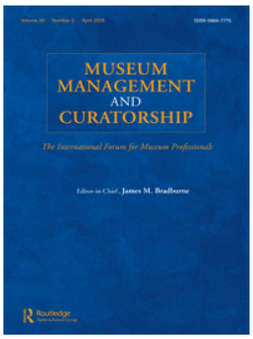

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Empowering cultural heritage professionals: designing interactive exhibitions with authoring tools

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ABSTRACT

This paper advocates for the involvement of Cultural Heritage Professionals (CHPs) such as curators, staff, and volunteers, in the design process for creating engaging museum exhibitions. The paper presents two prototypes: a desktop system that assists CHPs in creating interactive tools easily and intuitively, and a mobile application that allows museum visitors to enjoy interactive experiences created by museum curators. The system supports CHPs in creating interactive exhibitions that engage museum visitors by making the process easier, efficient, and effective. The paper discusses four case studies involving three museums in Madeira, Portugal, with 9 curators and 59 visitors participating; and it concludes by emphasizing the importance of involving CHPs in creating interactive museum exhibitions and providing guidance on using authoring tools. This approach can improve museum management and curatorship practices, leading to engaging exhibits, better learning outcomes, reduced costs, and innovation for visitors.

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Cultural heritage; interactive tools; authoring tools; museum visitors; curators; cultural heritage professionals

Introduction

Despite the rapid advancement of technology in the museum sector, there has been a significant lack of involvement of Cultural Heritage Professionals (CHPs) in the design process of these interactive exhibitions (Ciolfi and Petrelli 2015). CHPs are responsible for shaping experiences within cultural heritage spaces and should be involved in the ideation of interactive tools as active players in the development of the technology design process (Ciolfi and Petrelli 2016). Their expertise and knowledge of the artifacts and exhibitions make them essential contributors to the creation of interactive experiences that are informative, immersive and engaging for the visitors. Moreover, involving CHPs in the design process ensures that the exhibitions remain faithful to the original intention of the museum, which is to preserve and communicate cultural heritage to the public (Sayre and Wetterlund 2008). If the development process is outsourced to other entities without the involvement of CHPs, it may lead to misinterpretations, inaccuracies or distortions of the intended meaning of the exhibitions, which can impact the visitor's understanding and engagement with the content (Cesário, Coelho, and

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Nisi 2018). Additionally, CHPs spend a considerable amount of time in the museum and develop detailed knowledge of the exhibits, making them the ideal experts to identify potential challenges and opportunities for the use of technology in the museum space. Therefore, the involvement of CHPs, especially museum curators, in the design process of interactive museum exhibitions is vital to ensure the authenticity, accuracy, and engagement of the resulting interactive visitor experience. Moreover, as visitors become increasingly active participants in museums, museums must embrace new technologies that promote dialogic interactivity (Witcomb 2003) and encourage visitors to actively seek knowledge (Mancini and Carreras 2010). This requires involving CHPs in the conception of interactive tools and experiences to ensure that exhibitions are successful in engaging visitors.

This paper aims to contribute to the growing body of literature that seeks to involve CHPs in the design of interactive museum exhibitions by presenting a system (*EasyARCreator*) for supporting CHPs in creating engaging exhibitions, and a mobile application (*EasyARViewer*) that allows visitors to enjoy the interactive experiences created by the museum. The *EasyARCreator* is designed to be accessible to curators with little or no programming experience, making it easy for them to create engaging interactive exhibitions that showcase the museum's cultural heritage. The *EasyARViewer* is designed to provide visitors with a personalized experience that caters to their interests and preferences, enhancing their overall experience and encouraging them to learn more about the museum's cultural heritage. This contribution seeks to address the need for CHPs to be involved in the design process of interactive museum exhibitions by providing CHPs with the necessary tools and guidance to create interactive exhibitions and use of authoring tools. Providing guidance for CHPs to create interactive exhibitions and to use authoring tools can be very beneficial for museum management and curatorship practice as museums can (i) encourage their curators to create exhibits that are more engaging and interactive; (ii) help their curators create exhibits that are more effective at teaching visitors about the exhibit's topic, (iii) help their curators create interactive exhibits without needing to hire outside contractors or invest in expensive software, (iv) can foster innovation in their exhibits. This can help museums stay relevant and attract new visitors.

The use of mobile technology in museums

The use of technology in museums has been evolving over the years, with audio guides being one of the earliest forms of interactive technology introduced in the 1950s (Tallon and Walker 2008). The traditional audio guide has since evolved, with visitors now being able to access information by scanning numeric codes placed on artworks (Acoustiguide Group 2014). However, today's museums have expanded their interactive offerings by incorporating new and engaging technologies, challenging old paradigms of audio and human guides. Furthermore, visitors are now seeking more active involvement, seeking knowledge rather than receiving passive information (Mancini and Carreras 2010).

Interactive multimedia applications for smartphones, augmented reality (AR), and virtual reality (VR) experiences are becoming popular tools for museum tours, replacing traditional audio guides, and personal devices are becoming smaller, cheaper, and more powerful (Damala et al. 2016; Hatpaz 2016; Merritt 2016). Mobile guides have the added benefit of providing educational, engaging, and memorable experiences by

enabling visitors to learn new concepts and interact with exhibits using multiple senses (Bailey-Ross et al. 2016). Mobile guides can be tailored to different exhibitions and categories of visitors and can access unlimited amounts of information from the internet, expanding exhibits beyond the museum's walls. Studies have shown that mobile devices increase visitor engagement with exhibitions, with students interacting for longer periods than those without mobile (Sung et al. 2010). Furthermore, a study by Vavoula et al. (Vavoula et al. 2009) has shown that children who use mobile technology during a museum visit are more motivated to ask relevant questions and actively engage with the environment. In conclusion, mobile guides are becoming increasingly important in museums and provide opportunities for visitors to engage in interactive, educational, and memorable experiences. However, to build immersive experiences that convey value, it is essential to understand the CHP's main difficulties and interests. Tools for creating interactive exhibitions should be designed in a way that allows curators to implement and test different solutions quickly to adapt to their target audience. The focus of the testing of the two prototypes – *EasyARCreator* and *EasyARViewer* – is to equip CHPs, especially museum curators, with the ability to build interactive exhibitions independently, without the need for specialized technical personnel.

Involving cultural heritage professionals in the creation of digital and interactive exhibitions

Museum and cultural heritage research has primarily focused on the engagement of the visitor experience of interactive exhibitions and how this can be supported and enhanced, rather than on the design process and practices of CHPs who create the interactive exhibitions. However, Hornecker and colleagues (Hornecker et al. 2013) investigated two aspects of CHPs work practices regarding interactive exhibits: their attitudes and perspectives, in particular, their values, goals, and aspirations to create exhibitions, and their current resources and methods to create and implement interactive digital exhibitions. This study found that CHPs showed a strong interest in incorporating digital interactive exhibits into their museum exhibitions. For smaller museums, the desire to include digital exhibits was driven by the perceived visitor expectation of being up-to-date, as digital technology can make visitors more aware of their surroundings by communicating otherwise invisible material. The involvement of CHPs in the ideation and creation of digital and interactive exhibitions is vital to the success of museum experiences and collections. It is essential to close the gap in the know-how of CHPs in the development of interactive exhibitions, their design motivations, and their attitudes towards technology.

Tools and platforms to create digital and interactive exhibitions

The emergence of interactive systems for museums has led to the development of tools that enable CHPs to have some control over the development of interactive exhibitions. Patrelli et al. proposed an approach in 2013 that gives CHPs the ability to create, maintain and alter exhibitions, which aim to bring materiality and physical interaction to the visitors' experience while expressing the cultural institution's values (Petrelli et al. 2013). White et al. also presented a system through which museums and CHPs can create, manage, and present both content and context for virtual exhibitions (White et al.

2004). This system provides software and tools that can digitize artifacts and create virtual interactive exhibitions online and on-site using kiosks and markers (Sylaiou et al. 2008; White et al. 2004). In the field of virtual reality, a system called 'VIRTUE' allows curators to configure virtual museum exhibitions using 2D content and 3D artifacts (Giangreco et al. 2019). This system presents two perspectives: the curator's perspective, which functions as a content management system, and the visitor's perspective, where they can navigate virtual rooms, inspecting the different artifacts and content displayed. In addition to these systems, recent studies have introduced other tools that enable CHPs to create interactive exhibitions independently. For example, the 'Curator' is a cross-platform tool that allows CHPs to build collections of information and display that information using an interactive tabletop (Sprengart, Collins, and Kay 2009). Stratton et al. presented a slightly different approach by introducing software called 'Quando,' which allows the creation of a visual programming based on blocks (Stratton, Bates, and Dearden 2017). Furthermore, the design of toolkits is no longer solely done by researchers. Commercial tools, such as 'OpenExhibits,' have emerged to create interactive, multi-touch, and multi-user tables by non-specialized personnel ('Open Exhibits | Multitouch, Multiuser Software for Museums' n.d.). Other tools, such as those created by some companies ('Genially, the Platform for Interactive Animated Content' n.d.; 'Home' n.d.; 'Metaverse Studio' n.d.; 'Wordwall - Create Better Lessons Quicker' n.d.), enable users, such as curators, to create content in the format of augmented and virtual reality. The ability to allow CHPs, specifically curators, to create and edit digital content has become increasingly important and is currently a very relevant topic of study (Ohlei et al. 2018). However, the need for advanced technical knowledge creates barriers that prevent curators from building interactive exhibitions on their own. Therefore, the creation of a platform that allows curators to independently build, maintain, test, and modify interactive exhibitions will fill a practical gap by enabling curators to quickly create and configure cross-reality environments (Bellucci et al. 2017). Furthermore, the use of mobile applications and other digital tools has the potential to democratize the creation of exhibitions, empowering CHPs to curate and present their own content in new and innovative ways. This can lead to a greater sense of ownership and pride in the cultural heritage sector, as well as greater engagement and participation from the public.

Challenges faced by cultural heritage professionals in designing interactive exhibitions

The challenges faced by CHPs in creating interactive exhibitions are multifaceted, ranging from technical difficulties to budget constraints and maintenance issues. Hornecker and colleagues (Hornecker et al. 2013) and Maye et al. (Maye et al. 2014) highlight the need to understand the attitudes and approaches of CHPs in the design of interactive exhibitions. Hornecker and colleagues found that while many CHPs express interest in creating and testing interactive prototypes, some lack the technical expertise needed to imagine what they can achieve with interactive exhibitions. Maye et al. similarly reported on gaps in the know-how of CHPs in building interactive exhibitions, indicating that more research is needed to understand the design processes and practices used by these professionals (Hornecker et al. 2013; Maye et al. 2014). Furthermore, Cesário et al. (Cesário, Coelho, and Nisi 2018; 2019) detected difficulties in the ability of CHPs to put themselves

in the visitors' shoes, resulting in some reported usability problems in the developed prototypes. Lack of budget, time, and human resources were also mentioned as major obstacles (Allen and Gutwill 2004; Bitgood 1991; Cosley et al. 2008; Gammon 1999; Hornecker et al. 2013; Parry 2013; Thomas and Mintz 1998). Additionally, many CHPs prefer to use content management platforms such as WordPress as they offer greater authorship and control over the final product (Maye et al. 2014). Personalization is also an important aspect for CHPs, as they seek to use technology to achieve specific ends and offer different methods of interaction to cater to diverse visitor preferences (Maye et al. 2014). Visual recognition technology has also been identified as a desirable tool for CHPs, as it can provide information about artifacts without distracting the public (Wein 2014). Although some literature addresses technophobia in cultural institutions (Dragicevic and Bagarić 2019; Greenberg 1996), this topic is becoming less relevant as technology becomes more prevalent in our daily lives. However, it is still important to approach this aspect carefully in order to gain support from curators. To do so, it is suggested that technology be used as a complement rather than a replacement for traditional museum experiences. Personalization and editing of content are key interests for CHPs, as they allow for a greater degree of control and the possibility of tailoring exhibitions to specific audiences. It is therefore crucial to consider these aspects when developing tools to support curators in the design of interactive exhibitions.

Materials and methods

The methodology used in this study aimed to assess the success of interactive exhibits in museums by understanding the opinions of both curators and visitors. Two user groups were formed – curators and visitors, and the entire system for creating and visualizing interactive exhibits was tested. The study evaluated the ease of use of the system for curators and how it motivated them to create interactive exhibits more frequently. This evaluation aimed to understand how the exhibits developed by curators using the system can influence visitors' interest. It was also important to evaluate visitors' interest in the exhibits to gain insight into their engagement. If the developed solution does not generate visitors' interest, having a simple and intuitive system will not be a relevant factor. A straightforward and user-friendly system will be ineffective if it does not produce content that visitors find engaging.

A user-friendly platform for creating and experiencing interactive exhibitions

We propose the testing of a dual prototype that has a user-friendly platform which allows curators to easily create and manage interactive exhibitions and allows museum visitors to experience them in an innovative and engaging way. The *EasyMuseumARCreator* is a desktop content management which allows curators to easily create, maintain, test, and modify interactive exhibitions. Each interactive content is associated with a QR code that can be interpreted by a mobile application, called *EasyMuseumARViewer*, allowing museum visitors to view the content in AR format. The decision to use a desktop and smartphone platform was based on the curators' preference for editing content (Cesário, Coelho, and Nisi 2018) on a larger screen and the high prevalence of smartphones among the

population. We chose QR codes for their ease of use and unique activation of contents, allowing technology to act as a complement to the exhibition. AR was considered a good solution since it has been frequently used in cultural institutions and has demonstrated good results (Cesário and Nisi 2022; 2023; Cesário, Olim, and Nisi 2020; Cesário, Petrelli, and Nisi 2020; Cesário et al. 2019). This dual prototype contributes to the advancement of museology, making it easier for curators to create interactive content, and improving the visitor experience in museums. Each of these systems is detailed in the section below.

EasyMuseumARCreator

The *EasyMuseumARCreator* (Figure 1) enables curators to input content without extensive technical knowledge: the platform must be user-friendly with a low learning curve for ease of use. It allows curators to perform basic operations to meet identified needs such as adding, editing, and disabling content. Curators can associate multiple types of content with a marker, including text, images, videos, and 3D objects, leaving the possibility of adding new types of content in the future if necessary. The platform also enables curators to select a language (within a pre-established number of options) for which they want to translate a particular content. Obtaining the QR code of a particular interactive content is easily done within the platform: the platform provides the QR code to the curator in an image file already sized for printing, removing any additional effort outside of the platform. When content is no longer needed or deemed dispensable, it can be permanently deleted. Curators can also temporarily disable previously created content when designing changes to it, and hide content from visitors whenever they wish. These functionalities provide curators with flexibility in managing the platform's content.

EasyMuseumARViewer

To complement the desktop application designed for curators, a mobile application named *EasyMuseumARViewer* (Figure 2) was developed to allow museum visitors to view the content introduced by curators. This mobile application offers a more immersive experience to the visitors and is available in several pre-established languages to ensure that language is not a barrier for visitors who want to use the application. To meet the

Figure 1. Screenshots of the EasyMuseumARCreator: The left screenshot showcases the interface for adding new contents, while the right screenshot demonstrates the intuitive content management system. Together, these elements allow curators to create an interactive experience for their audience with ease.

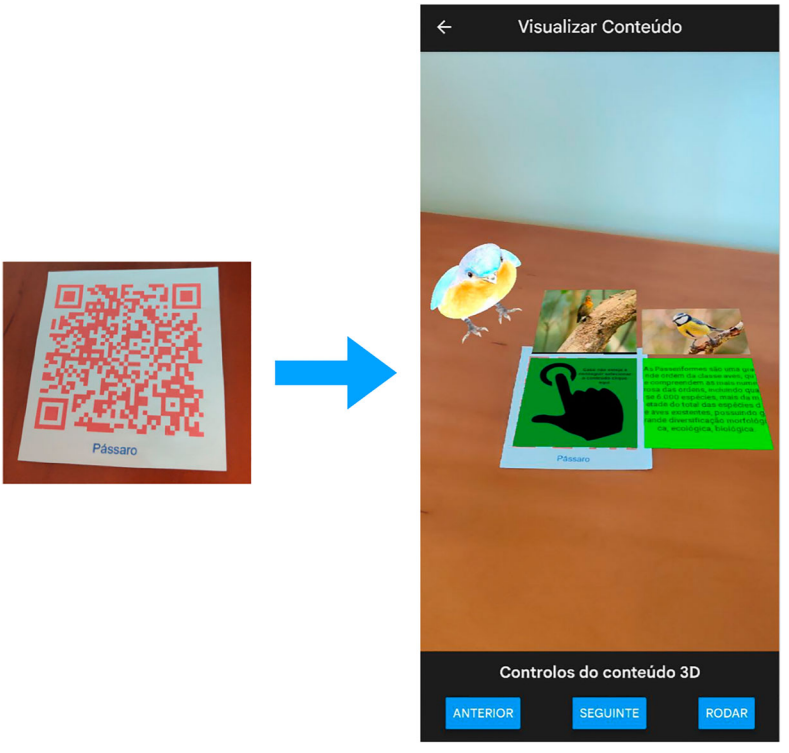

Figure 2. Screenshots of the EasyMuseumARViewer: The left image highlights the user experience of pointing to the QR code in the museum, triggering the display of interactive contents on the visitor's device. Meanwhile, the right screenshot showcases the interactive content that visitors can explore. This mobile application allows visitors to delve deeper into the exhibit and gain a deeper understanding of the captivating history and natural wonders on display.

identified needs, the application includes a short set of necessary functionalities, such as support for different languages, AR content visualization capability, the capability to 'unlock' content through the scan of a specific marker, and capability to interact with the elements introduced by the curators. The application adjusts to the visitor's language so that the content displayed is also in their language. Visitors are able to activate the content through markers, which provides them with the freedom to decide whether or not to have an immersive experience, making interactive content a complement rather than a substitute for museum artifacts. To ensure an easy and intuitive experience for visitors, the application provides various types of interaction with the user, such as rotation and touch. This mobile prototype is kept as simple as possible so as not to overshadow the natural beauty of the museum, as excessive use of technology can lead users to prioritize technology over the museum, which is not desirable.

Sample

To conduct the tests, three museums were approached in Madeira Island: the *Museum of Natural History of Funchal, Museum 'A Cidade do Açúcar,'* and *Museum of Quinta das Cruzes*. Nine curators, aged between 22 and 58 years, were interviewed during the entire process.

The curators' names were replaced by anonymous identifiers (C1-C9) to maintain their anonymity, as well as their profession/specialty as curator, length of service, age, and gender. Information was also collected on the visitors who visited the *Museum of Natural History of Funchal*, represented by identifiers (V1-V59), including their name, profession, gender, age, and country of origin. To test whether the contents created by curators using the developed system would increase visitors' interest, a series of interventions were carried out. One of the curators from the *Museum of Natural History of Funchal* created interactive content that could be viewed by 59 visitors of the same museum, ranging in age from 12 to 70 years old. The developed solution's influence on visitors' interest was tested through these interventions.

Evaluation with cultural heritage professionals

The study aimed to understand whether the developed system allowed curators to create interactive content easily and intuitively and to determine their opinion of the system's usability and their motivation to use it in the future. The procedure for each intervention included showing an interactive content previously built to each curator to understand the visitor's perspective. Then, a brief explanation of the entire desktop platform was given, and the curator was asked to perform a series of tasks using both the mobile and desktop platforms. After the manipulation of both platforms, a questionnaire – System Usability Scale (Affairs 2013) – and a semi-structured interview were conducted to gather feedback and to understand how using the system influenced their motivation and state of mind for creating future interactive exhibitions. Difficulties encountered during the manipulation of the system were recorded to identify possible issues with the interface. Informed consent forms were filled out by all curator participants, and interviews were recorded to obtain a digital record of everything that was discussed. To ensure fairness, each intervention with each curator was carried out separately for each curator (Figure 3).

Results: feedback from the cultural heritage professionals

The results obtained from the testing carried out with nine curators from three different museums in Funchal indicated that the system was simple, intuitive, and easy to use. All

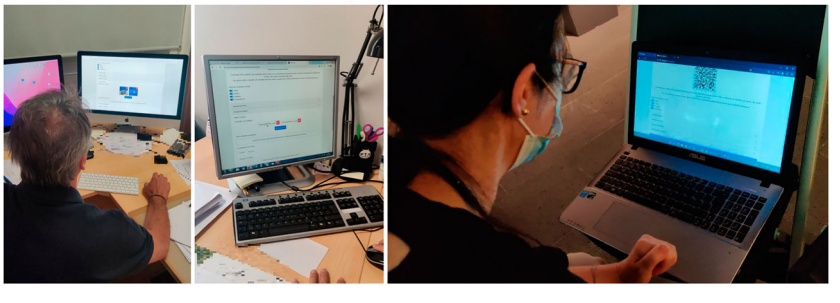

Figure 3. A glimpse into the hands-on testing of the desktop application, EasyMuseumARCreator, by a group of dedicated curators of the Museum of Natural History of Funchal. The participants in the images are seen putting the app through its paces, exploring its various features and functionalities.

curators were able to complete the proposed tasks, with 8 of the 9 curators having practically no doubts during the completion of the tasks. One curator (C7) had more doubts than the others, but these were mainly related to aspects that they wanted to confirm before performing certain tasks. All curators mentioned during the semi-structured interviews that they enjoyed the ease of use of the system, found it simple and intuitive, and had an interest in using it in the future, which is a strong indication that the system could have good adhesion if implemented. The System Usability Scale showed that the average score for the 9 curators was 89.722, indicating a grade of 'B' and a best imaginable classification. The results suggest that the developed system is simple, intuitive, and easy to use, which increases the motivation of curators to carry out interactive exhibitions in museums more frequently.

Evaluation with museum visitors

The testing of the mobile prototype was conducted with four artifacts, and the two main objectives were to understand how much time visitors spent contemplating the different museum artifacts varied with the use of the mobile and to understand how the interactive exhibitions created by one of the curators affected visitor engagement, learning, experience quality, and connection with the museum. To achieve this, the Museum Experience Scale (Othman, Petrie, and Power 2011) and visitor retention index were used (Bollo 2005; Hammady and Ma 2021). The Museum Experience Scale aimed to provide a general notion of how the interactive exhibitions influenced visitor engagement, learning, experience quality, and connection. The visitor retention index was used to carry out a more quantitative analysis of visitors' level of interest. For each visitor, permission was requested to participate in the study, and to record the details of their experience through photos and audio (Figure 4).

Results: feedback from the museum visitors

The obtained results suggest that the developed system has a positive impact on visitor experience. The components that received the highest scores were *visitor engagement* and *visitor learning*, indicating that visitors were actively engaged and gained knowledge while interacting with the exhibits. The retention index for objects when using AR was approximately three times higher compared to when it was not used, indicating that the system successfully increased visitor interest. Visitors preferred video content, and

Figure 4. A glimpse into the engagement of visitors to the Natural History Museum of Funchal as they test the mobile app, EasyMuseumARViewer. The participants in the images are seen interacting with the app and immersing themselves in the rich history and fascinating natural wonders of the exhibit.

the mobile application was generally perceived as easy to use. However, some visitors suggested improvements such as enhancing the presentation of text content and allowing content be fixed in place. Furthermore, some visitors experienced initial difficulties in handling the application, which highlights the need for further usability testing. Overall, the results suggest that the developed mobile app has the potential to enhance visitor engagement and interest, and can be used to view interactive exhibitions in museums.

Implications for the museum management and curatorship practice

With guidance on how to create interactive exhibits, museums can encourage their CHPs to craft exhibits that truly engage visitors, leaving a lasting impression that will encourage them to return in the future. By using authoring tools, CHPs can create interactive exhibits more efficiently and at a lower cost. This is an especially important consideration in today's economy where many museums have had to tighten their budgets. Additionally, with the help of authoring tools, CHPs can develop innovative exhibits that set them apart from other institutions. This, in turn, can help museums attract new visitors and stay relevant in an increasingly crowded field.

Designing effective interactive exhibitions is a complex process that requires a nuanced understanding of the attitudes and approaches of CHPs. To achieve this, it is essential to conduct user research to identify the knowledge gaps, barriers, motivations, and objectives that CHPs face when creating interactive exhibitions. This can be done through surveys, interviews, and usability testing. One important step in designing effective interactive exhibitions is to provide technical support to CHPs who lack technical expertise, which may involve offering training and tutorials to help them learn how to use authoring tools and platforms. Personalization options can enhance the effectiveness of interactive exhibitions by allowing CHPs to tailor the exhibitions to specific audiences. Offering flexible options that allow CHPs to experiment with different approaches to designing interactive exhibitions is crucial: this could involve the ability to add and remove modules or switch between authoring platforms. When creating interactive exhibits, CHPs should use authoring tools that are user-friendly and intuitive to create content efficiently and with less frustration. Conducting research is essential to understand the design processes and practices used by CHPs when building interactive exhibitions. Additionally, designing tools and authoring platforms that address the challenges faced by CHPs requires a deep understanding of the issues they face, such as technical difficulties, budget constraints, maintenance issues, and lack of human resources. To ensure a great visitor experience, the exhibitions should be designed to offer flexibility and personalization options, and the technology used in exhibitions should integrate seamlessly with the visitors' existing technology, such as mobile devices or social media platforms. The use of AR can increase visitor interest and retention, suggesting that museums can consider incorporating AR in their interactive exhibitions to enhance the overall visitor experience. Overall, a balance between interactive technology and traditional modes of engagement is necessary to create successful interactive exhibitions that cater to the needs of CHPs and visitors.

Mobile experiences should contain multimedia content, interactive elements, and relevant information about the exhibit. Clear instructions should be provided to visitors,

considering varying levels of technical expertise, along with resources and support to facilitate the use of the mobile application. When designing exhibits, CHPs should bear in mind that visitors prefer video and multimedia elements to other forms of content. Therefore, incorporating high-quality multimedia content, such as videos, animations, and interactive elements, is crucial in improving visitors' understanding of the exhibit. Multimedia content provides an excellent way to tell a story and provide context for the exhibit. CHPs must be thoughtful about how multimedia content can be used to enhance visitors' understanding of the exhibit and provide a more immersive experience. By using multimedia content in a strategic and deliberate way, CHPs can make the exhibit more compelling and memorable. Our studies have highlighted the importance of incorporating interactive exhibits that engage visitors and provide knowledge. The *visitor engagement* and *visitor leanring* components have received high scores, suggesting that visitors were actively engaged and gained knowledge while interacting with the exhibits. Museum management and curatorship should consider incorporating interactive exhibits into their exhibition design to create a more immersive and educational experience for visitors.

Prior to developing interactive exhibitions, CHPs must have a thorough understanding of visitors' perspectives and their likely interaction with the exhibits. User testing with a small group of individuals can help CHPs design exhibits that cater to a specific demographic. During user testing, scenarios can be used to guide visitors through the exhibition, enabling them to comprehend the exhibit's purpose and providing context for interactive features. To enhance the exhibition's engagement and effectiveness, CHPs must integrate feedback collected during user testing. They should keep track of visitor engagement data, such as time spent at the exhibit, interaction with the exhibit, and feedback on the exhibit's content. CHPs can employ various methods, such as surveys, interviews, and observations, to collect feedback. Identifying challenges that visitors face when using interactive exhibits and issues with the interface is crucial. CHPs must provide opportunities for improvement by addressing any areas that require modification. Data analysis can be used to identify potential solutions, such as redesigning the experience, providing additional instructions, or modifying the exhibit's content. Finally, CHPs must use the feedback collected to improve future exhibits continually. By continuously gathering feedback and making improvements, CHPs can create more engaging and effective exhibits for visitors.

The guidance for creating interactive exhibits and using authoring tools in museums is innovative for several reasons. Firstly, it highlights the importance of user testing and feedback to create exhibits that meet the needs of visitors and provide a positive experience. Secondly, the guidance encourages the use of multimedia content and mobile applications to cater to diverse interests and learning styles while maintaining the core mission of the museum. Additionally, the guidance emphasizes the need for providing museum staff with necessary tools and ongoing research to identify areas for improvement. By adopting the recommendations proposed in this study, museums can create more engaging and educational exhibitions that provide a unique and immersive experience for visitors while reducing development time and costs. Therefore, it is recommended that museums adopt the user-centered approach to exhibit design, leverage new technologies and authoring tools, and prioritize ongoing learning and improvement in their work.

Conclusion

Providing guidance for CHPs (curators, staff, volunteers) to create interactive exhibitions and use authoring tools can be a game-changer for museum management and curatorship practice in today's competitive museum landscape. CHPs can create interactive exhibits more efficiently and at a lower cost by using authoring tools. This is an especially important consideration in today's economy where many museums have had to tighten their budgets. Additionally, authoring tools can help CHPs develop innovative exhibits that set them apart from other institutions. This, in turn, can help museums attract new visitors and stay relevant in an increasingly crowded field. In summary, providing guidance for CHPs to create interactive exhibitions and use authoring tools is an important step towards improving museum management and curatorship practice. By doing so, museums can create more engaging exhibits, improve learning outcomes, reduce costs, and promote innovation. These benefits are not only good for the museums themselves, but also for the visitors who will enjoy a richer and more rewarding museum experience.

Disclosure statement

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Geolocation information

This study was conducted in Madeira Island, Portugal.

Notes on contributors

Vanessa Cesário, a PhD holder in Digital Media, is a postdoctoral researcher in the Interactive Technologies Institute (ITI/LARSyS) and a passionate Professor at IST, University of Lisbon, who teaches 'Technology and Society': her goal is to provide students with an understanding of the ethical implications that arise from the development and use of information technology products and services. Vanessa's research uses participatory design to create immersive and engaging experiences in cultural heritage sites. She combines game design and storytelling to break down barriers and make heritage accessible to all. Participatory design is uncovering new ways to engage people with cultural heritage, promoting empathy, understanding, and preservation. These experiences are delivered through virtual reality, interactive exhibits, or mobile apps, encouraging active participation in preserving history and traditions. Vanessa's work has been published in international journals and conferences in Human-Computer Interaction (HCI), Museum Management, and Interaction Design.

João Freitas is a recent graduate of Computer Engineering who has been working for the past year on developing a mobile application that assists curators in creating interactive experiences in museums. His dedication to merging technology with the cultural heritage sector has led him to explore ways in which HCI can be applied to enhance visitor engagement.

Pedro Campos is an Associate Professor of HCI at the University of Madeira, Portugal, and Senior Researcher of the Interactive Technologies Institute (ITI/LARSyS). He is also Associate Researcher at the Visualization and Intelligent Multimodal Interfaces Group at INESC-ID Lisbon. He is currently Chair of IFIP's Technical Committee 13.6 on Human Work Interaction Design, National Representative for the TC13 and serves the editorial board and program committee of several HCI journals and conferences. Pedro has authored more than 100 scientific publications in the field.

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