

Analyzing the potential of people with Down Syndrome to access and participate in the main exhibition of Museu do Amanhã, Rio de Janeiro (Brazil)

Análise do potencial de acesso e participação de pessoas com Síndrome de Down na exposição principal do Museu do Amanhã, Rio de Janeiro (Brasil)

Análisis del potencial de las personas con Síndrome de Down para acceder y participar en la exposición principal del Museo do Amanhã, Rio de Janeiro (Brasil)

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Abstract

In this study, we aim to understand the factors that facilitate (or hinder) access and participation of people with Down Syndrome (DS) at the main exhibition of the Museu do Amanhã, Brazil. Data were collected through documentary and bibliographic research, technical visits to observe onsite practices, and an interview with a museum professional. The analysis of this triangulated data used accessibility indicator categories—attitudinal, physical, and communicational. The results show that the museum is making progress toward meeting these three categories. However, some improvements may be necessary to fully ensure access and participation for people with DS. The museum's entrance and overall infrastructure meet physical accessibility standards. Still, the immersive exhibitions, the abundance of sensory stimuli, and the layout of certain galleries may pose barriers. In terms of attitudinal practices, the museum displays some good standards. However, the discontinuation of a simple language material indicates a lack of sustained institutional policy toward accessibility. Communicational accessibility is the most significant challenge. Despite offering different media and interaction methods with the exhibition content, much of the information and abstract concepts are presented in technical, poetic, and philosophical language, with no simple language options, making comprehension more difficult for people with DS.

Keywords: social inclusion, science museums, accessibility, person with disability.

Resumo

Neste estudo, buscamos compreender aspectos que favorecem (ou não) o acesso e a participação de pessoas com Síndrome de Down (SD) na exposição principal do Museu do Amanhã, Brasil. Os dados foram coletados por meio de pesquisa documental e bibliográfica, visitas técnicas para observações de práticas in loco e entrevista com um profissional do museu. A análise desses dados triangulados utilizou categorias de indicadores de acessibilidade — atitudinal, física, comunicacional. Os resultados mostram que o museu está progredindo em direção ao atendimento das três categorias de indicadores. No entanto, algumas melhorias podem ser necessárias para garantir o acesso e a participação de pessoas com SD. A entrada do museu e sua infraestrutura geral atendem aos requisitos de acessibilidade física. Ainda assim, as exposições imersivas, a abundância de estímulos sensoriais e a localização de uma galeria podem apresentar barreiras. Em suas práticas atitudinais, o museu demonstra alguns bons padrões. No entanto, a descontinuação de um material de linguagem simples indica uma falta de política institucional sustentada em relação à acessibilidade. A acessibilidade comunicacional representa o desafio mais significativo. Apesar das diferentes mídias e formas de interação com o conteúdo da

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exposição, uma grande quantidade de informações e conceitos abstratos são apresentados em linguagem técnica, poética e filosófica, sem oferta de materiais de linguagem simples, tornando sua compreensão mais difícil para pessoas com SD.

Palavras-chave: inclusão social, museus de ciências, acessibilidade, pessoa com deficiência.

Resumen

En este estudio, buscamos comprender los aspectos que favorecen (o no) el acceso y la participación de las personas con síndrome de Down (SD) en la exposición principal del Museu do Amanhã, Brasil. Los datos se recopilieron mediante investigación documental y bibliográfica, visitas técnicas para la observación de las prácticas in situ y una entrevista con un profesional del museo. El análisis de estos datos triangulados utilizó categorías de indicadores de accesibilidad: actitudinal, física y comunicacional. Los resultados muestran que el museo está logrando avances en el cumplimiento de las tres categorías de indicadores. Sin embargo, es posible que se necesiten algunas mejoras para garantizar el acceso y la participación de las personas con SD. La entrada del museo y su infraestructura general cumplen con los requisitos de accesibilidad física. Aun así, las exposiciones inmersivas, la abundancia de estímulos sensoriales y la ubicación de una galería pueden presentar barreras. En sus prácticas actitudinales, el museo demuestra algunos buenos estándares. Sin embargo, la discontinuación de un material en lenguaje sencillo indica la falta de una política institucional sostenida en materia de accesibilidad. La accesibilidad comunicacional representa el desafío más significativo. A pesar de los diferentes medios y formas de interactuar con el contenido de la exposición, se presenta una gran cantidad de información y conceptos abstractos en un lenguaje técnico, poético y filosófico, sin ofrecer materiales en un lenguaje sencillo, lo que dificulta su comprensión para las personas con síndrome de Down.

Palabras clave: inclusión social, museos de ciencia, accesibilidad, persona con discapacidad.

Introduction

Museums and science centers are considered scientific-cultural spaces where nonformal education can occur. These have been established as places for exhibitions, conservation, research, education, and citizenship (Bell *et al.*, 2009; Massarani *et al.*, 2019). As Norberto Rocha, Scalfi and Massarani (2021) point out, access to science communication, museums, education, and leisure are listed as human rights.

According to Argyropoulos and Kanari (2019), policies to create an inclusive society have been increasingly emphasized in recent decades. Adopting the social model of disability has placed greater importance on the right of individuals to participate in various areas of social life, education and culture. Many science museums and centers have sought various means to increase and diversify their audience and to create a closer relationship with people who do not usually attend their exhibits and who face barriers in doing so. Thus, initiatives from the perspective of special education, disability studies, social inclusion and studies attempting to understand the interaction between spaces and their different audiences have gained ground in the literature (Sandell; Dood; Garland-Thomson, 2010; Norberto Rocha, 2021; Bevan; Ramos, 2021; Massarani; Norberto Rocha, 2021).

Innovations in Brazil and other Latin American countries' science museums and centers are increasing educational and accessibility strategies to promote the access and participation of visitors with disabilities (Norberto Rocha *et al.*, 2017; Norberto Rocha *et al.*, 2020). However, as Reich (2014, p. 2) states, "although museums have made great strides in the last 20 years to become more inclusive, the inclusion of people with disabilities in museum learning is still a specialized rather than a normalized practice." One of these

barriers is the lack of institutional practices that underpin a long-standing history toward accessibility and inclusion, turning it into a routine practice. In this sense, an organizational change is needed so that accessibility and social inclusion become an inherent part of the core museums, more than just the sum of individual learning. Reich (2014, p.16–17) argued that “knowledge generated through organizational learning can become ingrained within the organization’s memory and persist beyond the organizational life span of any one group of individuals.”

In this way, many barriers prevent different people or groups from being involved in science communication and education activities in museums. The more diverse strategies and flexible possibilities of interacting with the exhibition and its contents a museum has, the better, since these have the potential to attract a broader and more diverse audience. Importantly, however, museums are not designed to cater to each individual’s characteristics; they are designed for groups. Also, a strategy designed for one group of people with disabilities will not serve the entire audience in question since each group has its own characteristics and ways of engaging with the world. Within each kind of disability, there is a wide range of specificities, and diversity within disabilities is challenging for institutions when planning their accessibility actions (Gómez Blázquez, 2015). In the case of people with intellectual disabilities, specifically people with DS, the challenge is even more prominent, due to the scarce research and experiences in informal science education and science communication focused on them.

Down Syndrome: From a Biological to a Social Participation Approach

Down syndrome is one of the oldest described pathologies linked to intellectual disability. Biologically, it is known as Trisomy 21 (T21), a condition characterized by the presence of an extra chromosome that results in a range of co-occurring conditions at birth and throughout life, including intellectual disability, physical and motor complications, and sensory alterations primarily related to vision and hearing (Antonarakis *et al.*, 2020; Shott; Joseph; Heithaus, 2001; Krinsky-McHale *et al.* 2014). These can imply learning difficulties. According to Pina (2014, p. 36):

It is common to observe in children with DS a severe alteration in the internalization of concepts of time and space, like location and orientation, which will make many acquisitions difficult and will reflect especially on memory and planning, in addition to making language acquisition very difficult.

People with DS may present deficits in praxis (or motor planning, which refers to the ability to program, plan, and execute a sequence of motor actions/gestures), mainly in children’s motor skill development and daily living activities (Fidler *et al.*, 2005). On the one hand, from a cognitive point of view, there is a great effect on language abilities, which can directly influence the use of language in various practical interaction contexts—for instance, difficulty in making generalizations and processing abstract thinking, auditory processing and comprehension, auditory short-term memory (Hulme; Mackenzie, 1992) or difficulties in

selecting a certain word from its lexical and semantic fields (Duarte; Velloso, 2017). On the other hand, most of the authors in our bibliographic review point out that people with DS can have a high ability in visual memory processing (Bissoto, 2005; Pelosi *et al.*, 2018).

It is relevant, however, to move from a biological to a social participation approach when thinking about their development, quality of life and rights. According to Hardee and Fetters (2017), by impacting the individual's activities of daily living and social participation, it may be possible to increase the quality of life. By participation, we are considering the definition of the World Health Organization (2002) as involvement in a life/social situation. Also, we must recall that the UN Convention on the Rights of People with Disabilities (UN, 2006) reinforces the right of people with disabilities to participate and to have access to cultural goods in accessible formats, eliminating barriers that may prevent their engagement. Despite not adopting a single model to address disability (Series, 2020), the arguments brought by the Convention strongly relate to the social model of disability, which has as fundamental principles the autonomy and emancipation of people with disabilities in all spheres of society. The model advocates the creation of ways and opportunities for people with disabilities to participate in the community and claim independent living, productive work, and control over their own lives (Shakespeare; Watson, 2002).

Although people with DS are not all alike and neither are their families (Skotko; Levine; Goldstein, 2011; Skotko *et al.*, 2016), research shows how family variables influence and consequently reflect on their success in the schooling process and cognitive, linguistic, and socio-emotional development in children with DS (Duarte, 2012). Through the lenses of the socio-historical-cultural approach proposed by Vygotsky (1998), the possibility of social and cultural interactions (internal and external factors) promotes the development of the child's intellectual potential, and the conditions for developmental delay are not determined only by a biological factor, but also by environmental or socio-interactional factors.

In addition, there is evidence that successful socio-emotional development in people with DS is closely related to stimulus and incentive, especially in the first years of life (Moreira; El-Hani; Gusmão, 2000). Hardee and Fetters (2017) demonstrate through literature studies that a range of exercise interventions (e.g., bike riding, dancing, judo training, and strength training) is reported to increase an individual with DS's social participation. A large-scale study in the USA, involving 284 people with DS (aged 12 and older) from the mailing lists of six non-profit DS organizations, found that most participants can make friends easily (Skotko; Levine; Goldstein, 2011). The authors emphasize that most people with DS included in the survey responded that they are living happy, fulfilling lives, love their families and have positive self-esteem (in varying degrees, mostly related to the number of parents at home and the person's religion, geographic location, living situation, and health condition). Most importantly, they declared they had the same hopes and dreams as people without DS and asked to be valued (Skotko; Levine; Goldstein, 2011).

In terms of accessibility, barriers faced by people with intellectual disabilities are often not immediately visible. As Yalon-Chamovitz (2009, p.395) points out, there are "invisible access needs," including factors like pace, complexity, and literacy that can affect their daily lives. Yalon-Chamovitz (2009) explains that individuals with intellectual disabilities tend to have slower processing and reaction times across various tasks. Therefore, pace

accommodations should be integrated into both environmental design and service procedures, such as giving instructions more slowly and allowing extra time to complete activities. Furthermore, they often encounter difficulties with complexity, including nonverbal communication, navigating physical and virtual environments, understanding and following instructions, and managing procedures. To address this, procedures and language should be simplified to meet their needs, for example, using maps, clear designs that aid orientation, and straightforward operating instructions. People with intellectual disabilities frequently have low literacy levels and struggle to read simple texts. They also find it challenging to process information, organize knowledge, and plan schedules, increasing their dependence on daily support for tasks requiring literacy skills. Recommended accommodations include using simple language and/or easy-to-read language guides, and graphic representations. Finally, it is important to recall that linguistic accessibility is also necessary. According to Uziel-Karl and Tenne-Rinde (2018), it refers to the process of adapting written or spoken information to make it clear, understandable, and inviting, using diverse linguistic and sensory means (i.e., visual, audio, or tactile). Accommodating these needs enables them to live with maximum independence.

People with DS, Museums and Science Centers

Museums are spaces for social interaction, leisure, individual and collective learning (Norberto Rocha, 2018), and rich family moments (Studart, 2005; Massarani *et al.*, 2021). They provide multisensory and immersive experiences, assorted means of communication, and an intense program of activities addressing science and technology. According to the new definition of the International Council of Museums (ICOM, 2022), they should also be accessible and inclusive. For people with DS, in particular, visiting a museum also has the potential to enable them to access what, in literature, is addressed as “free-choice learning” (Falk, Dierking, 2002; 2019), “family learning” (Scalfi, 2020; McManus, 1994), and social participation (Cazelli *et al.*, 2015; Studart, 2005; Scalfi *et al.*, 2022; Massarani *et al.*, 2021). This aligns with Vygotsky's (1998) view that the learning process is a social activity where individuals grow their knowledge through interactions with the environment and others, constantly connecting personal and collective factors, the subject and the context (Pinto, 2012). Therefore, they can help support various learning processes in people with DS.

However, a limited number of publications on people with DS and museums still exist in the literature. For an in-depth bibliographical search on people with DS in scientific-cultural spaces, we used PublicAcessibilidade (MCCAC, INCT-CPCT, 2020), an extensive database resulting from a project by the *Museus e Centros de Ciências Acessíveis*. This initiative holds academic works published online in Portuguese, English, and Spanish on accessibility and inclusion in museums, science centers, and cultural and scientific spaces. Its database is updated every six months based on information available in digital scientific repositories, such as Scopus, Web of Science, Scielo, CAPES Theses and Dissertations (Brazil), among others, encompassing publications from 1926 to 2021.

The database contained 534 items in a search carried out in December 2020. Of these, 20 academic papers were related to intellectual disability and published between

1953 and 2019. Nine were on the autism spectrum disorder, eight were on general intellectual disability (mild and moderate, cognitive) and only four were on DS: Pina (2014), Silva *et al.* (2017), Mascarenhas (2018), Junger (2019). The few studies and reports we have found so far on the experience of individuals with DS in science museums and other scientific-cultural spaces suggest that establishing a relationship between the population with Down syndrome and these places may yield a fruitful study – mainly due to the paucity of the theme in the national literature.

Also, not many institutions are implementing educational actions aimed at this audience. According to a survey of 110 participating museums in the “Guide of Accessible Science Museums and Centers from Latin America and the Caribbean” (Norberto Rocha *et al.*, 2017), only 11 museological institutions claimed to provide accessible and inclusive activities or programs, flexible itineraries for the exhibitions and interpretations of the exhibitions that could benefit people with intellectual disabilities. Six were in Brazil, two in Colombia, two in Mexico and one in Chile, as can be seen in table 1.

TABLE 1. Science museums and centers which declared some type of accessibility for people with intellectual disabilities.

Institution	Country/State	Audience	Proposed activities
Science Room (Sesc Amazonas)	Brazil/ Amazonas	Autism spectrum disorder	Flexible and adaptable exhibition content.
Alexis Dorofeef Museum of Earth Sciences (UFV)	Brazil/ Minas Gerais	Down syndrome; intellectual; multiple disabilities	Activities focused on the audiences' needs.
Museum of Geodiversity (UFRJ)	Brazil/ Rio de Janeiro	Intellectual disabilities	Flexible visits and itineraries – shorter and more objective exhibition interpretation and educational and hands-on objects.
National Museum (UFRJ)	Brazil/ Rio de Janeiro	Intellectual disabilities	A specific space/exhibition where some material and exhibits can be touched and partially serve this group.
Scientific and Cultural Center (USP)	Brazil/ São Paulo	Down syndrome; Autism spectrum disorder; intellectual disabilities	Flexible visits to the exhibition and its interpretation.
Museum of Public Health Emílio Ribas – Butantan Institute	Brazil/ São Paulo	Intellectual disability	Specific educational program.
Interactive Museum Mirador	Chile	Autism spectrum disorder	Educational material is available online to support the visit to the museum.
La Salle Natural Science Museum	Colombia	Intellectual disability	Activities specifically developed to meet the needs of this audience
Museo del Oro	Colombia	Intellectual disability	The guides were trained to engage this audience.
Interactive Museum of Economy (MIDE)	Mexico	Intellectual disability	Activities specifically developed to meet the needs of this audience.
Universal Museum of the Sciences (UNIVERSUM)	Mexico	Intellectual disability	Flexible visits to the exhibition and its interpretation.

Source: Norberto Rocha *et al.*, 2017.

This data indicates that only 11 museums declared offering some accessibility or activity focused on people with intellectual disabilities, six from Brazil. Only two of these museums are located in the country's southeast region, with the highest concentration of museums' self-declared initiatives for this audience. This evokes a reflection on how far the science museums and centers still need to go in aligning theory and practice in accessibility for people with disabilities and their effective participation (Anila, 2017; Tojal, 2015; Sarraf, 2008).

We understand the relevance of studying the accessibility and inclusion of people with DS in museums and science centers, focusing on the informal education potential of these spaces. This work aims to answer the following research question: How can the exhibition at the Museu do Amanhã (MA, Museum of Tomorrow) potentially favor (or not) access and participation for people with Down Syndrome?

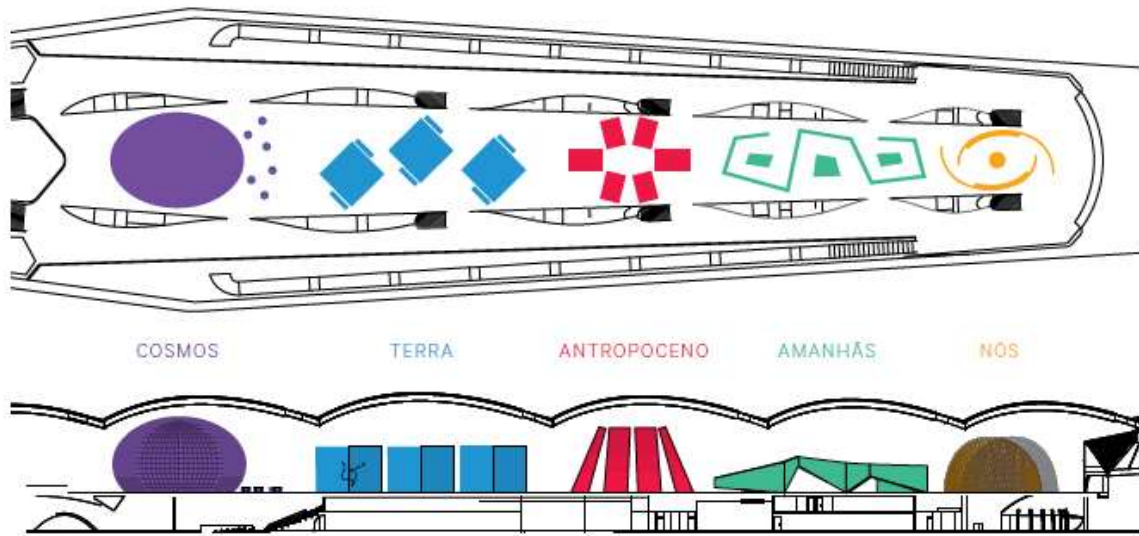
Materials and Methods

The present research is qualitative and exploratory, characterized by its dialogical and subjective aspects, construction and interpretation of reality, and focus on a single case study (Yin, 2001). This type of study encompasses different interpretive techniques in the analysis and understanding of the components of a complex system and their meanings (Lüdke; André, 1986). We utilized the following methods to collect substantive and relevant data: 1) documentary research and review to gather relevant data from institutional documents (such as projects, reports, and other publications); 2) technical visits for observations of in-locus practice; 3) an interview with a museum professional.

Using a qualitative approach in the context of museum investigations has proven fruitful and this is usual method for this type of research (Reich, 2014; Dodd, 2010; Sandell, 2003; Norberto Rocha, 2018). Understanding issues that permeate institutional work facilitates a closer relationship with audiences that do not usually attend these spaces (Cazelli *et al.*, 2015). Additionally, it allows institutions to seek alternatives for better communication processes with visitors and to identify bottlenecks that need to be overcome.

Launched in 2015, the MA offers exhibitions and other activities focused on an ethical reflection on the present and future of the planet based on current scientific evidence. The museum stands out for its highly technological forms and materials, rendering the presented content in a sensory, interactive manner and leading visitors to experience the processes with their affection and imagination. The narrative proposed by the MA is based on the relationship between past, present, and future. A central path is offered for the museum exhibition, which, through questions and not ready-made answers, encourages visitors to reflect on possible socio-environmental scenarios and their respective challenges and trends. It seeks to investigate the possible futures for the next 50 years from the perspectives of sustainability and coexistence, using questions to represent the human condition in five exhibition experiences (called "moments") (Figure 1): 1) Cosmos: Where did we come from?, 2) Earth: Who are we?, 3) Anthropocene: Where are we?, 4) Tomorrow: Where are we going?, 5) Us: How do we want to get there?

FIGURE 1. Illustration of the MA's main exhibition plan views from the top and the side. Museu do Amanhã, 2016,14.



Available online at: https://museudoamanha.org.br/sites/default/files/Mda_BookConteudo_jan2016.pdf.
(accessed: February 18, 2024).

Data Collection and Analysis

This paper presents the results of a master's dissertation conducted during the COVID-19 pandemic, which required some adjustments to the initial methodology. The pandemic posed a significant global health threat from 2019 to 2021. It spread rapidly, causing severe impacts on human lives, public health, and the economy. Museums worldwide had to close their doors for months, facing numerous challenges in their administration, education, and communication efforts (ICOM, 2020, 2021; Almeida *et al.*, 2021).

In our research, we initially planned to observe and record visits by people with DS and their families in loco, due to the importance of understanding the experience of this audience in museums and their participation and voices in the research process (Hewitt *et al.*, 2023). However, because of the social distancing health measures imposed by COVID-19, face-to-face activities at the MA were unfeasible for almost two years (as in most museums around the globe), especially during the proposed data collection time frame: March-June 2020. Therefore, for the safety of everyone involved, no visit to the MA by people with DS and their family members occurred during this period.

Therefore, we reformulated part of our methodology and made data collection modifications while seeking new resources to continue the research. This is the main reason why we use the word “potential” to favor (or not) access and participation of people with DS, given that we did not analyze their perspectives in visiting the museum. We analyzed the museum’s potential to provide accessibility and encourage participation from this audience through the perspective of the authors of this paper, based on literature reviews, online consultations with people with DS and their families about memories of visiting the MA and

other museum experiences, as well as our practical knowledge in accessibility, disability studies, and special education. This research is part of the ANONIMO project, overseen by the second author and approved by the Ethics Committee of the Joaquim Venâncio Polytechnic School of Health-EPSJV of the Oswaldo Cruz Foundation in Rio de Janeiro, under the number ANONIMO.

After receiving the museum's approval to conduct the study, we organized two technical visits in May 2020, during the brief period the museum reopened during the pandemic, and interviewed a museum representative. On the first visit, the researchers observed and took field notes and photos of the main exhibition of the MA without prior scheduling with the museum team or being guided by them. The second visit was focused on the technical demonstrations of the accessibility strategies by the museum's education department staff, who guided the researchers, presented activities, provided interpretation, and used the objects and materials offered when people with DS visit their exhibition. The aim of the researchers' technical visits was to observe, register, identify, and systematize the inclusive initiatives in the museum's main exhibition, the potential of physical, attitudinal, and communicational accessibilities and possible barriers for people with DS.

Following the systematization of the data collected during the technical visits, we carried out a semi-structured interview with a museum representative who is responsible for visitors' experiences and accessibility—chosen by the institution—to gather the institutional perspective, issues, and policies related to accessibility and the inclusion of people with disabilities in general and to deepen and clarify aspects that emerged from the technical visit. The interview analysis took into consideration the potential bias and subjectivity of the answers given by a professional from the MA itself.

In this way, our database is composed of observation field notes of the two technical visits, our photo data, our study of the museum documentation, our literary and bibliographical research and a semi-structured interview with a museum professional. Each of these sources integrates and complements with each other in creating a comprehensive picture of the accessibility status of the MA.

To explore and analyze the data collected, we used the analytical tool “Indicators of Accessibility in Science Museums and Centers” (table 2) as elaborated by Inacio (2017) and adapted by Norberto Rocha *et al.* (2020). The tool was built with analytical categories based on the national and international literature on accessibility and the rights of people with disabilities, as well as official documents that deal with standards and good practices in accessibility. According to Inacio (2017), these indicators were planned to identify the accessibility resources an institution provides to its audience. It has been used by various studies, with adaptations when needed (Marinho, 2023; Marinho; Norberto Rocha, 2022; Fernandes; Norberto Rocha, 2022, Carmo; Massarani, 2022; Fernandes, 2020). Researchers have been using indicators to create analysis frameworks, especially in science education and communication, museology, and their interconnections (Marandino *et al.*, 2018).

TABLE 2. Indicators of Accessibility in Science Museums and Centers

Indicators	Physical	Attitudinal	Communicational
Attributes	1a. Architecture, physical access, accommodations and use of space	2a. Inclusive practices, welcome and engagement	3a. Communication (onsite and external) and signage
	1b. Design and use of objects and facilities	2b. Institutional policy/mission	3b. Media, equipment, resources, etc.
Barriers: obstacles, non-inclusive practices, missed opportunities and untapped potential of adaptations, whether identified by the visitor, researcher, or reported by the museum team.			

Source: Norberto Rocha *et al.* (2020), adapted from Inacio (2017).

For the present study, we maintained the tool's categories (indicators physical, attitudinal, and communicational); however, we detailed the subcategories (attributes) focused on people with DS based on bibliographic reviews as follows:

Indicator 1. Physical Accessibility

Attribute 1.1. Access to the Institution: This attribute includes aspects that cover the physical accessibility of the museums' buildings and surroundings: from the visitors' arrival to the location to their reception, accommodation, and visitation, without significant barriers or obstacles that can prevent their locomotion or make it somehow unsafe.

Attribute 1.2. Informative Signage: This includes entry and exit signs, access to toilets, drinking fountains, and other services, such as reserved parking spaces for people with disabilities, using visible and easy-to-read lettering with contrast, short statements and/or pictograms (visual signals). It also includes tactile maps, audio descriptions, and simple language guides of both the museum's structure and the exhibition.

Attribute 1.3. Design and Use of Objects: This assesses whether the exhibition environment, as well as its objects and exhibits, allows a broad, flexible, and democratic approach, with minimal physical effort and access opportunities for all people.

Indicator 2. Attitudinal Accessibility

Attribute 2.1. Human Resource Training and Qualification: This refers to the structuring, training, and qualifications offered to the staff for receiving and assisting people with disabilities and regular courses, forums, and debates on accessibility for specific groups of people with disabilities.

Attribute 2.2. Inclusive Interventions: This relates to the representation of people with disabilities among the museum's staff, the provision of mediated visits or interpretation specifically aimed at people with disabilities, and the existence of projects or programs to promote the access and participation of people with disabilities, including people with DS.

Attribute 2.3. Reception and Welcoming: This refers to the availability of trained staff (receptionists, educators, explainers, interpreters) to be available to perform a mediated visit that acknowledges the various specificities of the visitors with DS without needing a prior appointment.

Attribute 2.4. Institutional Policy: This encompasses the existence of actions, projects, or funding and partnerships that promote the accessibility and inclusion of people with

disabilities. It also includes the presence of a culture of inclusion in the museum and accessibility being addressed by and across different museum departments throughout the history and memory of the institution and diversity and representativeness in the museum staff and group of collaborators and consultants, including different professionals with disabilities.

Indicator 3. Communicational Accessibility

Attribute 3.1. Internal Communication: This refers to communication aimed at employee relationships while simultaneously creating and sharing an organizational culture of inclusion and accessibility. Also, it relates to the contents of the exhibitions and objects of the museum itself, the message, the media, and the way they are offered in the exhibition and throughout the museum space.

Attribute 3.2. External Communication: This refers to accessible practices aimed to reach diverse audiences and meet specific needs, providing information about the functioning of the space (days and times, location, ticket prices, transportation, etc.), accessibility strategies and their programming and schedules. Different formats (paper, media, video, audio, simple language material) and types and media of communication (broad and focused on specific groups – for instance, WhatsApp groups, associations of people with DS and their families) are also considered in this category.

Attribute 3.3. Media, Equipment, and Resources: media and aspects involving communication at the exhibition, including the design and visualization of texts, oral, and written languages, the use of images, and lighting, the use of large characters, multimedia devices, multisensory experiences, and the linguistic adequacy of scientific themes and subjects, among others.

Barriers: This category encompasses one or more missing aspects of the accessibility indicators. Barriers can add to, interrelate, or intersect with each other, causing a complex array of obstacles that prevent the engagement of persons with disabilities or make it challenging or risky. Often, these include non-inclusive practices, missed opportunities, and untapped adaptations, whether identified by the visitor, researcher or reported by the museum team (museum educator, coordinator, etc.).

Research Limitations

Using inclusive research methods with people with intellectual disabilities is increasingly common and needed (Hewitt et al., 2023). Thus, as one limitation of this study, we could not research the actual experiences of people with DS visiting the museum, due to the COVID-19 pandemic. Although we made efforts to engage people with DS and their families in the research process, they were not able to experience the planned visit to the MA itself. We conducted online consultation about previous experiences in the MA and other museums and their memories.

Studies, such as Levent and Reich (2013) and Reich (2014) show that learning directly from visitors is essential, as only they are truly aware of what their needs are, what assets they bring with them to the museum, and what they are looking for from a museum experience. We acknowledge, then, that the only people who can really tell us if they had access, could participate, and felt included in the museum visit are people with DS themselves. As previously explained, this is why we chose to use the word “potential” to favor the access and participation of this audience since the study was developed through the lenses of researchers who are not people with DS.

Results

As this is an exploratory and qualitative study with a vast amount of descriptive data, in the following sections, we present the analysis of each accessibility indicator using key examples from our complex data collection. In each type of accessibility indicator, we highlight the main points that can better illustrate the panorama of the study, provide an understanding of each category and the researchers’ interpretation and analysis of the potential access and participation and the nature of the barriers that can appear during visits of people with DS.

1 Physical Accessibility

All the analyses regarding the museum’s physical accessibility, came from technical visits performed by the researchers, since most of the main aspects are visually noticeable. The MA’s interior and exterior spaces, long-term main exhibition, and general infrastructure cover physical accessibility indicator features, especially for visitors with DS.

With regard to attribute 1.1, access to the institution, the outside entrance of the museum is leveled, with no steps or ramps from the street to the museum’s main doors. The entrance is clear of significant barriers and the main exhibition is placed in a large exhibition hall, with one level of steps that can be accessed through working elevators. Getting around the halls or accessing the five exhibition experiences is somewhat easy and intuitive, since the major flow of the visit occurs in one direction. All exhibit displays had the same height and rounded shape and were spaciouly arranged.

Along with the entire main exhibition hall, there is a corridor called Gallery of Forms, in which are displayed tables with diverse media such as models, replicas, descriptive texts and braille texts representing a major part of the exhibition’s contents: this gallery was intentionally built as an accessibility strategy. These resources try to turn the exhibition’s abstract concepts and topics into a more concrete and touchable experience, contextualizing and deepening knowledge for visitors with and without disabilities.

We also find features of attribute 1.2, informative signage, in the clear signs for access (entrance and exit) and restrooms, and other visual cues using legible and easy-to-read lettering with contrast, pictograms, signs and figurative drawings throughout the exhibition. Such resources are meaningful for people with DS who tend to have language

struggles in their practical lives when interacting with a word-based society. Therefore, signage with clear language for access, using easy-to-contrast letters and figurative drawings represents the possibility of a more simplified information reading and a more autonomous visit.

The presence of tactile maps of the museum, its surroundings, and the exhibition space before entering the exhibition indicates the presence of both physical and communicational attributes (1.2. Informative Signage) (3.3. Media, Equipment and Resources). People with DS may have deficits in praxis, so they need specific information given in advance to avoid possible discomfort and stress (Fidler et al., 2005). This also enables a more fruitful and comfortable visit to the museum exhibition, since, through interacting with these maps, they (and/or their families) can choose where to go. Such interventions can be used to anticipate high stimulation and/or stress situations to control conditions where sensory processing may be affected.

In attribute 1.3, the design, layout, and presentation of the exhibits encourage group interaction, allowing multiple individuals to handle objects and engage with the exhibits and each other. The interactive, touchable, immersive, and engaging science center-style exhibit, designed for all ages, can also support “family learning” and foster “free-choice learning”. Concerning the exhibition design and use of objects and how the layout influences visitor orientation, circulation, and interaction with the exhibition, we noticed that most of the physical spaces of the exhibition allow free access and visitor autonomy without demanding effort, which can mean a more autonomous, fluid, and safe visit for people with DS.

As for physical accessibility barriers, we noted that the closed exhibition spaces are potentially the most concerning for some people with DS. The ‘Cosmos’ section consists of a giant dome with a movie projection, similar to a cinema theatre, which introduces the rationale of the entire exhibition narrative. It is closed and dark, which can be intimidating for people with DS. The Earth exhibition experience has three immersive exhibit rooms or “cubes.” The enclosed and small space inside of them hinders both the reading of the expository text plotted on the wall, the interaction with the content in the monitors around it, as well as the visitor’s movement autonomy, especially for those with DS or difficulty in locomotion (attributes 1.2 and 1.3). In this space, depending on the visitor’s angle, there is a veil that can cover the informative text plotted on the wall (attributes 1.2 and 1.3), and both the dim lighting of the space and the tight circulation pattern make reading uncomfortable and reduce the likelihood of engagement.

Also, one of the cubes presents a consistent barrier, since the curatorial experience is made to be discomforting for any person and creates a sensation of “too much of everything,” since it depicts the concept of cultural diversity along with human history, dense populations and the complexity of life. There are several columns covered with photographs, creating a labyrinth that can significantly limit internal circulation; in addition, there are mirrors which can cause a certain feeling of awkwardness and/or confusion in visitors with or without disabilities. This represents a potential risk and discomfort for people with DS (attribute 1.2), which can be highly disorganizing and overwhelming, as it potentially causes situations of great stimulation and/or stress; such conditions can contribute to awkwardness

or even a feeling of panic in visitors. In this sense, depending on the number of visitors, this module should be avoided by people with DS or their visit needs to be anticipated by the museum's educators.

The central part of the exhibition—the Anthropocene—also presents barriers. Despite providing ample space and allowing visitors to circulate, the main tall screens deliver excessive sensory stimuli (strong imagery and loud sounds), and a considerable volume of information is displayed in the videos, which can cause discomfort. These would characterize barriers in the physical (1.3. Design and designer) and communicational (3.3. Media, equipment and resources) attributes.

2 Attitudinal Accessibility

The MA presents all the attributes of attitudinal indicators at different levels (2.1. Training and Qualification of Human Resources; 2.2. Inclusive Interventions; 2.3. Reception and Welcoming; 2.4. Institutional Policy). These results consider our technical visits, the museum's documentation study, and the museum representative's interview.

Accessibility for people with disabilities is present in its institutional guidelines and educational actions, as demonstrated in its work plan (Museu do Amanhã, 2020) and activities, and is emphasized by the museum representative during the technical visit and interview, demonstrating the direct relating to the attribute 2.4 (Institutional Policy).

One of the questions posed in the interview was whether the museum offers any theoretical and practical training to the professionals involved in the reception and welcoming of people with intellectual disabilities, since we did not have any concrete evidence of this from the technical visits or the documentation from the museum. The answer was positive: the respondent declared that the professionals undergo training given by experts qualified to serve people with disabilities and the diverse public, and all the education team is encouraged to regularly participate in courses, conferences, and debates on accessibility. They also conduct periodic training and meetings to provide consultancy and follow-ups with people with disabilities. These sessions aim to discuss the interpretation process and the creation of mediating resources and objects used during scheduled visits of people with disabilities. This process fits into attributes 2.1 (Training and Qualification of Human Resources, 2.2 (Inclusive Interventions), and 2.4 (Institutional Policy).

An aspect that highlights the presence of some attitudinal accessibility is the fact that there is a Deaf educator on the education team, which was characterized by the interviewed museum representative as “enriching and political.” We agree that this is a relevant attitude and shows the willingness of the MA to be inclusive, something that many museums still haven't achieved yet. During our studies at the MA, we learned that the Deaf educator is an activist and had changed the museum's inclusivity culture since he entered there, which was around five years prior to our data collection. The deaf community feels welcomed and represented in the MA, and the educator brings the deaf perspective and culture to the museum, which falls under attributes 2.2 (Inclusive Interventions) and 2.4 (Institutional Policy). However, we must note that having only one person does not cover the diversity

and complexity of the various types of disabilities, including the one we focus on in this paper, Down syndrome.

Concerning attribute 2.3, the reception and welcoming of people with disabilities to the museum, we noticed during the technical visits the existence of a common entrance accessible to all, avoiding any constraints. During the interview, the museum representative explained that when the visit of a person with a disability is not previously scheduled, the educators who are spread throughout the museum's halls try to approach and serve him/her and their companions without being invasive and taking their subjectivity into account, and not just the disability itself. The interviewed museum professional also highlighted that "not every disability is apparent," meaning that if a person with disabilities or his/her companions do not explicitly tell the museum team, there is a chance of them being unable to access the inclusive interventions and other inclusive practices offered by the museum. With regard to attribute 2.2, inclusive interventions, the museum has a push-cart full of mediating objects, called "aesthetic mediating objects", designed and created by the educational team together with people with disabilities that the museum educators can use depending on the approach and visitors' needs.

People with disabilities or their families or companions can schedule a mediated visit, called "cognitive-sensory visits" through the website or over the phone. When making the appointment, visitors are asked questions addressing accessibility topics, access needs and the specificities of the people with disabilities that will be served. With the visit scheduled in advance, the education team organizes themselves according to the disability, age, and other information provided and develops mediation strategies that best serve the group. For people with DS and other intellectual disabilities, the mediated visits can happen at exclusive times (in general, an hour before the museum opens, for those visitors who have difficulties with social interaction and crowded and loud spaces) or during the regular opening hours of the museum—depending on the visitors' preference. During the scheduled visit, sensory stimuli such as lighting and sound can be customized to meet the needs of visitors with disabilities.

The team responsible for mediating the visit usually makes use of some of the "aesthetic mediating objects" from the pushing car, offering alternatives in terms of language and media. These multisensory resources represent a possibility of playful and didactic language in transposing the exhibition's scientific knowledge. Also, the education team responsible for the visit addresses specific areas of the exhibition that are more suitable to their needs and reduces the dense content to a more didactical approach. The use of the objects and the experience in the addressed part of the exhibition is not mandatory for visitors, and the choice is made by the visitors and their interests.

One of the main barriers we must highlight in this topic is that when we were doing our documentation and bibliographical studies, we became acquainted with Mascarenhas (2018) work, a "Simple Language Guide" of the video shown at Cosmos dome, which was co-created with people with DS and validated by the museum's curator. Surprisingly, by the time of our data collection, this rich material was not being used and was not known by the museum's representative and the team. They got to know of the existence of this material

through us during the research. This probably happened because the museum changed staff and the head of departments a few times, and, unfortunately, the material had been forgotten in the museum's archives, discontinuing an important effort to provide accessibility to people with DS. Therefore, it comprises a barrier in both attributes 2.4 (Institutional Policy) and 3.1 (Internal Communication).

3 Communicational Accessibility

This indicator is crucial for our research. Accessible (internal or external) communication in the museum is of primary importance for people with DS, since communication is a key interaction point. Communicational accessibility can contribute to the democratization of knowledge and enable the autonomy of visitors in these spaces. We used the data from the technical visits, documentation studies and the interview to analyze this topic. The main exhibition at the MA presents strategies that partially meet attributes 3.1 (Internal Communication) and 3.2 (External Communication). There are, however, significant barriers related to attribute 3.3 (Media, equipment, and resources).

Attribute 3.1 is expressed through internal communication which, although presented with some gaps and weaknesses, still explicitly demonstrated through the interview the value given to creating and improving an organizational culture of inclusion and accessibility. According to the interview, the MA periodically offers theoretical and practical training for professionals involved in welcoming and mediating people with disabilities, including people with DS.

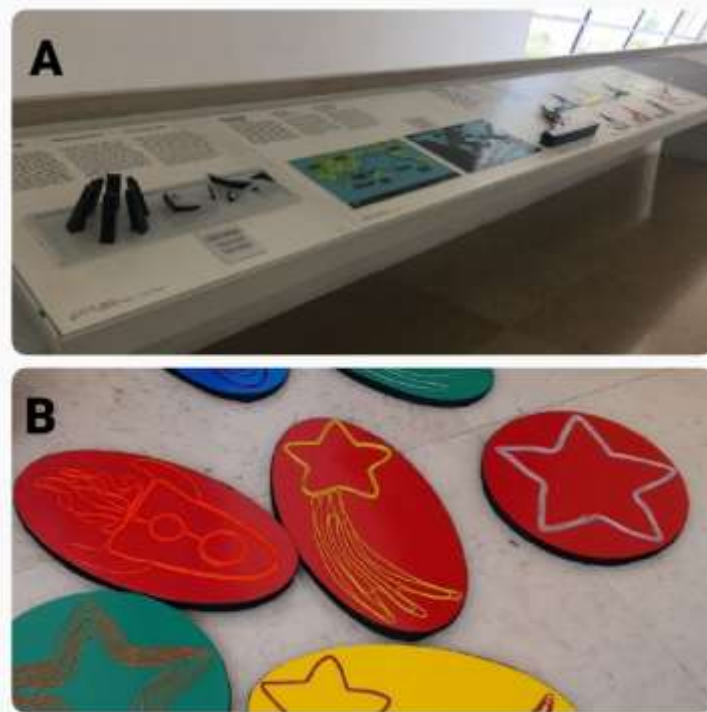
Regarding attribute 3.3, however, we can consider that the MA's main exhibition still presents significant barriers. Although the different textual forms (verbal, non-verbal and mixed) mostly follow formal guidelines -- e.g., Brazilian Association of Technical Standards, NBR-9050 (ABNT, 2015) -- we observed during the technical visits that the language in the different sections of the exhibition tends to not favor the access and participation of people with DS. The entire exhibition presents either predominantly poetic, philosophical, or abstract language or very technical and scientific terminology. We also observed that despite offering imagery and tactile resources, the informational volume is extensive, and the language of the descriptive texts is predominantly technical and scientific. In other words, it may not be welcoming for people with DS and may not favor their understanding and engagement; therefore, it can potentially exclude them (Fischer, 2020).

Another aspect related to the barrier found in attribute 3.3 is the large volume of information and sensory experience, which can be considered excessive for visitors with DS. Experiences such as the Cosmos dome (the introduction of the main exhibition) and the Earth exhibition experience (which has three immersive "cubes") stand out since they are the main potential critical points for the audience we are focusing on. Communication accessibility for the public with DS could be easily improved by focusing on the simple language and didactic organization of content, such as is used in the discontinued Cosmos "Simple Language Guide" by Mascarenhas (2018).

As an alternative and way to minimize these barriers, the education team works together to meet the needs of scheduled and unscheduled visits of people with disabilities. As an external communication accessibility strategy (attribute 3.2), we also emphasize the relevance of offering prior-scheduled “cognitive-sensory visits,” focused on access and participation in which the lighting and sounds can be adapted to make the experience more comfortable for the audience. Also, the visit features “aesthetic mediating objects” (figure 2B), offering alternatives in terms of language, media, and content, which is also a pertinent part of attribute 3.3 (Media, Equipment, and Resources).

In addition, visitors with DS can also access the Gallery of Forms (figure 2A) in the corridor parallel to the main exhibition. The content is available on an inclined table display that is easy to approach. It enables a tactile and interactive experience, allowing visitors to feel the graphics and replicas of installations and modules with their hands (attribute 3.3). Nevertheless, we must consider that as they are in a parallel corridor outside the main exhibition hall, the location and the lack of adequate signage may be a barrier, since most visitors may unknowingly pass by them without noticing. It also can be understood as a barrier in two senses: first, because it explicitly shows that it was an adaptation made after the main exhibition was designed to meet accessibility needs and compliances; second, because it reinforces the idea that this corridor is a space only for people with disabilities, conforming to a segregationist logic.

FIGURE 2. **A.** One of the four tactile tables from the Gallery of Forms, which addresses contents, such as the concept of the Anthropocene, human migrations and air routes and the Anthropocene in numbers, causes, and effects. **B.** Lamps called “Lumicosmas,” one of the sensory mediating objects that can be used during the exhibition of the video at the Cosmos dome in the cognitive-sensorial visit.



Discussion

After analyzing the data collected using the analytical tool “Indicators of Accessibility in Science Museums and Centers” (table 2), as elaborated by Inacio (2017) and adapted by Norberto Rocha et al. (2020), we found some evidence that the MA can potentially favor the access and participation for people with Down Syndrome. The results show that the MA is progressing in meeting physical, attitudinal, and communicational accessibility indicators and their respective attributes. However, some improvements are necessary to enhance access and participation for people with DS.

Concerning physical accessibility, the museum’s infrastructure complies with accessibility standards set by most national regulations. Additionally, the design, layout, and presentation of the exhibits encourage group interaction, allowing multiple visitors to handle objects and engage with both the exhibits and each other. From a Vygotskian perspective, this social engagement can serve as a valuable learning experience for people with DS. Specifically, the museum’s presentation style—can foster “free-choice learning” (Falk; Dierking, 2002; 2019). An interactive, touchable, immersive, and engaging science center designed for all ages can also support “family learning” (Scalfi, 2020; McManus, 1994).

Nonetheless, specifically for people with DS, the immersive and enclosed spaces combined with the abundance of sensory stimuli can create complexity and navigation challenges (Yalon-Chamovitz, 2009). The location of the Gallery of Forms in a separate space is a significant concern. This gallery, which lacks adequate signage, is situated outside the main exhibition hall, reinforcing the idea that this corridor is only for people with disabilities and suggesting a segregationist approach. It also appears to be an adaptation made after the main exhibition was planned to meet accessibility needs and regulations. This does not align with best practices of accessibility and inclusion in museums, where accessibility should be an integral part of the entire institution and one of the first considerations in planning a new project or exhibition. This situation highlights a lack of both physical and attitudinal accessibility.

Regarding attitudinal practices, the museum presents professional training, continued development of accessibility institutional culture, inclusive interventions through “aesthetic mediating objects,” and the offer of scheduled mediated “cognitive-sensory visits” during regular museum hours or at an exclusive time before the museum’s opening. These initiatives are a positive aspect in terms of accessibility, since they represent necessary recreational resources for transposing scientific information from the main exhibition’s complex and abstract content. Nevertheless, we observed that some of these features could contribute to the infantilization of people with disabilities and unintentionally reproduce ableism. Thus, special attention must be paid to the specificities of people with DS to be inclusive of their needs and requirements.

The fact that the museum has an activist Deaf educator on the team is highly positive, and we noticed through their practice and documentation that his incorporation into the institution brought relevant changes for the participation of the deaf community in the museum and the accessibility and inclusion of its institutional culture. We must highlight that

hiring one person with disabilities is a big step that some other museums have not achieved yet or are struggling to do so (see Norberto Rocha; Fernandes and Massarani, 2021); however, it is not enough to guarantee access and participation of a variety range of people with disabilities and, in particular, people with DS. Here, we recall Gómez Blázquez (2015), who argues that diversity within disabilities is a challenge for institutions. Ideally, the museum should make an effort to bring people with intellectual disability onto its team or at least work with them in consultations, since, more than visitors, we need people with disabilities to be part of the museum processes and protagonists of this journey.

Concerning the communication indicator, the MA offers a wide range of media (tactile, digital, audiovisual, artistic exploration), but communication still represents the most significant challenge given the nature of the main exhibition -- which has a great volume of complex information and concepts, as well technical, poetic, and philosophical language which may impair the understanding of the message by people with DS. This may consequently promote the exclusion of those with considerable difficulties in language and cognition, such as elaborating abstract thoughts, understanding metaphors, and connotative language, as explained by Yalon-Chamovitz (2009) and Uziel-Karl and Tenne-Rinde (2018).

During the analysis, we point out that delving into communicational accessibility, particularly in the discussion of simple language, is relevant for this audience (Fischer, 2020). Thus, we reiterate that the offer of material in simple language in-locus and available on the institution's website, social networks, and apps is also essential for this audience. We had evidence of the discontinuation of content material exhibiting simple language and didactic organization that was co-created with people with DS, which can be understood not only as a barrier to accessible communication but also as a gap in institutional policy toward accessibility (an attitudinal indicator).

In this aspect, we emphasize Reich's (2014) argument that to create a solid inclusion culture in the museum and become ingrained within the organization's memory, an organizational change is needed in which the knowledge generated through organizational learning perseveres beyond the specific group of individuals. Thus, when accessibility and inclusion are incorporated into different museum departments, being a mission of the institution and an institutional policy, they have a higher chance of being part of the museum's long history. Also, specific projects towards accessibility can go beyond specific members of the staff or departments and not be "lost" between one management group and the other.

Research Contribution: Accessibility Strategies that Can Favor the Access and Participation of People with DS

The analyses and notes made in this study can be relevant and adequately transposed to other museums and science centers. Knowing, appropriating, and transforming experiences is essential for a culture of accessibility and inclusion in science communication and education, especially with niche audiences. As previously

demonstrated, there is a significant lack of and a growing demand for studies and research on best practices within the context of intellectual disabilities and people with DS.

We present, in table 3, a systematization of strategies focused on people with DS to act as a complement to the “Indicators of Accessibility in Science Museums and Centers” (Norberto Rocha *et al.* (2020), aiming to favor their access and participation and to enrich and facilitate their experience, which is a result and a contribution of this research.

TABLE 3. Systematization of strategies for the accessibility of people with DS in science museums

Indicators	Strategies focused on people with DS
<u>1. Physical Accessibility</u>	- Common entrance accessible to all visitors - Clear and proper signage of entry and exit doors, other services, and information - A tactile map and simple language and/or easy-to-read guide of the museum installation and its surroundings at different moments of the exhibition - Flexible lighting and space sounds - Little or no demand for physical effort or fine motor coordination when handling objects, modules or equipment
<u>2. Attitudinal Accessibility</u>	- Offer of courses and training for employees of the museum specifically aimed at assisting people with DS and developing content - Professionals with intellectual disabilities, especially (but not only) in sectors responsible for accessibility actions and in other areas, such as leadership, consultancy, curatorship, etc - Presence of exhibitors and artists with DS in museum exhibitions - Existence of a quiet room from sensory stimuli
<u>3. Communication Accessibility</u>	- The offer of simple language and/or easy-to-read guides/ materials for the museum's initiatives and primary information, such as days and times, location, ticket price, transportation, etc. - Availability of either on the institution's website or social networks activities for people with DS and intellectual disabilities - Information on the museum's website about less busy visitor hours - Existence of an internal communication protocol when the presence of visitors with DS is identified - Anticipation of the dynamics of the exhibition experiences and activities - Offer of tactile, audio and/or visual support - Didactically organization of the museum's content - Use of artistic, playful and didactic language without infantilizing - Use of a legible font, in large characters and with good contrast - Offer a multimodal evaluation and commenting tool for visitors

It is worth highlighting that these contributions result from reflection based on experience, observation, reading, and study. This is a generalization based on gathered pertinent information that can help to serve people with DS better, enhancing and creating a more productive and memorable interaction. This systematization can be valuable for researchers and museum professionals, who can freely use or adapt it to implement, develop, study, and analyze their inclusive practices.

We do not intend to define rigid protocols or a “recipe” for this audience engagement in museums. We highlight that the people with DS must be the main protagonists of any work addressed to them. One also must consider the diversity and complexity of the different types of people with DS. Beyond chromosomal alterations, this group has no general

behavioral patterns or preferences. Added to age, gender, sociodemographic and cultural varieties, there are multiple experiences from environmental stimulation, which is an essential development factor (Schwartzman, 1999; Pueschel, 2005). Their personal stories are unique, and people with DS cannot be understood and identified as a homogeneous group (Saad, 2003).

Finally, we intend to deepen the discussion on strategies and accessibility for people with DS in museums through the development of future productions. As noted, an extension of this research is already in progress. It aims to give people with DS a voice by collecting their reports and investigating how they participate in science museums as visitors, staff, or consultants.

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