From #MuseumAtHome to #AtHomeAtTheMuseum: Digital Museums and Dialogical Engagement Beyond the COVID-19 Pandemic

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The novel coronavirus spurred a keen interest in digital technologies for museums as both cultural professionals and the public took notice of their uses and limitations throughout the confinement period. In this study, we investigated the use of digital technologies by museums during a period when in-person interaction was not possible. The aim of the study was to better understand the impact of the confinement period on the use of museum technologies in order to identify implications for future museum experience design. We compared museums across four countries – France, Japan, Luxembourg, and the United States – by conducting an international survey in three languages on the use of digital technologies during the early phase of the pandemic. Additionally, we analyzed the Facebook activity of museums in each country and conducted a series of interviews with digital museology professionals in academia and the private sector. We found that despite a flurry of online activities, especially during the early phase of the pandemic, museums confronted a number of internal and external challenges that were often incongruent with their ability to offer new forms of digital engagement. In general, digital solutions served only as a temporary substitute for the museum experience rather than as an opportunity to usher in a new digital paradigm for cultural mediation, and many cultural professionals cited a lack of digital training as a limiting factor in robust ICT implementation. We also argue that the most successful digital engagement came from those activities that promoted a sense of community or an invitation for self-expression by visitors. We conclude with a framework that describes a 'virtuous circle of museum participation', aiming to support public engagement with museums through the development of content that builds on the interconnectedness of on-site and online interactivity.

CCS Concepts: • **Human-centered computing → User studies;**

Additional Key Words and Phrases: Digital museums, digital cultural heritage, museum experience design

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1 INTRODUCTION

First appearing at the start of confinement in March 2020, the #MuseumAtHome movement and its many variations, such as #CultureChezNous in France and #おうちでミュージアム (#OuchiDeMyūjiamu) in Japan, went viral across social media networks. The movement grew out of increasingly strict social distancing measures that forced many museums around the world to temporarily close their doors, ultimately shifting public attention to the museum experience online. The sudden popularity of the #MuseumAtHome movement, which aimed to connect the public with museum objects, activities, and educational resources resounded across the Web, spilling into print media, TV news coverage, and into the homes of people around the world.

Research in human-computer interaction has long reported on the design and development of museum and cultural heritage technologies, primarily with the aim of engaging visitors during in-person visits [20, 41]. However, much work remains to understand the digital visitor experience, which includes interaction with digital tours and collections [55, 67], storytelling and serious games [46], social media engagement [22], and virtual community building [26]. While many museums had to swiftly react to unexpected closures and lingering unpredictability, the initial months of the confinement period nevertheless presented a unique lens through which to consider the long-term implications for museum digital strategies and design best practices for online interactivity.

The present study extends current research in human-computer interaction on the digital museum visit by identifying the experiential dimensions of successful museum engagement online in a context where in-person interaction was not possible. To achieve these aims, we created an international museum survey during the early months of the pandemic. The survey, originally distributed to museums in five countries, sheds light on the immediate aftermath of the initial confinement period, offering rich insights into the early priorities of museums as they shifted into a digital-only format. Additionally, we conducted a Facebook post analysis before, during, and after the initial months of confinement in order to identify the types of interaction available while museums were closed to the public. Finally, to ground our reflections in both industry and research, we interviewed two digital museology experts from each domain.

2 RELATED WORK

In the following section we introduce the state of the art in the design of interactive technologies for museums, specifically emphasizing those areas within HCI research that focus on the shift from on-site to online. For the purposes of this study, we distinguish between *virtual museums* as object-centered online exhibitions (either 2D and 3D) featuring any manner of digital object [67], and *digital museums* as a platform-agnostic, all-encompassing digital experience of museums more generally (e.g., virtual museums, social media, museum websites, digital newsletters, etc.). We also introduce the notion of the digital visitor and the implications of social interaction and user participation within a digital-only context. Finally, we discuss the work of Simon [73], whose hierarchy of social participation in museums plays an integral role in our analysis of the digital museum experience.

2.1 Design for the Virtual Museum

An important challenge for the future of museum experience design concerns the shifting focus from discrete museum visits into 'continuous dialogical engagement' [81], that is to say, an on-going, active, and participatory relationship that implicates museum education, collections, and technologies alike. These developments are the result of extensive work in visitor psychology [25, 30–32, 82], advances in museological theory [50, 67, 74], and research on new technologies in museums [26, 41, 45, 47], all which place increasing emphasis on the visitor experience in lieu of other factors. In parallel to these changes, there is a growing tendency among scholars and museum professionals to consider a shift in their attitude toward shared authority, especially 'after the plague' [21, 24, 36].

Despite these trends, however, current research has yet to effectively translate emerging theoretical and methodological developments into the digital visit. Indeed, a recent monograph on HCI for museums by Hornecker & Ciolfi [41] acknowledges a growing interest in digital-only environments, but nevertheless excludes them from consideration, focusing instead on the in-person experience. Moreover, Kabassi [44] completed a state of the art on museum website evaluations, which included both traditional museum websites and virtual reality environments, and concluded that usability and accessibility were the primary aim of the studies. While certainly important, usability and technology acceptance alone do not contribute to an overarching framework of museum experience design. Indeed, Kabassi notes that a limitation of the studies is precisely their self-referential focus and overall lack of generalizability.

Contemporary research in HCI on the digital visit remains in its nascency, and this is likely due to a number of factors. First, there is a pervading belief that online offerings are somehow separate from the museum experience altogether. As Petrelli et al. [68] argue, this reality is often reflected in the internal structures of museums, where curatorial departments and digital communications exist independently of one another. Additionally, discourse on virtual museums commonly defaults to notions of authenticity, object materiality, and the extent to which the digital visit compares to the in-person experience [17, 29]. In contrast, we echo Falk & Dierking [33], who advocate for reconceptualizing the museum experience as a continuum of moments that comprise before, during, and after the visit. We therefore argue instead that online activities also play an important role in one's on-going, dialogical relationship with the museum, rather than merely as a replacement or supplement to an in-person visit.

Virtual museums also face a number of usability and user experience challenges that hinder their ability to engage visitors in a sustainable way. Decades of digitization efforts have resulted in a staggering amount of cultural data across multiple platforms [10, 87], but research has yet to fully grasp the emerging information behaviors associated with different visitor types [61, 84–86]. The needs of museum curators, for example, differ quite substantially from those of first-time visitors or families with young children. Moreover, the context of use is also an important consideration in the design and development of virtual museum environments. For example, considerable work has investigated the role of visitor engagement using mobile devices, which has the potential to tap into audiences around the world who make use of smartphones on a daily basis. However, much of this work focuses on the context of in-person experiences or experiences designed for free exploration in the world (see for example [9, 42, 69]. While social media apps like Facebook and Twitter have emerged within a climate of mobile-first interaction, many virtual museums are part of museum websites and therefore may not necessarily be optimized for mobile devices, or may simply face data usage challenges as a result of high resolution images and video, as discussed by Boiano et al. [11]. Additionally, virtual museums found on museum websites are more likely to represent a museum's institutional philosophy or ethos [38], whereas on social media, museums must conform to the opportunities and limitations of the platforms themselves, often competing with other content creators.

Recent work by Barbieri et al. [5] presented a study on the comparative evaluation of virtual museum systems, allowing researchers to consider both pragmatic and hedonic elements of the user experience through a triangulation of methods. Later contributions by Morse et al. [61] echo this approach, combining the AttrakDiff questionnaire [39] with observations and semi-structured interviews. While highly effective for evaluation purposes, additional work remains to support the design of new systems from the ground up.

In consideration of available frameworks for design, MacDonald [55] argued that poor UX was a central component to the unpopularity of digital collections and the online experience of museums more generally. The digital collection as a feature originated as a tool for subject-matter experts to access collections remotely [15, 70], and many continue to be reminiscent of this original purpose. MacDonald's UX framework for digital collections, which builds on the work of Norman [62], addresses some of these challenges by categorizing different UX facets of digital collections, such as *strength of visual content*, *interface usability*, *uniqueness of virtual experience*, and *support for casual and expert users*. However, this framework only captures one element of the digital museum experience, namely digital collections, and does not consider the varieties of experiences that took place

during the peak of the #MuseumAtHome movement. A more recent framework called the MUSETECH Model [20] adds an important element insofar as it evaluates technologies from multiple perspectives: the cultural heritage professional, the cultural heritage institution, and the museum visitor. However, this framework focuses on the in-person museum experience, rather than a digital-only context.

2.2 Understanding the Digital Visitor

Although museum technologies have long been the subject of HCI research, their impact on cultural practices and other social implications remain largely unexplored [29]. This is especially true in the context of the digital visit, which has yet to capture the same attention as on-site technologies, despite the fact that visits to institutional websites generally far exceed annual foot traffic at the world's largest museums [38, 75]. We argue that understanding the needs of digital visitors can support improved engagement with the museum's digital presence.

The notion of the digital visitor, however, is not a monolith. Early studies by Marty [56, 57], Fantoni & Bowen [34], and Fantoni et al. [35] demonstrated the increasing need to understand museum visitor information behavior on the Web and its relation to the museum visit itself, ultimately identifying a number of user behaviors, motivations, and expectations regarding the digital visit. Additionally, research on casual leisure and hedonic information behaviors [60, 61, 84, 85] has indicated that information environments common to museums and other cultural institutions do not optimize for free exploration and discovery, but rather serve primarily as tools for expert users.

For the purposes of our study and in consideration of the digital visitor, we draw primarily on the work of Parry [66], whose meta-analysis of the digital user in the context of museums identifies three frames of reference: *operator*, *individual*, and *actant*. These three conceptions of the digital user have direct corollaries to developments in HCI and UX research more generally, such as described by Baecker [3] and Bødker [16]. The *operator* represents early conceptions of the user from the 1960s–70s, and as Parry [66] describes, is "a generic user seen anonymously as part of the efficiency of the 'designed system'." In the 80s and 90s, the operator archetype evolves into an *individual*, a user with a unique context of use and particular information needs. In later decades, the user becomes the *actant*, a value-oriented, socially active agent who participates within a designed system, even having the power to shape its development. It is within this final frame of reference, the *actant*, that we consider the modern digital visitor, who by virtue of their participation, self-expression, and increasing agency in the cultural sector, contribute to the fulfillment of the modern visitor-centered museum ethos [81].

2.3 Engagement and the Digital Museum

Early work by Barry [8] theorized that connecting the museum experience on-site and online was a virtuous circle that focused on providing museum content across digital and physical spaces. Our study extends this idea and the work of Simon [73], who originated the hierarchy of social participation in museums across five levels of interaction (Figure 1). Simon's framework of museum interaction is an essential contribution to understanding museum engagement, and has tremendous relevance for a #MuseumAtHome context, where visitors and museums alike encountered one another in a digital-only manner. Ascending from level 1 to 5, each progression toward the top of the pyramid represents an increase in participation or interaction between visitors and the museum.

In the first level, *museum to me*, visitors passively receive content provided by the museum, such as a featured image from the collection or a video about the museum behind-the-scenes. The second level, *museum with me*, allows visitors to interact with content in some way. For example, visitors might play a game or take a quiz, but ultimately the content is non-networked, meaning there is no interaction beyond the visitor and the content itself. The third level, *me & me & me & museum*, represents interactivity that becomes available to all participating individuals, such as voting, commenting, or surveys where the results are public. In these cases, while it is

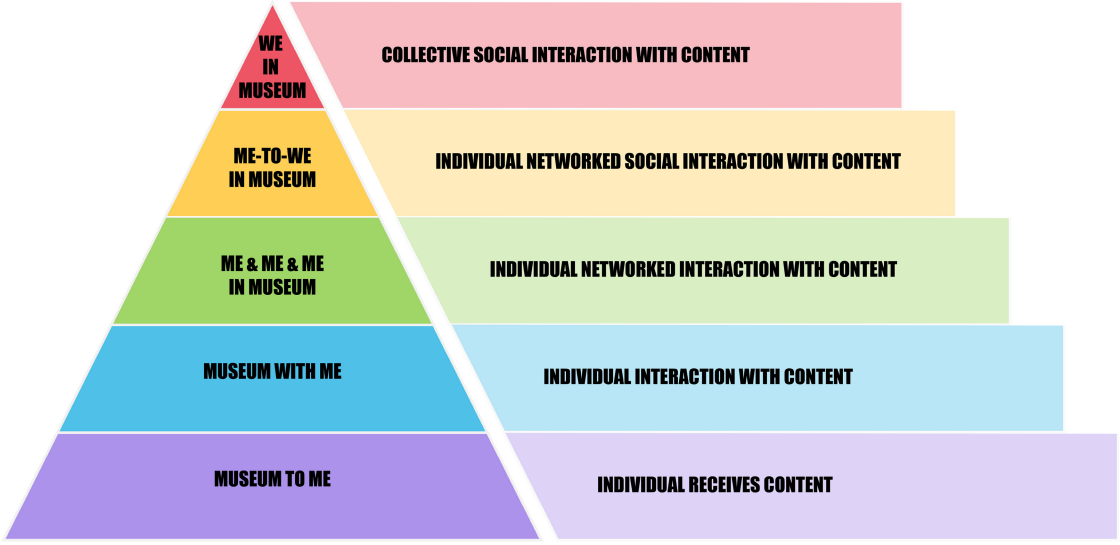

Fig. 1. Simon's hierarchy of participatory interaction in museums.

possible to view the contributions of others, one's actions do not have any influence on those of other people in the network. The fourth level, *me-to-we in museum*, represents a mode of interaction where visitors still interact with content individually, but their efforts have a social dimension. For example, a live gallery talk on the Web allows visitors to interact with a curator by asking questions, which may influence the interests or actions of others present, but nevertheless interaction remains between individuals and the museum. However, if the Q&A also has a community component, such as a digital coffee break where visitors can interact amongst themselves or some other kind of open forum, the interaction reaches the fifth and final level, *we in museum*. This final level comprises collective social interaction around content, including things like message boards, social media, public events, and other opportunities to build community around and beyond content.

In the context of Parry's [66] *actant* user type, Simon's framework, namely categories 4 and 5, represent a culmination of the actant's role and mode of expression in an increasingly connected and social museum. For this reason, we pay special attention to activities relating to these higher level participatory categories.

2.4 Museums and COVID-19

Concurrent with the present research, a number of related studies in the cultural sector on the impact of COVID-19 have begun to shed light on the evolving situation in museums since the beginning of confinement. We distinguish between higher level, international studies conducted by leading institutions such as UNESCO, NEMO, and ICOM [64, 65, 79], and those studies that take a deeper dive into national and/or local museum contexts [1, 71].

Initial findings from the UNESCO, NEMO, and ICOM reports all detail the severe financial implications of long-term closure, with three out of five museums in the NEMO report citing revenue losses upwards of €23,000 per week [64, p. 2]. In addition to lost profits, staffing concerns also came into focus as both the NEMO [64, p. 8] and ICOM [65, p. 18] reports emphasized a sharp decrease in freelance and volunteer work, while the UNESCO report suggested that more than 10% of museums affected by the crisis may never reopen altogether [79, p. 4]. The reports also detail a number of key considerations relating to the digital implications of the crisis, a primary focus of the present study. First, many museums indicated that their digital outreach had grown since the start

of confinement (four out of five museums in NEMO [64, p. 2]; 15% of museums in ICOM [65, p. 2]), whereas the UNESCO survey more broadly emphasized a growing digital divide, not only among cultural institutions, but also in terms of inequalities among public access around the world [79, p. 6]. More than half of museums included in the ICOM survey also indicated an increase in social media activities [65, p. 9–13], and 40% of museums in the NEMO survey reported an increase in online traffic [64, p. 14–15]. These findings offer an initial view into the first months of the confinement, largely beginning in March 2020. They also demonstrate how public demand for museum content online grew sharply during this initial period.

Within the literature there are also case studies that report on the early reaction of museums during the first half of 2020. For example, Agostino et al. [1] investigated Italian state museums from the 8th of March until the 30th of April 2020, monitoring very closely the social media accounts and activities of Italy's national institutions. The findings of this study emphasize the changing duration of the museum visit in the digital sphere, suggesting that shorter visits across a wide variety of digital content had become the norm. Moreover, the findings also suggest that a hybrid model of on-site and online experience has the potential for improved public engagement, and the authors encouraged future work on this subject.

A similar case study by Samaroudi et al. [71] investigated the museum response to COVID in the UK and the US from April to July 2020. This study offers new insights into audience needs during the first phase of the confinement period, namely *educational*, *emotional*, and *stakeholder involvement*. The findings advocate for a stronger focus on vulnerable audiences, and those who may not easily access digital content, echoing the notion of the widening of the digital divide as discussed in the UNESCO report. Moreover, the results suggest that more work is needed to better produce virtual visits, and that monetizing digital content may support museums in the long-term. This reiterates the findings of Agostino et al. [1] , who indicate a growing importance of a more thoroughly defined hybrid on-site/online model.

Building on these initial studies, the current work extends the duration of observation throughout the whole of 2020, and provides a comparative analysis that also includes museums in Luxembourg and Japan. Moreover, a primary concern of the current research is to understand the implications of the COVID-19 pandemic on long-term digital strategies in museums to better define hybrid models of visitor-centered cultural access going forward.

3 RESEARCH OBJECTIVES

While the matter of digitization in museums is by no means new, the specific context of the COVID-19 crisis compelled museum professionals to accommodate to a new paradigm, namely in addressing the evolving needs of a digital-only audience. Our study investigates how museums used digital tools to face the challenges of the confinement situation for daily activities and communication, within and beyond the museum walls. The investigation follows the chronology of their initial reactions, beginning with the underlying goals and strategies that institutions set during confinement. We then analyze the different forms that online museum activity took, in order to determine beyond this specific crisis the short- and long-term implications of these changes. We define the initial months of the confinement as March–July 2020 (the duration of our first Facebook analysis), and the second period as September–December 2020 (the duration of the secondary Facebook analysis). Altogether we explored the following research questions:

- What were the goals and strategies informing museums' responses to moving online? (RQ1)
- What forms did museums' digital activities take during the confinement? (RQ2)
- What are the future implications of the coronavirus pandemic on museum online interactivity? (RQ3)

4 RESEARCH DESIGN

In order to address our research questions, we conducted a mixed-method study consisting of four phases: *international museum survey*, *first analysis of museum Facebook activities*, *expert interviews*, and *secondary Facebook*

analysis. We chose a mixed-method approach in order to obtain a comprehensive snapshot of museum activities – first in a quantitative sense to ascertain changes in the number and variety of activities before and during the pandemic, and then from a qualitative standpoint to better understand the rationale of museums in their decision-making process.

4.1 Participants

In 2016, Google and The Economist published a report on the digitization of arts and heritage [27], ranking countries by their digital cultural heritage initiatives. Countries such as the US and UK both scored quite high across the determined categories: *institutional websites*, *social media presence*, *interactive experience capacity*, *digital access to archives*, and *digital education initiatives*. In contrast, France and Japan had overall lower scores across the categories, namely *digital education initiatives*. This seems unexpected for Japan, one of the top OECD performers for digital literacy [63], and presented a situation that was interesting to compare with that of Luxembourg. Similar to Japan – and unlike the US, UK, and France – the history of museums in Luxembourg is relatively recent. In the case of Japan, the education reformation following World War II led to the establishment of The Museum Act in 1951, which officially codified the role of museums and their curators. Since that time, the number of museums in Japan has grown rapidly from 255 to well over 5,500 [59]. In Luxembourg, few major institutions existed until the 1960s (with exceptions including the Musée National d'Histoire et d'Art & Musée National d'Histoire Naturelle), and thereafter a number of prominent institutions appeared (e.g., Lëtzebuerg City Museum in 1996 and MuDAM in 2006). And like Japan, Luxembourg is a country with some of the highest scores for access to high-speed Internet in the world (93% of the population), high Internet use (9 out of 10 use it daily, compared to 68% in France and 65% overall in Europe), and it is also the first country in the EU to purchase educational content online since 2009 [49].

Altogether, this allowed us to determine a list of five countries with a certain diversity regarding their museum history and their use of digital technologies, especially in the case of museums: the US, UK, France, Luxembourg, and Japan. These were also countries in which the authors had established networks, guaranteeing a higher turnout of responses during a time when many museums were rapidly responding to the pandemic situation. As such, we designed an international museum survey to target institutions across these five countries. Of the five, we received sufficient data from France, Japan, Luxembourg, and the United States for our in-depth analysis. Having only received one response from the UK, we ultimately removed it from consideration in the study. The survey ran from mid-May 2020 until the end of July 2020 across three stages of distribution to museums in each country. During the first phase, we reached out to museums in our personal networks. For the second phase, we connected with international and local groups to help distribute the survey, such as the **International Federation for Public History (IFPH)** and Collections Trust. Finally, we contacted museums outside of these networks through LinkedIn and museum website contact forms. Our aim was to achieve a global view of the museum situation in each country through heterogeneous sampling.

4.2 International Museum Survey

We designed a survey to understand the rapidly evolving situation inside museums and to learn more about their decision-making process during the pandemic and going forward. The survey collected information about the digital offerings of participating museums, their target audiences before the pandemic, and how those aspects had changed since. Additionally, we asked museum professionals to reflect on their individual working conditions in order to understand how museums adapted to remote working, increased workloads, and other factors resulting from the confinement.

4.2.1 Survey Design. The survey consisted of four main sections and was accessible in three languages: English, French, and Japanese. All participants gave their informed consent before beginning the survey. We

administered the survey online using the software LimeSurvey and all responses were stored on internal university servers.

In the first section of the survey, *institutional affiliation*, participants reported their museum affiliation, job title, and the dates their institution closed as a result of the confinement. In the second section, *personal experience*, we inquired about how they adapted to the confinement situation and whether their work changed as a result (RQ1). In the third section we asked them to compare their institution's digital activities before and during the confinement (*comparison before/during*) through a series of multiple choice questions (RQ2). The fourth section, *impact of the crisis*, asked participants to reflect on how they preferred to engage with their audiences, and how COVID-19 might impact their institution's digital strategy going forward (RQ3). We pretested the survey with eight HCI experts in order to get feedback on language use, structure, and adherence to research objectives.

4.2.2 Survey Analysis. We received 38 submissions, from which we removed one duplicate and those that were not from the target countries, resulting in a total of 31 responses across 29 unique institutions (France: 14; Japan: 6; Luxembourg: 6; US: 5). This included two museums where two participants each submitted a response, and one instance where a single individual representing two city museums responded. Generally speaking, museums forwarded the surveys to the appropriate personnel who were able to provide responses to the survey's questions.

We followed a qualitative content analysis approach for open-ended questions in order to derive themes from the data regarding the experiences of museum professionals during confinement and the resulting impact on their institutions' evolving strategies (RQ1, RQ3). The authors, who are fluent in the languages included in the survey, have translated all direct quotes from participants into English for ease of comprehension. We then compared and visualized the answers to the multiple choice questions about museum digital activities by country and overall (RQ2).

In response to requests for anonymity in our reporting, we pseudonymized survey participants in the following manner: MF1 (a museum in France with the ID 1), MJ2 (a museum in Japan with the ID 2), ML3 (a museum in Luxembourg with the ID 3), and MU4 (a museum in the United States with the ID 4), and so on. The ID associated with each museum in the analysis section has no relation to the order of appearance in Table 1.

4.3 Expert Interviews

In order to get additional perspective, both from a geographical and a scientific point of view, we asked two experts to share their views on our findings and on the use of digital tools by museums during confinement. We conducted short interviews over Zoom with Wouter van der Horst, former Digital Learning Educator at the Rijksmuseum and founder of We Share Culture [80], a museum experience design firm. Additionally, we interviewed Dr. Chiara Zuanni, Assistant Professor in Digital Humanities at the Centre for Information Modelling at the University of Graz. In choosing museum experts, we aimed to include perspectives from both academia and industry, which guided our selection. Both have long histories working in museum contexts and currently focus on the digital experience of museums, including on-site technologies and online. More recently, Dr. Zuanni published the *Museum digital initiatives during the Coronavirus Pandemic* [89], an interactive map of digital initiatives by museums during confinement around the EU. Both professionals provided their informed consent to be interviewed and included in the study.

4.4 Facebook Post Analysis

We conducted an analysis of Facebook posts by museums in our target countries in order to identify digital initiatives and activities occurring throughout the confinement period (RQ2). We focused on Facebook specifically because it is the primary social media network used by museums around the world [22].

4.4.1 Phase I: Before/During Confinement. We chose a subset of five museums per country from the survey to balance out the much larger response we received from France (13 museums), compared to Japan (6),

Table 1. Participating Museums in the International Survey

Museum	City	Country
Musée d'Arts de Nantes	Nantes	France
Nancy-Musées	Nancy	France
Musée Dobrée et sites patrimoniaux	Nantes	France
Musée de la Cour d'Or - Metz Métropole	Metz	France
MuséoParc Alésia	Alise-Sainte-Reine	France
Musée Condé Château de Chantilly	Chantilly	France
Musées de Châlons-en-Champagne	Châlons-en-Champagne	France
Paris Musées	Paris	France
Musée des Moulages de l'Université Lumière Lyon 2	Lyon	France
Musée Barrois	Bar-le-Duc	France
Musée d'Archéologie Nationale	Saint-Germaine-en-Laye	France
Musée Saint-Raymond	Toulouse	France
Musée des Augustins	Toulouse	France
Pola Museum of Art (ポーラ美術館)	Hakone	Japan
Teshima Art Museum (豊島美術館)	Kagawa	Japan
Miho Museum (美秀美術館)	Koka	Japan
Tokugawa Museum (徳川美術館)	Nagoya	Japan
Museum of Contemporary Art, Tokyo (東京都現代美術館)	Tokyo	Japan
Hiroshima Peace Memorial Museum (広島平和記念資料館)	Hiroshima	Japan
Musée des Maquettes des Châteaux et Châteaux Forts & Musée de la Bataille des Ardennes	Clervaux	Luxembourg
Musée Rural et Artisanal, Musée de Calèches Grande-Duchesse Charlotte de Peppange	Peppange	Luxembourg
Musée National d'Histoire Naturelle	Luxembourg City	Luxembourg
Aquatower Berdorf	Berdorf	Luxembourg
Musée National d'Histoire et d'Art	Luxembourg City	Luxembourg
Harvard Art Museums	Cambridge, MA	United States
Smithsonian Institution	Washington D.C.	United States
Ohr-O'Keefe Museum of Art	Biloxi, MS	United States
Art Institute of Chicago	Chicago, IL	United States
Museum of Fine Arts, Boston	Boston, MA	United States

Luxembourg (5), and the United States (5). In the case of Luxembourg, we selected an additional museum outside of the survey as one museum did not have a dedicated Facebook account. For French museums, we identified five institutions based on the diversity of their situations (administrative status, size, budget, type of collection, location). In addition to the museums chosen from the survey, we also selected three additional internationally renowned museums within each country that did not participate in the survey in order to make sure that the larger, and oftentimes more digitally savvy institutions were well represented in the study. We list these in Table 2.

Post collection began on the respective closing date of each museum (circa March 2020) up until their reopening, or the date of July 13, 2020, which was the conclusion of the survey.

For each museum studied, we manually scraped and coded all posts for the entire duration of the temporary closure. We iteratively developed a coding system to describe the data by observing 500 Facebook posts from museums in our target countries to understand what kinds of content appeared, the target audience of each

Table 2. Museums Chosen for the Facebook Analysis

Country	Museum
France	**Musée du Louvre (Paris)**
	Musée d'Orsay (Paris)
	Musée National d'Art Moderne - Centre Georges Pompidou (Paris)
	Musée des Moulages (Lyon)
	Musée d'Arts de Nantes (Nantes)
	Musée Barrois (Bar-le-Duc)
	Musée Saint-Raymond (Toulouse)
	Muséoparc Alésia (Alise-Sainte-Reine)
Japan	**Mori Art Museum / (Tokyo)**
	Edo-Tokyo Museum (Tokyo)
	National Museum of Western Art (Tokyo)
	Tokyo Metropolitan Art Museum (Tokyo)
	Miho Museum (Koka)
	Pola Art Museum (Hakone)
	Tokugawa Art Museum (Nagoya)
	Teshima Art Museum (Kagawa)
Luxembourg	**Mudam Luxembourg (Luxembourg City)**
	Villa Vauban (Luxembourg City)
	Lëtzebuerg City Museum (Luxembourg City)
	Centre National de l'Audiovisuel (Dudelange)
	Musée Rural et Artisanal (Peppange)
	Aquatower Berdorf (Berdorf)
	Musée National d'Histoire et d'Art (Luxembourg City)
	Musée National d'Histoire Naturelle (Luxembourg City)
United States	**Metropolitan Museum of Art (New York, NY)**
	Museum of Modern Art (New York, NY)
	J. Paul Getty Museum (Los Angeles, CA)
	Harvard Art Museums (Cambridge, MA)
	The Art Institute of Chicago (Chicago, IL)
	Smithsonian Institute (Washington D.C.)
	Museum of Fine Arts (Boston, MA)
	Ohr O'Keefe Museum of Art (Biloxi, MS)

Museums in bold are additions that did not participate in the original survey.

post, and other factors relating to the museums' activities. We then pre-tested this coding scheme with eight HCI experts, leading to the removal of redundant categories and the addition of others (e.g., a code under the "hashtag" category for "no hashtag"). The final scheme included six categories:

- **reference:** whether the post refers to a form of external media (website, social media account, TV/newspaper/radio, other)
- **audience:** the target audience of the post, ranging from general audiences to children/families, teenagers, accessibility, or other
- **media:** the type of media included in the post (image, audio, video)

- **content:** referring to the contents of the post, for which we derived a series of digital activity types (Figure 11)
- **mentions:** whether the museum refers to confinement, museum/exhibition opening/closing, or other special events/periods (e.g., Mother's Day or Black Lives Matter)
- **hashtags:** whether the museum uses international, national, or museum specific hashtags (e.g., #MuseumAtHome or #MusuemMomentofZen)

We mapped these event types onto the hierarchy of social participation as described originally by Simon [2007], a framework used to understand the different levels of interaction within experience design for museums. Through this we were able to identify how museum activities compared across different levels of interaction, and which were the most engaging for digital visitors.

In order to get a sense of how the frequency of posting by museums changed as a result of confinement, we identified one week at the start of February (February 3–9, 2020) before the confinement began, and calculated the post frequency during that week for each museum. We chose these dates based on the public holiday schedule of each country, aiming to cover a full week where none of the studied countries had any national observances. This snapshot allowed us to estimate the average post frequency prior to confinement in order to compare that number with post-confinement frequencies.

4.4.2 Phase II: September–December 2020. We conducted a secondary Facebook analysis of museum activities during the months of September–December 2020. By this time, many but not all museums included in the Facebook analysis had reopened at some point during the summer months or shortly into the fall. During this second phase of the Facebook analysis, we observed whether museum social media had shifted toward higher levels of participatory engagement, namely Simon's [2007] category 4 or 5 interactions (RQ3). Our aim was to understand to what extent the digital strategies of museums had changed after several months into the pandemic.

5 RESULTS

In the following, we describe the results of our analysis across the four phases of the study: the international museum survey, the expert interviews, and the two Facebook analysis periods.

5.1 Survey Analysis

First, we report on the initial reaction to the closing of museums during confinement, and then discuss how this affected communication strategies and digital offerings for the public (RQ1, RQ2). Then, we address the forward-looking aspects of the survey where museums shared their impressions of the long-term impact of temporarily adopting a digital first approach (RQ3).

5.1.1 Reaction to Confinement. Generally speaking, most participants felt confident that their institutions were ready to use digital communication tools at the start of confinement (Figure 2). However, fewer felt prepared in regards to offering digital content (Figure 3). For example, museums that expressed partial preparedness discussed a number of challenges influencing their situation. For example, as MU1 explained, *"while we produced a good amount of online digital content, it always came second to the physical exhibitions and gallery spaces in terms of institutional focus, and we were slow to ramp up production to meet the increased needs of the museum."*

A majority of respondents indicated that, beyond merely adapting to teleworking, they also took on new kinds of work in response to their museum's closure (65%). For some, the move online resulted in an immediate increased workload due to changes in museum access. As MU3 explained: "*my workload increased dramatically as a result of all departments switching to a digital first mindset. During the first few weeks many staff were scrambling to figure out how to continue their research without access to physical objects. This meant lots of staff were thinking very creatively on how to use digital tools to showcase their work.*"

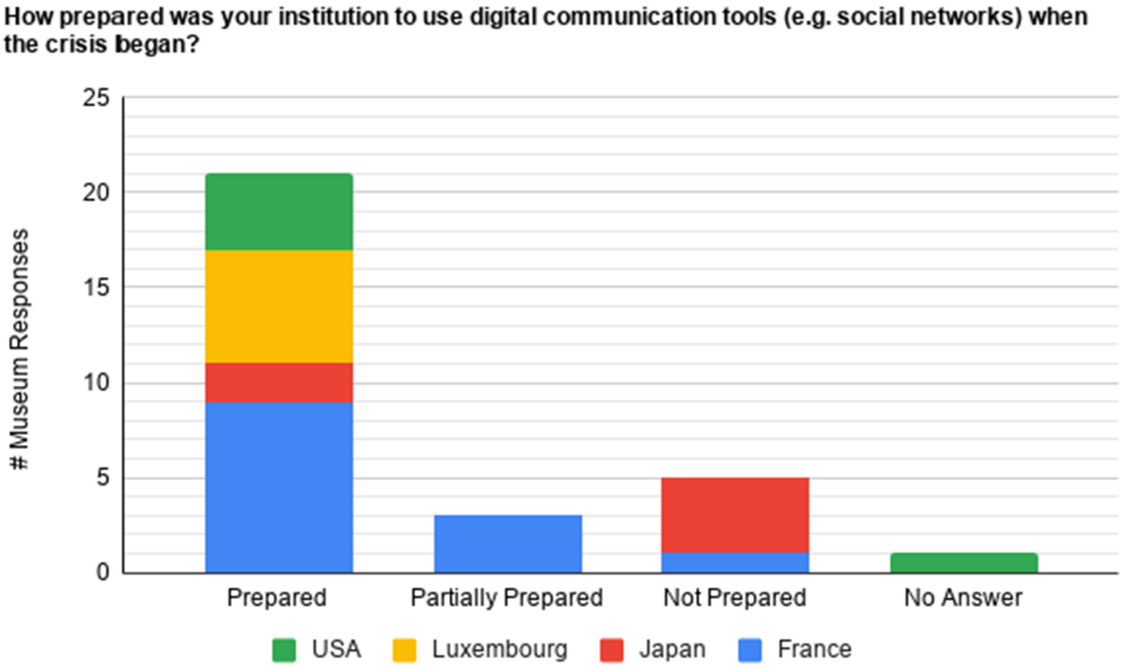

Fig. 2. Museum survey on readiness to use digital tools for communication at the start of the pandemic.

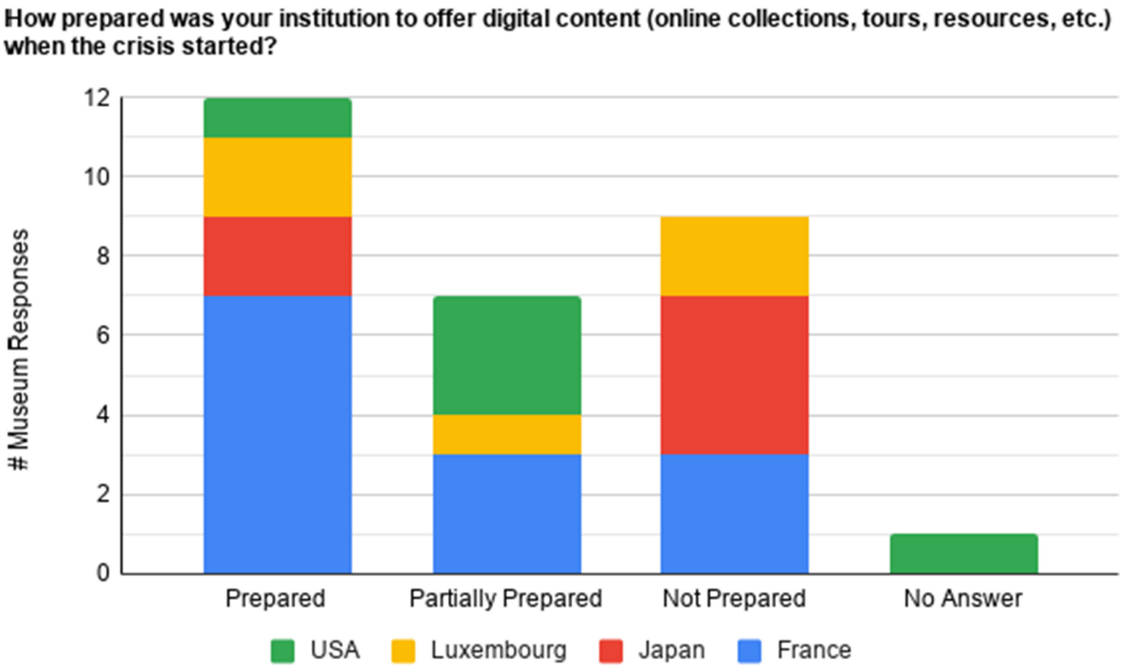

Fig. 3. Museum survey on readiness of digital content at the start of the pandemic.

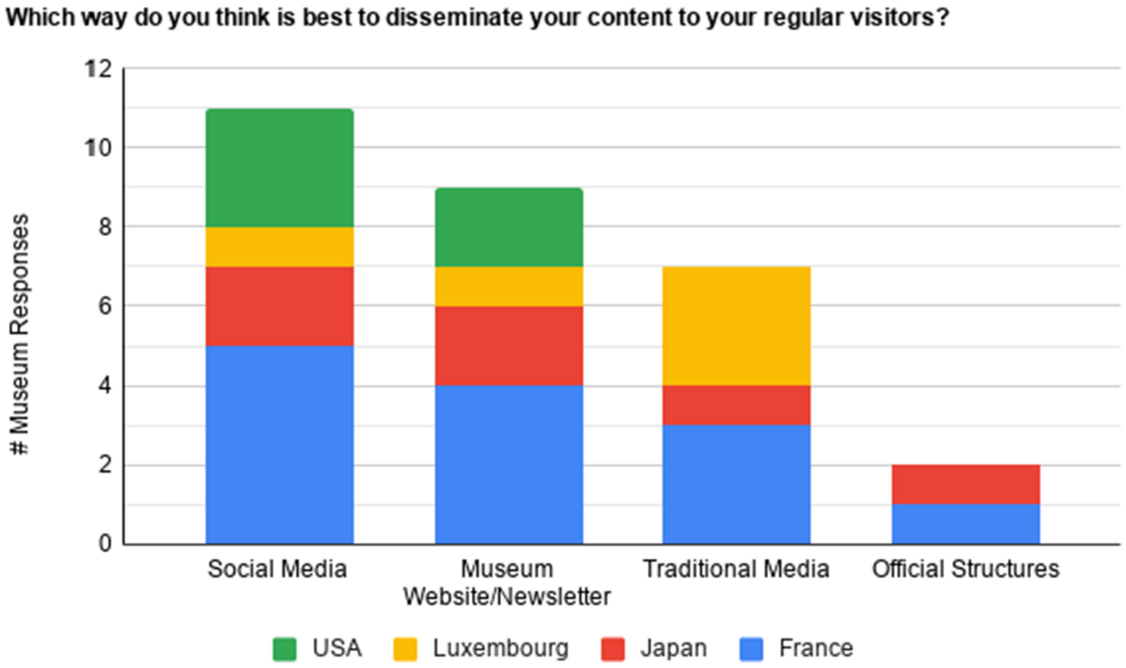

Fig. 4. Museum survey on best method to disseminate content to visitors.

Museums also saw this period as an opportunity to raise awareness about the need to develop digital communications (MF12, MF2), to restart projects delayed due to time constraints (MF2, ML5, MU2), and perhaps most importantly, to focus their efforts on the museum infrastructure and collection preservation (MF10, MJ1, MU3). On a more personal level, some museum professionals reflected on the role of museums and cultural professionals more generally. As MF10 explained, "*closing to the public made me wonder about the vanity of our professions and our priorities or 'emergencies'. The link with visitors, and in particular the possibility of having an almost carnal relationship with the works for them is the most important point that emerges from my reflections.*"

Another salient reflection comes from MJ4, who reconsidered the evolving role of museums as a result of the confinement: "*The social mission of the museum has changed. Originally it was thought that the mission of the museum was to touch the real thing, but it has changed to a place where objects are transmitted as information.*" These sentiments are not uncommon, as others expressed doubts about the long-term sustainability of the digital visit. While some wanted to ensure that online visitors turn into on-site visitors (MJ3, MJ2), others feared that for some the digital experience may jeopardize interaction with the real thing (MF10). Moreover, as ML2 noted, despite investing in touch screen technologies, the museum has halted their use due to health safety concerns.

5.1.2 Communication Strategies. The survey asked museums about the best method to communicate with their audiences (Figure 4). A majority of museums (38%) ranked social media first, followed by museum website/newsletter (31%), and traditional media (24%). Museums in France and Japan demonstrated the most communication diversity, spanning all four categories, whereas participating institutions from the United States tended to prefer social media channels and museum media.

All museums in the survey had some form of online presence before 2020 (Figure 5), mostly through institutional websites (86%), but also on social media, especially Facebook (83%). Overall, museums tend to use social media to target general audiences, though some museums have indicated a particular strategy or audience type. For example, MF9 described different target audiences depending on the platform: young adults on Instagram

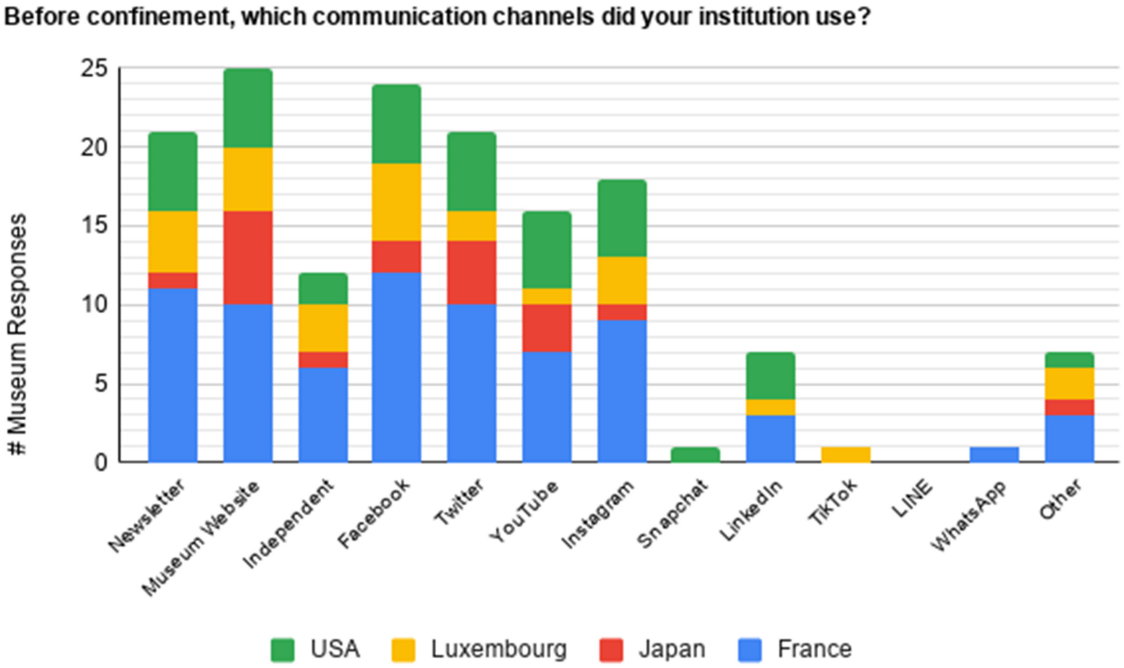

Fig. 5. Museum survey on communication channels prior to confinement.

and Twitter, and hobbyists on Facebook. MJ2 employs a similar strategy by targeting 20–30 year-olds on Twitter, and 30+ on Facebook.

Since confinement, five museums (17%), indicated that their target audience had changed. For example, MU2 has expanded its outreach from women over 40 to a slightly younger demographic as a result of their increased digital presence. The remaining four museums (MF8, MF9, MF4, MU4) turned their attention to creating learning resources for students and families with children at home.

Concerning the frequency of communication, 13 museums (45%) reported a change since the start of the pandemic. Of those, eight museums indicated that they posted more frequently, some with a particular strategy in mind, such as MF11: "*Wednesdays for children, Saturdays 'all aboard to...', Tuesdays 'visit from your sofa', etc.*" For others, it was more abstract, such as ML4 who posted "*more globally in a less specific manner.*"

Seven museums (24%) reported that they had made changes to their communication methods since confinement, typically with the addition of new social network accounts. For example, MJ3 initiated a new Facebook and Instagram account, while MF7 joined LinkedIn, and ML4 created a YouTube presence. In other cases, museums prioritized digital communications over print (MF9), or digital communications ceased altogether as an unfortunate result of the museum's closure (ML3).

Prior to confinement, the most common digital offerings (Figure 6) found at participating museums included online collections (69%), pedagogical resources (58%), and virtual tours (34%). Since the beginning of confinement, 12 museums (41%) indicated that they had changed their digital offerings, such as described by ML1: "*We have established a diversified virtual offer strategy, scheduled daily on our social networks (Facebook, Instagram, Twitter) under the [museum name] @ Home banners. Some content has been adapted in improvised audiovisual mode, such as the [program name], others have been specifically designed as more educational offers... for young audiences.*"

5.1.3 Going Forward. Finally, the survey asked participants whether the confinement had changed their opinions on digital tools and what effect this might have on their digital strategies going forward. A number of

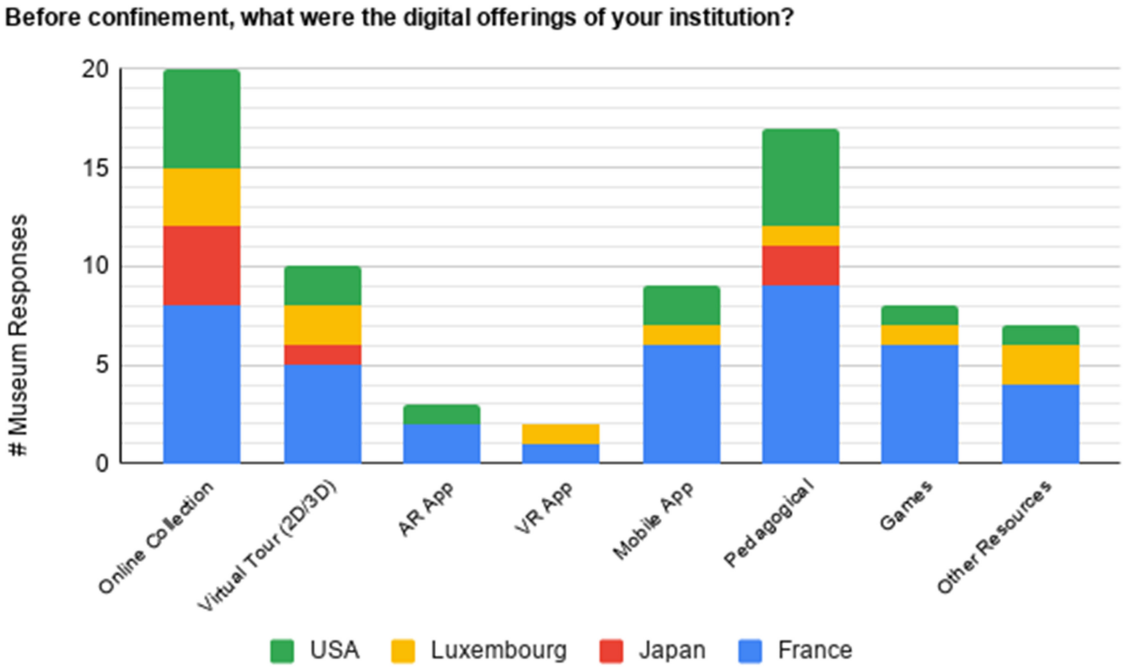

Fig. 6. Museum survey on digital offerings prior to confinement.

institutions expressed interest in creating or expanding digital pedagogical resources for students and young children (MF8, MJ5, MU4), and as MJ5 wrote: "*From the perspective of the curatorial department, we are considering using digital tools in the future for educational dissemination programs (especially for elementary and junior high school students).*"

In other cases, the confinement helped museums to focus their efforts on making the museum available to audiences who may not be able to visit even during normal circumstances, such as in the case of MF4, where curators leaned into content creation for audiences with mobility impairments. Other museums, such as MU2, felt empowered to build a digital strategy to incentivize new membership from digital visitors, sharing special content in a members-only fashion followed by a public release only after some time. Many museums also indicated that they intended to push for more digital content creation, either through new leadership (MU4), a new website (MF4), new kinds of interactive media (MF9, ML3), or through heightened awareness of the digital more generally (MF11).

Museums also reported a number of challenges relating to their digital presence. As MF12 reported, "*it is very time-consuming and establishments do not necessarily have the human resources, once they return to everyday life, to carry out intense digital activity simultaneously in the field.*" Others expressed concern for the sustainability of digital initiatives once museums reopen: would digital visits continue at the same rate after the pandemic? As MF10 stated, "*the digital policy will be maintained, I do not believe in virtual visitors but in real visitors. We will seek to seduce in order to bring visitors to the museum.*" Indeed, as MJ4 argued, it is necessary to move beyond technology for technology's sake and connect digital tools to the *big picture*.

6 EXPERT INTERVIEWS

We transcribed our interviews with Wouter van der Horst and Dr. Chiara Zuanni, and used thematic analysis to derive a series of themes from the discussion.

- **Digital training and literacy**. Digital training and literacy programs remain an important need for museum staff. As Dr. Zuanni described, digital literacy in the context of the museum directly informs her own teaching within the field of digital museology. Wouter van der Horst also insisted on the fact that no action can be conducted without the proper resources, and that museums should invest in their employees' ICT skills.
- **Creation of participatory content**. Despite what the use of social media might suggest, confinement did not appear to be the most opportune moment for museums to engage their audiences with new modes of interaction. Dr. Zuanni pointed out that many museums actually reused existing material and Wouter van der Horst underlines that in most cases the contents tried to "copy the physical experience to the digital world", without fully acknowledging the possibilities of these technologies. Our qualitative results seem to support these claims insofar as many institutions described having to recycle old content, or create new content based on the physicality of the museum (e.g., 3D scans of the gallery floors).
- **Practical and research perspectives**. Technology is not a goal in itself, but merely a tool that museums could and should use to meet the needs of their visitors. However, in order to do so, museums must understand them. This idea was expressed by Wouter van der Horst, and completed by Dr. Zuanni, who indicated that understanding the "human factor" in technology is key to finding the right balance between expertise and enjoyment, and in order to foster participation that is meaningful for audiences. There is an inherent disconnect between the private sector and the academy. Museum professionals rarely have the time or resources to inquire into recent advances in user experience design and digital museology as found in the literature, and researchers often struggle to find practical ways to communicate these results. In order to assure a successful integration of emerging research with practical applications in museum settings, researchers and museum professionals alike must find a meeting point in-between.

7 MUSEUM FACEBOOK ANALYSIS

In the following, we report the results of our Facebook analysis, focusing on the frequency and types of digital content shared by museums on Facebook during the pandemic.

7.1 Frequency of Communication

In total, we collected 6,540 Facebook posts across the 32 museums selected for analysis (France: 1,654; Japan: 790; Luxembourg: 1,654; United States: 2,569). We calculated the post frequency for each museum during confinement and compared it to the frequency before confinement during the week of February 3–9, 2020. These results are visualized in Figures 7, 8, 9, and 10. It is important to note that the February 2020 and September–December 2020 durations are of a fixed length (one week and four months, respectively), whereas the March–July 2020 duration is variable depending on the museum. During the March–July analysis, we counted only posts during each museum's closing period, therefore we calculated the frequencies for that period individually by museum.

Figure 13 shows an overall increase in the total number of Facebook posts in Japan and Luxembourg during the latter phase of the pandemic (Sept–Dec) compared to the first phase of analysis at the start of the pandemic. In contrast, France and the United States show a decline in that latter part of 2020. Figures 7, 8, 9, and 10 offer more insight into museum-specific activities during these periods. It is worth noting that many museums in Japan and Luxembourg reopened to the public much sooner than museums in France and the United States, and this may account for the general increase in social media activity given that public events were allowed to continue (with various social distancing measures in place). In the case of Luxembourg and Japan, where many museums are public institutions, the early reopening dates were established based on decisions by government and health officials (e.g., see for example [88]).

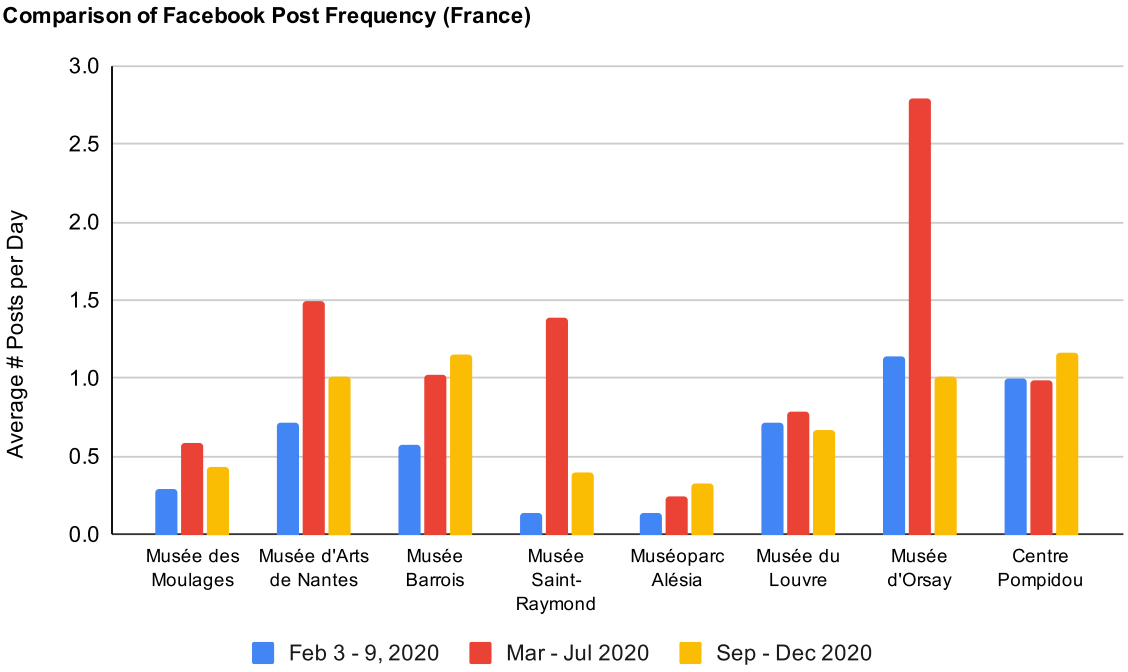

Fig. 7. Frequency of posts before and during confinement (France).

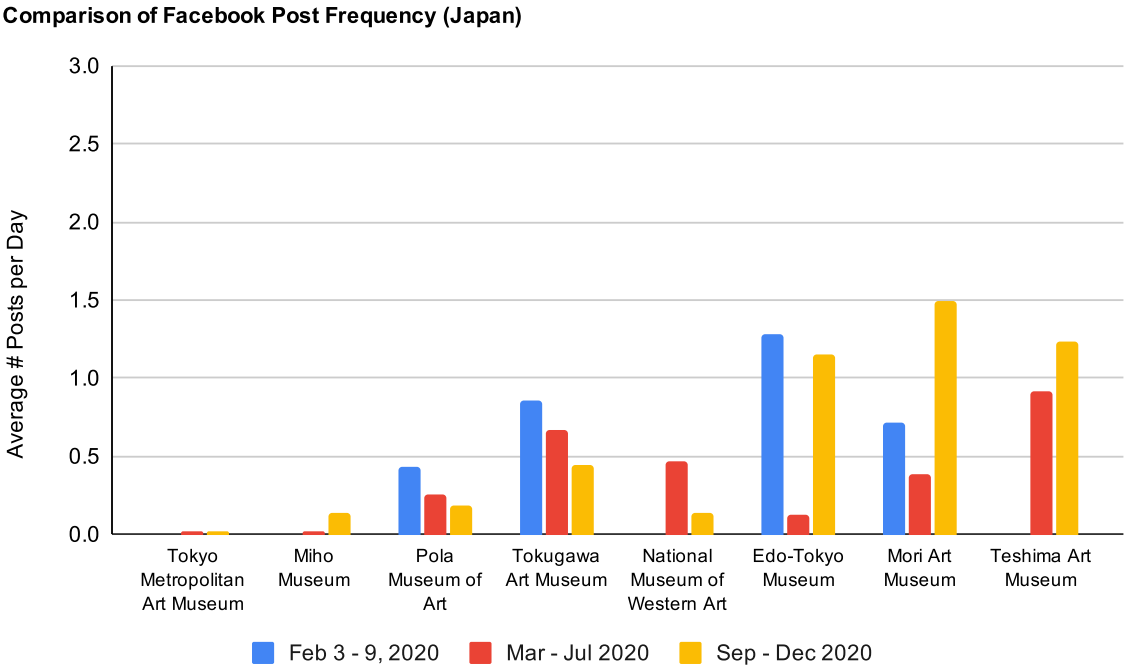

Fig. 8. Frequency of posts before and during confinement (Japan).

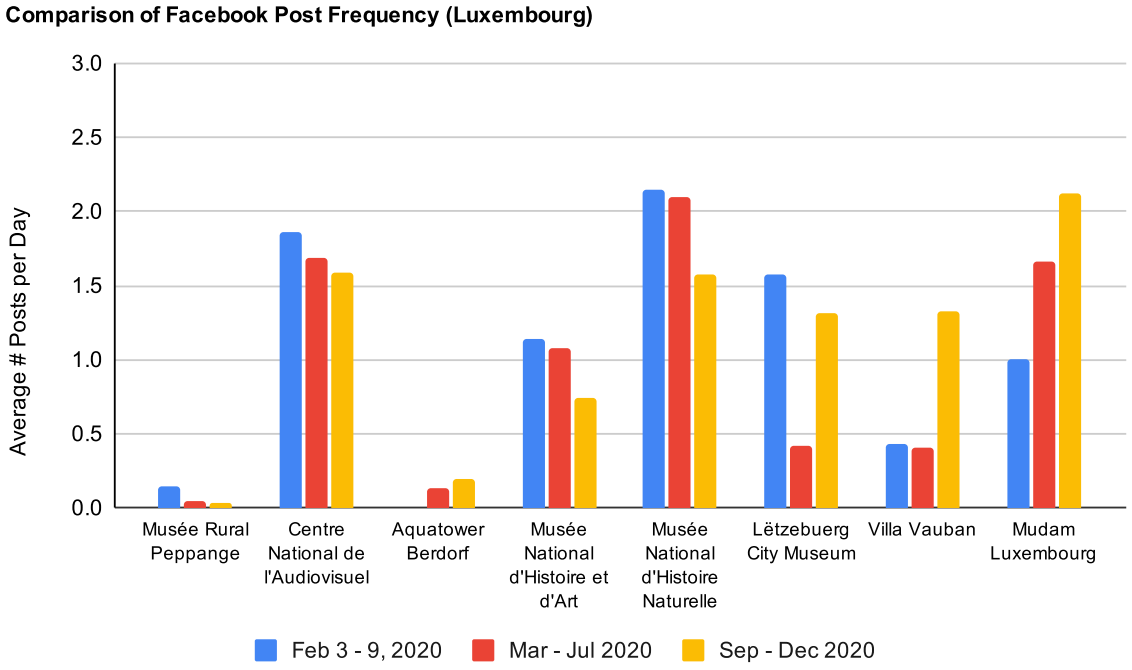

Fig. 9. Frequency of posts before and during confinement (Luxembourg).

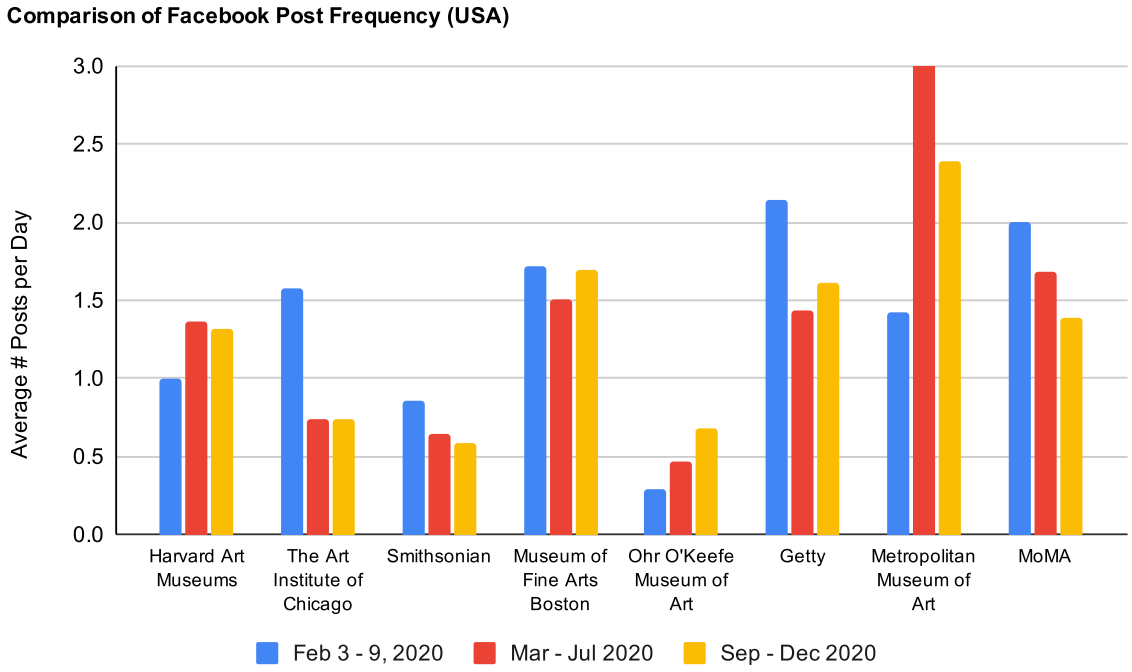

Fig. 10. Frequency of posts before and during confinement (USA).

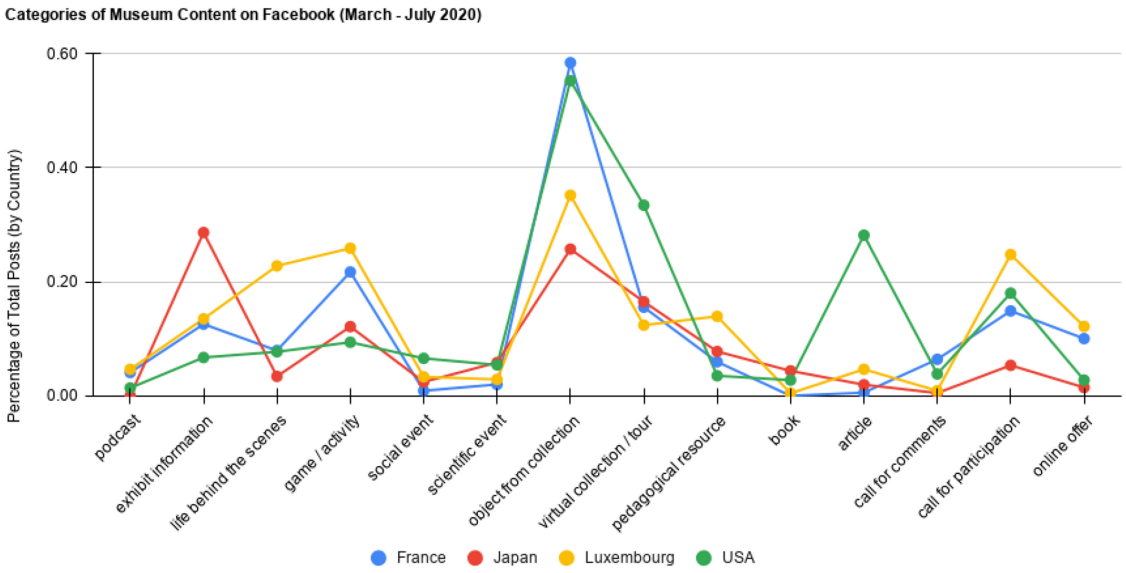

Fig. 11. Types of digital content shared during the March - July confinement period.

7.2 Categories of Digital Experiences

Across the different categories that we established in our original coding scheme, the largest proportion of posts featured objects from the collection, either as an image together with other content, or as a focus on the object itself (Figure 11). This was particularly true in the case of the United States (55%) and France (58%) where more than half of all posts featured objects from the collection. If we include posts advertising virtual tours or invitations to the museum's digital collections the proportions dominate the global amount of posts for both France (74%) and the US (89%), and constitute a significant share of them for Japan (42%) and Luxembourg (48%). This shows that regardless of current discussions about what constitutes a museum [14, 40], the physicality of the collection nevertheless strongly defines these types of institutions.

We identified a variety of different museum activities advertised throughout the confinement period. Ranging from video games to book clubs and even a virtual MET Gala, museums experimented with different approaches to engage audiences. We mapped the varieties of museum activities onto Simon's [73] hierarchy of interaction (Figure 12), with the particular aim of identifying those activities with high levels of social engagement (levels 4 and 5).

Overall, museums offered a diversity of content across the different levels of interaction. Interestingly, some activities that began as a lower level of networked interaction evolved to a higher level as a result of online visitors making them 'their own'. The Met Gala, for instance, which under normal circumstances has the reputation as an event for a privileged few, acquired a new participatory dimension when it made its virtual debut. Influencers and laypeople alike joined to answer the invitation to celebrate online in their finest dress [37].

The hashtag #TussenKunstenQuarantaine followed a similar, though more complex path. Beginning as a private initiative on March 14, 2020, the hashtag became a viral sensation after its adoption by the Rijksmuseum and other international museums such as The Metropolitan Museum in New York, the Musée du Louvre in Paris, and the Hermitage in St. Petersburg [28]. The Getty Museum in Los Angeles then appropriated the hashtag, transforming it into their own unique version #GettyMuseumChallenge, resulting in greater visibility, and echoing locally with direct translations of the original Dutch hashtag (between art and quarantine) [6].

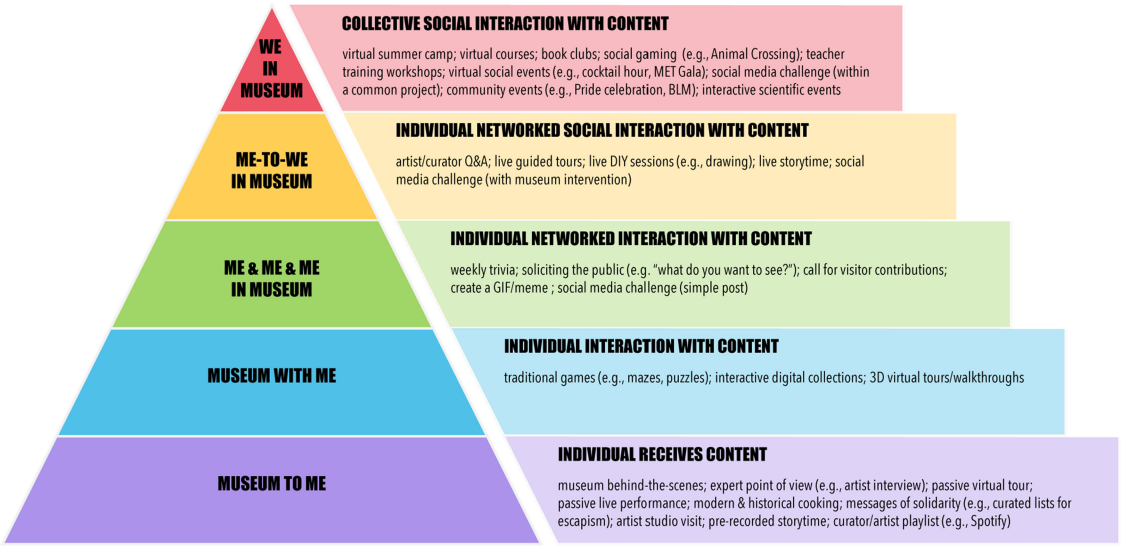

Fig. 12. Museum online activities mapped onto the Simon framework.

7.3 Evolution of Participatory Content

The results of our secondary analysis allowed us to compare the proportion of posts with high levels of participation (Simon's categories 4 and 5) between the first stage of the pandemic (March–July 2020) and the last four months of the year (September–December 2020). We visualize our results in Figure 13. In general, the proportion of posts that had participatory elements (e.g., calls to action, public events, etc.) did not change very much in the case of France and the United States (France: Mar–Jul 16%, Sept–Dec 16%; USA: Mar–July 18%, Sept–Dec 15%), though in the US the frequency of highly participatory posts decreased somewhat. However, in Japan there is a clear distinction between the early phase of the pandemic and the later phase. It appears that as a result of the museum closures, Japanese museums involved in the study became more focused on community building and participatory activities to stay in touch with visitors. The data for Luxembourg shows an initial thrust of participatory activities during the period when the museums were closed to the public. This seems to taper off later in the year. We hypothesize that a combination of museum re-openings around the world, in addition to the increasing sense of screen fatigue due to reliance on digital tools for long periods of time [54] may have contributed to the lack of growth in the proportion of participatory posts. Indeed, participatory posts require an extra amount of involvement by museum professionals, a sentiment we found often in the survey data as museum professionals voiced their concerns about taking on extra work or questioned the longevity and efficacy of the digital-first approach. Moreover, the limitations compelled by the pandemic on public and community-oriented events likely added to the complexities of highly participatory events and activities.

8 DISCUSSION

In spite of the relatively homogeneous situation of the museums from our sample – especially when compared to museums from less privileged areas, as representatives from Columbia and Cameroon pointed out during the webinar "Preparing for the Reopening of Museums: The Aftermath of a Pandemic" organized by ICOM [43]– the museums studied nevertheless used digital tools to face the challenges of the confinement situation in rather different ways.

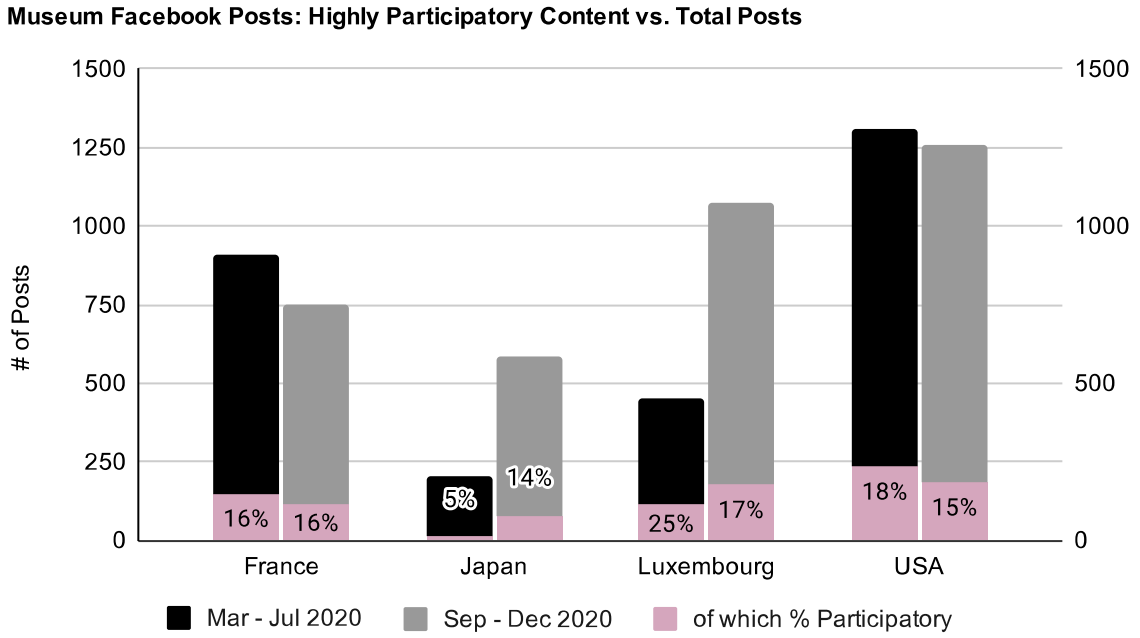

Fig. 13. Proportion of highly participatory activities during the early and later stages of the pandemic.

First, we distinguish between *internal* and *external* use of digital communications and content. A notable similarity across institutions internationally was the need to adapt quickly to new digital tools and workflows. In the past, remote work may have been a consideration for certain activities (ML2), but never at this pace or scale. Another common issue was digital literacy, which many participants felt they lacked, as well as related challenges including unstable internet connections (MF7) or issues accessing the museum's servers (MF13). The individual situations of museum professionals (their familiarity with IT and social media resources, their personal situations, their ability to access content and communicate with their teams) played a key role, as well as the fact that professionals often found themselves struggling with the challenges of isolation while simultaneously attempting to cultivate a feeling of solidarity amongst colleagues (MF2, MF1, MU4).

This period also emphasized the fact that no matter how virtual museums become, their physicality remains essential insofar as they are the custodians of objects that require tremendous care, a task that became a true challenge as confinement rules grew stricter over time. No digital tool could replace regular check-ins on the collections, and this reality seemed to translate directly into the *external* use of digital tools by museums as well. The larger share of Facebook posts dedicated to featuring physical collections reiterates precisely this institutional self-concept: many museums self-identify by means of their collections, and that is how they communicated, both on-site and online. Indeed, the sudden interest by museums around the world to collect COVID-related objects [18, 23] is also symbolic of this collection-based ethos.

Generally speaking, the frequency of social media posting did not change dramatically during confinement, but without traditional upcoming events or news to write about, museums had to be creative. Additionally, given that many museums recycled content already available to them, there may also have been a lack of new content to share. Prominent international institutions, such as the Smithsonian or the Metropolitan Museum of Art, who already drew large majorities of the physical and digital visitors before the pandemic, had the technical and financial means to face this challenge. They were also the institutions with the largest stock of digital content

available before the lockdown, which like many institutions around the world, they made available. A primary goal of museum digital communication was to maintain a connection with audiences, as the majority of posts across all institutions targeted the general public in lieu of any particular demographic. Occasionally, some museums responded to the needs of parents who were home with children, offering educational resources or youth activities, but overall posts concerning this information tended to comprise only a small percentage of the total. An even smaller proportion of posts targeted persons with disabilities, despite ongoing calls for ethical and informed accessible design within the museum and HCI communities [26, 52, 72]. For museums who already endeavor to make their content accessible, it is possible that they may not explicitly advertise it as such, but we hypothesize that for the museums who largely struggled to provide digital content throughout the confinement, either due to lack of resources or expertise, that a lack of design know-how for accessibility concerns was likely a major limitation.

8.1 The (Digital) Visit and Dialogical Engagement

We identify four types of visitor interactions in museums, which are not mutually exclusive but rather complementary:

(1) with their peers (family, members of the group)
(2) with experts (guide, curator, etc.)
(3) with mediation devices (texts, maps, screens, etc.)
(4) with physical objects (objects on display, space of the museum itself)

In the case of online visitors, especially in a context where the museum is closed to the public, the 4th interaction type is impossible, and 1 and 2 are strongly reduced. This places unique emphasis on type 3, which must exist by itself despite its original conception in direct relationship with type 4. While new technological approaches, such as substitutional and virtual reality attempt to approximate type 4 interaction with some success [76], nevertheless, in the context of the pandemic situation, visitors might seek to compensate for the lack of type 1 and 2 interaction, that is to say, by sharing a moment with people they know (or with strangers), exchanging with someone who could broaden their horizon, and developing a connection or sense of community beyond their screens. In consideration of this dialogical engagement with museums, we present two examples previously referenced in the results section: The MET Gala and Tussen Kunst & Quarantaine, which provide deeper insight into visitor initiatives with museums at the center.

8.1.1 The MET Gala and Tussen Kunst & Quarantaine. 'Why don't we have our own Met Gala next year?' wondered then University of Michigan bachelor student Aria Olson after the 2019 edition, as her fashion journalism student friend Margaux Merz reported in an article on Artnet in May 2020 [13]. Olson, together with eight online friends from seven different countries, decided to create four challenges echoing the theme of the 2020 Met Gala ("About Time: Fashion and Duration"), which soon took over the top trend on High Fashion Twitter. Two weeks before the event, their invitation was passed on by personalities such as singer and actor Billy Porter, echoing into Facebook, TikTok, Instagram, YouTube, and even Animal Crossing with the hashtags #MetGala, #MetGalaChallenge, #HFMetGala2020, ultimately making its way onto the Metropolitan Museum's social networks [2, 13]. People on social media were quite responsive, from famous vloggers like Bernadette Banner [4] and The Try Guys [78], to friends nominating each other and fashion professionals reposting the invitation [51], and when the virtual version of the Gala took place on May 4th, 2020, it gathered more than 1,000 participants online on High Fashion Twitter alone [13]. Large outlets such as The New York Times and Marie Claire but also websites like Buzzfeed reported on the event [19, 51] The New York Times even creating a page inviting people to participate [37] and on the museum's blog an article expressed how they had been 'inspired by everyone who took on this challenge' [48]. Starting as a small private initiative among friends, the challenge allowed anyone to participate in a once restricted-access event, and resonated with audiences on social media.

People felt encouraged to join the Metropolitan Museum of Art, making both the event and the museum much more inclusive.

A similar dynamic can be observed with the "Tussen Kunst & Quarantaine" (Between Art and Quarantine) challenge. Also beginning as a private initiative between friends on Instagram in the Netherlands in March 2020, it soon went viral on Instagram, Pinterest, Facebook, etc., echoing worldwide beyond just the circles of museum-enthusiasts, thanks to traditional and social media coverage [6, 7]. In April it spread even broader when the Getty Museum "rebranded" it as the #GettyChallenge, and within weeks both hashtags together had achieved hundreds of thousands of submissions [83]. Most cultural institutions, from international blockbusters like the Metropolitan Museum or the Musée du Louvre to local museums, including culture and most media, mentioned the challenge and invited the public to participate [12].

Similar to the previous example, visitor-driven initiatives going viral could suggest that when museums open their *virtual* spaces to outside influences, giving a voice to people they may not usually include, it can be the starting point of a mutually enriching exchange. The popularity of the Met Gala and #TussenKunstenQuarantaine challenge underscores the importance of active participation, self-expression, and the sense of community with the museum at its center, namely levels 4 and 5 of Simon's [73] framework.

8.2 A Virtuous Circle of Museum Participation

Building on Barry's [8] virtuous circle in museums and Simon's principles on how to give way to a 'participatory museum' in a traditional physical context, we argue that online tools, especially social media, should be analyzed through the same lens, across two main axes: *understanding digital visitors* and *giving them a sense of community* (Figure 14). For each coupling (e.g., online visitors -> on-site community) we map related low- and high-participation activities based on Simon's interaction levels. Just as on-site visitors can gather to become a community thanks to highly participatory mediation actions, highly participatory online actions can allow online visitors to build networks and achieve a sense of community, both online and on-site.

Within the inner circle of the diagram are low-participation activities, such as passive consumption of museum content (e.g., post about an image from the collection). These activities do not directly contribute to a sense of community or belonging on their own, but nevertheless form a part of the museum's digital presence. In order to enhance the outreach of these lower participatory activities, museums might find ways to make them relevant to their community. For example, when featuring an image from the collection of an object once belonging to a local indigenous population, the museum could invite members of that indigenous group to comment on its significance, or highlight the presence of its members in the local community.

In another example, a museum may connect its physical and digital spaces in ways that promote a sense of personal meaning and community well-being, concepts that have become an important consideration in contemporary HCI research [58]. During the confinement period, The National Gallery created a mindfulness meditation exercise on YouTube that featured breathing exercises while viewing artwork [77]. Transforming these static YouTube clips into live sessions can elevate the level of participation even further, especially if visitors can interact with the instructor. Advancing a step further along the virtuous circle, inviting visitors to join live sessions in the gallery spaces moves the mindfulness activity from online to on-site, creating new avenues for community participation in museums.

To evolve from #MuseumAtHome to *at home in the museum*, visitors need to have a sense of belonging – they must feel that they are a legitimate *part of it*. Surveys done in 2020 show that the people who visited the museum's social media and websites were younger and less familiar with these institutions than their average on-site visitors [53], which presents a unique opportunity to make a new audience feel welcome in a place they have only dared to enter virtually, reaching out to this new digital visitor. Whether online or on-site, museums must foster their communities, especially in a context of isolation and social divide when the very existence of museums is under scrutiny, politically and economically.

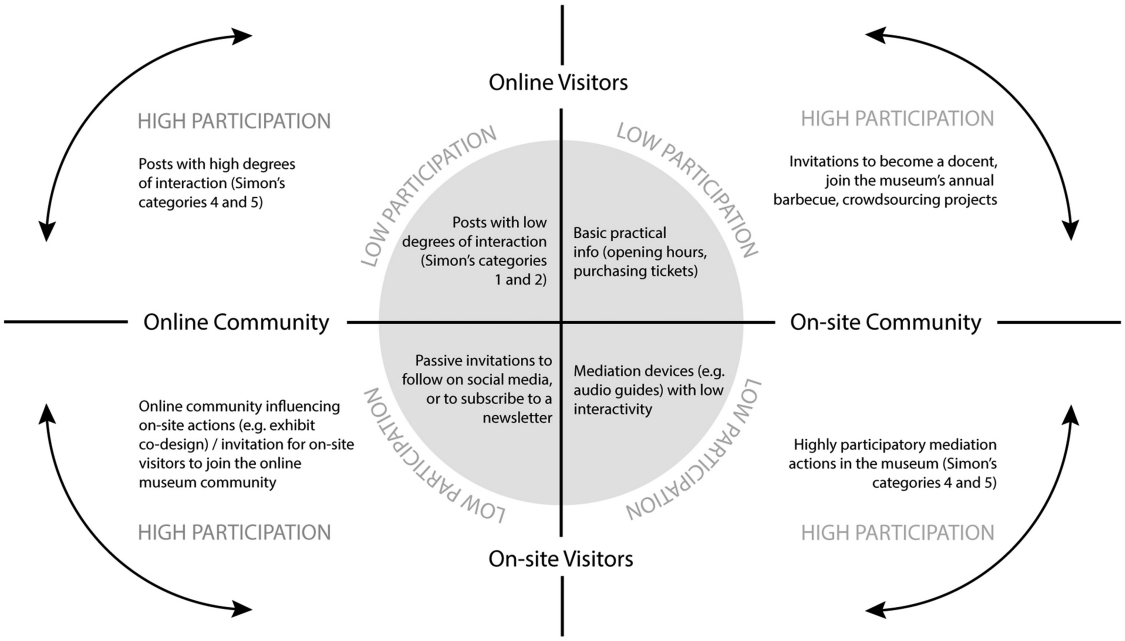

Fig. 14. Giving way to a 'participatory museum' on-site and online: A virtuous circle of high participation.

In this strained context, taking into account digital fatigue and limitation of means is essential, and the *virtuous circle* we propose aims to integrate existing services offered by museums as much as possible rather than simply requiring additional resources. In contrast to the traditional conception of the museum, where selected groups of experts seen as 'wardens' are the sole providers of content, and where interaction happens in a limited, usually top-down manner, this scheme encourages curators and cultural mediators to adapt their production to a new reciprocal form of engagement with the public.

9 LIMITATIONS AND FUTURE WORK

In reflecting on this research, we identify the following limitations and opportunities for future work. First, our sample size (31 responses from 29 museums) is comparatively lower than some of the other studies discussed in the related work section. In spite of this, our results demonstrate similar trends in the data, such as a surge in social media activity by museums (or a continuation of activity by those who already had a well-established presence) and visitors alike, as well as many of the infrastructural and technical challenges faced by institutions around the world. Moreover, the sample size concerns only the survey itself, and not the larger Facebook analysis we conducted, which included both participating museums and numerous internationally-oriented institutions (e.g., The Met, Mori Art Museum). We also included interviews with two museum professionals outside of the geographical area of focus to achieve a wider perspective from both an academic and industry context.

A second limitation concerns the role of different audiences who accessed museum content during the pandemic. In taking a more global view, our findings showed that while the large majority of Facebook posts from museums targeted a general audience, that future work may benefit from understanding the digital visitor across a wide variety of contexts, such as users who seek educational experiences, people with disabilities, young children, or even casual users.

Finally, future work will explore how the virtuous circle can apply to museums of different sizes, funding schemes, and levels of digital expertise to optimize its use in a variety of institutional settings.

10 CONCLUSION

For institutions as deeply tied to their physical dimension as museums, it was striking to observe the extent to which the need to maintain a connection with people from within and beyond the walls of the museum led professionals to rely on digital tools. This did not mean that the importance of the collections or their tangibility has in any way diminished. Just as confinement made us all aware of the limitations of virtual socializing, confronting ourselves to the physical reality of the museum and its collections gains a special meaning in a society where a growing number of our activities are dematerialized.

During the first confinement, pressured by the urgency of the situation and a lack of means at their disposal, museum professionals faced an unforeseen challenge: finding new ways to engage with audiences using tools which, for many, were at least partly new. Moreover, the work continued without what constituted the heart of their job, that is to say, direct contact with the collections. Thanks to the help of national and international institutions – but mostly to the dedication and hard work of entire teams – a very large majority managed to overcome this challenge, at least partly.

Indeed, museums in most cases managed to maintain a connection with their audience. Also, they remained "open online" and allowed many people, especially children and educators, to find an escape, solace, or support during a difficult period. In some cases, this might have even allowed some to reach new audiences. But in most cases, the use of new tools did not signify a new approach to audience engagement or technological development. Our findings build on previous work that argues for a hybrid museum experience that embraces the interconnectedness of the digital and physical visit. When a museum, whether through its community manager, members of the education team, or an open-minded curator, engages in dialogue with online initiatives and gives them visibility, it empowers its community, and in return gives the institution visibility and a stronger connection to its visitors. In a context where the very existence of many institutions is questioned, we can only call for stronger museums, tightly engaged with a stronger community. It is a long but essential process, one that means changing #MuseumAtHome into #AtHomeAtTheMuseum, making it a part of the community through a virtuous circle of engagement.

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