

Cultural Heritage Professionals Developing Digital Experiences Targeted at Teenagers in Museum Settings: Lessons Learned

Vanessa Cesário
Madeira Interactive Technologies
Institute & University of Porto
Portugal
vanessa.cesario@m-iti.org

António Coelho
Faculty of Engineering of University of
Porto & INESC TEC
Portugal
acoelho@fe.up.pt

Valentina Nisi
Madeira Interactive Technologies
Institute & University of Madeira
Portugal
valentina.nisi@m-iti.org

Teenagers have been identified as an audience group that is often excluded from museum curatorial strategies. One strategy to counteract this problem is to involve cultural heritage professionals (CHPs) in the design process of museum based digital experiences targeted at teens. In this paper, 12 CHPs from a local natural history museum took part in a co-design activity over 20 hours, aiming to create and deploy digital tours for teenagers aged between 16-19. We present the three prototypes that derived from these design sessions. These were then tested by both 12 CHPs and 12 teenagers separately, and we report on lessons learned from the evaluation of these prototypes by both groups.

Cultural heritage professionals. Museums. Teenagers. Design. Authoring tools. Digital experiences.

1. INTRODUCTION

Cultural Heritage takes many forms and settings; from museums and historic buildings to open-air sites and urban areas (Ciolfi & Petrelli, 2016). Cultural Heritage Professionals (CHPs) are responsible for shaping museum experiences and collections (Ciolfi & Petrelli, 2016). Storytelling can be a highly effective way to convey ideas and beliefs; museums not only tell us stories but also build those stories through the meaning-making process in which the visitors embark (Kelly, 2007). This allows a museum's audience to indulge in narratives that aid the construction of meaningful memories as well as providing the fulfilment of a complete experience. According to Falk (Falk, 2009), the so-called "one size fits all" principle does not apply to visitor experiences. Notably, teenagers seem to be a difficult audience to engage, and at the same time, a neglected typology of visitors for cultural heritage sites. "Generation Z" (13-18 years old) is especially seen as quite different from previous generations, particularly regarding their beliefs and behaviours (Wikia, 2013). This generation is identified as an audience group that is often excluded from a museum's curatorial strategies (Tzibazi, 2013) and appears to be generally disinterested in what museums might offer. In return, museums often seem to ignore them. Museums today are engaging with new and

interactive technologies, challenging the old paradigms of audio and human guides. Mobile applications can engage visitors with a memorable approach (Bailey-Ross et al., 2016) and require minimal changes to an exhibition space. Mobile applications present many options that can be tailored individually to suit respective exhibits or the visitors' current identity-related visit motivations. Furthermore, without some degree of digital interactivity, it is challenging for a museum to remain interesting and relevant to a young tech-savvy audience. Since CHPs are responsible for shaping experiences within cultural heritage spaces, they should be involved in the ideation of interactive tools as active players in the development of the technology design process (Ciolfi & Petrelli, 2016). It is crucial to involve CHPs in the design process to attract teenagers, given they are the adults of tomorrow, and a future museum-going audience which is currently neglected by curatorial strategies. In this paper, we report on the design process and collected data derived from evaluating the prototypes developed by CHPs targeted at teenagers. Placing CHPs in the role of experience developers and teenagers as the target audience, allowed us to open the professionals' mind by placing them in the shoes of their audiences, and not only of their client (the museum). Moreover, targeting teenagers proved to be a timely challenge given their neglected state as

museum audiences and pressing needs of the museum to expand their offering to a broader pool.

In the rest of this article we present the three augmented reality prototypes derived from design sessions with the CHPs. These prototypes were then tested by both CHPs and teenagers separately and we report on lessons learned from the evaluation of these prototypes by both groups.

2. RELATED WORK

Within the frame of Human Computer Interaction (HCI), there are approaches for designing interactive exhibitions which involve visitors and other stakeholders as informants on the design to create user-centred approaches (Ferris et al., 2004; Iversen & Smith, 2012; Taxén, 2004). CHPs have seldom been involved in the design of such technologies, and since they are an integral part of the museum, integrating them in the development process of such technologies will additionally create museum activities (Maye, Bouchard, Avram, & Ciolfi, 2017). Co-design methods and techniques have been deployed in the design of technology for cultural heritage as a means to commence novel museum engagement exhibitions and programs (Bossen, Dindler, & Iversen, 2012; Roussou, Kavalieratou, & Doulgeridis, 2007; Taxén, 2004). We will now go on to describe some studies which involved CHPs in the design of interactive interpretative exhibitions which inspired us to engage a group of CHPs from a selected museum to co-design museum experiences targeted at teenagers.

Maye and colleagues (2014) report how CHPs engage in the design of interactive exhibitions in terms of their attitudes, processes, understanding, and expectations of technology. These researchers identified a gap regarding the know-how of CHPs in the development of interactive exhibitions, their design motivations and their attitudes towards technology. Museum and cultural heritage research has been 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. In HCI, existing literature examines the design processes involved in creating interactive museum experiences (Ciolfi & McLoughlin, 2012; Ferris et al., 2004), with examples of work that adopted participatory design or user-centered approaches (Bossen et al., 2012).

Other examples see the inclusion of visitors and CHPs within the design team, providing the curatorial goals and the educational missions of the museum, as well as providing expert advice on content (Taxén, 2004). Hornecker and colleagues (2013) examined two aspects of CHP 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 the smaller museums, the desire to include digital exhibits was driven by the perceived visitor expectation of being up-to-date. Including digital technology can be seen as the desire to communicate invisible material, making visitors more aware of their surroundings. However, there is a conflict concerning understanding what is achievable with digital interactive exhibits and its disadvantages, such as high costs, maintenance issues, timely design, and distraction to visitors. Hornecker and colleagues (2013) also argue that this challenge could be addressed through authoring tools for digital fabrication, which focuses on making low-cost, rapid prototyping accessible for the general public as well as helping curators and designers to develop interactive exhibits. However, and as noted by Hornecker in another study (E. Hornecker, 2008), if interactive tools are difficult to use, they can distract visitors from engaging with heritage artefacts. From another point of view, and concerning this authoring tools approach, Avram and Maye (2016) report on a collection of co-designed case studies and methods framed for CHPs to help them to create their own interactive exhibitions. This co-design resource integrates an authoring tool and a plug-and-play hardware and software platform (the meSch kit). This resource was created thanks to the diversity of the curators' background and professional skills, and also a possibility due to resources of the institutions.

3. RESEARCH QUESTION & METHODOLOGY

From analysing the state of the art, we highlighted a series of questions that are still in need of deeper investigation. Through our research we aim to answer the following research questions: Do cultural heritage professionals understand teenager's needs and desires when it comes to designing engaging museum experiences for them? How do teenagers receive CHPs ideas, and how can CHPs learn from teenagers in order to improve museum experiences targeting this young audience?

To answer the above questions, we followed the results from a focus group study with 130 teenagers where we gathered teenagers' views regarding what they would add to museum tours to prompt them to visit these institutions (Cesário, Coelho, & Nisi, 2017). It was mainly found that teens would like to experience 1) interaction with the artefacts, 2) multimedia within the tour, 3) new and less mundane experiences at museums; 4) their interests reflected on the tours. These outcomes were communicated to a group of CHPs from the Natural History Museum of Funchal (NHMF). This group of CHPs

were then instructed how to design and use free digital interactive media tools to develop their ideas.

Many museums opt to outsource digital experience development to designers and engineers, however not all the museums have adequate funding available for these services and solutions. Alternatively, there is a range of free digital interactive media tools (QR codes and Augmented Reality apps) that museums and CHPs could use to create and deliver digital content to their audiences without outsourcing. Hence, with the aim of understanding whether CHPs could deploy engaging digital experiences for teenagers through a free digital interactive media tool.

CHPs were introduced to the HP Reveal App. This software allows the unlocking of digital content displayed as Augmented Reality (AR) when capturing a specific visual marker (trigger image). To this end, CHPs needed to develop the digital content to be displayed as AR on site, in addition to the trigger image, and then upload both to the HP Reveal Studio.

The CHP group was split into teams of 4 and given around 14 hours to develop an interactive museum tour for teens, bearing in mind that teenagers would test their interactive tours later. Once the tours were developed, all the CHPs and teenagers tested them separately, answered surveys, and were briefly interviewed about what would they change about the experience, and how, in order to be more attractive for teenagers.

Finally, we compared the results of each tour between both groups (CHPs vs teens).

4. PROCEDURE

Within this section, we describe in detail the process we used to work with the CHPs and teenagers. Firstly, we describe the natural history museum chosen for this study; secondly, we describe the CHPs of the museum and how they acted as developers and testers of their AR experiences; thirdly, the AR software used; and fourthly, the teenagers as testers of these experiences.

4.1. Natural History Museum of Funchal

The Natural History Museum of Funchal (NHMF) is not only the sole museum dedicated to natural history on Madeira island (Portugal) but it is also a very striking venue. It is rich in diverse content from across the island, such as the world-renowned millenary forest protected by UNESCO and an abundance of marine life and maritime patrimony. Last year alone, the museum conducted around 4,000 guided tours. More than 1,000 children under the age of 11 visited the museum without being in a school field trip – almost half of which were of foreign origin – as well as

780 teenagers aged between 12-17 years old. The NHMF has different guided tours tailored for children (6 to 10 years old) and adults, but nothing specific for teens. While the museum offers plenty of content, the experience of the visitors (especially that of teenagers) is very plain and lends itself to the use of recent technological advancement to improve the offering. However, the museum does not have the financial means to fund outsourced interactive applications and is looking for alternative solutions to overcome this challenge.

4.2. CHPs as developers and testers

CHPs from NHMF were invited to take part in a training course which would lead to the design and development of early concept prototypes of interactive tours aimed at teenagers visiting the museum. This group of CHPs was composed of 12 participants (aged from 41-54, 8 females and 4 males) which included 7 biologists, 2 tour guides, 2 technicians from their scientific library, and 1 member of communication personnel. This training course was carried out over two weeks and had a total duration of 20 hours (2 hours per business day). The proposed schedule was the following:

03h – Ice breaking and brainstorming

Taking into account the information gathered on what teens would add to museum tours (Cesário et al., 2017) to inspire them to visit these institutions, the CHPs were split into groups and invited to think about an 'ideal experience' to engage teens in their museum (Figure 1). This exercise was designed to break the ice between the participants. To boost their imagination and critical spirit, they were free to think that everything was technically possible.

01h – Introduction to the practical part

CHPs were introduced to the 14-hour training course. The following topics were summarised:

- 1) definition of the interactive tour experience, 2) script writing of the tour experience, 3) development of the digital content (videos), 4) uploading of the digital content to the HP Reveal software, and 5) testing and evaluation of the tours.

02h – Definition of the tour concept

The participants, divided into groups, decided which of the museum's rooms to focus on, which points of interest (POIs) to work with and the concept of their tour experiences. Participants were encouraged to think in terms of storytelling as well as game mechanics to guide the teenage visitor through the POIs, bearing in mind that the digital content to unlock in each POI would be a multimedia video made by them. These videos needed to include an indication to guide the visitor to the following POIs.

04h – Script writing of the tour experience

After defining the tour concept, participants began creating scripts for the videos to be unlocked at each

POI. For each POI, they were required to describe: 1) which location the video is related to; 2) if any image appears; 3) dialogue, if any; 4) how they would guide the user to the next POI.

06h – Development of the digital content (videos)

With the script finished, the participants started creating the video for each POI. The content of these videos was produced by the participants on their own. Some of them recorded a theatrical performance while others recorded their voices and put together images and animations. The videos and voices were recorded with an iPhone 6, and the manipulation and animations of the videos were made in native video software on their own computers (Windows Movie Maker, Keynote, and PowerPoint).

02h – Uploading of the digital content to the HP Reveal software

The participants were instructed on how to upload their videos to the HP Reveal studio and how to use the HP Reveal app to perform the digital tour with the content created.

02h – Testing and evaluation of the tours

All the CHPs tested the tours developed (in this order: Tour #1, Tour #2, Tour #3), answered surveys, and commented on their experience. (Figure 2).



Figure 1. CHPs split into groups working on their AR experiences targeted to teenagers.



Figure 2. CHPs testing their experiences in groups.

4.3. Software used

The HP Reveal software (Figure 3) is one of the many easy and free tools available on the market. It was chosen for this activity as it was ranked highest by users on Google Play and offers a visually clean studio within which to upload digital content. HP Reveal is AR software which allows us to see and interact with the world through digital content. The digital content can be as simple as a video and a link

to a web page, or as complex as a live 3D animation. For the purpose of simplicity and the CHPs' abilities in this area, we chose to make each piece of content rendered as a video. Users of this software need to select a trigger image which unlocks the digital content. The trigger image can be a picture of an artefact in the museum or a picture of its label. After selecting the trigger image, it is necessary to upload the digital content. Therefore, when the user's smartphone camera points to that trigger image, it will unlock the digital content previously uploaded.

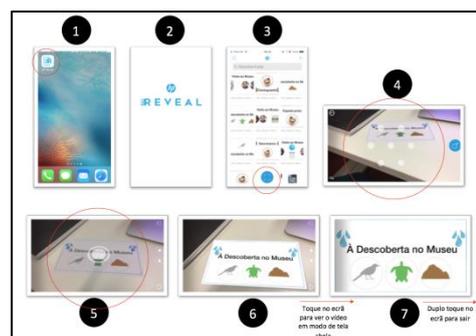


Figure 3. Tutorial of the HP Reveal app shown to the teenage participants before the experiments. Point 6 says “click on the screen to watch the video in full screen”. Point 7 says “double click on the screen to exit the video”.

4.4. Teenagers as testers

A group of teenagers was invited to test the interactive tours created by the CHPs. We tested the digital tours made by the CHPs with 12 students (aged between 16-19 years old) from a local secondary school next to the museum (Figure 4). Unexpectedly, all the users were male, and we were unable to recruit females for this early evaluation. Parents and legal tutors signed consent forms on behalf of their children to take part in the study. After obtaining all the necessary permissions, we scheduled a day for the testing. As we had limited devices to test the prototypes, we split the sample in four groups of three and given a smartphone per group. The students did the tours at the same time but always remained in their groups (order: Tour #1, Tour #2, Tour #3). After the end of each tour, teenagers came to a room where they answered surveys and commented on the experience they had just had.

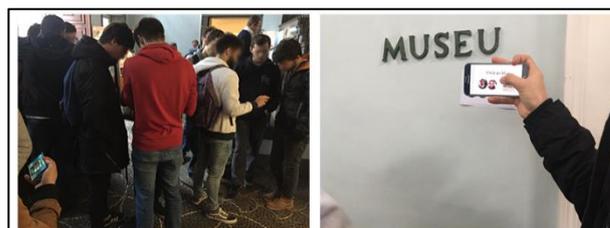


Figure 4. Teenagers, split into groups, testing the experiences that CHPs developed.

5. MEASURES AND ANALYSIS

To gather answers to the research questions above mentioned, the experiment we conducted at the museum incorporated different research methods. We applied the Museum Experience Scale (MES), the Multimedia Guide Scale (MGS) (Othman, Petrie, & Power, 2011), and the Positive and Negative Affect Schedule (PANAS) (Watson, Clark, & Tellegen, 1988).

All these scales were translated from English to the participants' mother tongue of Portuguese and verified with an English professor to guarantee that the meaning was the same in both languages. To minimise some disadvantages of the closed answers in the questionnaires mentioned above, and in order to gather qualitative feedback about the tours, at the end of the surveys for each tour the participants were asked to verbally express their opinion on the tour they had just completed.

5.1. Quantitative analysis: scales applied

The MES measures a visitor's overall experience in museums, particularly the engagement with the exhibition. This scale has 4 components: 1) *the engagement with the exhibitions and exhibits*; 2) *the knowledge/learning gained from the exhibition and exhibits*; 3) *the meaningful experiences from the interaction with the exhibitions/exhibits and/or other visitors*, and 4) *the emotional connection with the exhibits/exhibitions*. Each component contains 5 questions each.

The MGS measures reactions to the usefulness and usability of multimedia guides. This scale has 17 questions within 3 components: 1) *the general usability of the guide*; 2) *learnability and control*, and 3) *the quality of interaction with the guide*.

The PANAS scale describes different feelings and emotions regarding an activity.

We used SPSS to run this quantitative analysis, and the *Mann-Whitney U* test was chosen as it is a statistic test of choice for small sample sizes and does not require any assumptions about the parametric form of the distributions.

In one hand, by applying both the MES and PANAS, we would be able to answer how CHPs and teens perceive and feel connected with the digital museum tours. On another hand, by applying the MGS, we would foster discussion on which problems encountered with the mobile tours both groups reported. Given that these quantitative measures can helpfully complement qualitative information about visitor experience, comparing the results gathered from CHPs and teens would help us to understand whether CHPs perceived teenagers' need and desires when it comes to museum tours, as well as how CHPs could learn

from these results to improve museum experiences targeted at teenagers.

5.2. Qualitative analysis: comments on each route

At the end of each tour, both CHPs and teens were briefly interviewed about their experience and what they thought teenagers would have liked most about it. These comments were recorded and transcribed. We used thematic analysis to report the data gathered. This technique is used for identifying, analysing, and reporting patterns within data. It minimally organises and describes the data set in detail (Braun & Clarke, 2006). NVivo 11 was used to organise the qualitative analysis for each tour.

6. RESULTS

Within this section, we describe each one of the three tours created by the CHPs, part of its script to contextualise the reader, and the results from the scales and interviews. The script gives us all the necessary information about the content to be found at each POI. To complete their scripts, the CHPs also wrote all the narrator's speeches to record and add to the videos, but for the purpose of simplicity and page constraints, we have chosen not to include all the narrator/character speeches, but outline the topics portrayed in these lines.

6.1. Tour #1 Discovering the museum

Tour #1 was created to make visitors aware of the scientific library as it is almost unknown to the museum's visitors. It encompasses four different POIs and at the end, invites the users to explore the real library there. This tour makes use of web links with detailed information about the POI, and of time-lapse videos to show the visitor where they need to go next. Detailed information about Tour #1 can be found in Figure 5 and Table 1.



Figure 5. Overview of the 1st POI from Tour #1, upper left to lower right: 1) Trigger image located at the entrance hall; 2) Video starts with information about the MHNF; 3) The scientific library of MHNF; 4) Frame from the end of the video launching the challenge: to look around the museum for those three symbols.

Table 1. Part of the script of Tour #1.

Theme	Getting to know the Scientific Library
Plot	A narrator gives information about the museum and lets the users know they can find more detailed information in the Scientific Library about certain artefacts in the museum.
Number of POIs	4
Mechanic	Information on the POI + time-lapse video of the route from one POI to another POI.
Video development	Keynote: voice of narrator accompanying images / text / videos appearing.
End of each POI	Time-lapse video of the walk from one POI to the next POI.
1 st POI, duration	Entrance hall (01m 45s)
Topics	This first POI gives an introduction to the museum and makes reference to the Scientific Library as it is hidden and many visitors, especially young people, do not know that it exists. This POI launches a challenge to find three symbols in the museum that are related to certain exhibits which will allow the user to learn more about them.
Going to the next POI	Time-lapse video of the walking route from this POI to the 2 nd POI (Sea Bird).
2 nd POI, duration	Sea Bird (00m 22s)
Topics	1) Scientific name and origin of the species accompanied by book covers that can be found in the library, 2) Web link that gives access to a web page about specific information about the Sea Bird.
Going to the next POI	Time-lapse video of the route from this POI to the 3 rd POI (turtle).
3 rd POI, duration	Turtle (00m 20s)
Topics	1) Scientific name and origin of the species accompanied by book covers that can be found in the library, 2) Web link that gives access to a web page giving specific information about the turtle.
Going to the next POI	Time-lapse video of the walk from this POI to the 4 th POI (Basalto Stone).
4 th POI, duration	Basalto Stone (00m 38s)
Topics	1) Scientific name and origin of the object accompanied by some book covers that can be found in the library, 2) Web link that gives access to a web page showing more information on the Basalto Stone.

Ending	The narrator thanks the user for making this tour and invites him to visit the library. Shows a time-lapse video of the walking route from the Basalto Stone to the Scientific Library.
--------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

6.1.1. Tour #1: Quantitative analysis between groups

Data shows that teens (MDN=4.4) could obtain more *knowledge/learning* with Tour #1 than the CHPs (MDN=3.44), and this was statistically significant (U=21.5, p=0.004). Also, it emerged from the data that teens (MDN=3.8) had a more *meaningful experience* than CHPs had (MDN=3.2), this being significant (U=24.5, p=0.006). Regarding *learnability and control*, this tour ranked higher among teens (MDN=4.67) than among CHPs (MDN=3.83); the difference is statistically significant (U=21, p=0.003). To end with, teens scored higher on *negative affect* (MDN=1.1) than CHPs (MDN=1), and this again was statistically significant (U=41, p=0.048).

6.1.2. Tour #1: Comments from CHPs and teens

Nobody clicked on the **links** in the videos, in fact, no one understood that the “www” image (Figure 6) was clickable. One of the CHPs only realised this at the last POI. All CHPs agreed that links need to redirect users to easily consumable information; a video, for example, rather than a webpage. At the design stage, CHPs were convinced that the “www” image would be noticed by teens, yet none of the teenagers understood that the image was clickable.

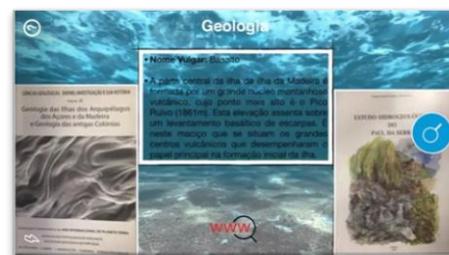


Figure 6. Screenshot of the video displayed on the 4th POI from Tour #1 displaying the “www” image linked to a webpage.

The CHPs considered Tour #1 very **interesting** from the experience design point of view but also highlighted that it would need **more detailed information** about the artefacts to be informative and impactful enough for teens to engage with. Moreover, CHPs agreed that the POIs were not consistent among themselves, the 1st POI was **very long** in relation to the others that were very short and light in information. Both groups agreed this tour was **too short**. Teenagers said that on top of being short and fast, they could not stop the video to read what was written on it. As a consequence, only six teenagers (two groups) realised they were supposed to go to the library at the end of it. However, they could not go because the door that gives access to

the stairs leading to the library was closed, and, as a consequence, the teenagers did not end up going to the library as the CHPs had envisioned. Moreover, both teens and CHPs **would advise to change the clues** guiding visitors from one POI to the next. Two CHPs reported they would lower the time-lapse speed. One teenager reported the time-lapse video as being too fast and therefore it was hard to remember where to go next. Three CHPs pointed out that it would be valuable to **add more sounds and multimedia videos** to this tour to captivate visitors. CHPs also thought that having a headset would improve their visit and minimise distractions; reducing **background noise** in the museum such as footsteps and people talking.

6.2. Tour #2 Gastronomic Route

Tour #2 was created to get visitors to discover some marine species in a different manner to which they are normally accustomed in a natural history museum. This tour was different from those regulars as it had a character that guides the user through a series of curiosities and recipes for a selection of marine animals. This tour uses pictures of animals to prompt the users to search for them and unlock the digital content. It includes four different POIs and at the last one, invites the users to click on a book which will lead them to view a PDF with more recipes. Detailed information about Tour #2 can be found in Figure 7 and Table 2.



Figure 7. Overview from the 1st POI of Tour #: 1) Trigger image; 2) Chef welcoming the users; 3) Chef introduces his recipe and invites the user to search for the main ingredient in the museum; 4) Ending frame of the video depicting the scabbard fish for the user to look for in the museum's premises.

Table 2. A part of the script from Tour #2.

Theme	Gastronomy
Plot	Chef of the old palace (now the museum building) invites the user to learn more about the dishes that he used to cook at banquets, guiding the user through the edible marine species in the museum.

Number of POIs	4
Mechanic	PowerPoint: Curiosities about specific marine species at each POI along with a picture of the species cooked on a dining plate.
Video development	Narrator voice of the main character accompanying images / text / videos appearing.
End of each POI	Drawing of the next animal in the museum that users have to look for to go to the next POI.
1 st POI, duration	Entrance Hall (00m 43s)
Topics	This first POI presents the narrator as a chef who will guide the users to visit the museum and show them three marine animals that are usually cooked.
Going to the next POI	Drawing of the next animal (swordfish) that users have to look for to reach the next POI
2 nd POI, duration	Swordfish (00m 47s)
Topics	Curiosities about the Swordfish along with a picture of this fish cooked on a dining plate.
Going to the next POI	Drawing of the next animal (Xara-branca) that users have to look for to reach the next POI
3 rd POI, duration	Xara-branca (00m 41s)
Topics	Curiosities about the xara-branca along with a picture of this shark cooked on a dining plate.
Going to the next POI	Drawing of the next animal (caranguejola) that users have to look for to reach the next POI.
4 th POI, duration	Caranguejola (00m 37s)
Topics	Curiosities about the caranguejola along with a picture of this crab cooked on a dining plate.
Ending	The chef says goodbye and invites the visitor to learn more about other fish recipes by clicking on a book that appears on the screen (Figure 10).

6.2.1. Tour #2: Quantitative analysis between groups

Data shows that teens (MDN=3.8) were *emotionally more connected* with Tour #2 than CHPs (MDN=2.8), and this was statistically significant (U=29, p=0.013).

6.2.2. Tour #2: Comments from CHPs and teens

Both CHPs and teens found the **content interesting** and were **aware of the link** displayed in the last POI (Figure 8). CHPs argued that having curiosities of the species was very good, and also mentioned that it is a non-common aspect addressed in their common guided tours, being something interesting to explore. Two CHPs suggested that it is necessary to deliver thematic content to engage more teen visitors. From the teenager's point of view, they thought it was nice to have a tour as different and interesting as this one, and that all the content displayed at each POI was understandable.

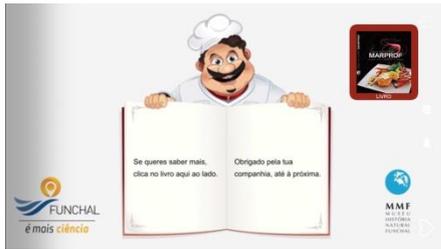


Figure 8. Screenshot of the video displayed on the 4th POI from Tour #2. It is possible to see the book image which would lead to a webpage to see the PDF of the recipes.

However, only four CHPs mentioned that this tour **did not focus on what the museum is about**, because it was mainly centred around gastronomic curiosities of some species in the museum. Also, three CHPs mentioned that the **words displayed on the device screen were too small** and difficult to read, although the teens mentioned they **could read** the text well on their mobiles. All CHPs mentioned that the **graphics were good**, and only three of the CHPs **would change the clues** giving more information to the user regarding the location of the next POI since those who come to the museum for the first time would not know the rooms. Two of the CHPs mentioned they would **add more and better animation to captivate** teens, while teens pointed out that it would be more attractive if there were 3D images of the species to interact with. Interestingly, two CHPs argued that they were almost certain that this tour **would not be appealing** to teenagers. However, the teens mentioned this tour was better and more **interesting** than they were expecting and agreed it worked well to simultaneously combine texts and the narrator's voice. One teenager mentioned that he would **add more expression** to the voice of the narrating character in order to make it more appealing. The students were in agreement that this was a good tour because they had time to observe the museum, and were able to explore it more freely than the first tour.

6.3. Tour #3 Visiting the museum

Tour #3 was created to acquaint visitors with the museum by following and assisting them through a guided tour hosted by two digital characters. An old

male character is giving a guided tour to a teenage character. During this digital tour between them, the curious teenage visitor asks questions about specific animals, and the guide answers them by showing some videos of those animals in their natural habitat. This tour uses the trigger images as clues to prompt the users to search for their locations in order to unlock the next piece of digital content. The tour includes four different POIs, and in each of them, shows videos of animals in their natural habitats. Detailed information about Tour #3 can be found in Figure 9 and Table 3.



Figure 9. Overview from the 1st POI of Tour #3: 1) Trigger image; 2) Adolfo character welcoming Bruna; 3) Bruna character very curious; 4) Video of the Mero in its natural habitat.

Table 3. A part of the script from Tour #3

Theme	Visit between a male guide and a female teenage visitor.
Plot	Theatrical performance from two characters interacting with each other: Mr. Adolfo as director of the museum gives a guided tour to the curious teen girl Bruna who is always asking questions.
Number of POIs	4
Mechanic	Bruna asks questions about the museum and the species exhibited. Mr. Adolfo answers and shows videos of the species in their natural habitat.
Video development	Two people acted the character parts and were recorded through video software chosen by the participants – Crazy Helium Voice Changer. Besides modifying them aesthetically through filters (hair, glasses), it also altered their voices. The images and voices of the characters were accompanied by video clips of the animals in their habitats.
End of each POI	The characters verbally announce the next location and the trigger image for the next POI appears.
1 st POI, duration	Entrance Hall (00m 48s)

Topics	The characters meet and begin talking about the building's history, and that it even has an aquarium, making Bruna curious and wanting to see it.
Going to the next POI	The characters verbally announce the next location and the trigger image for the next POI appears (Aquarium).
2 nd POI, duration	Aquarium (00m 52s)
Topics	Adolfo tells Bruna that the Mero fish is one of the oldest in the aquarium, raising curiosity about him from Bruna. She asks him more questions about the fish. We observe videos of the fish in its natural habitat at the sea.
Going to the next POI	The characters verbally announce the next location and the trigger image for the next POI appears (museum entrance on the 1 st floor).
3 rd POI, duration	Museum Entrance (01m 16s)
Topics	Bruna is surprised to see sharks, and Adolfo talks specifically about a shark that is on a shelf. Includes videos of this shark in its natural habitat.
Going to the next POI	The characters verbally announce the next location and the trigger image for the next POI appears (bird: cagarra)
4 th POI, duration	Cagarra (01m 40s)
Topics	A video of this bird appears in its natural habitat at the same time that Adolfo is talking about the species.
Ending	Bruna says goodbye and thanks Adolfo for the visit. Adolfo tells her to always come back and to bring friends to learn about the other species in the museum. The users can see a "thank for watching" screen.

6.3.1. Tour #3: Quantitative analysis between groups

CHPs (MDN=3.0) ranked more on the *quality of interaction with the guide* under the Tour #3 than the teens did (MDN=2.7), and this was statistically significant (U=31, p=0.017). However, it was also significantly reported (U=27.5, p=0.004) that teens were *negatively affected* by this tour (MDN=1.5) than CHPs (MDN=1.0).

6.3.2. Tour #3: Comments from CHPs and teens

Both CHPs and teens agreed that the characters' **voice would have to be changed**. Only one CHP mentioned that he **would add text** or keywords to the video displayed so that the content would be more understandable, whereas the teens mentioned they could not perceive anything because there was

no accompanying text. The CHPs rated this tour as **the most interesting** and also mentioned that due to **background noise**, the dialogue between the characters was not understandable. The CHPs involved in the creation of this tour also reported that the **software used to manipulate** the characters voice and appearance was very limited, but they preferred this solution as it meant less work when editing the videos. They also mentioned the initial idea was to model a 3D image of the character Adolfo but did not have this skill. Additionally, one CHP pointed out that before going directly to the video of the species in their habitat, it **should show the species** in their exhibit shelves first, otherwise no-one would look at the real embalmed animal in the museum and would only see a picture on the screen of the smartphone. Only the teens **would change the characters** as they did not like the filters applied to the characters and the fact they did not move. They also argued that it would be better to have a real person guiding and talking to them directly rather than watching the characters in the app. CHPs felt that the **videos were interesting** to make the visit appealing and thought they removed the formality of the visit itself. However, only one teenager described the videos of the species as 'awesome'.

7. REFLECTION AND LESSONS LEARNED

In the following section, we reflect on the data collected in relation to our original research questions.

Do the cultural heritage professionals understand teenagers needs and desires when it comes to designing engaging museum experiences for them?

Despite having access to teenagers' ideas and preferences regarding exciting museum tours, it was hard for CHPs to include the interests of teenagers within the tours. CHPs had some difficulties in thinking of and designing experiences that were evaluated as pleasant by the sampled teenage testers. This was noted in Tour #3 where the CHPs developed a simple story and characters which did not trigger the teens excitement. Tour #2 was more positively rated by teenagers, while CHPs thought it was the tour that would least appeal to teenagers as it did not reflect what the museum was about. CHPs found it difficult to put themselves in the teenagers' shoes, which is an undeniably noticeable fact. The sampled CHPs grew up and were educated in a very different era with different sets of technologies. Despite involving CHPs in the design process has its value per se, we have seen the difficulties of this group in thinking and understanding the museum through the teens' eyes. The museums need to strive to involve this group of visitors. Moreover, performing such co-design exercise does not imply that all intended interactive experiences would be

delivered and perceived successfully by teens. Allowing for error and learning from mistakes can be a strategy to raise awareness among CHPs about the changing goals strategies and audiences of museums.

How do teenagers receive CHPs ideas and how CHPs can learn from teenagers in order to improve museum experiences targeted at this young audience?

Concerning Tour #1, from the Museum Experience Scale, the teenagers learned more from the exhibits of this tour than the CHPs, as the CHPs already held this knowledge. Considering the topics of *knowledge, meaningful experience, and learning and control*, it is normal to have significantly higher values for the teens as it was their first visit with the interactive guide. However, teens felt more *negatively affected* by the tour than CHPs did. This result highlights how learning is not necessary a motivation for teens to visit museums, while it seems to be still a high priority in CHPs. With this tour, we also learned that teenagers might be keen to discover places inside the museum that they were not previously aware existed. However, from the results of this study, museums should ensure that all paths to the completion of the digital tours are not obstructed and should facilitate the passage of the visitors, as the teens were not able to access the library as CHPs had envisioned. Furthermore, the inclusion of links in the videos have to be well thought out at design and usability level, otherwise, the user may not be aware of them and not click on to the additional material. For example, CHPs argue that the links were something teens would not have missed while all teens did. CHPs operated on a preconceived idea. They projected their own perception and understanding of technology on how teens, who are very differently able than them with tech stuff, would act with the technology. We also learned that CHPs should measure the amount of time that text appears on-screen because if there is too much text in too short time to read it, users end up frustrated. This issue is due to a first usability mistake made by interaction design beginners. This shows that CHPs were not able to go beyond basic design issues of designing for mobile, neither thought of testing it first to understand which issues could arise.

Tour #2's results reported that teens were more *emotionally connected* with this tour than the CHPs. The CHPs mentioned this tour did not convey what the museum is about, yet it was the tour that the teenagers felt more connected to. It is interesting to note again how teens perceptions differ from the CHPs prognostics. With Tour #2 we learned that the inclusion of several more informal themes than the ones carried out in regular museum tours are viewed as positive and engaging, as the teens were seeking general and different overviews of the environment

rather than specific information. We also learned that simple ideas and simple development of videos (the case of this tour) might work better than complex ones (the case of tour #3).

Tour #3 also yielded interesting results. Although the CHPs thought this would be an exciting tour due to the information quality delivered through the videos and character interaction, the teenagers disagreed. For this tour, the teenagers reported being more negatively affected than CHPs. Here we noticed a considerable difference between the views of CHPs and teens. Mainly due to the distortion of the character voices and the filters applied to their images, which was what CHPs thought was the most engaging part of it, teens found the tour childish. The narrating voices were also hard to understand, which was a result of the filters applied. Again, here some amateurs mistakes from the CHP had potentially negatively influenced the concept as a whole. However, on a more positive note, the use of videos of the featured species in their natural habitat was seen as a positive element of the tour.

8. CONCLUSION

This paper positions CHPs from a local natural history museum as developers of digital experiences targeted at teenagers. The development of creative content and the use of free digital authoring tools seem to be a viable solution for museums with a lack of funding resources to improve their message and engage these audiences. In conclusion, the main take away from this study concerning our research questions can be summarised as 1) Authoring tools are suitable for early prototypes; however, the experiences derived should be improved taking into consideration usability, and interaction design levels as CHPs without interaction design skills could compromise the experience as a whole. 2) CHPs tend to operate on preconceived ideas, and this could compromise the whole experience; CHPs should be instructed to conduct usability tests with their target users to understand what more they could do to foster a better and more exciting experience. 3) Teenagers are looking for having a general overview of the place through informal themes rather than specific knowledge through more formal ones. 4) CHPs should be careful regarding the design by which they would deploy an experience as teenagers would not like to be seen as children; the implementation of images and sounds manipulated need to be seriously thought in order to meet the teenagers' motivations and not the children's. In this first approach, the prototypes were tested with a group of male teenagers, but as future work, we would test them with a sample of females as we envision to compare their opinions, split by gender, between the three prototypes developed by the CHPs.

Acknowledgments: ARDITI, project number M14-20-09-5369-FSE-000001.

8. REFERENCES

- Avram, G., & Maye, L. (2016). Co-designing Encounters with Digital Cultural Heritage. In *Proceedings of the 2016 ACM Conference Companion Publication on Designing Interactive Systems* (pp. 17–20). New York, NY, USA: ACM. <https://doi.org/10.1145/2908805.2908810>
- Bailey-Ross, C., Gray, S., Ashby, J., Terras, M., Hudson-Smith, A., & Warwick, C. (2016). Engaging the museum space: Mobilizing visitor engagement with digital content creation. *Digital Scholarship in the Humanities*, fqw041. <https://doi.org/10.1093/lc/fqw041>
- Bossen, C., Dindler, C., & Iversen, O. S. (2012). Impediments to User Gains: Experiences from a Critical Participatory Design Project. In *Proceedings of the 12th Participatory Design Conference: Research Papers - Volume 1* (pp. 31–40). New York, NY, USA: ACM. <https://doi.org/10.1145/2347635.2347641>
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp063oa>
- Cesário, V., Coelho, A., & Nisi, V. (2017). Teenagers as Experience Seekers Regarding Interactive Museums Tours. In *Proceedings* (pp. 127–134). Barcelos: IPCA - Instituto Politécnico do Cávado e do Ave. Retrieved from <http://www.digicom.ipca.pt/>
- Ciolfi, L., & McLoughlin, M. (2012). Designing for Meaningful Visitor Engagement at a Living History Museum. In *Proceedings of the 7th Nordic Conference on Human-Computer Interaction: Making Sense Through Design* (pp. 69–78). New York, NY, USA: ACM. <https://doi.org/10.1145/2399016.2399028>
- Ciolfi, L., & Petrelli, D. (2016). Walking and designing with cultural heritage volunteers | ACM Interactions, 46–51.
- Falk, J. H. (2009). *Identity and the Museum Visitor Experience*. Walnut Creek, Calif: Routledge.
- Ferris, K., Bannon, L., Ciolfi, L., Gallagher, P., Hall, T., & Lennon, M. (2004). Shaping Experiences in the Hunt Museum: A Design Case Study. In *Proceedings of the 5th Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques* (pp. 205–214). New York, NY, USA: ACM. <https://doi.org/10.1145/1013115.1013144>
- Hornecker, E. (2008). “I don’t understand it either, but it is cool” - visitor interactions with a multi-touch table in a museum. In *2008 3rd IEEE International Workshop on Horizontal Interactive Human Computer Systems* (pp. 113–120). <https://doi.org/10.1109/TABLETOP.2008.4660193>
- Hornecker, E., Clarke, L., McDermott, F., & Avram, G. (2013). Challenges and opportunities faced by cultural heritage professionals in designing interactive exhibits. *NODEM Conference Proceedings 2013*. Retrieved from https://www.academia.edu/5694408/Challenges_and_opportunities_faced_by_cultural_heritage_professionals_in_designing_interactive_exhibits
- Iversen, O. S., & Smith, R. C. (2012). Connecting to Everyday Practices: experiences from the Digital Natives exhibition. In E. Giaccardi (Ed.), *Heritage and Social Media* (pp. 126–144). London, UK: Routledge.
- Kelly, L. (2007). *The Interrelationships between adult museum visitors’ learning and their museum experiences* (Ph.D.). University of Technology, Sydney. Retrieved from http://australianmuseum.net.au/uploads/documents/6663/final%20thesis%20for%20graduation_kelly.pdf
- Maye, L. A., Bouchard, D., Avram, G., & Ciolfi, L. (2017). Supporting Cultural Heritage Professionals Adopting and Shaping Interactive Technologies in Museums. In *Proceedings of the 2017 Conference on Designing Interactive Systems* (pp. 221–232). New York, NY, USA: ACM. <https://doi.org/10.1145/3064663.3064753>
- Maye, L. A., McDermott, F. E., Ciolfi, L., & Avram, G. (2014). Interactive Exhibitions Design: What Can We Learn from Cultural Heritage Professionals? In *Proceedings of the 8th Nordic Conference on Human-Computer Interaction: Fun, Fast, Foundational* (pp. 598–607). New York, NY, USA: ACM. <https://doi.org/10.1145/2639189.2639259>
- Othman, M. K., Petrie, H., & Power, C. (2011). Engaging Visitors in Museums with Technology: Scales for the Measurement of Visitor and Multimedia Guide Experience. In P. Campos, N. Graham, J. Jorge, N. Nunes, P. Palanque, & M. Winckler (Eds.), *Human-Computer Interaction – INTERACT 2011* (pp. 92–99). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-23768-3_8
- Roussou, M., Kavalieratou, E., & Doulgeridis, M. (2007). Children Designers in the Museum: Applying Participatory Design for the Development of an Art Education Program. In *Proceedings of the 6th International Conference on Interaction Design and Children* (pp. 77–80). New York, NY, USA: ACM. <https://doi.org/10.1145/1297277.1297292>
- Taxén, G. (2004). Introducing Participatory Design in Museums. In *Proceedings of the Eighth Conference on Participatory Design: Artful*

Integration: Interweaving Media, Materials and Practices - Volume 1 (pp. 204–213). New York, NY, USA: ACM.

<https://doi.org/10.1145/1011870.1011894>

Tzibazi, V. (2013). Participatory Action Research with young people in museums. *Museum Management and Curatorship*, 28(2), 153–171. <https://doi.org/10.1080/09647775.2013.776800>

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. *Journal of Personality and Social Psychology*, 54(6), 1063–1070.

Wikia. (2013). Generation Z: A Look At The Technology And Media Habits Of Today's Teens. Retrieved April 11, 2017, from <http://www.prnewswire.com/news-releases/generation-z-a-look-at-the-technology-and-media-habits-of-todays-teens-198958011.html>