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I. INTRODUCTION

In contemporary society, scientific communication is essential for disseminating progress and innovation to diverse audiences (Ferrer & León 2008). Media, as a significant source of scientific content, have the power to influence public knowledge and understanding of academic and technological development. Moreover, these media allow to explore ways to overcome challenges and improve the quality of life (Martínez 2012). Consequently, scientific communication has been characterized by innovation in the use of languages, narratives, and various formats with the purpose of communicating science in privileged settings that foster learning in scientific, artistic, and social realms (Ferrer & León 2008; Jenkins 2008). Specifically, this way of communication seeks to promote social change in the communities by disseminating information that inspires individuals to act consciously and critically in the face of contemporary challenges (C. A. Scolari 2014; C. A. Scolari et al. 2014).

The way scientific information is disseminated has undergone significant changes over time. Traditional media are no longer the only means of transmitting scientific messages, as digital media have opened new spaces (Amado 2014; C. A. Scolari 2014). In this context, new opportunities have emerged to experiment with participatory, interactive, playful, and visual formats (Harmatiy 2021). For instance, numerous science communicators are using social networks like Instagram and TikTok to disseminate a wide variety of content related to scientific research or new technological applications of knowledge (Matin et al. 2023).

In the current museological trend, museums are conceived as communication media, as highlighted by Torres (2012). Compared to other media, museums offer an ideological vision of the world, narrate stories, and construct arguments by reconstructing the past and present, bringing research and knowledge closer to society. Within this framework, the transformation experienced by museums is an example of the evolution in scientific communication (Gonzalez & García 2022). Today, museums have become interactive spaces that aim to establish a connection with visitors and generate new ways of accessing knowledge (Torres 2012).

New museology focuses on interacting with communities and fostering enriching encounters (Wagensberg 2001). Consequently, the role of museums as memory devices innovating and communicating with their audience is questioned

when the level of adoption and appropriation of transmedia narratives is evaluated (C. A. Scolari 2014). According to José Luis Brea (2016), the museum must be restructured to transform into a space for social communication through multimedia technologies, innovating in public reception methods and modes of contemplation. Similarly, the fundamental role of museums as social transformers telling stories alongside the innovation and invention of concepts and practices has been highlighted (Chagas 2009).

In Colombia, museums are characterized by being cultural, social, and artistic representation spaces of events that have marked the country's history over the years (Ayala 2019; Llanos 2015). Many of these museums have been declared heritage spaces internationally (ILAMDIR 2023). In the country's capital, Bogotá, there are 63 museums registered with the District Institute of Tourism (IDT 2016), mainly located in tourist and cultural aggregation zones (Gonzalez & García 2022). According to a study published by Statista Research Department, Bogotá is the most populous city in Colombia and one of the most populous in Latin America, making it the city with the highest number of museum visitors nationally (Statista Research Department 2023). Due to its cultural diversity, architectural heritage, artistic variety, and innovation in scientific communication, Bogotá has currently consolidated as one of the cultural capitals of Latin America (Gonzalez & García 2022).

Considering the above, a netnographic analysis of 25 museums in Bogotá was conducted in this work, accompanied by the construction of key bibliographic bases for the theoretical formulation of concepts associated with transmedia narratives and museology. This was done to address the implementation of transmedia narratives in Bogotá museums as a communication and scientific dissemination tool. This work highlights the importance of using these narratives as a challenge and commitment to ensure their survival within the new cultural logics of museology, scientific dissemination, and access to knowledge and culture.

II. MATERIALS AND METHODS

2.1 Unit of Analysis

The unit of analysis for this study comprises the museums in Bogotá D.C. The selection process for the museums included in this study was based on two specific criteria: (I) alignment with the National Strategy for Social Appropriation of Science, Technology, and Innovation by Minciencias, and (II) the use of various digital media and platforms for the scientific communication of their exhibitions.

Out of the 63 museums identified by the Bogotá District Institute of Tourism, 25 were selected that met these criteria. These include the Museo Arqueológico Casa del Marqués de San Jorge (MUSA), the Museo Botero, the Museo de Arte Colonial, the Museo de Arte Contemporáneo (MAC), the Museo de Bogotá, the Museo de la Independencia, the Museo de Arte Moderno de Bogotá (Mambo), the Museo de Trajes Regionales de Colombia, the Museo del Oro, the Museo Santa Clara, the Museo Nacional de Colombia, the Museo Quinta de Bolívar, the Museo Oficial Millonarios Fútbol Club, the Museo Casa Caro y Cuervo, the Museo del Espacio, the Casa Museo Ricardo Gómez Campuzano, the Museo de Ciencia y Tecnología Interactiva Maloka, the Museo de Historia Natural de la Universidad Nacional de Colombia, the Teatro Colón, the Museo Militar, the Museo de Artes Visuales de la Universidad de Bogotá Jorge Tadeo Lozano, the Museo Claustro de San Agustín, the Museo Sociedad de Cirugía de Bogotá-Hospital San José, the Museo de Historia de la Escuela Militar de Cadetes General José María Córdova, and the Observatorio Astronómico Nacional.

2.2 Literature Review

To complement this study, a robust literature review was conducted, allowing the construction and understanding of the main thematic concepts used in this analysis. The methodological process outlined by Codina (2020) was followed to determine publication trends and build a state of the art of the topics of interest. A systematic review of the SciELO and Scopus bibliographic

databases was carried out, searching for the terms "Narrative," "Transmedia," "Communication," and "Museology" for the period from 2015 to 2023. For each search, variables such as the total number of articles published, the country with the highest number of publications, the year with the highest number of publications, and the number of annual publications were recorded.

2.3 Netnography and Description of Digitalization of Bogotá Museums

During the netnographic analysis, a descriptive-analytical method was employed to observe and analyze the implementation of transmedia content in the scientific communication of museums in Bogotá D.C. Visits to the selected museums were conducted between June and August 2022, where detailed observation and exhaustive analysis were fundamental tools for describing and understanding these characteristics.

Four aspects of interactive digital communication that define user experience and presentation of works in the 25 selected museums were considered. These aspects are: (1) Digitalization, focused on evaluating the transformation and adaptation to technological media; (2) Networkability, focused on evaluating the configuration of spaces to favor interactions among different attendees; (3) Hypertextuality, focused on evaluating non-sequential textual structures; and (4) Interactivity, focused on evaluating user participation with the content. Specific questions for each aspect were employed to evaluate the museums analyzed, as outlined in Table 1.

Subsequently, specific criteria were described as a tool to detail the communication characteristics in each museum. Factors such as the existence of social media accounts (Twitter, Facebook, Instagram, and TikTok) dedicated to each museum, the presence of publications or strategies focused on disseminating and informing about works related to scientific communication, and the presence of individual or joint websites were evaluated.

Table 1: Concepts, questions, and criteria corresponding to the aspects of interactive digital communication studied for the 25 museums in Bogotá.

Topic	Concept	Question	Criteria
1	Networkability	How varied is the museum experience in terms of content presentation?	3 = Much
			2 = Some
			1 = None
2	Hypertextuality	How much do museum visitors have space to interact with each other?	3 = Much
			2 = Some
			1 = None
3	Digitalization	How does the museum use transmedia content to present its exhibitions in an innovative or interesting way?	3 = Good
			2 = Regular
			1 = Absent
4	Interactivity	How do new technologies facilitate access and dissemination of scientific knowledge of the works present in the museum?	3 = Good
			2 = Regular
			1 = Absent

III. RESULTS AND DISCUSSION

3.1 Literature Review

The results of the systematic search using key terms in bibliographic databases are presented in Table 2. The keywords were chosen due to their relevance in current research on media and digital culture. The selected databases, SciELO and Scopus, are among the most important in the field of academic and scientific research. By using these keywords, the aim was to obtain a selection of articles discussing transmedia communication

and its impact on various areas, thereby providing a description of the state of publications related to the keywords and the countries with the highest scientific output.

Table 2: Results of the keyword search in bibliographic databases (Scopus and SciELO). Source: Own elaboration

Keyword	Database	Number of publications	Country with most publications	Country with most publications	Number of publications per year
Narrative	Scopus	1647	Spain	2021	313
	SciELO	4935	Brazil	2021	727
Transmedia	Scopus	1478	Spain	2021	223
	SciELO	124	Colombia	2021	22
Communication	Scopus	3113	Spain	2022	484
	SciELO	14599	Colombia	2021	1568
Museology	Scopus	70	Brazil	2012	12
	SciELO	125	Brazil	2019	20

Table 2 indicates that there is a significant amount of research on the key terms studied. It was found that for the terms "Narrative," "Communication," and "Museology," SciELO hosts a greater number of publications compared to Scopus. Conversely, regarding the term "Transmedia," Scopus led in the number of available articles with a total of 1478 articles, compared to 124 publications available in SciELO. Similarly, the countries with the highest number of publications vary depending on the search term and the database used, with Spain, Brazil, and Colombia standing out as the countries with the highest scientific production related to the keywords used. Additionally, it was observed that 2021 was the year with the highest number of publications across all the keywords presented in the table, which could indicate an increase in research in these areas in recent years.

It is important to note that the analysis was conducted with terms in Spanish because the objective of this research focuses on the specific context of Bogotá D.C., which is why the language in the systematic search was restricted. This restriction may explain the significant difference in the number of publications available in each database, as Scopus is a bibliographic database that covers a wide variety of thematic areas primarily from Europe and is therefore mostly in English. SciELO, on the other hand, provides access to scientific journals that mostly correspond to research from Latin America and Spain, which causes these publications to be primarily in Spanish.

3.2 Concept construction

Based on the conducted literature review, an adequate conceptual construction was achieved for the most relevant terms in current research on media and digital culture.

IV. NARRATIVES

The initial frameworks of digital narratives focus on audiovisual and multimedia narratives. Hermann (2015), as one of the main authors in this aspect, mentions that since the advent of the internet, social practices have transformed, and the use of Information and Communication Technologies has contributed to the production of audiovisual discourses in the search for identity construction and the imaginaries of subjects. In this sense, the concept of narrative has had several guidelines supported by the development of new technologies and the appropriation of these technologies by users. Phillippi and Avendaño (2011) address the concept of narratives from a multidisciplinary perspective,

recognizing their importance in various fields of knowledge and highlighting that narratives play a fundamental role in the construction of personal and collective identity. Thus, narrative implies a sequential, structured, coherent, and meaningful way of telling a story, whether written, oral, visual, or digital (Jauregui & Ortega, 2020; Phillippi & Avendaño, 2011).

V. TRANSMEDIA

Regarding transmedia narratives, recent authors such as Jauregui and Ortega (2020) and Sáiz (2016) mention that transmedia tools are characterized by the use of interactive elements, linking, and creation by users, which can contribute to facilitating the social appropriation of scientific knowledge. Thus, the importance of implementing these tools in museology lies in the need to provide more immersive and participatory user experiences that engage the public in the learning and dissemination process of science, allowing for flexibility that considers the audience's needs and various platforms (Jauregui & Ortega, 2020; Peñafiel, 2016). As UNESCO stated in 2014, heritage is something built from collective memories of the past and traditional practices, with their social and cultural functions, continuously reviewed and updated in the present. This is essential for societies to relate these memories to current problems and maintain their meaning and function in the future (UNESCO, 2014, p. 132).

VI. COMMUNICATION

Internationally, communication is defined as a complex process involving the transmission and reception of information, whether verbal or non-verbal, between two or more individuals or groups (Jenkins, 2008). Habermas regards that communication is a continuous process developed in social interaction with the aim of creating a public space where relevant societal issues can be discussed (Habermas, 1981). In the same museological trend, museums are currently conceived as social communication media. Carlos Scolari emphasizes that museums play an important role in transmitting cultural narratives and constructing collective identity (C. Scolari, 2018). Consequently, Henry Jenkins has highlighted that effective communication strategies in museums involve creating a coherent and attractive narrative that connects exhibited objects with the public, allowing for a meaningful and enriching experience (Jenkins, 2008).

VII. MUSEOLOGY

In general terms, museology is an interdisciplinary science that studies and practices the management, interpretation, and exhibition of cultural and heritage objects in museums and similar environments, combining knowledge and skills in areas such as art history, anthropology, archaeology, cultural management, education, and communication (Wagensberg, 2001). According to Burcaw, museology focuses on the theory and practice of creating, developing, and operating museums and related cultural institutions. Additionally, museology also concerns understanding and analyzing the social and cultural function of museums and their role in preserving and promoting cultural heritage (Burcaw, 2015). Museology has evolved over time, adapting to societal and cultural sector changes. Currently, it focuses on democratization and inclusion, seeking to make museums more accessible and relevant to communities. It has also adopted a more critical and reflective approach to museums' roles in creating memory and cultural identity, using new technologies, decolonizing museological practices, and returning cultural objects to their communities of origin (Mensch, 2015).

6.1 Netnography and Digitalization Description of Museums from Bogotá D.C.

From the netnographic analysis conducted on the 25 selected museums, clear differences were evidenced regarding the aspects and criteria set forth, as shown in Figure 1. With visits and the determination of specific criteria, it was identified that there is great variety in how each museum presents its exhibitions and uses different tools for scientific communication.

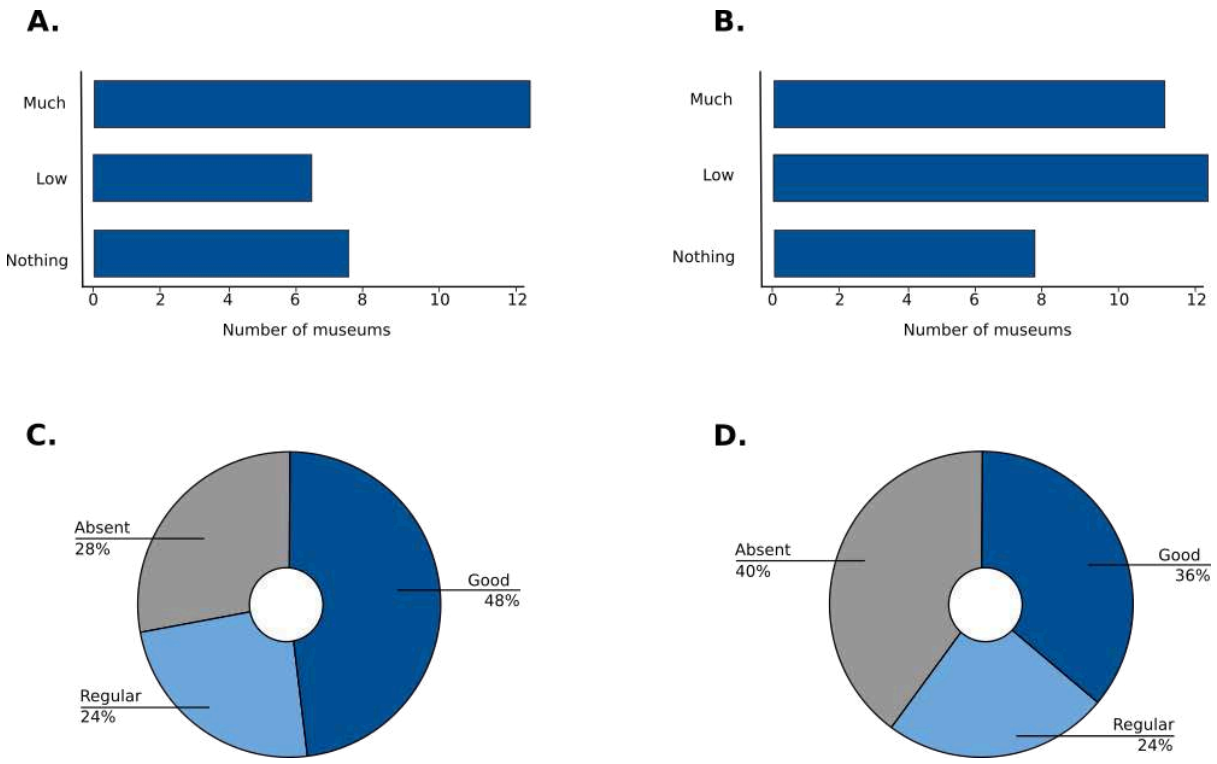

Figure 1: Graphical representation of the aspects of interactive digital communication analyzed based on specific criteria for the 25 museums in Bogotá. Where: Panel A. corresponds to the results obtained for Reticularity concept. B. Hypertextuality. C. Digitalization and D. Interactivity.

In Figure 1A, it is evident that approximately 50% of the studied museums have a highly varied content presentation, which is fundamental for achieving a satisfying and enriching experience for visitors (Riveros, 2016). The fact that most of the studied museums are categorized under the criterion "High" in this aspect indicates that Bogotá museums not only act as information providers but are also becoming access points to a wide variety of resources and knowledge. This promotes multiculturalism and interdisciplinarity in the dissemination of scientific content, broadening the diversity of the visiting public. Conversely, other museums exhibit very little or no variety in their exhibitions, mainly corresponding to historical museums that aim to maintain the colonial history they wish to portray.

On the other hand, analyzing the aspect of hypertextuality, it was found that most museums present low levels of interaction among visitors (Figure 1B). It is important to consider that depending on the type of exhibitions and content displayed in museums, interaction levels among visitors will vary. Science and modern art museums, such as the Interactive Science and Technology Museum, the National Astronomical Observatory, the Museum of Modern Art of Bogotá, and the Colón Theater, stood out in this aspect. This is due to their promotion of interaction through the exhibition of elements, interactive experiments, and innovative artistic representations via immersive scientific experiences, fostering dialogue and discussion among participants.

However, it is crucial to highlight that most studied museums correspond to classic art and history museums, where interaction is based more on the analysis and contemplation of displayed works. Consequently, this implies that spaces and common areas of most studied museums are primarily established for individual analysis and interpretation of works. Several experts in current museology, such as Lynn D. Dierking and John H. Falk and Nina Simon, suggest that visitors want to feel part of the museum's creative process, not just passive observers, learning better when they have the freedom to explore and experiment for themselves (Falk, 2009; Falk & Dierking, 2000;

Simon, 2010). The results of this research indicate that there is still a need to implement more participatory strategies to enhance interaction levels among visitors to museums in Bogotá, aligning museums with the community rather than merely serving as information providers.

Regarding the use of transmedia narratives, it was observed that 72% of the studied museums have implemented these types of narratives in their exhibitions (Figure 1C), with 48% categorized as having a good handling of these narratives and 24% as regular. Notably, most of these museums correspond to those with higher levels of variety in their presentations (Figure 1A) and greater levels of interaction among visitors (Figure 1B). This suggests that, as Jenkins states, technology can be used to create transmedia experiences that combine physical, digital, and social elements and foster visitor participation. Consequently, transmedia narratives become a fundamental tool for disseminating scientific knowledge to a more diverse audience by promoting curiosity and discovery (Jenkins, 2008).

Finally, regarding the use of new technologies to facilitate access and dissemination of scientific knowledge, it was demonstrated that although the majority of museums use social media, a significant percentage (40%) currently do not utilize these communication channels to disseminate information (Figure 1D). The analysis revealed that museums in Bogotá have yet to fully exploit the potential of content dissemination to attract audiences. This aligns with Figure 2, which shows that Facebook is the most utilized social network by museums, while they have not yet integrated the use of social media platforms popular among younger communities, such as TikTok. It is crucial for museums in Bogotá to better exploit new technologies as social media allows for reaching diverse audiences and expanding the cultural institution's reach (Matin et al., 2023). As communication and museum expert Elena Villaespesa notes: “social media allows reaching audiences who would otherwise not approach the museum, such as young people, tourists, or individuals who do not habitually visit exhibitions” (Villaespesa, 2018, p. 49).

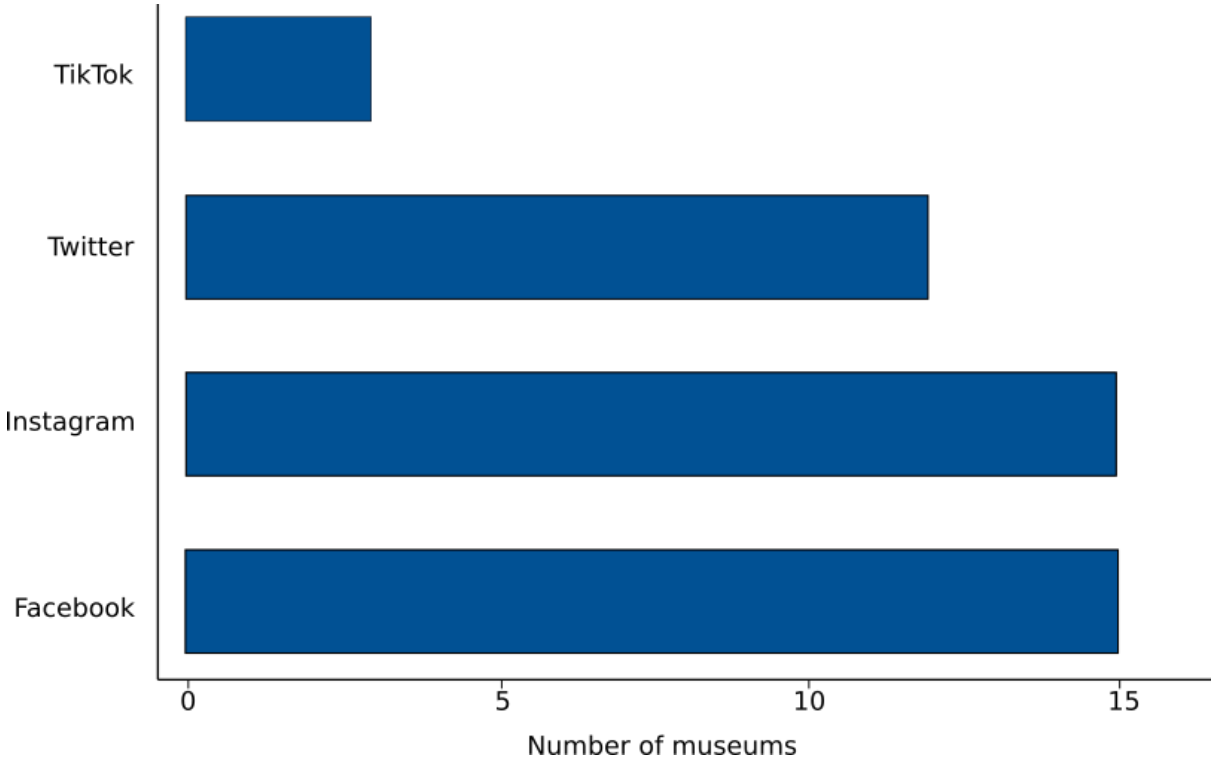

Figure 2: Number of museums studied that use social media as a tool for disseminating their exhibitions. Source: Own elaboration.

VIII. CONCLUSIONS

One of the main pillars of the social appropriation of scientific knowledge is the active participation of various social groups that act as knowledge generators. Transmedia narratives are an increasingly important tool in scientific communication. This study determined that such narratives are key to disseminating scientific knowledge to a broad and diverse audience, including those without prior experience or interest in science. This fosters greater participation in public debate on important scientific topics and their relevance in decision-making. However, it is essential to emphasize that a robust theoretical foundation is required for the proper implementation of these narratives in the dissemination of scientific knowledge.

The results of the systematic search for key terms in the Scopus and SciELO databases demonstrated that the topics of "Narrative," "Transmedia," "Communication," and "Museology" are areas of interest to the academic community. The results also showed that the countries with the highest scientific production in these areas can vary depending on the search term and database used. These findings highlight the importance of considering regional variations in scientific production and suggest the need to establish collaborations and research networks in specific areas across different countries. Overall, these results can be useful for planning and designing future research in these areas, as well as for identifying potential collaborators or research networks in various countries.

Additionally, this research determined that museums, as spaces of encounter and knowledge, can be considered a valuable source of scientific information as they allow for the dissemination of the cultural heritage of humanity. Similarly, they have great potential to spread knowledge through the implementation of transmedia narratives and the use of different resources and media, making information more accessible and attractive to the public. However, the implementation of transmedia narratives as communication tools presents challenges in creating accessible, diverse, and interactive spaces, achievable only through the collaboration of all involved stakeholders. For these reasons, it is important to continue researching and developing new strategies to improve scientific communication through museums as cultural spaces.

The netnographic analysis conducted on the 25 museums in Bogotá identified significant differences in how each museum presents its exhibitions and uses scientific communication tools. While most museums have varied content presentations, visitor interaction is still limited in most cases, except for science and modern art museums. Additionally, it was found that museums using transmedia narratives have higher levels of variety in their presentations and greater levels of visitor interaction. Furthermore, a high percentage of museums do not use social media to disseminate information, indicating significant potential to exploit this field for content dissemination.

In general, the results of this research indicate that although there has been significant development in the use of innovative strategies for disseminating scientific information in Bogotá's museums, more participatory and technological dissemination strategies are needed to improve visitor interaction levels and access to information. This study highlights the importance of these narratives as a challenge and commitment to ensure their survival in the new cultural logics of museology, scientific dissemination, and access to knowledge and culture. This is necessary to enhance the visitor experience, positioning museums as part of the community and not just as information providers.

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