label error was found as a common error in this study and in much of the literature discussed.

Headings and hyperlink construction are very important to screen readers because users skim web pages using these elements (Southwell & Slater, 2013). Common errors included non-descriptive headings, missing hyperlink text, and inconsistent hyperlink text. Albeit an optimum accessibility requirement, the purpose of the hyperlink should be contained in the text due to how it functions in tandem with assistive technology.

Content must be written such that instructions do not require specific senses to understand (e.g. sight). Content must also be written and arranged with knowledge of the reading order of screen reading software. A LibGuide will have a completely different arrangement based on zoom, resolution and device (e.g. mobile). A screen reader will read content in this order, so reading order is important for this reason, as well.

Conclusions based on study findings and future work appear next.

Conclusion

As stated at the beginning of this article, the rubric was created based on the authors' desire to create a comprehensive resource for evaluating their online information materials' adherence to ADA requirements and universal design best practices. As explained, the rubric brought together standards and guidelines from the WCAG 2.0, Section 508 of the Rehabilitation Act of 1973, and web design best practices.

Based on the depth of detail regarding the rubric's creation made available in this article, the above-described study where the rubric was applied, the results and recommendations put forth at the study's conclusion, and the appropriate revisions made to the rubric post-study; the authors will pursue further testing with the rubric. This will include asking heterogeneous groups of users to apply the rubric to library guides outside of this study to ensure that this rubric can be used as a standalone resource when evaluating the compliance of online content with ADA/accessibility requirements.

Although the authors believe strongly in the need for ADA-compliant online information resources, they also believe and have experienced firsthand that sometimes supreme accessibility compliance in online design conflicts with universal design practices. To that end, the authors recommend that designers should ensure first that minimum and improved accessibility requirements (Level A and AA) are maintained, and that they weigh universal design considerations with increasing accessibility considerations as they advance to

AAA criteria. For example, creating material that complies with Level A and AA criteria requirements for people with visual disabilities and impairments is critical for online information resources. However, creating a universal information resource that can be used by everyone will deliver equitable content to all users and simplify content maintenance for the designer. Consequently, when using the rubric to evaluate one's online materials, each criterion and its associated compliance levels should be used to evaluate the resource with universal design in mind, as well.

As seen throughout this article, a common theme in the literature and espoused by the authors of this study is that academic libraries must do more to improve the accessibility of their web content. During the writing of this article, Springshare (the software platform of which LibGuides is a tool) began fixing the accessibility errors in LibGuides 2.0 – the version used by the authors of the LibGuides included in the study. In time, the authors hope that all LibGuides' accessibility barriers will be addressed and corrected by Springshare. However, it is worth noting that even if all barriers to accessibility are removed by Springshare within LibGuides, web administrators and guide authors must still endeavor to create content with accessibility and universal design in mind.

Building accessibility in from the start is much easier than remediation. Lush (2015) had to hire new staff and contractors, as well as work on a project under much pressure in a short period of time, to bring his institution's online resources into compliance. Aside from the web page content, Lush (2015) mentioned there were more than 25,000 assets, so remediation was not a small task. In addition, they had to develop a completely new workflow and accept added responsibility and cost.

As evidenced through the lessons learned by the authors during their study and shared within this article, and in the information shared by Lush (2015) and from many others invested in the accessibility of online materials: creators and designers of online information resources should make accessibility and universal design a part of the construction process whenever possible.

Accessibility of online information resources is critically tied to information accessibility, particularly within higher education. Therefore, the creation and design of these resources must treat accessibility and universal design as critical, too, from prototype to product and beyond.

Future work

In the short term, the authors plan to use the results of the study to assist librarians at the study's institution in bringing their LibGuides into compliance. After making corrections to the LibGuides, usability testing will be performed with a heterogeneous sample of users, including students with various disabilities, to identify barriers that still exist. It should be investigated if the current LibGuides provide hyperlinks to inaccessible material. The remainder of the library's web pages should be tested for accessibility using the rubric, as well.

In the long term, the authors plan to continue their investigation into universal design efforts that expand information accessibility for a wide variety of user types and preferences, not only for U.S. higher education institutions but toward expanding global higher education access, as well. For information to be ubiquitous it must be universally designed, therefore this continued investigation is paramount to the utility of online resources serving an increasingly diverse higher education population. It is the hope of the authors that the rubric discussed in this article will be used by all those creating online materials in higher education frequently, and that it will encourage continued conversations in academia about the universal accessibility of online education and information materials.

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Appendix

The rubric is based on the Web Content Accessibility Guidelines (WCAG) 2.0, the U.S. 508 Standard of the Rehabilitation Act of 1973 as effective at the time of the study 2015-2016, and web design best practices. Most of the web design best practices suggested within the rubric are from Anderson et al. (2010).

At the time of writing this article, the rubric has been updated to use the Information and Communication Technology (ICT) Standards and Guidelines, Appendix C to Part 1194 (Section 508 of the Rehabilitation Act of 1973) – Functional Performance Criteria and Technical requirements, Chapter 3: Functional Performance Criteria (2017, p. 5837). The updated rubric also complies with Appendix A to Part 1194, Section 508 of the Rehabilitation Act: Application and Scoping Requirement, E207.2 WCAG Conformance: "User interface components and the content of platforms and applications shall conform to Level A and Level AA Success Criteria and Conformance Requirements in WCAG 2.0" (2017, p. 5835). A living version of the rubric can be found at http://adarubric.pbworks.com/ .

Table 6. Study-implemented Accessibility Rubric

Criteria	Optimum Accessibility (Level AAA)	Improved Accessibility (Level AA)	Minimum Accessibility (Level A)	Does not Pass
1. Text Alternatives: Provide for non-text content within web pages so content can be changed into other forms that people need (1.1.1).	N/A	N/A	1) All non-text content has text alternatives except for the specific conditions in WCAG 2.0 Criteria 1.1.1.	All non-text content doesn't have text alternatives except for the specific conditions in WCAG 2.0 Criteria 1.1.1.
2. Time-based Media: Provide various accessible alternatives (1.2.1-1.2.9).	1) All pre-recorded audio in synchronized media has sign language (1.2.6). 2) All pre-recorded video in synchronized media provides extended audio descriptions when needed (1.2.7). 3) All pre-recorded media have a text alternative (1.2.8). 4) All live audio-only uses a caption service (1.2.9).	1) All live audio in synchronized media have captions (1.2.4). 2) All pre-recorded video in synchronized media have audio descriptions when needed (1.2.5).	1) All pre-recorded media have an alternative content format (1.2.1, 1.2.3). 2) All pre-recorded audio in synchronized media have captions (1.2.2).	All content doesn't meet level A.
3. Adaptable: Create	N/A	N/A	1) All content preserves structure and	All content

Criteria	Optimum Accessibility (Level AAA)	Improved Accessibility (Level AA)	Minimum Accessibility (Level A)	Does not Pass
content that can be presented in different ways (1.3.1-1.3.3).			relationships regardless of presentation (1.3.1). 2) All content has a logical reading order, which is preserved regardless of presentation. (1.3.2). 3) All instructions don't require use of the senses alone (1.3.3).	doesn't meet level A.
4. Distinguishable: Easier for users to see and hear content (1.4.1-1.4.9).	1) All text and images of text have a contrast ratio of at least 7:1 except for the specific conditions in WCAG 2.0 Criteria 1.4.6. 2) All pre-recorded audio speeches have at least 20 dB between the speech and background audio or the ability to turn the background audio off (1.4.7). 3) All blocks of text are formatted to meet the five conditions in WCAG 2.0 Criteria 1.4.8. 4) Use text instead of an image unless it is pure decoration or essential, such as a logo (1.4.9).	1) All text and images of text have a contrast ratio of at least 4.5:1 except for the specific conditions in WCAG 2.0 Criteria 1.4.3. 2) All text, excluding captions and images of text, can be resized up to 200% with equal content quality without using assistive technologies. 3) Use text instead of an image when possible except for the specific conditions in WCAG 2.0 Criteria 1.4.5.	1) No content uses color alone to distinguish an element (1.4.1). 2) No audio plays longer than three seconds automatically without the typical user controls being provided for it (1.4.2).	All content doesn't meet level A.
5. Keyboard Accessible: All functionality	1) All functionality is keyboard accessible and doesn't trap focus without exception (2.1.3).	N/A	1) All functionality is keyboard accessible except for the specific	All content doesn't meet

Criteria	Optimum Accessibility (Level AAA)	Improved Accessibility (Level AA)	Minimum Accessibility (Level A)	Does not Pass
available from a keyboard (2.1.1-2.1.3).			conditions in WCAG 2.0 Criteria 2.1.1. 2) No keyboard trap. If there is a need to use non-standard keys to move focus, the user is notified (1.2.2).	level A.
6. Enough Time: To read and use content (2.2.1-2.2.5).	1) Timing isn't essential except in the case of non-interactive synchronized media and real-time events (2.2.3). 2) All interruptions can be postponed except in emergency situations (2.2.4). 3) Likely, authentication isn't necessary for LibGuides, so WCAG 2.0 Criteria 2.2.5. isn't applicable.	N/A	1) Likely there aren't time limits, so WCAG 2.0 Criteria 2.2.1. isn't applicable. 2) Users can pause, stop, or hide all non-essential content that blinks, moves, or scrolls for more than five seconds, or updates automatically unless the user can control the frequency of the update (2.2.2).	All content doesn't meet level A.
7. Seizures: Don't design content known to cause seizures (2.3.1-2.3.2).	1) Doesn't contain anything that flashes more than three times a second (2.3.2).	N/A	1) Doesn't contain anything that flashes more than three times a second or falls below the general and red flash thresholds (2.3.1).	Contains items that flash more than three times a second and doesn't fall below the general and red

Criteria	Optimum Accessibility (Level AAA)	Improved Accessibility (Level AA)	Minimum Accessibility (Level A)	Does not Pass
				flash thresholds.
8. Navigable: Ways to help users navigate, find content, and determine where they are on each web page, are provided (2.4.1-2.4.10).	1) Users are provided with information about their location within the website, such as the provision of a breadcrumb trail (2.4.8). 2) The purpose of all links can be determined by its text alone (2.4.9). 3) All content is organized by section headings (2.4.10).	1) Multiple ways to locate web pages are provided except when each page represents a step in a process (2.4.5). 2) Headings and labels describe their content or purpose (2.4.6). 3) There is a visual cue that indicates a component has focus (2.4.7).	1) Can skip blocks of repetitive content on multiple web pages (2.4.1). 2) Web page titles describe their purpose (2.4.2). 3) Components receive focus in an order that preserves their meaning (2.4.3). 4) Hyperlink purpose can be determined from the link text in context (2.4.4).	All content doesn't meet level A.
9. Readable: Text content is readable and understandable (3.1.1–3.1.6)	1) All specialized words are defined. If none, not applicable (3.1.3). 2) All acronyms are defined. If none, not applicable (3.1.4). 3) All content is available in a secondary education reading level (3.1.5). 4) A mechanism to pronounce words is available	1) All content that differs from the default language is indicated except for the specific conditions in WCAG 2.0 Criteria 3.1.2.	1) All Web pages have a default human language (3.1.1).	All web pages don't have a default human language.

Criteria	Optimum Accessibility (Level AAA)	Improved Accessibility (Level AA)	Minimum Accessibility (Level A)	Does not Pass
	when it is needed for meaning (3.1.6).			
10. Predictable: web pages appear and operate predictably (3.2.1-3.2.5).	1) Any change of context is user initiated only or they can turn the feature off (3.2.5).	1) Navigation that appears on multiple web pages occurs in the same relative order unless the user changes it (3.2.3). 2) All components with the same functionality are consistently identified (3.2.4).	1) No presented content changes the context automatically when it receives focus (3.2.1). 2) Context doesn't change automatically when the user changes settings, unless they are advised prior to changing it (3.2.2).	All content doesn't meet level A.
11. Input Assistance: Users are provided with assistance to avoid and correct mistakes (3.3.1–3.3.6).	1) Context-sensitive help is provided (3.3.5). 2) Likely, web forms aren't on course or subject LibGuides, so WCAG 2.0 Criteria 3.3.6. isn't applicable	1) User input suggestions to correct the error are described unless it would jeopardize security or purpose of content (3.3.3). 2) Legal and financial data wouldn't be entered on course or subject LibGuides, so WCAG 2.0 Criteria 3.3.4 isn't applicable.	1) All user input errors are described and identified (3.3.1). 2) All user input controls have labels or instructions (3.3.2).	All content doesn't meet level A.
12. Compatible: With current and future user agents, including assistive technologies	N/A	N/A	1) No code validation errors (4.1.1). 2) All user interface components have names, roles, and are available to user agents (4.1.2).	All content doesn't meet level A.

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Criteria	Optimum Accessibility (Level AAA)	Improved Accessibility (Level AA)	Minimum Accessibility (Level A)	Does not Pass
(4.1.1–4.1.2).				
13. Usable: Provide a hyperlink to software required to interpret content (§1194.21m)	N/A	N/A	There are hyperlinks to software the web page user needs	Missing hyperlinks
14. Web Design Best Practices	N/A	N/A	The guide conforms to web design best practices	The guide does not conform to web design best practices

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DESIGN CONSIDERATIONS FOR A DENTAL HEALTH CARE CENTER FOR PATIENTS WITH SPECIAL NEEDS

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***Abstract**:* Out of 121 million population, 2.86 crore accounts for disabled people which 1.21% of total population. It has been reported that oral health care status of disabled people are poor than non disabled population. The main reason for this situation is the barrier to access health care centres. This article throws light on definition and types of disability listed by the Indian government. It also highlights the prevalence of disability and their oral health status. This article focuses on the barriers to access dental care and guidelines required to build a disable friendly dental health care delivery center to make the treatment acceptable for such patients. It is essential to provide dental care to such patients by overcoming the barrier to accessibility. Before motivating the patients and caregivers, it is the dentist who has to be motivated first in fulfilling special health care needs of patients resulting in improvement of the quality of life.

***Keywords**:* developmental disability, oral health status, architectural barrier, design consideration.

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Introduction

Health is a term that encompasses multiple dimensions apart from the absence of a disease or infirmity. It represents physical, social and mental well being of an individual (Park, 2017). Healthy individuals form a healthy society which in turn produces healthier individuals. The general health status of a person is often affected by poor oral health, and this relation is vice versa. Hence maintaining good oral health becomes essential for one to lead a healthy life. Providing oral health care to all the people in a community is imperative to build a healthy society (Bharathi & Abhinav, 2012).

However, studies of literature show that children with special needs receive inadequate oral health care when compared to the non disabled population. What makes it more ominous is the fact that children with special needs have a higher incidence of dental caries, periodontal diseases or dental trauma (Ajay, Manish, Sudhanshu & Kothari, 2011).The encumbrance of the oral diseases in these individuals adds to the existing psychological, emotional and financial burden caused by the already existing medical condition.

Oral health of a person not only influences general physical health, it also has a strong impact on the psychology and social behavior of the person (Bharathi & Abhinav, 2012). Unfortunately, oral health care needs of individuals with special needs are plenty yet they remain unattended. The main contributing factor to this is the presence of obstacles at the level of gaining physical access to the dental clinic. Literature shows that one of the most significant challenges faced by patients with special needs is the access to dental clinics for treatment (Adyanthaya, Sreelakshmi, Ismail & Raheema, 2017).

This review paper highlights the prevalence of individuals with special needs, their oral health status, and the design considerations for building a disable friendly dental clinic.

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Defining disability

WHO explains disability as an existing difficulty in performing one or more activities which, in accordance with the subject's age, sex and normative social role, are generally accepted as essential, basic components of daily living, such as self-care, social relations and economic activity (WHO report on disability, 2011).

Thus disability could lead to activity limitation that precedes participation restriction. Hence disability cannot be merely called a disease; it is a complex phenomenon hindering the physical needs of the individual and his/her interaction with the society. This review throws light on challenges faced by individuals with special needs at the point of delivery of dental care.

Epidemiology

Right to Disability Act was formulated at New Delhi in the year 1995 which lists 7 disabilities under the Act which includes blindness, low vision, leprosy cured patients, hearing impairment, locomotor disability, mental illness and mental disability.

This Act was later changed into Disability Act whose bill for the amendment was drafted by the legislation in 2010, but the change was put into force by 2010. The bill has been brought to comply with the UN convention on the right of persons with disabilities, to which India became signatory in 2007.The 2014 bill expanded the definition of disability with 19 other conditions which include blindness, low-vision, leprosy cured persons, hearing impairment (deaf and hard of hearing), locomotor disability, dwarfism, intellectual disability, mental illness, autism spectrum disorder, cerebral palsy, muscular dystrophy, chronic neurological conditions, specific learning disabilities, multiple sclerosis, speech and language disability, thalasemia, hemophilia, sickle cell disease, and multiple disabilities including deaf and blindness.

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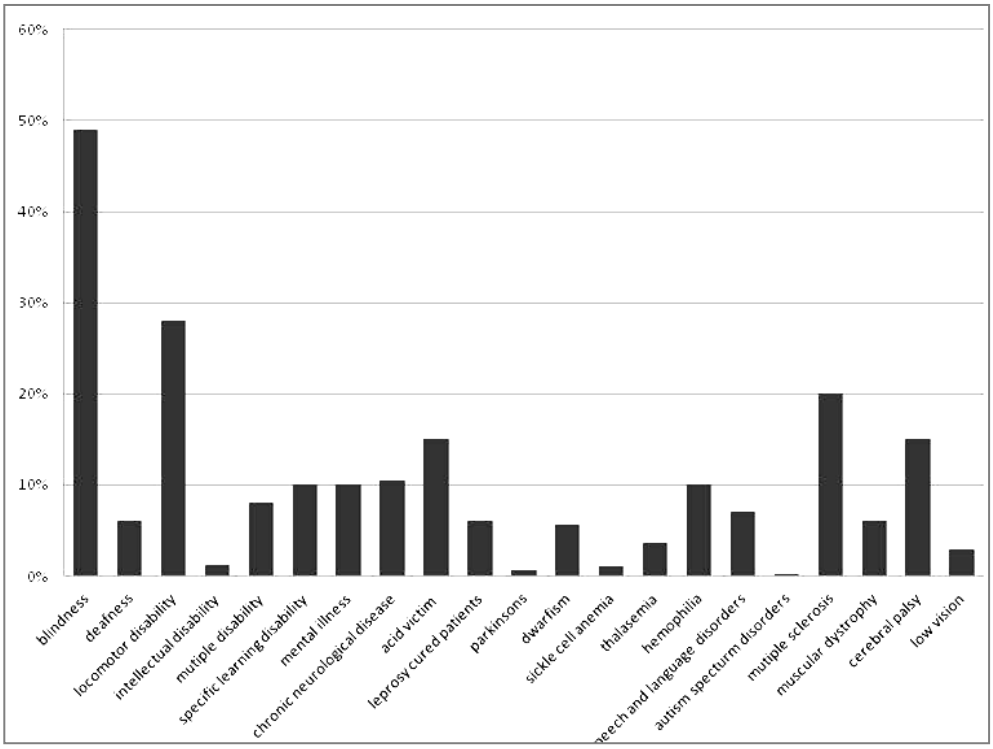
It also emphasized on schemes to ensure barrier-free access in buildings, transport systems and all kind of public infrastructure, and not to discriminate against the disabled in the matter of employment.

The 2011 census put the number of disabled in India as 2.86 million which is 2.21% of the population. This is a gross underestimation, under the light of proposed amendments which significantly widen the current census definition of disability.

Therefore this Act was again modified in the year 2016 by Lok Sabha in which the following 2 disabilities were added: victims of acid attack and Parkinson's disease.

Though these amendments rightly recognize wider range of disabilities, they fail to specify the degree of disability. Furthermore, there are no suitable tools to quantify disabilities like autism or learning disabilities.

Figure 1. Prevalence of the 21 disabilities listed in Disability Act 2016 in India. Source: Harmonized Guidelines And Space Standards For Barrier Free Environment For Persons With Disability And Elderly Persons (2016) Government Of India Ministry Of Urban Development.



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Oral health status of the people with special health care needs

People with special health needs form a substantial part of the community in the Indian population. Patients with special needs in any form have poor oral health (Vignehsa, Soh, Chellappah, 1991.) This could be a direct impact from the underlying medical condition or an indirect effect due to inability in practicing oral hygiene measures. Various studies have been conducted among different sectors of individuals with special needs, and it can be concluded that incidence of dental caries is most followed by periodontal diseases, trauma and malocclusion (Vyoma, Nagashree & Rekha, 2017.)

Table 1. Prevalence Of Oral Manifestation Among The Disabled Population.

Disability	Most prevalent oral manifestation	Prevalence percentage	Author
Blindness	Trauma	39%	Muhot.H (2017)
Deafness	Dental caries	65%	Sandeepl(2016)
Locomotor disability	Gingivitis	88.9%	Bhatia.R (2016)
Intellectual disability	Periodontal disease	69%	Abhisekh .M (2015)
Mutiple disability	Dental caries	89.8%	Bharathi .M(2012)

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Disability	Most prevalent oral manifestation	Prevalence percentage	Author
Specific learning disability	Dental caries	39.58%	Aditi .M(2017)
Mental illness	Gingivitis	58.82%	Aditi .M(2017)
Leprosy cured patients	Periodontitis	78.25%	Rawlani Sm (2011)
Parkinson's	Sialorrhea	56%	Ujawala .R(2017)
Dwarfism	Periodontal disease	98%	Franco .F(2017)
Sickle cell anemia	Gingivitis	21.5%	Jaideep.S (2013)
Thalasemia	Dental caries	34%	Jaideep .S(2013)
Hemophilia	Hemorrhages	72%	Nagaveni NB (2016)
Speech and language disorders	Dental caries	31.27%	Aditi .M(2017)
Autism spectrum disorders	Occlusal anomalies – crowding	33.85%	Aditi .M(2017)
Multiple sclerosis	gingivitis	15.3%	Eva santa.E(2012)

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Disability	Most prevalent oral manifestation	Prevalence percentage	Author
Muscular dystrophy	Malocclusion-open bite	86%	Morinushi .T(1986)
Cerebral palsy	Malocclusion – class 1	82.62%	Aditi .M(2017)
Low vision	Trauma	39%	Munhot .H (2017)

The significance of oral health

Oral health is an integral part of general health and has a notable influence on the quality of life (Mehta, Ahishek, Gupta, Radhika, Mansoob, Saleha et al 2015). Individuals with special needs have plenty of oral health burden as mentioned previously (Table 1). The reason behind this incompetence is the diminished dexterity due to lack of concentration, uncoordinated muscular movement, and deficient neuromuscular or neuromotor skills. The impact of dental disease in individuals with special needs is more than that in individuals without disability. Maintaining optimal oral health is mandated to combat against the side effects of essential and regular medications taken by the individuals with special needs. Dry mouth, gingival overgrowth, oral muscle spasms are some of the common manifestations of the medication side effects among the special needs population. Dental related pain is obnoxious and can modulate the behavior of the individuals with special needs eventually minimizing their food intake and nutrition supply (Bharath & Abinaya 2012). This further worsens their existing condition affecting the overall health.

Thus a good oral health is necessary to prevent this vicious cycle. Taking proper care of oral hygiene will make their smile aesthetically pleasing

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thereby boosting their confidence in social life. In summation, preserving a good oral health brings about affirmative changes in all aspects of life of an individual.

Challenges in delivering dental care

There are plenty of unmet dental care needs among the individuals with special needs. Although various reasons account for this situation, a major challenge is personal accessibility to health care society to avail dental care. Most dental care set up are either or partially not accessible to people with special needs (Bhataia, & Matharwala, 2016.) Also, there are no structured regulations set for setting up a health care center. Therefore there is need to eliminate the barriers causing this discrepancy.

Lack of access: The physical barriers of a healthcare set up play a significant role in delivering dental treatments. Architectural designs of healthcare set up in India are not disability friendly, thus worsening the current scenario of delivering dental needs to the individuals with special needs. To combat this situation the Ministry Of Urban And Development, Govt. Of India has formulated guidelines in the year 2016 which provides specifications for building a barrier-free environment thus making health care needs accessible to them.

The panacea for the challenges faced

1. Preliminary examination / assessment

    - Thorough anamnesis of the patient should be recorded. Proper understanding of the medical condition is required. Before commencement of any dental treatment, an informed consent should be taken from the caretaker/parent of the patient and a medical fitness certificate issued by a general physician is a must.

- In case of appointments they should be scheduled in the convenient timing of patient and caregiver (Ajay, Manish, Sudhanshu & Kothari, 2011).

2. Patient management

- Adhering to the protocol of behavior management eases out the stress on both patient and doctor during treatment procedures (Ajay, Manish, Sudhanshu & Kothar, 2011).

3. Establishing a disable friendly dental clinic

- Providing a relaxed, pleasing environment to any patient is important.
- Physical barriers in the clinical environment cut the access for the patients to dental clinics.
- Therefore it is desirable to follow the guidelines given by central ministry of urban and rural development and incorporate them thereby constructing a suitable dental clinic for the individuals with special needs.

Guidelines for a friendly dental clinic set up considerations for people with disability

According to Harmonised Guidelines And Space Standards For Barrier Free Environment For Persons With Disability And Elderly Persons (Government Of India Ministry Of Urban Development, 2016) following should be installed in a dental clinic.

1. PARKING SPACE

- Parking space should be provided in the proximity of the clinic preferably within 98 feet distance.

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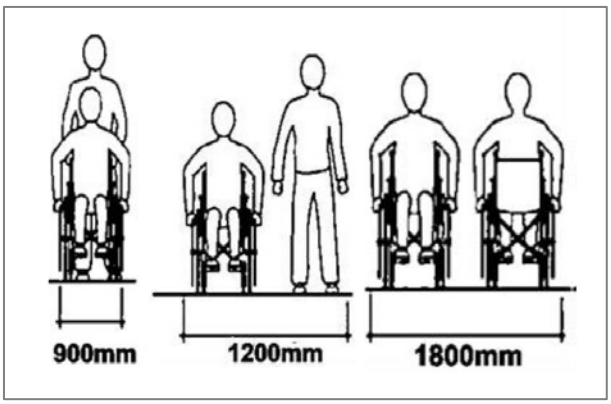
2. WALKWAY

- Should be smooth, hard and have leveled surface suitable for walking and wheeling.
- Walkways should not exceed 60 meters in length, if exceeded it is desirable to provide rest area adjacent to the walk at suitable intervals of 98 feet for bench/ resting seats. For comfort, seat height should be between 17.6 -19.6 inches, have a backrest and hand rests at 27.54 - inch height.
- Minimum walkway width should be 70.6 inches for two way traffic. However, in exceptional cases (such as around trees/poles etc.), the width could be 59 inches.

Figure 2. Minimum Width Of A Clear Walkway. Source: Harmonized Guidelines And Space Standards For Barrier Free Environment For Persons With Disability And Elderly Persons (2016) Government Of India Ministry Of Urban Development.



3. TACTILE PAVERS: GUIDING & WARNING BLOCKS

- For visually impaired patients tactile pavers should be used.
- These are of two types; dot type and guiding block type.
- They act as guide in pathway for visually impaired patients.

Figure 3. Configuration And Layout Of Tactile Pavers. Source: Guiding And Warning Harmonised Guidelines And Space Standards For Barrier Free

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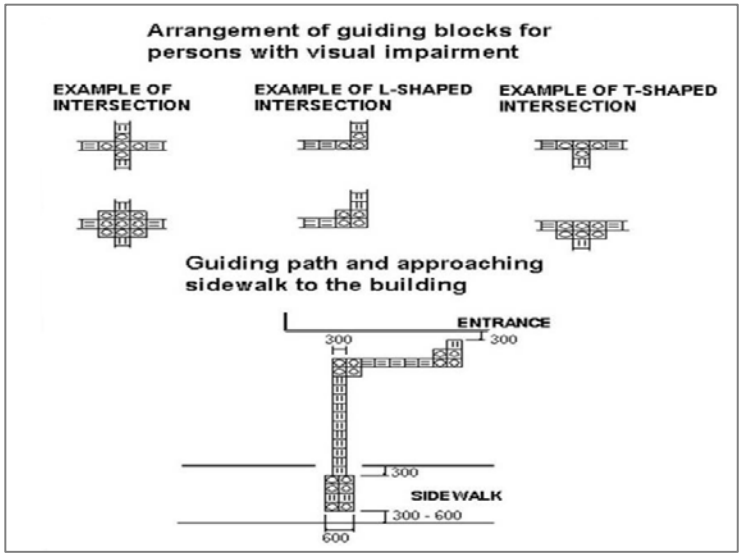
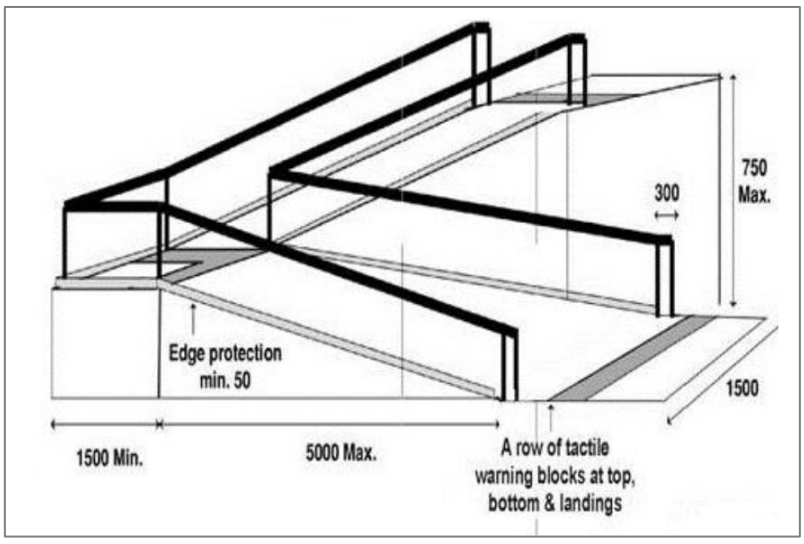
Environment For Persons With Disability And Elderly Persons (2016) Government Of India Ministry Of Urban Development.



4. RAMPS

- A ramp run with a vertical rise greater than 6 inches should have handrails.
- The minimum clear width of a ramp should be 47 inches.

Figure 4. Ramp Design. Source: Harmonised Guidelines And Space Standards For Barrier Free Environment For Persons With Disability And Elderly Persons (2016) Government Of India Ministry Of Urban Development



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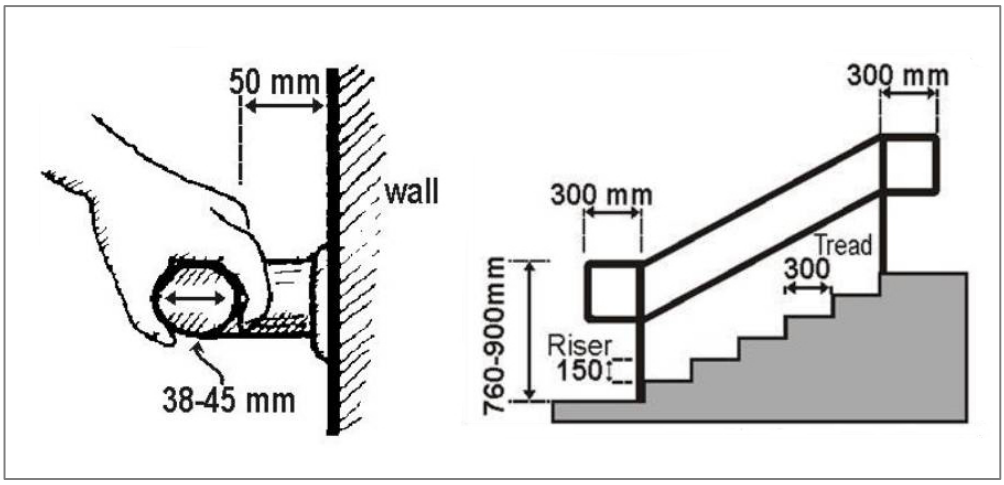
1. STAIRCASE

- TO BE SUPPLEMENTED WITH RAMP /LIFTS
    - Treads should be 12 inches deep and risers not higher than 6 inches.
    - There should be no more than 12 risers in one flight run.
    - The stairs landing should be minimally 48 inches deep and 60 inches in width.
    - Staircase must have grab bars for holding while walking.
    - The specifications for the grab bars are as follows:
        - Slip-resistant with round ends
        - Have a circular section with a diameter of 1.4 to 1.7 inches.
        - Installed at the height of 30 to 35 inches.
        - They should be able to bear a weight of 550 pounds.

Figure 5. Grab Rail Measurements And Staircase Measurement. Source: Harmonised Guidelines And Space Standards For Barrier Free Environment For Persons With Disability And Elderly Persons (2016) Government Of India Ministry Of Urban Development



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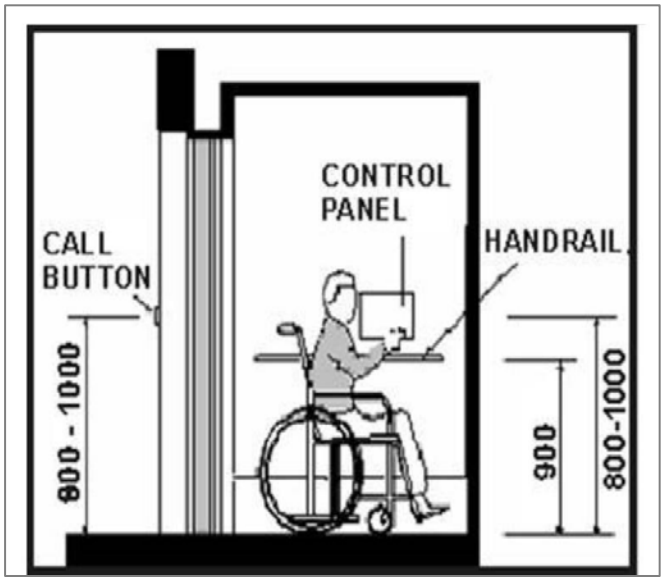
2. LIFTS

- The minimum size of the lift should be 48 inches wide by 48 inches deep, if possible a 13 passenger lift is to be provided for easy maneuverability of wheelchair

Figure 6. Placement Of Lift Accessories. Source: Harmonised Guidelines And Space Standards For Barrier Free Environment For Persons With Disability And Elderly Persons (2016) Government Of India Ministry Of Urban Development.

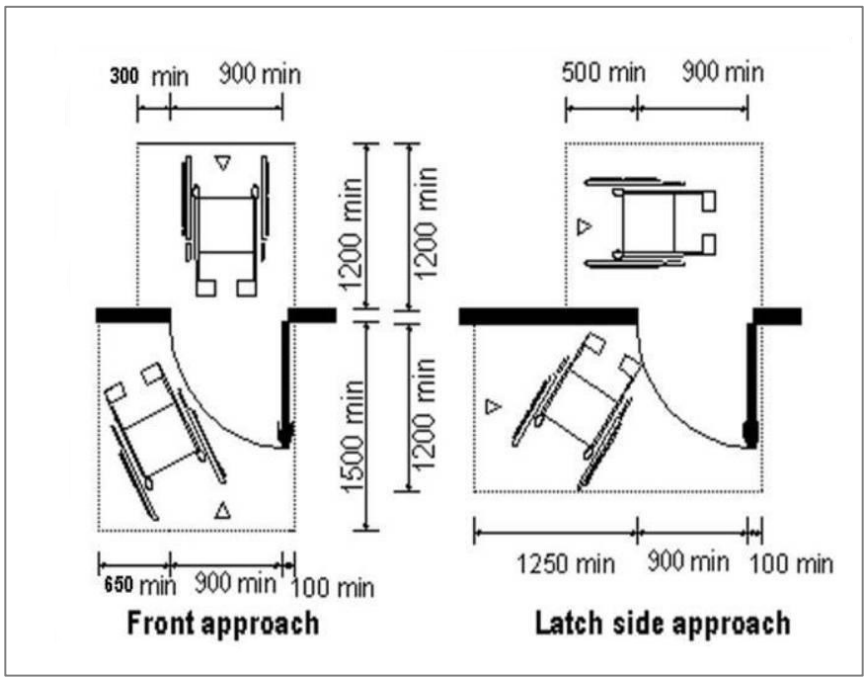


3. DOOR

- Use sliding or folding doors. The door should not be too heavy to operate and should not require a force of more than 20N to operate.
- Automatic doors should have a push button system to open them.
- All external doors should have warning blocks installed 30 inches before entrances.
- Minimum opening of doorways should be 35 inches.
- If the door is operated by hand, the handle must be mounted at the height of 33 inches to 43 inches from the floor.

- For wheelchair users, the door should have a horizontal handle provided on the closing face of the door, approximately 30 inches from the floor.

Figure 7. Maneuvering Space Needed For Wheelchair Users To Approach Doors .Source: Harmonised Guidelines And Space Standards For Barrier Free Environment For Persons With Disability And Elderly Persons (2016) Government Of India Ministry Of Urban Development.



4. WAITING ROOM

- CORRIDOR FLOORING
  - Complex patterns should be avoided.
  - Floors should be leveled with dimensions 35*48 inches. If greater, floor should be designed as a ramp.
  - Carpets should be securely fixed and have firm cushion, pad or backing.
  - Have exposed edges of carpets fastened to floor surface and trim along the entire length of the exposed edge.

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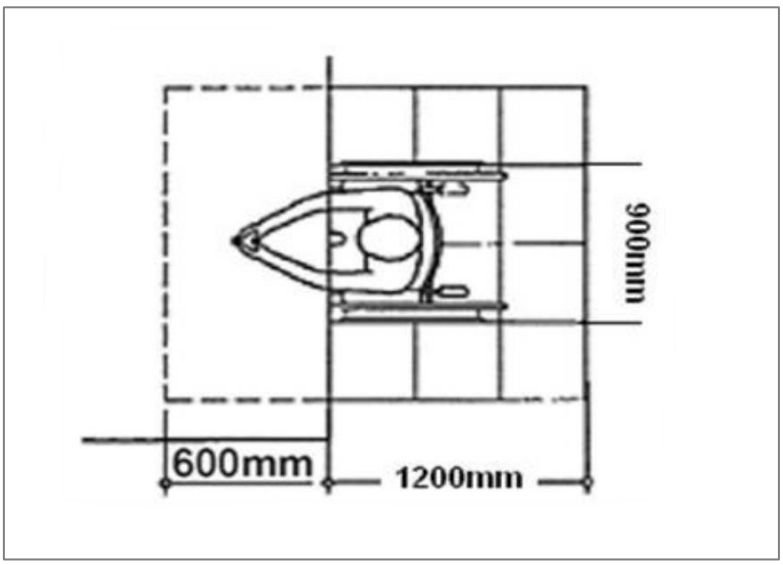
- LIGHTING

  - Lighting must be white (example: high-pressure sodium) with an average lux of 35 to 40. This helps to increase the contrast of the images present.

Figure 8. Clear Floor Space For Wheelchair .Source: Harmonised Guidelines And Space Standards For Barrier Free Environment For Persons With Disability And Elderly Persons (2016) Government Of India Ministry Of Urban Development.



5. OPERATORY ROOM FACILITIES

- TAP

  o Either hand-operated or electronically controlled.

6. SIGNS

- Direction signs should be provided at junctions of circular routes and key destinations such as doorways, at reception points, at facilities such as drinking water facility and toilets, etc.

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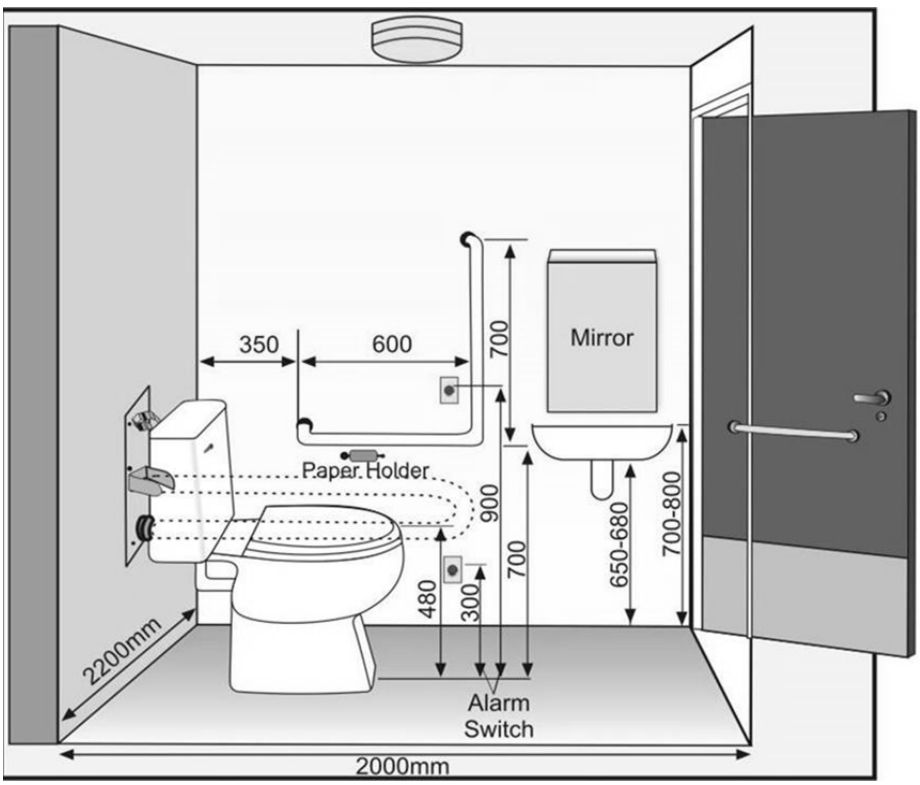
7. RESTROOMS

- Unisex accessible toilet allows Persons with Disabilities to be assisted by caretakers of the same or opposite gender.
- A minimum internal dimensions of 86 inches * 86 inches is to be present
- Each restroom should have a western closet with grabrails attached to them
- Toilet paper dispenser is to be present at 2 inches to 8 inches height above the top of the closet.

Figure 9. Layout Plan Of Unisex Accessible Toilet. Source: Harmonised Guidelines And Space Standards For Barrier Free Environment For Persons With Disability And Elderly Persons (2016) Government Of India Ministry Of Urban Development.



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Standardised design - ICF aspect

The international classification of functioning, disability and health has refined disability on the basis of Society medicine model. This model states that disability of a person is exhibited due to the environmental factors. Hence, considering this model and the classification, modifications of the dental clinic is standardized broadly to the respective disabilities.

Figure 10. Recommendations of dental clinic based on ICF aspect

Contextual factors	Blindness	Deafness	Physically challenged	Mentally challenged
Positive aspects	TACTILE PAVERS	PLEASANT LIGHTING	WIDE PARKWAYS, RAMPS, AND LIFT	WIDE WAITING ROOM
Negative aspects	SMOOTH FLOORING	DULL LIGHTING	STEPS WITHOUT RAMPS	CONGESTED WAITING SPACE

Dental chair - Design considerations

Exploration of literature reveals that the first dental chair was made in the year 1790 by Josiah Flagg.Over the years dental chair has undergone numerous modifications to accommodate the patient needs and comfort. Analysing the various chair designs gives us an insight that headres have all along been a hindrance to patient's comfort. Apart from these, tranferring a special need individual from their wheelchair to dental chair is strenuous Paul, 2014.) UK government created a dental chair called DIACO exclusively for wheelchair patients, but the high cost and space occupied by the chair has lead to further research (Diaco,2004.) The chair designed by DIACO company accommodates

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only disabled patients. A portable dental unit was created by Tamazawan et al. (2004) for both general and disabled patients. But designing a universal chair to accommodate all is still an undiscovered mystery.

Considering these modfications, changes can be incorporated in a dental chair to make them friendly for the people with disability as well as use them for general. This can be achieved by making the body rest part detachable such that it could be fitted to the ramp structure for general patients and removed in case of wheelchair patients.

Keeping the above guidelines in mind while setting up a dental clinic will help us to carry out the dental procedures in a better manner, thereby decreasing the prevalence of dental diseases among the individuals with special needs.

Conclusion

There are numerous challenges faced by a practitioner while delivering dental care to patients with special needs. Managing these patients is a herculean task for many. This scenario can be changed by inculcating the protocols in curriculum which would result in better understanding of their medical conditions and helps the clinician to provide good dental treatment. Studies highlight that though dentists show a favorable attitude in treating the patient with special health care needs, only a few private clinics meet the architectural requirements (Adyanthaya, Sreelakshmi, Ismail, Raheema, 2017).

Therefore, forming an exclusive decision-making body to approve or set norms for building a disable free dental clinic is the need of this hour. Thus, increasing awareness about the guidelines among dental pracitioners and training them to manage the individuals with special needs patients will bring a huge change in dental care delivery system for the patients with special needs.

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