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An augmented environment for the valorization of heritage: an experience proposed by the MOdE¹

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Abstract. The paper presents the research hypothesis of a new project in which Augmented Reality (AR) is used as a didactic tool to experiment cultural heritage in the virtual educational museum MOdE (Museo Officina dell'Educazione) of Bologna. Since the MOdE was born, in 2008, the students of the Alma Mater University of Bologna had the possibility to create new installations through the virtual museum in which they could reorganize and reinterpret artworks, sculptures, objects, places, architectures etc. in new meanings and through a new significance. Through this paper our intent is to give the possibility to students to recreate that new significance directly on the site of cultural heritage/museum using Augmented Reality. This new phygital place, will connect the physical museum with the virtual White Board of the MOdE, creating a continuous exchange between physical data taken from the museum, digital data taken from the Augmented Reality tool and virtual data taken from the virtual MOdE.

Keywords: Aesthetic competence, Augmented Reality, Augmented Museum, Virtual Museum, Creation.

¹ The structure of the contribution was shared entirely by all authors and the assignment of roles follows the Contributor roles taxonomy (CRediT): Giorgia Mauri wrote paragraphs n.3.2, n.3.4 and n.3.5; Anita Macaudo wrote paragraphs n.2 and n.3.1; Salvatore Messina wrote paragraphs n. 3.3. and n.3.6, Chiara Panciroli wrote paragraph n.1, the coordination of the project and the scientific review of the paper.

1. Theoretical framework on cultural heritage and digital technologies

In the context of the 2030 Agenda, European policies increasingly recognise as a priority the development of actions aimed at cultural heritage education (Cultural Heritage Education - CHE) and digital heritage (Digital Heritage Education - DHE), with a specific reference to the Sustainable Development Goals (SDGs), based on the acquisition of knowledge and skills necessary to promote sustainable development through educational and cultural actions (United Nations, 2015). In this regard, Italy has defined its priorities in the PNRR under Mission 1 'Digitisation, innovation, competitiveness and culture' through a specific measure dedicated to cultural heritage 'Cultural heritage for the next generation' (M1C3), based on two main investments: 1.1- Digital strategies and platforms for cultural heritage; 1.2. Removal of physical and cognitive barriers in museums, libraries and archives (MiC, 2021). In this regard, a large body of scientific literature (Pineiro et al 2018; Perra et al. 2019; Boboc et al 2022; Silva & Teixeira, 2022) recognises that cultural heritage plays a strategic role in educational terms, which requires the development of educational actions (Achille & Fiorillo, 2022; Tan et al., 2023) capable of imprinting interest on young people, starting from their cultural roots (Jagielska-Burduk, 2019; Jagielska-Burduk & Stec, 2019). Heritage education is understood as a formal and non-formal educational activity that, while educating in the knowledge and respect of heritage, places heritage as an object of research and interpretation, adopting the perspective of active citizenship. The different models of learning and didactic mediation contribute to define in a broader sense the educational function of heritage and museums, with a focus on visitors and the meaning they attach to their experience (Panciroli, 2016). Heritage appreciation can fulfil important functions: (I) the first to sharpen the ability to read and analyse heritage in order to make people reflect and denounce even those culturally deteriorated aspects present in today's societies; (II) the second aimed at prefiguring, through imagination, a reality still rich in creative potential for all.

However, heritage education does not consist only in the communication of cultural contents, or even in the set of initiatives aimed at consolidating the relationship between the public and objects, but above all in the possibility of reflecting on the identity of man and the community to which he belongs, of which heritage is an expression. Education therefore becomes the ultimate goal of any experience with heritage through the development of intellectual, relational-emotional, ethical and aesthetic dimensions (Panciroli et al. 2023). Hence the need for design action (Zreika, Fanzini, 2023) that places cultural heritage as a privileged space to create opportunities and situations in which

to experiment with different educational and learning strategies, employing both traditional methods (writing, drawing, oral storytelling) and new technologies (multimedia products, digital storytelling, social media) (Panciroli, et al. 2017). Precisely because of the opportunities offered by digitisation, the focus is on the use of ICT (e-learning and m-learning) in heritage education (Fontal, & García, 2020; Castro-Calviño et al., 2020).

Of particular interest is the use of digital technologies for participatory approaches to cultural heritage: from interactive apps to QR Code systems, from multitouch and multi-user digital walls to extended reality (XR) apps and devices (Silva & Teixeira, 2022) functional for the creation of integrated environments in which physical and digital objects coexist and interact (Palmas & Klinker, 2020). Furthermore, the diffusion of digital twins provides new opportunities for access and knowledge of cultural heritage (Daniela, 2020), just as the use of XR tools integrated with AI systems opens up new forms of cultural heritage valorisation through the creation of visits and exhibition events in immersive digital environments (Clini et al., 2018; Hutson & Olsen, 2022). In these dilated spaces, works can tell something that belongs to them and distinguishes them in an original and individualised way. Indeed, the relationship established with heritage objects requires a type of interaction of an interpretative nature, which is built through the reading of characterising elements, contextual reconstruction, and the identification of similarities and differences. These aspects give rise to a dialogue between the work and its user through a continuous elaboration that leads to the involvement of the person to the point of making him or her an integral part of the work itself. Attention thus turns to the dual role of the user subjects: on the one hand, consumers of information; on the other, active subjects and producers of cognitive content (Panciroli & Luigini, 2018; Panciroli & Macaуда, 2022). In this sense, heritage places become meeting spaces where people can tell their stories and propose their point of view. It is only in this way that cultural heritage expands and becomes contaminated with new aspects and interpretations.

2. Cultural Heritage Education in Augmented Reality environments

Technological advances in recent years have increasingly led to experiments in heritage sites with new ways of dilating physical spaces through Augmented Reality (AR), recognising its specific educational potential in terms of access to knowledge and the quality of its dissemination (Bekele et al. 2018; Perra et al. 2019; Boboc, et al. 2022; Panciroli et al. 2023). AR technology, understood as

the superimposition of digital elements on the physical world (Craig, 2013), allows users to have an experience that is both real and virtual, resulting in a visit enriched on a perceptual-sensory level. Reference is specifically made to the recreation of non-existent environments, places or constructions, to the complete or partial visualisation of an object without damaging the original, to the setting up of exhibition routes that provide information that is not immediately usable with respect to objects or places of cultural interest, or again, routes in which a virtual guide accompanies the visitor (Ibañez-Etxeberria et al. 2020; Chatsiopolou, & Michailidis, 2023).

AR therefore proposes new ways of accessing knowledge through variable levels of interaction with the heritage in situ made possible by a layering of data layers of a contextual nature. In this sense, the design of connected physical and virtual spaces, both in museums (Hornecker, & Ciolfi, 2019) and heritage sites, requires specific attention directed at the field of human-computer interaction (HCI) and more specifically at the ways in which digital technologies influence and shape augmented visitation experiences (Mosca, 2020; Münster, 2022). Of particular interest in this regard is the Collaborative Augmented Reality Approach (Haynes, 2018) by which continuous multi-user interaction between real and digital environments is ensured, as well as the possibility for subjects to simultaneously share both the real world around them and the virtual space. Indeed, the collaborative nature of the environment in AR allows multiple users to observe the same tangible cultural object and virtually interact with it, beyond differences in scale (monuments, buildings, statues, paintings, ...) (João & Rui, 2021). Therefore, AR in heritage contexts is recognised as having the capacity to enhance a continuous learning process (Ozdemir et al., 2018) and to increase levels of attention, satisfaction and confidence in relation to the motivational dimension (Khan et al., 2019; Luna et al., 2019), with specific reference to the younger generations (González Vargas et al., 2020). In this sense, AR acts as an environment within which the acquisition of basic knowledge (didactic information) takes place, as well as the possibility of further investigation (contextualisation, logical connections,...). Indeed, the use of AR correlates with an increased accessibility of the information provided to the subject who can explore and interrogate heritage objects, extending the range of possibilities related to the fruition experience (Panciroli & Macauda, 2018; Ibañez-Etxeberria et al., 2020). The augmented information is provided in a layered manner to allow step by step the search for further meanings related to the origin of an object, the historical and economic context of production, the technique of production, and the curiosities related to it. The languages and media used are varied: short textual content, images, graphic representations, video

reconstructions and audio content (Unal et al. 2021; Díaz et al., 2023). In relation to these aspects, the use of AR in Cultural Heritage education can be declined in two different modalities: (I) AR for knowledge at different levels of heritage through personalised and customisable paths; (II) AR to support creative expression, promoting forms of participation and re-elaboration (Macauda, 2018; 2029). (I) The first modality refers to the field of reception/use of artistic heritage (Panciroli, Macauda & Russo, 2018). (II) The second modality lies in the sphere of experimentation and production of novel content with non-stereotypical but creative and original meanings through engaging and participatory forms of learning (Panciroli, Macauda & Corazza, 2019; Silva, Zagalo, & Vairinhos, 2023). A new research direction that has been particularly active in recent years also leads to the integration of AR environments with AI by supporting the creation of immersive experiences for CH sites and museums. Visitors can virtually explore archaeological and historical parks or museum exhibitions by interacting with virtual characters or objects generated by artificial intelligence (Münster, 2022; Münster et al. 2024). A strong interest lies in deep learning approaches (Lalonde, 2018) exploited to manage complex and dynamic environments (sudden changes in lighting conditions, etc.) and to create a more realistic, perfectly integrated and aesthetically pleasing rendering of the virtual layer (Allal-Chérif, 2022; Fanini et al. 2023). In this sense, we highlight how the possibility of combining developments in AI with AR technology opens up unprecedented application perspectives in the field of CH education (Giordano, Russo & Spallone, 2021).

3. Project proposal: the MOdE in Augmented Reality

In relation to the framework presented above, this contribution proposes to develop a research hypothesis concerning the use of AR in the digital environment of the MOdE (Museo Officina dell'Educazione), with the aim of improving the visits set up and proposed in the virtual museum by amplifying the bodily experience in augmented environments.

3.1. Context

The MOdE, which is part of the University of Bologna's University Museum System, is a digital museum centred on elements of innovation and accessibility that collects, catalogues and exhibits tangible and intangible

evidence, expression of educational culture. "The sense of the action and movement of the MOdE can be glimpsed in the expression 'experience to heritage', which is intended to represent the force needed to 'go towards' heritage, first to approach it and get to know it, then to create new forms of interpretation" (Panciroli & Macaуда, 2019). Indeed, one of the main functions of the MOdE is to set up environments for the in-depth study: the valorisation and reinterpretation of cultural heritage. The reference is specifically to White Rooms, which are digital environments with a high level of customisation, aimed at promoting youth creativity (Panciroli, Macaуда & Ghizzoni, 2020; Panciroli & Russo, 2020). These are spaces for the co-construction and re-elaboration of knowledge that stakeholders can set up by referring to both internal and external museum content. Users are encouraged to create new artefacts that act as mediators to give substance to the meanings discovered during their experience with heritage. Each new object inserted in addition to or in substitution of another entails a remodulation of meaning. It follows that the White Rooms are not rigidly defined, but can be continuously transformed and implemented as "part of an ecosystem that should be conceived and analysed as a complex system and not as an isolated entity" (Panciroli, & Rossi, 2019).

3.2. *Research problem and objectives*

If "the heritage experience" (Panciroli & Macaуда, 2019) takes place in the intermingling of existing elements and new forms of interpretation, AR is triggered as an *educational device* because it allows this same intermingling to take place in a single moment: that of the visit to the museum site. The relationship between AR and heritage education, in fact, represents a field of research that has already been beaten, and the reflections given at the beginning (paragraphs 1 and 2) summarise the theoretical assumptions, constituting the basic scaffolding of the project proposal being planned. Starting from these considerations, an attempt was made to answer the following research questions:

(I) How can AR implement the White Rooms of the MOdE? The hypothesis from which the project stems involves the use of AR as an integrated tool for the White Rooms of the MOdE to try to break the mechanism of *Being Elsewhere* - being in a virtual context dislocated from the real - and reconstruct an extended experience directly in the physical place of the museum.

(II) How can AR act as a *device* (Rossi & Rivoltella, 2019) for heritage education? The question is to understand how AR is configured as a tool that *situates* the experience in the museum place; extends the experience beyond the physical space into the virtual space; *builds* participatory experience among those involved.

To answer to the research questions, the following objectives were identified:

(I) conduct a literature review focusing on the relationship between cultural heritage and AR;

(II) improve the MOdE visits by amplifying the bodily experience in augmented environments. The White Rooms are, in fact, spaces dedicated to different audiences and offer visitors the possibility to build digital narratives through Visual Gallery of objects, docu-videos and reels to make heritage more accessible and usable (Panciroli & Macaudo, 2019). In this sense, the construction of digital narratives, with the use of AR, would take place directly in museums and heritage sites, creating personalised interpretations of the works usable through digital data superimposed on physical data;

(III) generate an innovative hybrid experience between physical and augmented space, combined with strategies and processes typical of gamification, such as flow (Csikszentmihályi, 1991), alternation between physical and virtual reality (McGonigal, 2011) or narration (Kapp, 2012). Visitors are, in fact, led into a physical space where they can build products shared with other people from "digital augmentations" (Sommerauer & Müller, 2014) superimposed on real elements to activate new narratives.

3.3. Methodology

In order to meet the first research objective, which was functional to the formulation of the project proposal, we initiated a search of recent specialist literature. The approach to the research is of a mixed type, whereby quantitative data (based on the analytics of the research in the literature) and qualitative data (based on the analysis of the papers and on the analysis of the scientific-didactic experience that allows the MOdE of the University of Bologna to have 15 years of history to its credit) are collected and analysed. Specifically, a literature review was formulated that focused on the relationship between cultural heritage and AR, starting from the questions: (I) How is AR used within cultural heritage? (II) What kind of interactivity does it provide with the user? (III) In what educational dimension does it fit?

Referring to the PRISMA model (Page et al., 2020), the following keywords were selected: 'cultural heritage', 'augmented reality', then they were inserted

into the Scopus database. Content published in English and Italian between 2020 and 2023 was selected. The search was developed using the following search string: TITLE-ABS-KEY ("cultural heritage") AND TITLE-ABS-KEY ("augmented reality") AND PUBYEAR > 2020 AND PUBYEAR < 2023

The search returned 269 results, of which 11 results were excluded because they reported incomplete data and 188 because they were not relevant to the research objective. Therefore, 70 results were included in the final analysis. The included primary studies were then analysed according to the following criteria:

- (I) the presence of a museum within the study;
- (II) the type of museum (physical, virtual, mixed);
- (III) the type of immersion (augmented, virtual, mixed reality, none);
- (IV) the type of use (through smartphones or tablets, projection device viewers, sound/sound devices);
- (V) the educational dimension in which user immersion is embedded: knowledge of the work, knowledge of the artist, knowledge of the composition of the work, contextualisation of the work, support and/or elimination of knowledge barriers;
- (VI) the interactivity of immersion with the user: immersion in augmented/virtual/mystical reality used as a dilator, which allows the user to intervene on the work by inserting his or her own content;
- (VII) immersion in augmented/virtual/mystical reality used as a consolidator, which allows the user to know more about the work.

Based on the analysis of the literature, it is possible to note that the studies are more concentrated between 2021 and 2022, mainly in Europe and Asia with significant peaks in Italy and Greece. The primary studies show a strong correlation between the physical environment, the museum environment, and the augmented reality device used by the visitor to immerse him/herself in further data, in this case virtual or digital. This aspect, brought to light by the scientific literature, highlights that the digital overlay does not replace the real reality, placing the user within an exclusively virtual context, but, on the contrary, it is part of it, inserting itself as a consolidating device (Kaimaris et al., 2021), thus allowing the visitor to know, experience, read, observe, experiment, and experience an extended reality.

The scientific literature brings to light a second decisive aspect in the use of AR within cultural heritage contexts: 66 of the 70 primary studies analysed show that AR is used as a consolidating tool and not as an expanding tool (Panciroli, 2016). In this sense, the experiments still require AR to be designed

a priori within that specific cultural context and then to be only passively enjoyed by the visitor or user. This aspect allows us to reflect on the need, on the contrary, to allow the visitor or user to become the actor of their own learning, their own discovery, their own knowledge, allowing them to manipulate Augmented Reality directly within a cultural context, such as that of the museum, and thus to construct knowledge within a baggage of meanings that belong strictly to the visitor.

An interesting element of the four primary studies reporting on extended interactivity is that all four do not refer in a strict sense to a museum. The studies do not present the physical place of the museum, but instead they refer to virtual spaces.

3.4. Technology and devices

In the implementation of the MOdE's White Rooms, AR is proposed as a device (I) of *situationality*; (II) of *extension*; (III) of *participation*.

Augmented reality as a *situational device* would allow the (I) users of the White Rooms of the MOdE to contract into a single time the moment of experience of cultural heritage, the moment of production of cultural content and the moment of reflection on the processes activated. In this sense, a contraction of time and space is created (Berthoz, 2021) as the visitor does not have a moment dedicated to fruition, one dedicated to production and one dedicated to reflection, but these three moments are contracted within a single time and simultaneously within a single space: the museum space. Visitors are thus given the opportunity to solve a problem in a real context (Gee, 2013), since, with the contraction of the three moments, it is necessary, already from the conception of one's own project, to meta-reflect on the processes activated.

(II) Secondly, AR becomes an *extension device*, because it allows to extend the spaces available to users, who enjoy and produce cultural heritage. The augmented digital context provides access to modified, hybridised cultural content (Jenkins, 2007) and reinserts it into the contemporary cultural flow.

(III) AR, from a situationality device to an extension device, also becomes a *participation device*, as it enables cultural heritage to communicate with the language of the postmedia era. Visitors, in the process of fruition-construction-remembrance of cultural heritage, share their artefacts with a much wider audience.

If AR can act as a device to enhance MOdE's visits and generate innovative experiences with heritage, the choice of an AR tool has to fulfil certain precise

characteristics. In this sense, the 2018 study by Tcha-Tokey Katy, Christmann Olivier, Loup-Escande Emilie, Loup Guillaume and Richir Simon was considered, which presents the interaction between three macro-areas referring to the user experience (UX) in immersive contexts.

(I) Firstly, the area of presence, which considers the user's immersion in the augmented place and his involvement in the activities.

(III) Secondly, the area of the consequence of the experience, which involves the technological adoption and the judgement that the user matures towards the characteristics of the technology.

(III) Finally, the third area, which considers (i) the user's skills in interacting with the augmented system; (ii) the emotions that the user experiences within the augmented system; (iii) the flow: the balance that is created between the user's skills and the challenge placed in front of him; (iv) the usability of the system that interweaves the three previous elements and their relationship with the user.

The three areas are positioned in a system of interdependence. If the augmented system takes this relationship into account, it enables the user to have a complete UX.

The interconnection of these three areas, with regard to the implementation of the MOdE, can be placed within three different levels. The three levels refer to the way in which users experience the activity of using cultural heritage and producing new meanings.

(I) Firstly, the level of design and creation. Within this, the visitor is the primary user of the cultural heritage of the physical museum and he is also involved in the production of new meanings that enhance the initial experience of fruition. The user is present in a physical and digital place and he is involved in production activities. He also uses an intuitive technology that enables effective usability.

(II) Secondly, the overlay layer. Within this layer, augmented digital elements can be superimposed on the physical elements that belong to the cultural heritage. This is where the project of re-signifying and understanding cultural heritage is realized by superimposing augmented details on the original work (Macauda 2018).

(III) Finally, the level of fruition. This level is experienced by the end user in the viewing of the White Rooms of the MOdE built by the experimental users or in the fruition of the physical museum augmented through the new artefacts. Within this last level the user experiences a UX that links physical and virtual contexts.

3.5. *Development phases*

The innovation that Augmented Reality would bring into the White Rooms of the MOdE is characterised by three moments: (I) a moment of fruition, (II) one of production and (III) one of reflection. The three moments merge into a single time.

This can be represented as the time of reflection, in which the user (I) understands the production logic he or she uses to design his or her artefact; (II) chooses the methods through which he or she wants to communicate with the audience of the Sale Bianche; (III) uses problem solving strategies within a context in which time and space contract.

This project aims to implement a process that generally requires visitors to the physical museum to experience (I) a preparatory phase, of preparation and enjoyment of cultural heritage; (II) an operational phase, of designing a new artistic cultural context; (III) a restructuring phase, of reflection and reconstruction of cultural meaning.

In this new scenario, users are asked, instead, that these three moments be contracted within a single space and a single time: the physical museum integrated with the digital one of the White Rooms of the MOdE.

Users, therefore, who find themselves in the museum context, specifically within one of the museums that are part of the Bologna museum network, thanks to the use of AR can enjoy the museum context and simultaneously design an extension of this context in AR through the Sale Bianche of the MOdE.

On an operational level, therefore, users access the museum space, enjoy the works of art and identify the works to which they wish to give new meaning through the White Rooms of the MOdE.

Intent on designing the new cultural meaning of the artworks they have selected, users use AR as a layer that allows them to superimpose new digital data on the artworks. They can create or retrieve images, audiovisual content, graphic representations, texts, audio content to be superimposed on the works they have selected.

Subsequently, this same superimposition is presented in the White Rooms of the MOdE, in which users have designed and organised the artworks in such a way as to recreate a narrative: a space in which the works regain a different meaning, a new sense of cultural heritage.

Therefore, the artefacts that users create turn out to be three:

(I) an artefact in AR built by the "student programmers" that coincides with their personal experience of cultural heritage (Panciroli & Macaudo, 2018);

- (II) an AR product used as a "student-user support" that can be consulted by visitors of the chosen museum site (Panciroli & Macaudo, 2018);
- (III) a new White Room of the MOdE, in which users' production becomes reflection.

3.6. Expected outcomes

With the present project proposal, our aim is to explore the intrinsic potentials of AR as an innovative educational tool within the MOdE, with a particular focus on the implications this technology can have on learning and interpreting cultural heritage. The central hypothesis of our work suggests - based on the analysis of best practices and scientific literature - that integrating AR into the educational process can enhance the learning experience by allowing users to interact with cultural heritage in previously unexplored ways. This leads to the need for users to develop media literacy skills that become essential in digitally augmented contexts (Messina et al., 2023). These skills encompass areas of access, analysis, evaluation, and creation of artifacts through various media forms (Potter, 2013). Media literacy, with its emphasis on decoding media messages, lays the groundwork for a critical and conscious understanding of digital content, an indispensable element in the context of an AR-enhanced virtual museum.

Another essential aspect is the possession of participatory skills for the creation and organization of digital artifacts and narratives (Macaudo & Russo, 2023), which shift the skills profile from decoding to encoding (Rivoltella, 2022). In the context of the MOdE, this means enabling students to produce digital artifacts that interact with cultural heritage, enriching exploration through AR. The organic integration of these skills in an academic museum context allows us to foresee a reduction in the time required for the development of consumption phases, artifact production, and critical reflection on the heritage itself (Panciroli et al., 2023). This acceleration and optimization in learning processes are expected due to AR's ability to immerse users in an augmented context, where the perception of cultural heritage is enriched by virtual elements that stimulate reflection and personal interpretation. Immersion and creation in such an augmented context should therefore promote more effective learning, making users not only passive consumers but active co-creators of cultural meaning. This is because AR technologies, operating primarily in the visual domain, offer a new dimension in cultural heritage mediation, promoting the development of critical-reflexive skills. The artifacts created by users in this context (which can also become phygital) not only enrich their educational experience but also contribute to the valorization of cultural heritage, making it

more accessible, immersive, and interpretable through a plurality of perspectives. The possibility of exploring and "staging" the museum and the White Rooms in an augmented context should make the cultural experience more engaging and accessible, promoting broader and more diversified participation. This, in turn, could have a positive impact on the public impact of cultural heritage, highlighting its relevance and dynamism in contemporary contexts. Last but not least, this design would have an inclusive dimension (Campitiello et al., 2022), ensuring access to and consumption of cultural heritage through AR for all users, including those with Special Educational Needs (SEN and SEND). The goal is to promote a fair learning environment, where each individual can experience cultural heritage in a personalized and individualized way. The inclusive dimension focuses on designing AR experiences that take into account the diversity of users, including specific adaptations for those with sensory, motor, or cognitive disabilities. For example, for students with visual impairments, AR can be enriched with audio narrations or ambient sounds that guide the exploration of cultural heritage, allowing them to "see" through hearing. This sound approach creates an immersive context, where the story and details of the exhibited objects are told and made vivid through sound, offering an inclusive and enriching experience. For users with motor difficulties, the user interface of AR applications can be designed to be operable through voice commands or adaptive input systems, allowing everyone to interact with the content without the need for complex manual controls. This type of adaptation ensures that users can navigate AR experiences independently, promoting independence and active participation. Furthermore, for those with cognitive difficulties, AR experiences can be simplified and made more intuitive, with guided paths that offer contextual support and positive reinforcements. The use of universal and/or accessible symbols, together with clear texts and instructions, can help reduce barriers, facilitating understanding and interaction with cultural content. The inclusive dimension, therefore, requires a user-centered design approach that involves personalizing educational experiences based on individual needs, contributing to building a more inclusive and welcoming culture within the museum context and beyond.

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