How Could Museums Improve Their Digital Collections for New Online Audiences? Some Suggestions From an Empirical Survey with Gen-Z students

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| abstract

The empirical research, conducted in May 2023 at the University of Bari (Italy), within the European project 'Cultural Heritage Active Innovation for Sustainable Society – CHANGES' code n. PE00000020 – CUP: H53C22000860006, analyzed how Gen-Z students in Museology approach museums digital collections after their online lockdown experiences. The theoretical framework of this research based on the Museum of Connection model and starts from the question: are museums understanding how young online audiences approach their digital ecosystem, of which digital collections are a key component? This theoretical framework was the premise to allow students to acquire skills for an evaluation workshop. By answering a questionnaire, the empirical analysis concerned the perception of 30 international and Italian museums' web strategies. Following the qualitative analyses, led in classroom and at home and then presented by each student to the others, by browsing the selected museums' websites, a real collective and participatory brainstorming started, from which a qualitative evaluation derived for 34 criteria (from usability to digital collections to communication on social media). While the general research on all the analyzed criteria is going to be published, this paper will, instead, analytically describe the single "online collection" criterion, according to 24 sub-criteria (from navigation usability to digital co-curation solutions of the online collections). As direct users of digital cultural content, through students' experiences we want to provide a general indication useful to show how much is necessary overthrowing the mindset, to fill the gap between perception, reality and desire for museums digital collections, and their communicatin, attractiveness, and interaction with young potential visitors.

Introduction

During the Museology course (2022-2023) at the University of Bari, a workshop has been organized, within the "Cultural Heritage Active Innovation for Sustainable Society – CHANGES" project[1]. A first overview about the evolution of the museum model started from the *forum* museum model (Cameron, 1971) to the

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1. "CHANGES" is a multi-technological and transdisciplinary ecosystem for training, research, technological transfer related to humanistic culture and cultural heritage, granted by the European Next Generation EU program (https://sites.google.com/uniroma1.it/changes/home?authuser=0).

museum of connection one (Bonacini, 2022), by considering the museum a sort of phygital hub, able to connect people and heritage through stories. The course developed as a new proposal in digital art-history teaching, in line with new disciplines about Digital Heritage and the digital museum ecosystem, according to new methods of management, enhancement, communication and dissemination of the museum heritage online. This framework was the essential premise to allow students acquire the correct skills for the online investigation activity, which they were called upon in the last part of the workshop: an empirical and qualitative analysis, by answering an open-ended questionnaire about the quality of online communication of 30 museums, as read through their perception of museums' web strategies, according to the qualitative evaluation derived on 34 specific criteria (from usability to communication on social media). While the general result of this work is going to be published by an interdisciplinary scientific group[2], a specific focus on "online collection" criterion will be presented in this paper, by analytically considering 24 sub-criteria (from navigation usability to digital co-curation solutions), that allow us to provide a separate commentary on students' online experiences as users of online cultural collections.

State of the Art

According to the ICOM-Italia survey (2018), museums' web strategies must be adapted to five macro-categories: *Information architecture, Content strategy, User interface design, Community building* and *Creative (re)use of contents*. While implementing contents with which users can interact, most of websites have an informative and one-way model rather than a dialogic, participatory, collaborative, and bi-directional one (Bailey-Ross, 2021; Kabassi, 2019). This was also confirmed by the students' user experience within their workshop activity.

The well-known digital reaction of museums to the lockdown has been widely documented by institutional surveys and reports on an international (UNESCO, 2020; ICOM, 2020a and 2020b; ICOM, 2021), European (NEMO, 2020 and 2021) and national scale (ICOM-Italia, 2020 and 2023; Civita, 2021; Cicerchia, & Minuti, 2021), which were followed by further specific publications (Agostino, Arnaboldi, & Lampis, 2020; Biedermann, 2021; Radermecker, 2021; Raimo et al., 2021; Resta et al., 2021; Ryder, Zhang, & Hua, 2021; Toffoletti, 2021) and countless digital mapping projects, such as the *Mnemonic Atlas*[3], the *Digital Museum*[4] or the *Culture Labs recipes*[5]. According to studies and reports, as a general digital reaction to the lockdown, implementation in online cultural experiences influenced both museums' engagement strategies, their own attractiveness and role on heritage preservation and memory-making (Markopoulos et al., 2021; Palumbo, 2022; Raimo et al., 2021; Ryder, Tinting, & Hua, 2021; Tamborrino et al., 2022; Yap et al., 2024).

While research on cultural digital offer appear to be numerous and increasingly transdisciplinary, studies conducted on the perception and impact that this offer had on the most diverse audiences and on the young people of Generation Z, who are the object of this investigation, are more limited. Representative of the so-called Z Gen or

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2. Bonacini 2024, forthcoming.
3. http://www.mnemonic.polito.it (Tamborrino et al., 2022).
4. https://digitalmuseums.at/index.html (Zuanni, 2020).
5. https://recipes.culture-labs.eu/public-assets (Kaldeli et al., 2023).

Zoomers, this is a "digital natives" generation (mid-1990s – 2010), who does not know a time without Internet and smartphones, fully involved in content production as pro-sumers and in a viral digital word of mouth process. Zoomers are natively familiar with mobile devices and social media, with new symbols and languages, with visual contents and immersive experiences (Diez, 2021; Feitosa, & Barbosa, 2020; Lee, Park, & Lee, 2022; Russo, 2023, Turner, 2015).

Unattractive for the youngers, generally considered non-visitors (Bonel, Capestro, & Di Maria, 2023; Cesário, & Nisi, 2022; Drotner, Knudsen, & Mortenesen, 2017; Kluge-Pinsker, & Stauffer, 2021; Ortega Mohedano, García, & Pérez, 2020), museums could develop adequate digital strategies to attract them (Batat, 2020; Manna, & Palumbo, 2018; Ortega Mohedano, García, & Pérez, 2020), by offering engaging experiences of storytelling, gami-fication, interactivity, sociality and virtual and augmented reality (Bonacini, 2022; Feitosa, & Barbosa, 2020; Khalil, Kallmuenzer, & Kraus, 2023; Longo, & Faraci, 2023; Markopoulos et al., 2021; Vrettakis et al., 2019). Their social and technological relationship with museums is, in fact, confirmed by recent studies (Bonel, Capestro, & Di Maria, 2023; Cesário, & Nisi, 2022; Diez, 2021; Lopatovska, 2015; Kluge-Pinsker, & Stauffer, 2021; Russo, 2023, Ryder, Tinting, & Hua, 2021; Tranta, Alexandri, & Kyprianos, 2021), but this relationship needs to be more Gen Z-oriented.

Research Question and Investigation Methodology

Previous studies have been oriented in defining museums websites' technological aspects rather than focusing on expectations, perception, and user experience of specific targets; in rare cases, the Zoomers target has been taken into consideration, always referring to high school students (Bonel, Capestro, & Di Maria, 2023; Lopatovska, 2015); only in a recent case, students come from university (Komarac & Ozretić Došen, 2023).

So far, we have not asked ourselves what kind of motivations, expectations and perceptions regarding digital museums more mature students have; specifically, digital native art students. Post 2000 class, they experienced lockdown starting from first-year matriculation at the University and interacted with art almost exclusively in a remote mode (Ryder, Tinting, & Hua, 2021). Their previous approach with digital cultural communication allowed them to appreciate its extreme variety and pro-activity potential, in line with cultural consumption during the pandemic period (figure 1). However, great expectations have been produced about the quality of digital museums' communication and their visitor-user oriented approach, considered as elements to reduce their sense of exclusion (Longo & Faraci, 2023, Russo, 2023).

This contribution therefore aims to fill the gap about documenting the Gen-Z university students' perception, with respect to specific digital cultural contents, such as the online collections, as analytically presented in this paper.

Through their loupe, we want to provide useful indications to understand the disconnection between perception, reality, and desires of cultural institutions, by reversing the perspective and placing them on the side of digitally educated students, as current consumers of culture onsite and online, and as future consumers, scholars, individuals, and families.
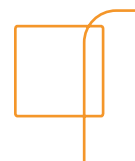
Pre-pandemic	During-lockdown
Activities during the online visiting:	**Activities during the online visiting:**
- **Looking for information** - **Playing games**	- **Taking virtual tours** - **Watching videos** - **Perusing & reading about collections**
Exploring of the collection	**Exploring of the collection**
- **Browsing** - **Following a logical digital tour**	- **Reading collection description** - **Following both a logical and a guided digital tour**
	Attributes liked during the visiting
	- **Learning / involving experience** - **Features of online experience** - **More time to enjoy collection**
	Motivation of visiting
	- **Because it is interesting** - **Performing the digital activities on website**

Figure 1. Differences in online museum visits between pre and post pandemic for the Generation Z target (adapted from Bonel, Capestro, & Di Maria, 2023, p. 154, fig. 1).

A crucial element in their life cycle, evaluation of museum websites can be carried out through empirical methods (involving potential users), inspections (involving experts) or in a mixed way (Davoli, Mazzoni, & Corradini, 2005; Chiou, Lin, & Perng, 2010; Kabassi, 2017; *Ead*., 2019).

As teaching activity, students chose 30 different Italian and international museums websites, motivated by a cognitive approach to the collection (for personal research or future travels) or by an in-depth analysis.

The survey involved a total of 13 international museums websites[6] and 17 Italians[7].

The qualitative analysis was first done at home, by answering analytically a specific open-ended questionnaire. Then, the online investigation was presented in classroom by each student to the others, browsing the chosen website. The peer instruction flipped classroom teaching method adopted allows students to become tutors for their peers, thus facilitating involvement, debate, and the social dimension of learning, further activated by the teacher as a mentor (Lage, Pratt, & Treglia, 2000; Strayer 2012). This interactive method appeared to be the most valid and useful in evaluating students' reactions, without limiting themselves to the answers provided in the questionnaire, since the debate in some cases reshaped their first impression.

Starting from the empirical analysis methods and the museum websites' and digital collection evaluation criteria known in literature (Chiang, Tsaih, & Han, 2016; Garzotto, Matera, & Paolini, 1998; Fotakis, & Economides, 2008; Kabassi, 2019; La Foresta, & de Falco, 2018; Lopatovska, 2015; Marty, 2007; Pallas & Economides, 2008; Theocharidis et al., 2014), as well as from the 5 web strategy macro-categories identified by ICOM-Italia (2018), and from the consequent collective brainstorming in classroom, together

6. British Museum and National Gallery; MET-Metropolitan Museum, MoMA-Museum of Modern Art and Morgan Library & Museum; Musées d'Orsay, de L'Orangerie and du Louvre; Russian State Museum in St. Petersburg; Egyptian Museum in Cairo; Museo Nacional del Prado and Museo Nacional Reina Sofia; National Museum of Korea in Seoul.

7. Galleria Borghese, GN-Galleria nazionale d'arte moderna e contemporanea, MAXXI, Musei Capitolini and Musei Vaticani in Rome; Galleria degli Uffizi and Museo Galileo in Florence; Museo Egizio in Turin; MADRE-Museo d'arte contemporanea Donnaregina and MANN-Museo archeologico nazionale di Napoli; Palazzo Ducale and Peggy Guggenheim Museum in Venice; Pinacoteca Ambrosiana and Pinacoteca di Brera in Milan; Pinacoteca di Bologna (Bologna picture art gallery); Reggia di Caserta (Caserta Royal Palace); MArTa-Museo archeologico nazionale di Taranto (Taranto Archaeological national museum).

with the mentor, all the results and feedbacks have been collected and re-adapted by co-building a general evaluation table of the analyzed websites. Starting from the teaching activity, this method produced a qualitative, collective assessment for 34 different criteria[8], inspired by the indicated literature and adapted to our needs and to the evolution of technologies, global platforms, tools, marketing strategies, as well as the expectations of remote users and of this specific target involved in the analysis. No analytics or quantitative metrics relating to permanence on the site or the amount of likes or views were taken into consideration. The analysis took in consideration the difference between the museums and their collections, both from a quantitative point of view and from the digitalization and digitization efforts made so far, therefore the quality of communication of the online collections and the digital and interactive experience on the user side have been evaluated.

Digital Collections: Evaluations From an Empirical Analysis

Starting from the overall evaluation, a specific commentary on museums' digital collection will be presented here, by analytically focusing the "online collection" criterion, according to 24 sub-criteria about the type of contents and their usability we could pull out from the empirical evaluation of *28 digital collections*[9] during the process of data analysis (figure 2): filterable database; high-resolution images; images download; images manipulation (zoomable/browsable); 3D models; highlights; thematic routes; alphabetical order by artists' names; catalog data (as author, object, era, dating, inventory number); scientific description; narrative description; bibliograph; tagging; interactive location in the rooms (through maps, tag etc.); records correlation (suggestions based on research, by author, typology, dating, etc.); Google Arts&Culture (if there is a profile); timeline; URL (directly obtaining the record's URL); sharing; printing; audio descriptions; related videos or multimedia content; creation of users' collections or favorites' galleries; digital co-curation (with suggestions, tagging by users, etc.).

As said, since these collections are numerically very different from each other, digital collections artworks' number was not taken into consideration. Evaluation has been strictly rigorous on how (and if) these collections are usable by remote users and if they are reusable for non-commercial use, according, in same cases, to specific statements on digital collections, as well highlighted by the British Museum, the Prado or the Louvre. As done in the general in-depth research, a reasoned score, from 0 to 10, was given to each sub-criterion, to obtain a new qualitative ranking specific for online collections (figure 3). The scores were given by the author, by extracting and re-using the individual data provided by the students for the general research, according to the specific sub-criteria.

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8. The evaluated elements concerned 34 categories: usability; accessibility (physical to the museum, digital to the museum, cognitive, digital to the website); information on the visit; exhibitions and events; archive of exhibitions and events; collection's catalog; newsletter/mailing lists; hyper textuality; interactivity (virtual tour, interactive maps, chance of creating your own collections, etc.); 3D models/Sketchfab; Google Arts&Culture; multimedia; application/audio guide; podcast,; game; e-ticketing; e-shop; card/membership; educational activities (guided tours, workshops, etc.); activities for different audiences (families, seniors, etc.); blog; YouTube; Facebook; Instagram; Twitter (become X in July 2023); Tik Tok; Pinterest; LinkedIn; Flickr; Foursquare; and a Strategic Plan. In addition to the aforementioned bibliography, the terminology adopted was based on the Digital and Technology Glossary published by ICOM-Italia (2020).

9. The websites of the GN and the MAXXI in Rome were excluded from this report, because they don't have an online collection on their own website.

	BROWSING DATABASE	HIGH RESOLUTION PHOTOS	DOWNLOAD PHOTOS	MANIPULATION PHOTS	3D MODELS	HIGHLIGHTS SECTION	THEMATIC ROUTES	ALPHABETICAL ORDER	CATALOGUE SHEETS	SCIENTIFIC DESCRIPTION	NARRATIVE DESCRIPTION	BIBLIOGRAPHY	TAGGING	INTERACTIVE LOCATION IN ROOMS	CORRELATION BETWEEN RECORDS	GOOGLE ARTS & CULTURE	TIMELINE	URL	SHARING	PRINTING	AUDIO-DESCRIPTIONS	VIDEO	CREATE YOUR OWN COLLECTION	DIGITAL CO-CURATION	FINAL SCORE
1 BRITISH MUSEUM	X	X	X	X	X	X	X		X	X		X	X		X	X		X		X	X			X	10
2 METROPOLITAN MUSEUM	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X		X				10
3 MUSEUM OF MODERN ART	X	X					X	X	X		X	X		X	X					X					8
4 MORGAN LIBRARY & MUSEUM	X	X	X	X	X	X	X		X	X	X	X	X		X	X						X			8
5 D'ORSAY	X	X		X			X		X	X	X	X	X		X	X		X						X	9
6 MUSEE DE L'ORANGERIE	X	X		X		X	X		X	X	X	X	X		X	X		X						X	9
7 MUSEE DU LOUVRE	X	X	X	X		X	X	X	X	X	X	X	X	X	X			X	X	X		X			10
8 MUSEO DI STATO RUSSO		X		X		X	X		X	X	X		X		X	X			X		X				7
9 MUSEO EGIZIO DEL CAIRO		X	X			X			X	X			X		X				X						5
10 MUSEO NACIONAL DEL PRADO	X	X	X	X		X	X	X	X	X	X	X	X		X		X		X	X	X	X	X		10
11 MUSEO NACIONAL REINA SOFIA	X	X				X	X	X				X		X	X	X						X	X		7
12 NATIONAL GALLERY		X	X	X	X	X		X	X	X	X		X	X	X	X						X			8
13 NATIONAL MUSEUM OF KOREA	X	X	X	X	X	X	X		X	X										X					6
14 GALLERIA BORGHESE	X	X	X			X	X	X	X	X	X	X	X	X											7
15 GALLERIA DEGLI UFFIZI	X	X		X	X			X	X	X		X		X	X			X				X			7
16 MADRE DI NAPOLI						X		X	X		X	X	X		X										3
17 MUSEI CAPITOLINI				X	X		X	X	X		X	X		X	X			X					X		7
18 MUSEI VATICANI	X			X	X	X	X	X	X		X			X			X	X							6
19 MUSEO EGIZIO DI TORINO	X	X	X				X	X		X	X														7
20 MUSEO ARCHEOLOGICO NAZIONALE DI NAPOLI		X				X		X	X	X	X	X		X	X										6
21 MUSEO ARCHEOLOGICO NAZIONALE DI TARANTO		X			X			X		X				X											3
22 MUSEO GALILEO		X				X	X	X	X	X	X	X	X	X	X			X	X		X				7
23 PALAZZO DUCALE DI VENEZIA	X					X	X		X			X		X											6
24 PEGGY GUGGENHEIM	X	X				X	X	X	X		X	X		X					X						7
25 PINACOTECA AMBROSIANA	X	X		X		X		X	X	X	X	X		X	X			X							8
26 PINACOTECA DI BOLOGNA	X							X	X																4
27 PINACOTECA DI BRERA	X	X	X	X		X		X	X	X	X	X		X				X			X				8
28 REGGIA DI CASERTA			X		X		X					X													5

Figure 2. Evaluation criteria for the selected museums' digital collection © Elisa Bonacini.

The presence of *easy-browsable collections*, in which artworks descriptions are rich in information and insights (in some cases in a plain and narrative language), data on restorations and bibliographic reference, good resolution photos, interactivity and ease of interface navigation, as well as well-articulated solution in indexing or tagging, displaying of related objects, linking to other contents, were considered strong points of the online catalog of the British Museum (the collection stands out for its organization by suggested universal themes, cultures, stories as well as by masterpieces; it offers a rich keyword search engine by fields; browsing and searching are very fluid and customizable; search sharing, saving or printing are available)[10], the MET (through a basic and an advanced search by highlights, collections, and themes, users can consult and filter the entire catalogue by different fields; a brief general overview with data record is given; collection can also be browsed by an interactive map and an art history timeline)[11], the Louvre (a separate site opens a database in French and English; the main sections are presented by type of artefacts; some sections allow quicker discovery, for masterpieces or specific themes, organized by albums; an interactive map allows an immediate perception of the works on display inside; sections are introduced by curiosities about the collections or the department and, in some cases, by videos; search sharing, saving or printing are available; the Louvre supports *Corpus*[12], the scientific research database, related to the collections)[13], the Morgan Library & Museum (a large collection of drawings as well as manuscripts, paintings and artworks is available; the navigation menu allows users to discover highlights and the specific collections; the *Digital Facsimiles* section offers a wide selection of accessible and downloadable digital content; users are allowed to tag but not to share or save their

10. https://www.britishmuseum.org/collection.
11. https://www.metmuseum.org/art/the-collection.
12. https://corpus.louvre.fr/s/corpus/page/accueil.
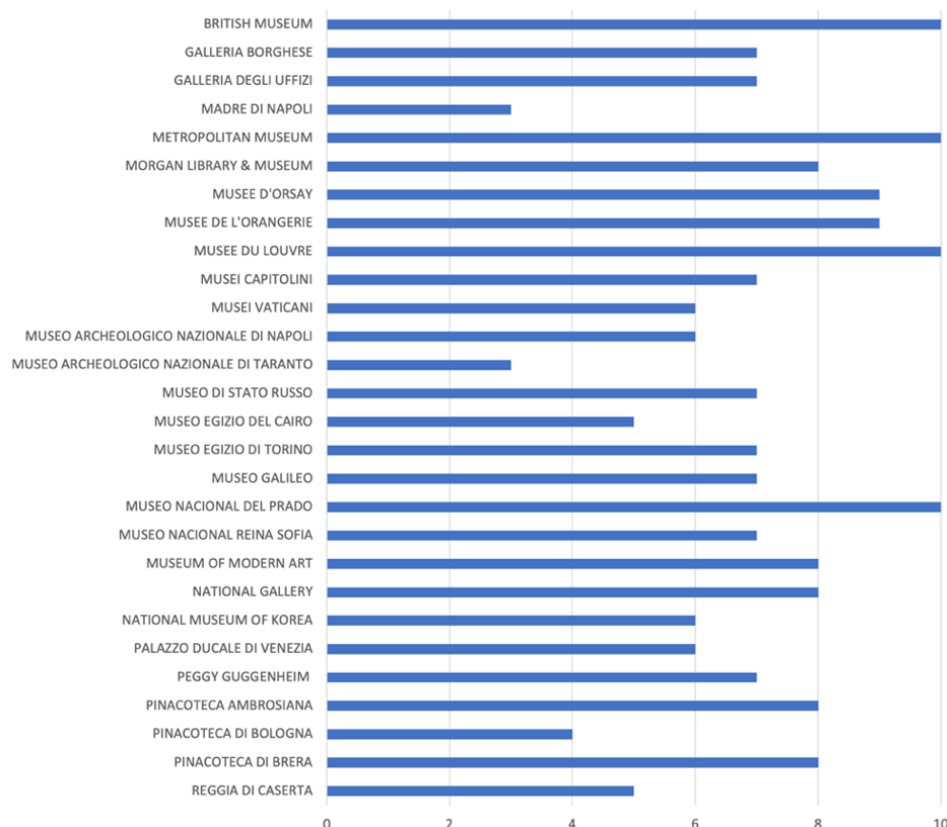13. https://collections.louvre.fr.

Figure 3. Evaluation score for the selected museums' digital collection © Elisa Bonacini.

searches)[14], the Museo Nacional del Prado (considered by the students the most easily and dynamically browsable for any type of search, thanks to tags and numerous database filters; the artworks' sheets are well detailed, supported by multimedia content, such as videos; a sliding alphabetical line allows users to consult all the artists in collection; tags and keywords facilitate records cross-searching; images could be collected as favorites in users' personal collection through *Mi Prado* area, where they are free to create their own art itinerary and share it on social networks or consult the suggested itineraries; an artwork can be related to historical events thanks to a virtual timeline; furthermore, the emphasis given to the artistic production of women in art stands out, with a specific online catalogue and thematic artworks itineraries)[15], and, finally, the Musée d'Orsay[16] and L'Orangerie[17], which have the same database and search structure (artworks descriptions are all very visual and well organized; in addition to a narrative description, an interactive index allow users to orient themselves in scrolling pages, with respect to the contents; users can copy the captions but not the text; they can suggest a new tag, but they can't create their own collection or share directly an artwork on social media).

The MoMA collection[18] offer an *Art terms* glossary describing some artistic techniques, movements and terms users will meet in their consultation, with direct links to the artworks; search by artist refers to a biographical page, while artworks have essential captions with the artist's name, the title, and the year of creation; basic technical details follow; descriptions are linked to the corresponding voices on Wikipedia. Unfortunately,

14. https://www.themorgan.org/collection.
15. https://www.museodelprado.es/coleccion.
16. https://www.musee-orsay.fr/fr/collections.
17. https://www.musee-orangerie.fr/fr/collection.
18. https://www.moma.org/collection/.

users can't create their own collections, nor download or reuse the images (copyrighted), which in any case have an excellent resolution.

Positive was the evaluation of the National Gallery online collection (figure 4)[19], with artworks shown in a very visual way; all tags allow users to browse the collection thanks to an interactive map. Consultation is very intuitive, users can search through the bar at the top left, even if simplified to the point of being reductive. Photo open in full screen and could be observed in detail, but users cannot create its own collections. Through side-opening captions, a top menu allows users to discover the key elements of an artwork, while the artist's biography is connected to videos, interviews, online resources; users can read a more concise description of the work, summarizing its history and technique in a few lines (*Overview*) or an *In-depth* one.

Disappointing due to the excessive conciseness of the artworks' sheets (despite a double online catalogue) is the other Spanish collection, that of Museo Nacional Reina Sofia. *Colección*[20] is introduced by video on each theme and an overview of the artworks on display. The actual catalog, which can be consulted from a database in common to all the other activities of the museum (causing confusion), allows users to filter the artworks, with images in high resolution, followed by brief data information, without any explanation or description. Download or enlarge photos is not allowed, nor tagging or creating our own collections. *La Digital del Reina*[21] is the second digital database (for archival, documentary, audiovisual, photographic collections etc.), where artworks have simple, but cold captions with limited data. In this website, however, registered users can create their own personal collection and tag the artworks.

The Russian State Museum[22] collects artworks from eight institutions, with some critical issues. Collections are divided into categories or themes, but the site often becomes black and white, when shifted in English. Users can't create their own collections or download the images. A selection of masterpieces shows about 20 artworks for each category from the different institutions, introduced by a brief data description. To discover the collection, users need to browse the *The Virtual Russian Museum* portal[23], in Russian, with a narrative artworks' description in English; it is possible to discover and browse all the artworks on display, linked to interactive maps and virtual tours of the rooms. High-resolution, zoomable photos, can be shared on social media. Lacking a filterable database doesn't allow a canonical consultation.

Browsed in English, the National Museum of Korea collection database[24] shows part of the online collection as a sort of photo gallery, through a simplified search. Each object is shown by a high-resolution image, a description with the main information and (not always) a more detailed description. The images can be enlarged, downloaded, and saved in Qr code and among users' favorites (if logged in), printed and shared on social networks and via e-mail; downloading the entire data record is allowed. Bibliographic references and tags are missing, and the database search is a bit cumbersome.

The Egyptian Museum in Cairo offers a masterpieces' selection[25], rather than an online catalog, a sort of photo gallery preview, with captions on a scrolling page, like a social wall; the descriptive captions are simple and easily understandable within the cata-

19. https://www.nationalgallery.org.uk/paintings/search-the-collection.
20. https://www.museoreinasofia.es/coleccion.
21. https://ladigitaldelreina.museoreinasofia.es.
22. https://en.rusmuseum.ru/collections/.
23. https://rusmuseumvrm.ru/collections/index.php?lang=en.
24. https://www.museum.go.kr/site/eng/relic/search/list.
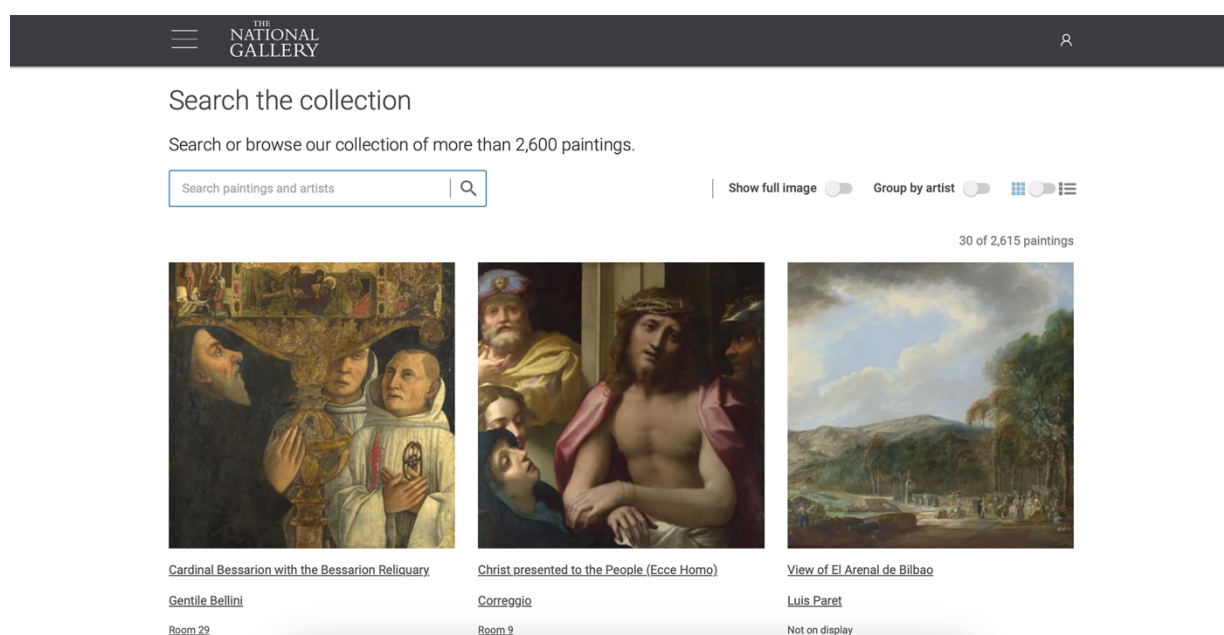25. https://egyptianmuseumcairo.eg/emc/the-collection/.

Figure 4. Screenshot from the National Gallery's digital collection.

loging data provided; there are tags and photos in excellent resolution (sharing on social networks and downloading are allowed). A simple didactic but not interactive timeline is a sort of scrolling page, in which artifacts are arranged on a vertical timeline with a brief explanation.

The richest in information and easily browsable Italian collections were those of the Pinacoteca Ambrosiana[26] (easy and intuitive; it is not allowed tagging, creating your own collection or download the images; however, sharing on social media is allowed; photos' resolution is very high; description is concise with the main info and a more detailed description, with tags as suggestions for a more interactive navigation); the Pinacoteca di Brera[27] (well-built and very interactive, thanks to tags and an interactive map; browsing is easy and intuitive, various sections are accessible, with the database useful for advanced search; a sheet catalogue provides the main information and a fairly detailed description; in some cases, a caption follows with related media, such as videos, insights with tags relating to further content or other related artworks; finally, users can share on social networks); the Galleria Borghese[28] (users can easily search for artworks by name, author, keywords, tags; images' resolution is excellent, and it is possible to download them; scientific descriptions are very accurate, complete with a detailed technical data sheet; a critical issue concerns displaying of images: by enlarging a page for better readability – the text is written in tiny characters –, the image of an artwork does not fit the correct proportions); the Egyptian Museum in Turin[29] (search could be free or advanced and be filtered by objects, periods, materials, while a pre-compiled range period make it easier to browse it; users can't create their own collections or tag objects; description schematically report basic information with a selected bibliography, sometimes very rich, and only in some cases a brief historical or curiosities addition; the catalog of artworks is supported by the photographic archae-

26. https://www.ambrosiana.it/scopri/collezioni/.
27. https://pinacotecabrera.org/collezioni/opere-on-line/.
28. https://www.collezionegalleriaborghese.it.
29. https://collezioni.museoegizio.it/.

ological archive, divided on a geographic base, and by the online collection of papyri, the *Turin Papyrus Online Platform*)[30].

The positive impression of the Uffizi Gallery catalog has been partially critic, due to the lack of a searchable database by periods, authors, keywords, techniques etc. (the website offers rich scientific online databases, accessible from the *Digital Archives*, two for scientific, photographic, and archival documentation[31] and the Catalog[32]; by clicking on *Opere* the collection section opens[33], with a preview of the masterpieces with excellent quality images, a brief caption, and multimedia content; a zoomable image can be directly shared on social networks through button links, but it cannot be downloaded; after a list of main data, the related history and description follow, with some links and a couple of suggested tags for related artworks; browsing is allowed only by collections and techniques, not for author or era; there are no artist biographies or bibliography).

The Capitoline Museums' online collection evaluating was positive, with some critical issues[34]. The catalogue offers many routes to browse it: *Cerca opere* (a simple search bar with a drop-down menu, by heritage type); *Tutte le opere* (a not very functional scrolling page, like a social wall, in which sheets' previews are on display); *Percorsi per Sale* (it allows users to browse interactive maps of the different exhibition areas of the whole complex); *Percorsi per temi* (thematic collections), the *Galleria Fotografica* (with photos shown as a social wall, with caption below, too) and, for registered users, *Il tuo percorso* (through which they can create a visit route, with their favorite artworks). Intuitive to navigate, however, the catalogue does not allow a more refined search by record and does not give a perception of the artworks' quantity in the catalogue itself. Sheets can be shared on social networks, but images cannot be downloaded; artworks are unattractive for their photos' low resolution. Artworks' descriptions are fluent and non-technical, but not all. In general, basic data are shown. Additional contents are suggested for the same room, for other rooms or by theme.

The only scientific collection investigated, the Museo Galileo collection, among the first in Italy, reveals a somewhat antiquated visual, but is functional for its purpose. Accessible from the *Museo Virtuale* section[35], users can discover it room by room, both by section and by list of displayed objects. The sheets can be consulted alphabetically (and not from search filters); they have basic caption data, a description, good resolution, but not downloadable photos and a series of tags and various insights, which facilitate personalized and transversal navigation between resources. Research sheets can be shared on social networks, via e-mail and printed; a series of thematic videos allow for in-depth analysis of the collections; additional content are biographies, insights, and a glossary. The catalog can be downloaded in .pdf format.

The Peggy Guggenheim website offers the online collection[36] through a double navigation line, for artworks and artists. Artworks are shown with a preview image (copyrighted) and an essential caption. The filter allows users to simply select artworks, described with a good resolution photo (but cannot be enlarged or downloaded), a detailed sheet providing a non-technical description. Sheets can be shared, and a link button allows

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30. https://collezionepapiri.museoegizio.it.
31. Archivio Fotografico e Inventari (https://fotoinventari.uffizi.it/it/) and Progetto Euploos (cabinet of drawing and prints: https://euploos.uffizi.it).
32. https://catalogo.uffizi.it, which allows users to search by museums: Uffizi, Palazzo Pitti and Boboli Gardens.
33. https://www.uffizi.it/opere.
34. https://www.museicapitolini.org/it/content/search-artworks.
35. https://catalogo.museogalileo.it.
36. https://www.guggenheim-venice.it/it/arte/.

copying the caption. Only typology, collection and author tags allow transversal navigation. Users cannot tag or create their own collections.

Although filterable by different keywords and themes, the database of the Vatican Museums[37] appeared distracting and unattractive, with technical sheets and no tags (users can consult the Italian menu and the search bar, with a few items in English, and they can discover 100 most important artworks, but only 26 are complete with photographic and descriptive sheets; there are many levels of records querying, but sheets don't have tags; photos are in low resolution: users cannot tag and/or create collections, nor reuse the images; however, it is allowed to share contents via e-mail or download them; the artworks in most cases present essential technical data; lacking a more narrative description).

The MANN collection[38] is a selection of artworks, browsable by type of findings, even if cannot itself be filtered by keywords. Beyond the beauty of the images (not downloadable), most of the artworks have only minimalistic captions; descriptive sheets, where existing, open separately in .pdf, preventing any intertextuality and tags between the resources; consultation appeared a bit disappointing. It is possible to browse a selection of findings from the permanent collections, with a side-scrolling preview; beautiful high-resolution photos of the most representative pieces are presented, with a scrolling view, but is not possible to create user's collection.

The Palazzo Ducale's collection usability appeared dispersive and not very appealing. The database, housed on an external site[39], collects records from the historical-artistic and naturalistic heritage of the Fondazione Musei Civici di Venezia. The database can be browsed through three levels of research, simple, advanced, and structured; record can be filtered by type of content, with related scientific sheets. Consulting the catalog sheets relating to Palazzo Ducale is cumbersome, being common with other museums: it is necessary to use the advanced or structured searches to find a specific artwork. The catalog has a more scientific than informative nature; technical-scientific data are reported in the archival cards. A direct filter for the historical period and artworks descriptions are missing. Tagging or creating user's collections is not allowed. Photos are not always of good resolution; they cannot be zoomed and bear the watermark (copyright protection policy were considered by students a real form of "rejection"). Users cannot download, share, or save the research.

Evaluation of the Reggia di Caserta's collection isn't satisfactory, judged static, without tags, with brief cataloging data and with troubles in usability, due to the slow loading of the pages. By clicking on the collections section[40], they are divided by typologies, each with its own preview image. Users can browse the database by searching through the bar or by entering each of the thematic collections. A collection opens with the artworks' preview images and basic data (author, title, datation). A sheet has a minimal caption and a zoomable image, with basic data in the caption. In some cases, a related work is suggested. There is no description, nor the artworks can be browsed by tag. Photos have an excellent resolution; they can't be full screen enlarged and downloaded.
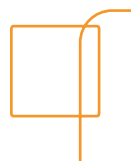
The user experience was totally not satisfying, due to a not very attractive and a not very interactive graphic design and layout (a sort of "digital wreck" 1.0), with non-zoomable images and heavy descriptions, in the case of the digital collection of the Pinacoteca

37. https://catalogo.museivaticani.va/.
38. https://mann-napoli.it/collezioni/.
39. https://www.archiviodellacomunicazione.it/Sicap/opac.aspx?WEB=MuseiVE.
40. https://reggiadicaserta.cultura.gov.it/collezioni/#/.

di Bologna: students assessed that offering this type of experience penalizes the value of the collection itself and, consequently, its attractiveness. The Pinacoteca has digitized a large part, if not all, of its collection of works of art. The negative evaluation about usability, graphics and layout of the website also weighs on the organization of the online collection, too. In an old-style interactive map of the museum, each room has a hypertext link to the list of artworks on display, distinguished by color. Preview images appear smaller than a postage stamp and the title is duplicated. Photos, in low resolution, cannot be downloaded or zoomed. Their sheets are simple and essential. The database offers the advanced search, which provides further filters, with selectable criteria from a pre-set drop-down menu.

Negatively evaluated were some solutions, as in the case of the MADRE collection[41], in which navigation appears chaotic, to the point of not understanding the collection's consistency (how many artworks and by which authors). *Collezione* opens a section where the artworks are organized by author. Clicking on a preview, essential information opens. Artworks have a brief description; a catalog sheet is missing. For some artists, there are external links, referring directly to the artists' personal websites. Photo resolution is not very good. Users can't download the images, nor create their own collection, but only share the information via e-mail and on social networks. They can't filter the data, nor browse through tags; one artwork refers to others without an understandable logic, making everything very confusing and dispersive. Moreover, captions appear difficult to be read, because they are too small and in a light gray color; the texts are often too long.

The other large southern archaeological museum analyzed, the MArTa, presents only a meager selection of findings, and consultation, therefore, it was very disappointing. Only introductions of the museum's thematic itineraries are shown, while the *Reperti* section[42] refers to a selection of 20 masterpieces with images and descriptive sheets. Images resolution is excellent, but users can't download or reuse them. Sheets, with essential data, are described in a narrative way, even if with a somewhat technical language; object's location within the museum rooms is indicated (but not linked to interactive maps). Users can't create their own collection or tag images or contents.

Really appreciated were those collections browsable through *interactive timelines*: as said, only the MET and the Prado Museum (figure 5) offer timelines, useful to "cross" time and geographical space or to "connect" events, historical figures, and artistic movements.

Even not only technical but *narrative description of artworks* were considered a strong point of some museums. The National Gallery provides two descriptive levels, one overview and one in-depth; while in Italy stands out the narrative style of the Capitolini Museums. In many cases, both narrative and scientific description are shown.

Disappointing, as said, are the Reina Sofia National Museum collection, the one from the Royal Palace of Caserta and the last one from the MANN, with *essential captions* or external in-depth information sheets in .pdf, only for masterpieces, in which it is impossible to search by tag or keyword.

Many international museum websites offer in general a rich *bibliography*. Only the MET offer downloadable bibliographic resources, the MET Publications; while the *Corpus* is the Louvre's database of scientific research related to the collections. In Italy,

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41. https://www.madrenapoli.it/collezione/.
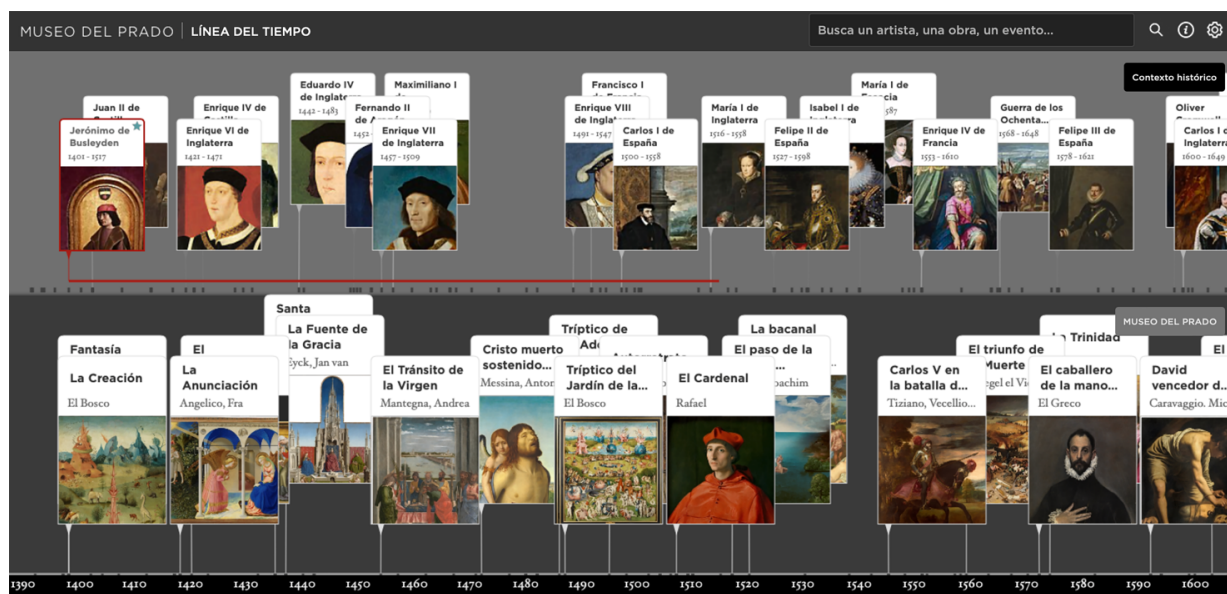42. https://museotaranto.beniculturali.it/it/percorsi-e-collezioni/reperti/.

Figure 5. Screenshot from the Prado Museum's timeline.

only the Galleria Borghese, the Egyptian Museum and the MANN offer bibliographical sources.

The choice of discovering displayed artworks in the permanent exhibition was also considered an important resource: *interactive maps with tags* have been adopted by the Louvre, the MET, the National Gallery; in Italy by the Capitoline Museums, the Borghese Gallery, the Galileo Museum, and the Pinacoteca di Brera.

Printing, downloading in .pdf, sharing on social networks or via e-mail, as in the British Museum, or scanning by Qr Code, as in the National Museum of Korea, have been considered valuable solutions for allowing users saving research.

Zoomable or browsable high-resolution photos appear to be a further fundamental resource in the historical-artistic approach to the collections: artworks from the Prado, the National Gallery, the Pinacoteca di Brera, the Pinacoteca Ambrosiana open full screen.

Obviously, *policies about images sharing and reuse* were fully appreciated from the British (photos are uploaded in Creative Commons and can be downloaded for non-commercial purposes reusing) to the Louvre (photos can be downloaded and reused if not copyrighted), from the Prado (if for personal or scientific use, photos are for free) to the MET (shared in open access mode) and the National Museum of Korea (all photos are reusable for free). In Italy, only the Egyptian Museum of Turin (through an ongoing digitization project oriented towards open access, thousands of photos are shared in Creative Commons, on Wikipedia too) and the Pinacoteca di Brera, allow users to download and reuse of images, for purposes of study, enhancement, and cultural promotion.

Only few museums share *3D models or 360 degrees photos* of their artworks, such as the British Museum (through Sketchfab), the Morgan Library (360 degrees photos), the National Museum of Korea (through a manipulation software on the website). In Italy, 3D models are available only from the Uffizi Gallery website (linked to Sketchfab).

Google Arts & Culture is a great solution for museums to share their collection and offer a virtual tour: 17/30 museums have a profile on the platform. While the most are connected to the platform with direct links, others, although on the platform with

their pages (MET, MOMA, National Gallery, Uffizi Gallery) do not provide any indication on their website; it was unpleasant for the students searching manually for the museum on Google Arts & Culture. Some important museums (Louvre, Egyptian Museum of Cairo, Prado Museum, Borghese Gallery, Vatican Museums, Egyptian Museum of Turin, Pinacoteca di Brera, Royal Palace of Caserta) haven't a page on the platform, leaving truly amazed the students, who consider the platform as an essential global research tool.

Audio descriptions on the website are rare, but it is a digital accessibility solution adopted by the British, the MET, the MoMA, the Prado, the State Russian Museum, and the National Museum of Korea.

Conclusive Evaluations

The choice of discovering history and collections of a museum through the website has never been considered a deterrent to visit it. Both in cases in which the visitor already knew the collection and in those others in which he had not visited the museum, the online cognitive and informative approach was considered able in encouraging a physical visit (if not even encouraging a return to the museum to go deeper into contents that were missed on a first visit).

Students revealed a great investigative capacity, focusing on these collections' critical issues and merits in communication and valorization. Their evaluation in browsing and search characteristics, manipulation, interactivity, aesthetics and design, ease and usability appeared in line with the cited studies.

The analysis confirmed what previously highlighted: despite implementing the offer of increasingly multimedia and interactive contents, the cultural website and collection model remain mostly informative and unidirectional, rather than dialogic, participatory, and collaborative. According to the ICOM-Italia survey (2023), museums are aware that an effort to improve is needed in this case, to encourage forms of engagement with museum collections. The collaborative aspects – a two-way dialogue leaving space for creative use and reuse of contents – are not yet expressed to their full potential. Only three museum collections allow forms of co-curation or digital collaborative revision (British Museum, Musée d'Orsay and de L'Orangerie) and only three allow users to create their own galleries or routes among the collections (Museo del Prado, Reina Sofia, and Capitoline Museums). The great absentee appears, above all, to be the community.

Our investigation also confirms what has been highlighted by other research (Artese, Ciocca, & Gagliardi, 2017; Goldman, & Schaller, 2004; Lopatovska, 2015, Russo, 2023): students involved in this qualitative analysis of digital museums and collections considered digital museum spaces as "attractive spaces" where the enthusiasm of discovery is possible thanks to an "extended museum experience" (Biedermann, 2021). The digitalization of collections itself is now considered a "prerequisite" for any multimedia and interactive activity museums want to carry out, both in the creation of new exhibitions, and in the creation of additional information tools for visits, from applications to interactive virtual tours, precisely to meet the needs of interaction and participation of new audiences, such as Gen Z online users (Russo, 2023; Müller, 2024). According to our online collections' evaluation, the tools and contents most appreciated are all those that allow users a gradual knowledge of an artwork, from the particular to the universal, from the basic information to the detailed ones, with appealing and non-technical

descriptions and detailed data and metadata if someone wants to deepen it; with interactive and multimedia related elements (such as timelines, tags, interactive maps, 3D models, videos, virtual tours etc.) that allow them a great interactivity and manipulation, a personalized navigation (and, in case, the creation of a personal gallery) able to deepen one's knowledge of an artist both from the point of view of his production and his historical context.

This work therefore aims to contribute helping institutions in changing strategies about how to build their online digital cultural offer, and specifically their online collections, so that they are increasingly oriented towards proposals able in involving (perhaps even exciting), rather than thinking that online digital valorization must pass through forms that are now static, formal, and emotionally sterile.

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