Co-designing Gaming Experiences
for Museums with Teenagers

Vanessa Cesário[1,2]([✉]), António Coelho[2,3], and Valentina Nisi[1]

[1] Madeira Interactive Technologies Institute, 9020-105 Funchal, Portugal
`{vanessa.cesario,valentina.nisi}@m-iti.org`
[2] Faculty of Engineering, University of Porto, 4200-465 Porto, Portugal
`acoelho@fe.up.pt`
[3] INESC TEC, 4200-465 Porto, Portugal

Abstract. Museums promote cultural experiences through exhibits and the stories behind them. Nevertheless, museums are not always designed to engage and interest young audiences, especially teenagers. Throughout this paper, we discuss teenagers as an important group to be considered within the Children-Computer Interaction field, and we report some techniques on designing with teens, in particular, arguing that participatory design methods can involve teenagers in the design process of technology for museums. For this purpose, we conceptualized, designed and deployed a co-design activity for teenagers (aged 15–17), where teenagers together with a researcher jointly created and designed a medium fidelity prototype. For this case study, participants were divided into groups and invited to think and create games and story plots for a selected museum. All the prototypes were made by the participants with the support and guidance of the researcher and the Aurasma software, an augmented reality tool.

Keywords: Museums · Games · Visitor experience · Co-design
Teenagers · Cooperative Inquiry · Augmented reality

1 Introduction

There is an increasing concern that the traditional exhibition and communication style of museums often fails to engage children; hence it denies the potencies of museums to be a fundamental institution in a society where cultural heritage is explored [1]. However, according to Roussou and colleagues [2], exhibits and educational initiatives for children are created without involving the children, with some notable exceptions [3, 4]. A systematic path towards making systems truly meaningful and intuitive to visitors is offered by human-centered design [5], together with participatory design methods [4].

Moreover, according to Falk [6], the so-called "one size fits all" experience does not apply to most of the museum visitors. The same can be said about "generation Z" which is seen as quite different from previous generations, particularly regarding beliefs and behaviors [7]. We can mostly verify in museums different guided tours for children and adults, without having any appropriate guidelines for the teens' generation in particular. This generation is identified as an audience group that is often excluded

from a museum's curatorial strategies [8]. In consequence, it is not only museums that seem to ignore a younger audience, but this group itself also appears to be disinterested in what museums might offer.

2   Co-designing with and for Teenagers

The target group of children between 15–19 years old was coined by Prenksy [9] as "digital natives" and critically discussed by Bennett and colleagues [10]. Recent work considers teenagers as being different from both children and adults in their perspectives [11]. Teenagers have collaborative behaviors wherein somehow the opinions of many come together to form a mass opinion [12].

Teenagers are an understudied group within the Interaction Design and Children (IDC) field [12]. The majority of research within this field focuses on children age 4–11, which leaves a gap in the literature for children 12–17. However, because teens represent a rapidly growing group of technology users [13], researchers have sought new ways to involve them more fully in the design process [14]. Methods for undertaking research with teenagers within the scope of interaction design has also been discussed [12].

The expression "co-design" is used because of the importance Cooperative Inquiry places on an equal partnership between children and adults, where designers participate in users' world [15]. In Cooperative Inquiry, children act as full partners helped by adults through the design process where they can share ideas and evaluations alongside with adults [16]. One method to use Cooperative Inquiry is a modified form of participatory design which encompasses sketching ideas with art supplies (paper, cardboard, glue) to create low-tech prototypes during the brainstorming process [16, 17].

Several studies have presented the value of co-designing learning technologies with children aged 7–16 [18, 19]. Participatory Design incorporates several methods and theories while the core philosophy is to include the final users as active participants in the technology design process [20, 21]. Taxén and colleagues [22] pointed out that participatory design is a strategic approach for producing user-oriented information technologies. Druin's seminal work on Cooperative Inquiry [17, 23] and the Scandinavian approach to Participatory Design [24] have gained acceptance within the IDC community. Participatory Design has gained new user groups such as children [17] and teens [25]. Teenagers and participatory design within museum studies are also covered by some papers in the IDC Community, as in the case of the study "Digital Natives" [26] where teens (15–19 years old) collaborated with designers, programmers, anthropologists and museum curators to create four digital installations for an exhibition. The case study "Gaming the Museum" [27] is another example that started from everyday practices where children's (14–15 years old) everyday engagement was strong and thus computers games and online communities were chosen to start a process of creating a game for a museum. However, none of these works incorporates teenagers as the developers of technology. In the study "Digital Natives" [26], the teens' ideas were presented to a team of interaction designers who would be responsible for integrating the voices of the participants into a prototype. Similarly, in the case study "Gaming in the Museum" [27], the participants have not developed a technological prototype.

3   Methodology

The researchers proposed a one-week activity plan to a summer camp in a Junior University. The activity, targeted for teens aged 15–17, consisted in developing gaming experiences for specific museums, and it was deployed for two weeks. The participants, 13 in total, were divided into 5 groups. The first week had 2 groups who worked with the Engineering Museum, and the second had 3 groups who worked with the Medicine Museum, both placed in Porto, Portugal.

The teens were involved in a series of game activities for one week, and two days were reserved for the design and deployment of the experience for the selected museum. The Aurasma software [28] was one of the many easy and free tools out in the market that was chosen to be used within this activity. Aurasma is an Augmented Reality (AR) site which allows us to see and interact with the world through auras. Auras are the digital content which will be unlocked by the Aurasma app. Auras 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, we chose to make each aura as a video that the participants would create. Over two days, the following activities were organized:

1. *Introduce the Aurasma software.* We stated that participants could unlock small videos with informative content in each artefact of the museum. These auras should enhance the artefacts' scientific information, and they would assemble the videos.
2. *First museum tour.* This tour was made by the museums' curators without any digital support. The participants were then invited to take pictures and notes from the artefacts they thought would best suit their interactive museum experiences through the Aurasma software.
3. *Brainstorming in groups.* This was the time wherein participants were divided into groups and the concept of the experience was defined. To prompt their imagination, they were required to brainstorm their experience as if it was an escape room [29], that is to say that they would have to create a story and riddles to solve within a time limit in order to successfully finish the experience. Participants were free to think of which storytelling plot suited best with the museum as well as which riddles to apply, bearing in mind that an aura would be just a video. Hence, the riddles should appear in the end of the video deployed to create one aura. These videos needed to include information about the artefacts within the story they created and give a clue to the other point of interest. The participants were the ones leading the ideas, while the researcher listened to them and also contributed to the reasoning of the ideas generated.
4. *Script construction I.* After defining the experience, participants started creating scripts for the videos at each point of interest. For each aura, they were required to write: (1) which location the aura is related to; (2) if any image appears; (3) which dialogues, if any; (4) which clue will guide the player to the other point of interest (Figs. 2 and 3). Again, the researcher had a more passive role. The participants led the script while the researcher contributed to it with small details to be added to the text and improve readability.

5. *Second museum tour.* A second tour to the museum was made to clarify some doubts about specific artefacts or points of interest regarding each experience that was being developed.
6. *Script construction II.* Finalization of the script according to the changes made regarding the second tour.
7. *Development of the videos.* With the script finished, the participants started making the video for each aura. The content of these videos was made by the teenage participants on their own. Some of them recorded theatrical performance while others recorded their voices and put together images. The videos and voices were recorded with an iPhone 6, and the manipulation of the video was made in the native video software of their computers (Windows Movie Maker).
8. *Converting videos to auras.* The videos were uploaded to the Aurasma software through a computer. Here the researcher had an active role in guiding and assisting the participants with the technology.
9. *Third museum tour.* This tour was finally made with the Aurasma software. As said in the beginning, the aim of these experiences was to be compared to an escape room. For this, each group experienced the game of others while the researcher was monitoring the time they took in order to check who would be the winning group (Figs. 1 and 2).
10. *Evaluation from the participants.* To end with, all the participants filled out a survey concerning their thoughts about this experience of designing together for a museum (Table 1).
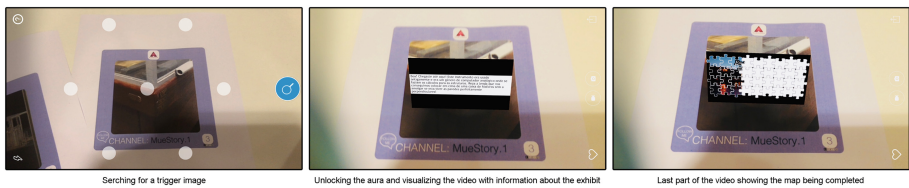
Fig. 1. Images of the interaction of the third moment from the *Bridge Builder* tour.
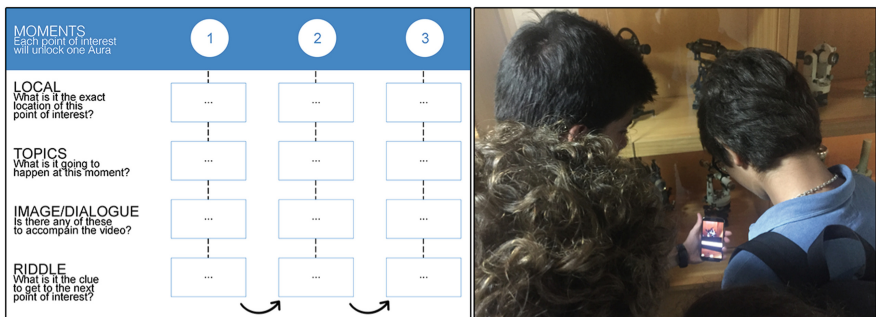
Fig. 2. On the left: graph showed to the participants to help them to construct the script. On the right: one group taking the bridge builder tour throughout the engineering museum, near the topographer no. 21.
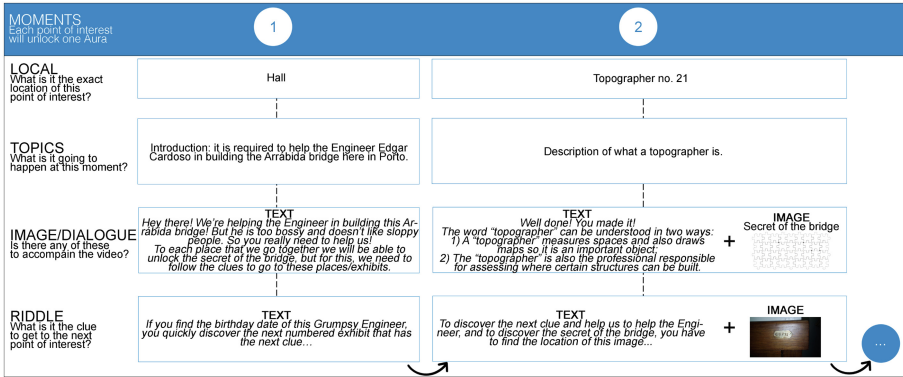
Fig. 3. Example of the first two moments of the *Bridge Builder*'s script.

Table 1. Questions and measures adopted.

Question	Measure	
(Q1) What did you think about the FIRST TOUR to the museum led by its director?	Five degrees of happiness [30]	Teenagers were asked to rate, on a 5-point Likert scale, how much they enjoyed the event. Each smiley was then scored as: 1 = awful, 2 = not very good, 3 = good, 4 = really good, and 5 = brilliant
(Q2) What did you think of the CO-DESIGN activity of a game for the MUSEUM?		
(Q3) What did you think of the activity of EXPLORING THE MUSEUM with the GAMES that your colleagues developed?		
(Q4) Do you think that you will use the AURASMA application in the future?	Again-again table [31]	In the table, users needed to select one of the following options: Yes, Maybe, No
(Q5) Describe all the activity you made for the MUSEUM in one sentence	Writing	
(Q6) On what occasions and for what reasons would you use the AURASMA app?	Writing	

4   Results

In this section, we present the results from the various co-design activities carried out with the teenagers, divided into three sub sections, such as (1) *storytelling plots;* (2) *game mechanics* of each work group; and (3) the *evaluation* of this design activity by all participants. Due to page length constrains, the videos created by the Portuguese participants are accessible online in the following link: https://goo.gl/T2RTZ9.

4.1 Storytelling Plots

The teens created several storytelling plots that can be grouped into five types of stories (Table 2):

(1) *Bridge Builder.* In this plot, throughout 5 points of interest, the player needs to help an Engineer to construct a bridge. At each point of interest reached, the player can unlock several pieces of the puzzle which will uncover the "secret of the bridge". This secret of the bridge is an image of a real bridge in their region coordinated by the engineer featured in the exhibition.

(2) *The Final Landing.* This plot revolves around an astronaut that landed in the earth and need to construct a landing bridge to go to his planet again. In each point of interest (total of 6), the player will find the necessary tools to build the bridge and take off towards his planet.

(3) *Help the Doctor.* In this plot, throughout 5 points of interest, the player needs to help a doctor, who it is in the middle of a surgery, to find a specific tool to complete the surgery.

(4) *Medicine History.* In this plot, throughout 7 points of interest, the player gets to know relevant facts about the history of medicine narrated by a character presented in the museum.

(5) *Visiting the Medicine Museum.* The story plot with 6 points of interest, tells the story of a person that would like to find a specific portrait in the museum and needs the help of the user to find it.

4.2 Game Mechanics

Teens created seven types of game mechanics (Table 2) all revolving around enigmas leading to the next artefact to encounter:

(1) *Calculation* of a number that will lead to the number of the next artefact;

(2) An *image* of an artefact that the player needs to find its location in the museum;

(3) A *name* that the player needs to find to which artefact it is related to;

(4) A *metaphor* in which the players need to find understanding regarding the museum premises;

(5) *Translation* that the players need to make, for example a sentence in other language, or a written phrase from back to front;

(6) *Morse code*, each symbol represents either a text character letter or numeral and is represented by a unique sequence of dots and dashes;

(7) *Binary code*, a coding system using the binary digits 0 and 1 to represent a letter.

4.3 Evaluation

In general, in regards the results from Q4 and Q6 (Table 2), all the participants enjoyed the activity and most would use the Aurasma application in the future in their school's assignments, or even to have fun with their friends. Regarding Q1, 11 participants out of 13 rated the first museum tour, led by the museums' curators, as "really good", and the others as "good". Concerning Q2, 11 participants out of 13 rated the co-design

sessions as "brilliant", and 4 rated as "really good". The activity of exploring the museum with the experiences developed by them (Q3) was rated by 9 out of 13 as "brilliant", and as "really good" by 4 out of 13. In overall, the co-design session of a museum experience was referenced by the participants (Q5) as "innovative", "fun", "interesting", "different", and "productive".

Table 2. Game mechanics used per experience.

	Calculation	Image	Name	Metaphor	Translation	Morse code	Binary code
Bridge builder	x	x					
The final landing		x	x	x		x	
Help the doctor			x			x	
Medicine history		x	x	x	x		x
Visiting the museum	x			x		x	x

5 Concluding Remarks

With this study, we contributed to the literature reporting on co-design with teenagers, opening up this area to further exploration [12] by researchers, designers and even curators of museums. Adopting a Cooperative Inquiry strategy, we placed the participants as the main subject throughout the whole design process of the sessions [16]. Teenagers played an active role in the creation and development of ideas, and the researcher had a more passive role in guiding their voices through the predetermined schedule for the sessions, as well as evaluating the logic of their stories and game elements that the young people proposed. According to other studies about participatory design session with teens in museums, such as "Digital Natives" [26] and "Gaming the Museum" [27], it is reported that young people, become enthusiastic and enjoy participating in activities in the museum created by them through paper mockups, or technical prototypes developed by others. However, our study seems to indicate that in terms of engagement, having the chance of realizing their own digital prototype, can be of greater satisfaction than having others do it. These teens visited the museum, took pictures, created a narrative with game elements that they remembered or searched on the Internet. Subsequently, they built the videos using native video programs on their computers. This generation of teens is very fluent in using new technologies and there were no great difficulties in handling this digital content.

From the practical results of this work, young people thought about adventure themes to add to a story plot. In 5 groups out of 6, they embarked on a journey through the museum in search of something to help a greater cause (*Bridge builder*, *The final landing*, *Help the doctor*, *Visiting the medicine museum*). This shows that the teens' everyday engagement in relation to games is mediated through the adventure genre and that a digital interaction in the museum directed to this audience should contain these elements of adventure in order to capture their attention. Regarding game elements,

participants thought of clues leading players through a treasure hunt. Clues ranged from basic one, such an *image* or a *name* of an artifact, or even a *metaphor* on how to get to these artifacts, or more complex ones such as to *translate* a sentence from a foreign language, or using *codes*, where participants had to use the internet to know how to decipher the code. We conclude that young people when invited to think of adding clues to the experience, think of several ones that challenge the players. The more difficult, the more challenging, and therefore more involvement from the users.

With this work, we have learned that games can benefit museums by promoting positive attitudes about museum spaces, creating fun destinations in order to promote meaningful informal learning combined with entertainment. Although people could not immediately adopt a game, the positive attitude of implementing technology inside a space cultivates good experiences for visitors, which could help museums achieving greater visitation rates. However, there are some disadvantages with the use of gaming experiences in museums. Players could become fascinated with the screen and fail to observe the physical exhibit in the museum, which is not the goal nor the message museums would like to convey. Clues and escape rooms' experiences in museums have also to be carefully crafted into the logic and purpose of the museum visit, as it could incur into pushing teens through the exhibits too quickly and inviting them to finish the visit rather than enjoying it.

From this study we can confirm that co-design techniques can change the way traditional museum exhibitions are considered by "digital natives" [9]. Teenagers are an important generation of users for museums as they are potential visitors for museums, and their perspectives are vastly different from today's adults [11]. In fact, these perspectives may remain different in the future, therefore it is fundamental to have access to design techniques so that we can anticipate these perspectives and create exhibitions that will attract them. While not all young people will be able or have the interest to take part in these co-design sessions, similarly, not all museums will have the time or resources in hosting these types of sessions. Nevertheless, we observed that from these co-design sessions we can detect patterns of interest (adventurous themes and game elements) that could be later validated through new museum experiences designed by museum designers and curators to be tested with teenagers. By validating and adopting teen-friendly design guidelines for museum exhibits, we believe this group could be encouraged to embrace more interest in museums.

References

1. Hooper-Greenhill, E.: Communication and communities in the post-museum: from metanarratives to constructed knowledge. University of Leicester, Copenhagen (2001)
2. Roussou, M., Kavalieratou, E., Doulgeridis, M.: 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. ACM, New York (2007)

3. Broadbent, J., Marti, P.: Location aware mobile interactive guides: usability issues. In: Fourth International Conference on Hypermedia and Interactivity in Museums, pp. 88–98, Paris (1997)

4. Taxén, G.: Introducing participatory design in museums. In: Proceedings of the Eighth Conference on Participatory Design: Artful Integration: Interweaving Media, Materials and Practices, vol. 1, pp. 204–213. ACM, New York (2004)

5. Kensing, F., Simonsen, J., Bodker, K.: MUST: a method for participatory design. Hum.-Comput. Interact. **13**, 167–198 (1998)

6. Falk, J.H.: Identity and the Museum Visitor Experience. Routledge, Walnut Creek (2009)

7. Wikia: Generation Z: A Look At The Technology And Media Habits Of Today's Teens. http://www.prnewswire.com/news-releases/generation-z-a-look-at-the-technology-and-media-habits-of-todays-teens-198958011.html

8. Tzibazi, V.: Participatory action research with young people in museums. Museum Manag. Curatorship. **28**, 153–171 (2013)

9. Prensky, M.: Digital natives, digital immigrants part 1. Horiz. **9**, 1–6 (2001)

10. Bennett, S., Maton, K., Kervin, L.: The digital natives debate: a critical review of the evidence. British J. Educ. Technol. **39**, 775–786 (2008)

11. Fitton, D., Read, J.C.C., Horton, M.: The challenge of working with teens as participants in interaction design. In: CHI 2013 Extended Abstracts on Human Factors in Computing Systems, pp. 205–210. ACM, New York (2013)

12. Read, J.C.C., Horton, M., Iversen, O., Fitton, D., Little, L.: Methods of working with teenagers in interaction design. In: CHI 2013 Extended Abstracts on Human Factors in Computing Systems, pp. 3243–3246. ACM, New York (2013)

13. Lenhart, A.: Teens, Social Media and Technology Overview (2015). http://www.pewinternet.org/2015/04/09/teens-social-media-technology-2015/

14. Winterburn, N., Gregory, P., Fitton, D.: Designing teenage emotions with a life of their own. In: Little, L., Fitton, D., Bell, B.T., Toth, N. (eds.) Perspectives on HCI Research with Teenagers. HIS, pp. 207–236. Springer, Cham (2016). https://doi.org/10.1007/978-3-319-33450-9_9

15. Muller, M.: A participatory poster of participatory methods. In: CHI 2001 Extended Abstracts on Human Factors in Computing Systems, pp. 99–100. ACM, New York (2001)

16. Druin, A.: The role of children in the design of new technology. Behav. Inf. Technol. **21**, 1–25 (2002)

17. Druin, A.: Cooperative inquiry: developing new technologies for children with children. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 592–599. ACM, New York (1999)

18. Isomursu, M., Isomursu, P., Still, K.: Capturing tacit knowledge from young girls. Interact. Comput. **16**, 431–449 (2004)

19. Danielsson, K., Wiberg, C.: Participatory design of learning media: Designing educational computer games with and for teenagers. Interact. Technol. Smart Educ. **3**, 275–291 (2006)

20. Muller, M.J.: Participatory design: the third space in HCI. In: Jacko, J.A., Sears, A. (eds.) The Human-computer Interaction Handbook, pp. 1051–1068. L. Erlbaum Associates Inc., Hillsdale (2003)

21. Salen, K.: gaming literacies: a game design study in action. J. Educ. Multimed. Hypermedia **16**, 301–322 (2007)

22. Taxén, G., Bowers, J., Hellström, S.-O., Tobiasson, H.: Designing mixed media artefacts for public settings. In: Darses, F., Dieng, R., Simone, C., Zacklad, M. (eds.) Cooperative Systems Design. Scenario-Based Design of Collaborative Systems, pp. 195–210. IOS Press, Amsterdam (2004)

23. Druin, A. (ed.): The Design of Children's Technology. Morgan Kaufmann Publishers Inc., San Francisco (1998)
24. Robertson, J., Good, J.: Children's narrative development through computer game authoring. In: Proceedings of the 2004 Conference on Interaction Design and Children: Building a Community, pp. 57–64. ACM, New York (2004)
25. Toth, N., Little, L., Read, J., Guo, Y., Fitton, D., Horton, M.: Teenagers talking about energy: using narrative methods to inform design. In: CHI 2012 Extended Abstracts on Human Factors in Computing Systems, pp. 2171–2176. ACM, New York (2012)
26. Iversen, O.S., Smith, R.C.: Scandinavian participatory design: dialogic curation with teenagers. In: Proceedings of the 11th International Conference on Interaction Design and Children, pp. 106–115. ACM, New York (2012)
27. Dindler, C., Iversen, O.S., Smith, R., Veerasawmy, R.: Participatory design at the museum: inquiring into children's everyday engagement in cultural heritage. In: Proceedings of the 22nd Conference of the Computer-Human Interaction Special Interest Group of Australia on Computer-Human Interaction, pp. 72–79. ACM, New York (2010)
28. Aurasma is now HP Reveal. https://www.aurasma.com/
29. Nicholson, S.: Peeking Behind the Locked Door: A Survey of Escape Room Facilities (2015). http://scottnicholson.com/pubs/erfacwhite.pdf
30. Hall, L., Hume, C., Tazzyman, S.: Five degrees of happiness: effective smiley face likert scales for evaluating with children. In: Proceedings of the 15th International Conference on Interaction Design and Children, pp. 311–321. ACM, New York (2016)
31. Read, J.C., MacFarlane, S.: Using the fun toolkit and other survey methods to gather opinions in child computer interaction. In: Proceedings of the 2006 Conference on Interaction Design and Children, pp. 81–88. ACM, New York (2006)