EXPLORING VISITORS' PARTICIPATION IN MUSEUMS AND GALLERIES USING AESTHETIC VISUAL MARKERS

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Abstract

Traditionally museums have been places that keep valuable artefacts and present them to visitors. However, in recent years and particularly in the developed countries, museums have shifted their focus beyond preserving and representing objects and content, towards a visitor-orientated approach to provide meaningful, unforgettable and interactive experiences. This has involved shifting the visitors' role from passive consumers to active participants through involving them in different activities to engage them personally and emotionally with the exhibition, including consuming content, interacting with the exhibition and participating in designing their own content.

To facilitate these activities, digital technologies in particular visual markers, usually in the form of QR codes, have been widely adopted in museums and galleries. They are relatively cheap, robust and easy to deploy as no new technical infrastructure needs to be installed; visitors use their own devices to scan the markers and retrieve multi-media contents and only new labels need to be added. Going further, QR codes can also be used to enable visitors to play games such as treasure hunts and even to contribute to the exhibitions by sharing own stories, interpretations, reflections and feedback. However, visitor engagement with QR codes in museum settings can often be low due to their inflexible and limited aesthetic quality, lack of meaning as the user cannot anticipate what kind of digital content can be revealed from scanning a QR code, as well as QR codes cannot be customised by users. Thus, this thesis explores the applications of a novel visual marker technology (Artcodes) which allows meaningful and aesthetic markers to be hand crafted in order to involve visitors in different types of participation in museums and galleries.

Three practical studies were carried out in three different museum and gallery settings. The first study focused on exploring a novel interaction with exhibits by involving visitors physically manipulating visual representations of artefacts to reveal digital information about their relationships. To explore this interaction mechanism, an interactive paper map was developed on which visitors can place tangible artcode representations of artefacts and scan the resulting arrangements. Based on an in-situ study of its use, it was revealed that museum visitors engaged in different strategies for exploring the relationships between artefacts in the museum collection (inspection, strategic and experimental configuration), and for social collaboration (sharing the interaction space, adopting interaction roles and sharing a reaction to the "reveal").

The second study focused on exploring how visitors engage with labels which can be designed to be more aesthetic and meaningful, using artcodes, to augment exhibited photographic portraits in an art gallery with complimentary information in the form of audio recordings. The second focal point of the study was to explore artcodes as a mechanism for enabling visitors to contribute their own reflections to the exhibition by drawing a marker and linking it to an audio comment. Visitors' hybrid contributions (artcodes) were then displayed within the exhibition space in order to find out how subsequent visitors engaged with them versus their interactions with the official markers. The findings show that visitors appreciated the use of the aesthetic markers and engaged with them at three levels – physical placement, aesthetic content and digital content. For content creation, the findings show that visitors appreciated engaging with the aesthetic visual markers to create meaningful contributions to express themselves through a combination of the physical image and the associated digital recording.

The third study built on the second study to further explore how different visual representations of the markers (hand-drawn and pre-designed artcodes with/without comments section) can support visitors further to contribute to the exhibition and how subsequent visitors can interact with such contributions. Secondly, the study further explored how the artcodes approach can be adopted in practice by museum curators. The findings show that visitors appreciated being able to choose between different visual representations of artcodes for their contributions. They chose to draw artcodes for extending exhibition through sharing additional layer of contents about own experiences and stories. Whereas, the pre-designed artcodes were mostly chosen by the visitors to augment the existing objects through adding own comments about them. In addition, the findings show the important role that curators play in facilitating visitors' contributions and integrating them into their setting.

Building upon the findings from all 3 studies, the thesis concludes by proposing the co-creation cycle where visitors can participate, using aesthetic visual markers, in different types of activities through three different stages which are interaction, response and reintegration. The main opportunities and challenges for designers and museum practitioners are then outlined. This is followed by a set of guidelines for the practical implementation of the co-creation cycle in museums and galleries using aesthetic visual markers.

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Chapter One: Introduction

1.1 Motivation of the thesis

Traditionally museums have been places to keep valuable artefacts and present them to visitors. In recent years and particularly in the developed countries, museums have changed their focus from "being about something to being for someone" (Weil, 2002:229). This has involved a shift beyond preserving and representing objects and content towards a visitor-orientated approach in order to enable them to make meaning of their visit experiences through providing unforgettable, meaningful and interactive experiences (Hooper-Greenhill, 2006). This has resulted in shifting visitors' role from passive consumer to active participants through involving them in different activities to engage them personally and emotionally with the exhibition through consuming contents, interacting with the contents and exhibition and participating in designing the contents (Adams et al., 2004; Falk and Dierking, 1992, 2000; Holdgaard and Klastrup, 2014).

Participation can be one of the effective ways to enable visitors to make meaning of their museum visit experiences. Visitors' participation in museum can have different types ranging from basic to deeper involvement. The basic type of visitors' participation is through consuming museum contents in order to engage with the physical artefacts. Another type of visitors' participation can be made to interact with the physical artefacts through manipulation activities such as puzzles and treasure hunts. The deeper participation type can be made through enabling visitors to create their own contents and interpretations about exhibits.

In this regard, Simon (2010) argues that the participatory institutions should not only focus on enabling visitor participation through creating own contents (user-generated content), instead, they should provide visitors with opportunities to participate in a number of different ways and in different activities such as enabling visitors to consume content in an interactive way. Simon has made this suggestion because museum visitors' preferences for participation various as some of them would like to consume static contents and exhibition, other visitors would like to engage with interactive programmes that allow them to gain more knowledge in an interactive way, and other visitors would like to share their own experiences and contents to the exhibition. Thus, not all visitors would be interested in participating through adding own contents and stories.

Digital technologies have been widely used in museums and cultural heritage sites, particularly in the developed countries, to enable visitors' participation which can result in enriching visitors' experiences through delivering additional information about exhibitions in more interactive ways, allowing interactive activities and enabling visitors to create content. The digital technologies range from fixed installations to mobile technologies and for each of these, different techniques and mechanisms have been used to enable visitors' participation.

For example, Augmented Reality (AR) for visualising contents in an interactive way such as a 3D representation (Azuma, 1997; Eissele, Siemoneit and Ertl, 2006), Tangible User Interfaces (TUI) to allow physical manipulation of objects to control the digital contents (Hornecker and Buur, 2006; Marshall et al., 2016; Ullmer and Ishii, 2000), Multi touch technologies to allow visitors to interact with the digital interfaces directly using fingers (Horn et al., 2012; Wilson et al., 2008; Wu and Balakrishnan, 2003), Location Based Services (LBS) in recommender systems to provide visitors with relevant information according to visitors' movement and position (Aoki et al., 2002; Hatala and Wakkary, 2005a; Oppermann and Specht, 2000; Satoh, 2008; Zimmermann, Specht and Lorenz, 2005) and visual markers.

Visual markers, in particular, have been widely adopted in museums and galleries and very promising as a way to exploit the capabilities of mobile devices carried by visitors to augment exhibits with digital content. There are many examples of visual markers such as 1D standard barcode which is the most common marker that was developed in the 1950s for product identification (D-barcode website, 2018; Woodland and Bernard, 1952). Other examples include ArToolKit (Kato and Billinghurst, 1999) and 2D barcode QR codes (Quick Response) (Denso-Wave Incorporated, 2014; ISO, 2000).

Visual markers, usually in the form of QR codes, are most commonly used as this is a low-cost mechanism to overcome the space restrictions of text labels and enable the incorporation of multimedia (audio, video, animations) in an easily updatable form. At the same time, QR codes are relatively cheap and easy to deploy, as no new technical infrastructure needs to be installed; visitors use their own devices to interact and only new labels need to be added. QR codes can deliver a broad range of applications simply by scanning a marker with their smartphone, visitors can get access to additional multimedia information about artefacts or to play games such as treasure hunts and puzzles. QR codes can also be used to enable visitors to contribute to the exhibition's interpretation by sharing their own stories, interpretations and reflections.

However, visitor engagement with QR codes in museum settings can often be low. A study by Wein (2014) found that QR codes were the least preferred mechanism by visitors for accessing background information on artworks with ease of use and distance identified as the main contributing factors. QR codes might not only be aesthetically unappealing, but also lead to a shift of attention away from the artwork (Wein, 2014). Schultz (2013) found that visitors at the Ryerson University Library and Museum of Inuit Art had an awareness of QR codes, but usage was observed to be low. The author suggests that a lack of perceived usefulness and misconceptions about ease of use might explain the low adoption.

For improving aesthetic appearances of barcodes and QR codes, attempts have been made through redesigning them such as (Barcode Revolution website, 2018; Liu, Yang and Liu, 2008; QR Pixel, 2011) (figure1.1). However, still their visual designs are not highly attractive and meaningful. Recently, there has been growing interest in vision technologies that can recognise more aesthetic or natural images. Various approaches have been proposed to create markers that contain the correct balance of features to make them recognisable by an image-processing algorithm. For instance, Data Glyphs (Hecht, 1994) and ReacTIVision (Bencina, Kaltenbrunner and Jorda, 2005). Alternatively through using more natural images and hide codes inside them such as Vuforia (Vuforia website, 2018), Blippar (Blippar website, 2018) or modifying an image such as using ARTcodes (Yang et al., 2016) and PiCode (Huang and Mow, 2013) and the transparent Embedded Media Marker (EMM) (Liu et al., 2009, 2010) (figure 1.1).

Figure 1. 1 Example of Barcode Revolution (left), QR Code (middle) and EMM (right)

Other approaches including drawing markers through following a set of rules to embed codes within the design such as ARTTag (Fiala, 2005; Higashino, Nishi and Sakamoto, 2016) and D-touch (Costanza and Huang, 2009). D-touch is a recognition technology that works based on topology rather than geometry in which it allows users to have more freedom to draw markers by themselves and to make them aesthetically more pleasing. Meese et al. (2013) extended the d-touch (Costanza and Huang, 2009) to hand crafted visual markers called

Artcodes technology, a type of hybrid visual markers which are previously known as Aestheticodes.

The term of hybrid refers to the way of integrating the meaning of both physical and digital content which can enhance and promote the value of both physical object and digital content. In this regard, the value of the physical object can be enhanced through augmenting it with a layer of digital content. Alternatively, the value of the digital content could be enriched though linking it with a physical object. The term of hybrid has been available in the HCI community for decades, such as ubiquitous computing (Weiser, 1993), tangible interfaces (Fitzmaurice, Ishii and Buxton, 1995; Ishii and Ullmer, 1997), AR (Azuma, 2004), hybrid artefacts (Benford et al., 2016) and hybrid user experiences (Benford and Giannachi, 2011).

Hybridity has been used for different purposes in different disciplines. For example, the Tales of Things and Electronic Memory (TOTeM) project used Internet of Things technologies and QR codes, RFID and web technologies in order to enhance the second hand products in a charity shop with digital contents of their previous owners in a form of stories and memories (Barthel et al., 2013). The Carolan acoustic guitar is another example where it was augmented with progressive and personal layer of digital contents of the people who played it (Benford et al., 2016).

In this thesis, the author uses the term of hybrid artefact or hybrid contribution to refer back to the museum's artefacts or visitors' contributions that consist of both physical objects with digital contents in a form of artcodes.

When this research began, there was a study which has been performed by Meese et al. (2013) showing that, with a simple set of instruction, designers were easily able to create meaningful, aesthetic and decorative patterns as artcodes to augment ceramic bowls and menus with digital contents in relation to the food preparation. The authors deployed the interactive ceramic bowls and menus in a Thai restaurant in London and the authors found that artcodes enhanced the dining experience of people (Meese et al., 2013). A further study by Benford et al. (2015, 2016) has shown that players were easily able to create and associate their own progressively personalised layers of digital contents with the Carolan acoustic guitar in order to augment it using artcodes (Benford et al., 2015, 2016).

During the course of this PhD, an additional work by Thorn et al. (2016) went on in parallel that further showed the benefit of using artcodes for engaging people to interact with artcodes successfully through interacting with large-scale illustrations in order to reveal the digital contents behind them. Thorn et al. (2016) designed large-scale interactive illustrations of aesthetic visual markers that were augmented with digital contents of stories in which they can be revealed through scanning multiple visual markers, that were embedded within the illustrations, in sequences by panning across its surfaces (pattern path) or scanning all in a group (pattern group). The illustrations were exhibited in a Writers' Studio in Nottingham and they were tested by graphic designers and writers and they highly appreciated and interacted with the approach. Preston et al. (2017) also designed an interactive wallpaper as aesthetic visual markers where the codes again were hidden in the decorative design in order to be used for decorating homes and offices through personalised digital contents.

For this research, Artcodes technology has been chosen as the visual markers because the drawing approach can promote visitor creativity and previous researches have shown that the rules are easy to understand and follow, with a variety of interesting designs created (Meese et al., 2013; Thorn et al., 2016). Also, it seems that artcodes are promising and can be an appropriate technology to be deployed in museum and gallery settings in order to involve visitors into different types of participation activities (consuming, interacting and creating own contents) which are not yet explored in museums. In the following section, Artcodes technology will be explained in more detail by focusing on the range of interactions that they support.

1.2 Artcodes and their applications

Artcodes technology, a new computer vision technology, was developed by Meese et al. (2013) which recognise visual codes based on their topology rather than geometry[1]. The code is determined by the number of connected regions (which gives the number of digits in the code) and the number of blobs contained within each region (which gives the value of each digit). These are then written in ascending order (see figure 1.2 for an example). The shapes of the regions and blobs, and ordering on the page are not considered, giving designers great flexibility to create varying designs which are highly aesthetic and meaningful through embedding codes in the images, following a simple set of instruction. Then linking these designs with mixed digital contents in a free downloadable Artcodes app (runs on Android

1 https://www.artcodes.co.uk/

and IOS) and such contents can be revealed using the same app on machine-readable devices such as mobile phones. A single pattern can denote more than one code and link to multiple digital content. Thresholding to black and white is performed on the images before recognition, so colour can be used in designs as long as there is sufficient contrast.

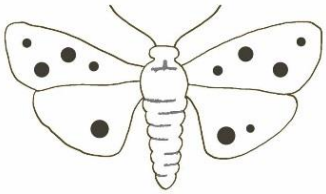


Figure 1. 2 An artcode with (1:1:2:4:4) code

In addition to enabling the creation of high aesthetic visual markers, Artcodes technology has a number of features regarding interactions. According to Thorn et al. (2013), Artcodes technology allows users to:

- Independently retrieve digital content of artcodes through scanning them individually.
- Retrieve digital content of artcodes through scanning two or more artcodes simultaneously in a group, where all the artcodes appear in the viewfinder, which is called pattern groups.
- Retrieve digital content of artcodes through scanning two or more artcodes sequentially by making a linear movement of the camera through the artcodes which is called pattern paths or panning.

Due to the opportunities that it offers, it seems that Artcodes technology could be an appropriate and promising technology to be deployed in a museum context in order to enable different types of visitors' active participation. Meaningful and aesthetic artcodes can be created for augmenting museum artefacts with digital contents which might engage visitors to consume content more regularly than QR codes. In addition, artcodes can be used as objects that visitors can manipulate and interact with them in order to explore more contents in an interactive and informative way. Furthermore, since artcodes can be designed following a simple set of instruction, visitors might be more engaged to design visually meaningful and aesthetic artcodes and link them to multimedia contents in order to contribute to the exhibitions. While the applications of Artcodes technology have not been explored in a museum context to support different types of visitor participation, this thesis explores the

effectiveness of artcodes, aesthetic visual markers, applications for enabling different types of visitors' participations (consuming, interacting and creating own contents) in museums and galleries.

1.3 Research Questions

The main research question of this thesis is:

How to enable different types of visitors' participation in museums and galleries using aesthetic visual markers?

This question is going to be explored through a series of practical studies that address the following sub-questions:

1. **How can visitors be enabled to interact with aesthetic visual markers to explore artefacts?**
    a. How can visitors be enabled to reveal digital layers of content about museum artefacts using aesthetic visual markers?
    b. How can visitors be enabled to access visitors' contributions using aesthetic visual markers?
    c. How can visitors be enabled to explore the relationships between museum artefacts using aesthetic visual markers?
2. **How can visitors be enabled to contribute content to the exhibition using aesthetic visual markers?**
3. **What is the role of curators throughout the process of visitors' participations?**

1.4 Approach and Methodology

To answer these research questions, a series of studies were designed to explore different types of participation (consuming, interacting and creating content) in museum and gallery settings through developing and studying high fidelity prototypes.

The first study focuses on answering the first research question (a and c) to explore how visitors interact with visual markers to reveal additional information about artefacts as well as to explore the relationships between them. The second study focuses on answering the first research question (a and b) and the second research question. This through exploring the approaches for enabling visitors to contribute their own reflections to the exhibition by drawing a marker and linking it to an audio comment and to explore how visitors interact

with displayed official and visitors' hybrid artefacts (artcodes). Both the first and second studies also answer the third research question related to the curator's role throughout the process of visitors' participation.

The third study focuses on answering the first research question (b) and the second and third research questions. This builds upon the second study to introduce new opportunities for engaging visitors to contribute their own contents to the exhibition using different visual representations of hybrid artefacts (hand-drawn and pre-designed artcodes). Also, the study explores the role of curators in the process of facilitating visitors' contributions, integrating their contributions into the setting and how subsequent visitors interact with different visual representations of hybrid artefacts that are integrated across different places in the museum.

All three studies followed the same approach which is an iterative user-centred design (UCD) in order to develop different high fidelity prototypes through collaboration with the curators of the museum and gallery settings and to involve visitors in the process of designing the prototypes. The UCD is an iterative design process in which designers focus on involving users at the centre of the design and development process of prototypes in order to consider users' needs and requirements towards a product or a system (Henry, 2009). In this research, the author followed the UCD as the main approach for all the studies in order to study the design of high fidelity prototypes in situ with two groups of users (curators and visitors) and to perform improvements to validate the design.

Curators were involved in the studies to consult them in designing prototypes and they were also interviewed to know their opinions and approaches about enabling visitors to contribute using aesthetic visual markers. In addition, curators were involved in facilitating visitors' contribution and integrating their contributions into the exhibitions. Whereas, visitors were involved in the process of designing and contributing content to the exhibition and how they interact with these contributions.

High fidelity prototypes were developed for each study because they allow designers to express their ideas visually and to involve the targeted users to test the prototypes for identifying strength and issues early and to improve them before creating the real product. The high-fidelity prototype appears same as the final version of the real product regarding details of its functionality, interactivity and visual appearance which make it more suitable to be tested and evaluated with real users during the design process. The main benefit of high fidelity is that more meaningful and realistic feedback can be obtained from users during

usability test since users would behave more naturally during test session same as if they would use the real product and how much of time do they need to complete a task (van Harmelen, 1989; Walker et al., 2002). Based on gathered feedback from users, it is easier for designers to refine designs and improve them before creating the real product (Nielsen, 2003).

The developed prototypes of each study were deployed "in the wild" to study the prototypes with the visitors in the real world settings (Crabtree et al., 2013). "In the wild" focuses on studying and evaluating new technologies or experiences in their real context with users in order to find out how they will be integrated into real settings (situ) and used by real users (Rogers, 2012). Overall, in designing and developing technologies or prototypes for visit experiences in museums and galleries, it is important not to study them in a lab, instead they should be deployed in their real context and find out how they would work and used by real visitors (Brown, Reeves and Sherwood, 2011).

The studies of this research have been carried out in three different real world settings which are the Museum of Archaeology, the Lakeside Arts gallery and the National Videogames Arcade (NVA) museum because they all are local and thus it was easy to access them. Throughout the process of designing the prototypes and carrying out the studies, there were collaboration and coordination with curators and staff of the museum and gallery settings to access artefacts and their interpretations and to decide on the suitable places for organising and carrying out the practical sessions of the studies. In the first and second studies that are reported in chapters 3 and 4, the participants were recruited to take part in the studies, whereas in the third study that is reported in chapter 5, visitors of the museum were approached to take part in the study.

For all the three studies of this research, the same methods were used for collecting qualitative data which are naturalistic observations, video recordings, semi-structured interviews and focus group discussions. Observation enables researchers to gather data from participants by observing their interactions, behaviours and experiences towards a specific phenomenon in a natural way (Bryman, 2004; Dewalt and Dewalt, 2002) and how they interact with one another (Schmuck, 2006). Whereas, interviews and focus group discussions allow for the collection of detailed descriptive data from a participant or a small group of participants, to understand their experiences and opinions in more detail (Wilkinson and Birmingham, 2003).

Finally, all the collected data were analysed thematically (using inductive thematic analysis). Thematic analysis is one of the most common approaches for analysing qualitative data which allows researchers to develop codes from the data and then to combine the codes to form themes or categories. Inductive thematic analysis, in particular, allows researchers to create themes according to codes, rather than fitting data into pre-established themes (Boyatzis, 1998; Frith and Gleeson, 2004; Patton, 1990).

More information about the methods and data analysis are explained in more details in chapters 3, 4 and 5. This research obtained approval from the University's ethics committee and the participants of all the three studies signed the consent forms and they were provided with an information sheet in advance of taking part in the studies (Appendix A and B).

1.5 Contributions

This thesis has made novel contributions to the HCI and museum communities. The main contributions are explained below.

1.5.1 HCI

The thesis contributes to the HCI community through proposing the co-creation cycle as a model for enabling visitors' active participation in different activities of three stages of the cycle which are interaction, response and reintegration in museums and galleries using aesthetic visual markers. The main opportunities and challenges for the activities in each stage are outlined for designers and museum practitioners.

The thesis also contributes a novel mechanism for enabling visitors to explore the relationships between museum artefacts through spatial interaction using aesthetic visual markers over a paper map. This contribution was published as a full paper at the 2018 NordiCHI (Nordic forum for Human-Computer Interaction (HCI) conference:

> Ali, S., Bedwell, B., & Koleva, B. (2018, September). Exploring relationships between museum artefacts through spatial interaction. In *Proceedings of the 10th Nordic Conference on Human-Computer Interaction* (pp. 224-235). ACM.

In addition, the thesis contributes a novel method for enabling visitors' participation in an art gallery through contributing to the exhibition using aesthetic visual markers to draw

meaningful and aesthetic markers and link them with audio commentary. Then how the visitors would interact with the displayed official versus previous visitors' artefacts. This research was disseminated as a full paper at the 2018 DIS (Designing Interactive Systems) conference which was awarded an Honourable Mention:

> Ali, S., Koleva, B., Bedwell, B., & Benford, S. (2018, June). Deepening visitor engagement with museum exhibits through hand-crafted visual markers. In *Proceedings of the 2018 on Designing Interactive Systems Conference 2018* (pp. 523-534). ACM.

The thesis contributes further to the HCI community by understanding how different visual representations of artcodes can motivate visitors further to participate in a museum to reflect to the exhibition and how these affect the nature of the digital contents. Then how the subsequent visitors would interact with the different visual representations of previous visitors' contributions across different places.

1.5.2 Museums

The main contribution that this thesis has made to the museum community is a set of guidelines for practical implementation of the co-creation cycle and aesthetic visual markers in real museum and gallery visit experience in order to enable visitors' participation using aesthetic visual markers. The guidelines also explain the main role of visitors and curators alike. The thesis also contributes an understanding to the essential role that the curators and staff have in facilitating visitors' active participation in museums and galleries using aesthetic visual markers.

1.6 Thesis Structure

Following this introduction chapter, the rest of this thesis is structured as the following:

Chapter Two presents a review of the key literature about the approaches and models that have been used by museums for engaging visitors to become active participants through involving them in different types of participation activities (consuming, interacting and creating content) and how digital technologies have been used to support these. The chapter then discusses the two cross cutting aspects: personalisation and socialisation that have been considered in the design of the digital technologies for facilitating different types of visitors' participation in museums. The chapter then discusses a reflection on the reviewed digital

technologies, highlighting their limitations and proposing Artcodes technology for addressing the challenges of the available technologies to enable different types of visitors' participation.

Chapter Three presents the first study of this thesis which focuses on exploring how aesthetic visual markers can be used for enabling visitor participation in the museum through consuming contents and interacting with the contents. Thus, the study addresses the research questions related to the approaches that can be used for enabling visitors to interact with museum artefacts (a) and explore the relationships between them (c) using aesthetic visual markers and developing an iterative paper-map prototype.

Chapter Four presents the second study of this thesis which explores how to involve visitors in the process of creating their own hybrid contributions in a gallery setting as well as how the visitors interact with the official versus visitors' hybrid contributions. Thus the study responses to the first research question (a and b) and the second research question of the thesis.

Chapter Five presents the final study of this thesis in which it builds upon the second study in chapter 4. The study focuses on a deeper understanding of visitors' approaches and preferences for contributing to the exhibition through introducing different visual representations of artcodes as well as how the subsequent visitors interact with the visitors' hybrid contributions. The chapter also highlights the role of curators throughout the process of facilitating visitors' contributions using hybrid artefacts and how they integrate the contributions physically in their settings. Thus, the study addresses the first research question (b) and the second and third research questions of the thesis.

Chapter Six presents a thematic discussion of the thesis with regards to the three studies and their findings. The chapter starts with a summary of the findings of all three studies followed by highlighting the three stages that were developed and identified from the findings of the three studies. The stages formed a concept model of a co-creation cycle which conceptualise the main contribution of the thesis. The model with its main stages are explained in depth and supported with the main key literature. This chapter answers the main research question of this thesis.

Chapter Seven concludes the thesis by summarising the main purposes and findings of the three studies followed by answering the research questions of this thesis. In addition, the contributions of the thesis are highlighted for each of the HCI and museum communities. Finally, the limitations of the research are highlighted and the opportunities for future researches are proposed for expanding the scope of this thesis.

Chapter Two: Literature Review

This chapter begins by reviewing the museum's motivation and general approaches for engaging visitors to become active participants through involving them in different types of participation activities. This is followed by reviewing the main models that are available for visitors' participations in museums. Then the key literature is reviewed regarding the digital technologies that have been developed to facilitate visitors' participation in museums. Next, the chapter discusses personalisation and socialisation: the two main cross cutting aspects that have been considered in the digital technologies for facilitating different types of visitors' participation in museums. The chapter then represents a discussion about the reflection on the reviewed digital technologies that have been used for supporting visitors' participation in museums and highlighting the issues of them and how these issues could be addressed through proposing artcodes, aesthetic visual markers, as an alternative mechanism to involve visitors into different types of participations. Finally, the chapter will be concluded by highlighting the main research questions that this research will explore. Figure 2.1 shows the key components of this chapter which is around visitors' participation in museum.

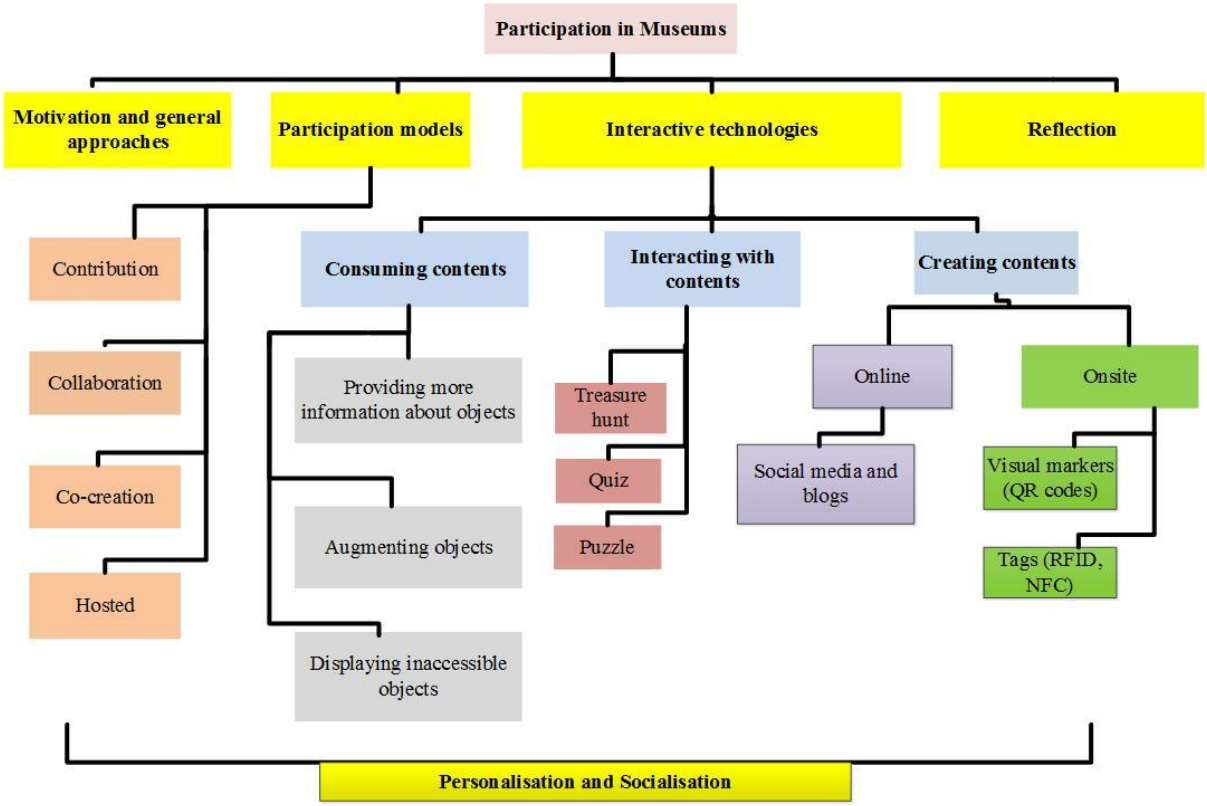


Figure 2. 1 Key components of the literature review chapter

2.1 Motivations for enabling visitor' participation in museums

Museums are places that are visited by a wide range of diverse visitors from different background. The overall focus of museums has changed from "being about something to being for someone" (Weil, 2002:229) which made museums to shift their focus beyond preserving and representing artefacts and contents towards a visitor-orientated approach to provide them unforgettable, meaningful and interactive experiences. Thus, visitors being seen as active individual participants in a social context (Falk, 2009; Hooper-Greenhill, 2007) which may result in persuading more people to visit (Black and Skinner, 2016; Camarero and Garrido, 2012; Jafari and Taheri, 2014; Kelly, 2004; Parry, 2013; Rentschler, 2007; Weil, 2002). These can result in shifting visitors' role from passive consumers to active participants through engaging them to interact with exhibitions more deeply (Falk, 2009; Holdgaard and Klastrup, 2014).

The main approaches for making visitors experiences interactive and meaningful is by involving them in different activities to engage them personally and emotionally with the exhibition as well as to allow them to participate in creating contents, experiences and designing exhibition (Adams et al., 2004; Falk and Dierking, 2000). Cosley et al. (2008) propose that for enabling visitors to participate in museums, edutainment should be considered in designing end-user engagement systems and exhibitions. Hood (1983) highlighted six categories as criteria that can influence visitors' experiences and one of the categories is that visitors should be involved in participation activities.

Museums are increasingly interested to involve visitors in participation activities in order to make them more active through providing different types of activities ranging from basic to more deeper activities. The basic type of visitors' participation is through consuming museum contents in order to engage with the physical artefacts. Going further, visitors' participation can be made by enabling them to interact with the physical artefacts through game and manipulation activities such as puzzles and treasure hunts. The deeper participation type can be made through enabling visitors to create their own contents and interpretations about exhibits.

Visitors' preferences for participation also vary as some of them would like to consume static contents, other visitors would like to engage with interactive programs which allow them to gain more knowledge in an interactive way, and other visitors would like to share their own experiences and contents with the exhibition. Thus, not all visitors would be interested in participating through adding own contents and stories. Simon (2010) argues that visitors

should be provided with opportunities to participate in a number of different ways and in different activities such as enabling visitors to consume content in an interactive way, make comment and share contents.

Previous researchers have identified a number of different models for supporting visitors' participation in museums. In the next section, these models are reviewed in more details.

2.2 Models for participation

Researchers have identified a number of different models for supporting visitors' participation in museums. In the "Participatory Museum" book, Simon (2010) explains three main models or forms of visitors' participations in museums which are contribution, collaboration and co-creation in which in the first two models, projects are designed by the museum staff (Bonney et al., 2009). **Contribution** refers to the possibility of allowing visitors to contribute to the interpretations in relation to artefacts and exhibitions in a museum-controlled process through sharing own stories, ideas and comments and leave them in the museum using, commonly used platforms such as comment boards and kiosks.

Whereas, **collaboration** refers to the strategy where museums provide visitors the opportunity in deciding and adding content to the exhibitions according to the museum policy and strategies. Thus, visitors are involved as "active partner" in the creation of the museum exhibition which is mainly controlled by the museum. **Co-creation,** on the other hand, refers to the project or activity where both museum and visitors or member of a specific community work together to plan, define and design the main goal and content of the exhibition from the beginning in accordance to the preference of the public community. Co-creation is similar to collaboration, however the co-creation project provides more powers to visitors and the aim and goals of the co-creation are mainly responsive to visitors' needs. Thus, visitors have more active roles in the co-creation model compared to the contribution and collaboration models.

These three models of visitors' participations are about shared experiences between museum staff and visitors in developing and designing exhibits or experience (Bonney et al., 2009). Simon (2010) extends these three models of participation by introducing the "hosted project" category in the museum context where museums turn their spaces to public participation in a formal way. This can be done through providing community members with the necessary resources and facilities for developing and creating programs such as running particular event and workshop that can be used by specific public group of visitors which can attract more audiences to participate (Simon, 2010). Macdonald also introduces the "genuine co-creation"

term to shift most of the control from curators to the audiences in a way that curators can play a role of facilitators rather than creators and leave their curator's role for visitors (Macdonald, in Atkinson, 2010). The “genuine co-creation” that was introduced by Macdonald is similar to the “hosted projects” by Simon (2010) and “radical trust” by Lynch and Alberti (2010).

The main benefit of each of the participation models is that the power of contribution and curation can be shifted, to some extent, from professional to non-professional which may result in involving more diverse audiences to the museum projects and making space for their voices (Ind and Coates, 2013:89). However, shifting curation power to visitors and the degree of visitors’ involvement depends on the museum’s aim from the participation and what they expect to be produced by visitors. In addition, using each of these forms of visitor participation depend on the contexts and the goal of the museum thus there is no form of participation that is better than another (Simon, 2010). However, providing high trust and authority could raise a challenge in the participation projects particularly in the co-creation projects since more powers are provided to visitors which need careful considerations (Varutti, 2013:70)

Since visitors or users have more power in the co-creation activities, a number of researchers from different disciplines have focused on discussing and developing models for different activities of the co-creation.

For instance, in an industry discipline, researchers have proposed co-creation cycle models for the process of creating products between suppliers, organisation and customers (Gouillart and Quancard, 2016; Prahalad and Ramaswamy, 2004b). Russo-Spena and Mele (2012) also developed the five “Co-s” model for co-creation of products with users which are: co-ideation, co-evaluation, co-design, co-test and co-launch. In a research discipline, the University of Minnesota Libraries (2006) proposed a model of co-creation for the main activities in a research process which are: discover, gather, create and share.

In a cultural heritage discipline, Minkiewicz, Evans and Bridson (2014) developed a model for visitors’ co-creation in a heritage context which consists of co-production, personalisation and engagement. Another model for the digital content life cycle was developed by the National Library of New Zealand (Make It Digital Guides, n.d.) to identify the main activities in the process of co-creation which are: selecting, creating, describing, managing, discovering, reusing and preserving.

From reviewing museums' motivations from visitors' participation and the available models of participation, it seems that the literature about visitors' participation can be categorised into three different types which are: **consuming contents**, **interacting with the contents** and **creating content**. For supporting each of these different types of visitors' participations and facilitate them, museums are widely adopted digital technologies in their settings ranging from fixed installations to mobile technologies. In the following section, the most widely used technologies for visitors' participation are explained followed by reviewing the technologies that are used for supporting each type of the visitors' participation.

2.3 Digital technologies for supporting visitors' participation in museums

For encouraging visitors to engage in the three different types of participation and support that, museums have implemented interactive digital technologies (Ciolfi, Bannon and Fernström, 2008) which can result in visitors satisfaction from their own participation (Adair et al., 2011; Black, 2005; Cameron, 2003; Drotner and Schrøder, 2014; Frost, 2013; Satwicz and Morrissey, 2011; Simon, 2010). The interactive digital technologies that have been implemented in museums range from fixed installations to mobile technologies that can be carried by visitors.

Fixed installations have become prevalent and common mediums in museums to enrich visitor experiences through enabling them to participate in different activities. The design and prototype of the digital interactive surfaces range from a kiosk to large multiuser surfaces such as tabletop computers, tangible and multi touch interface. Most of the interfaces have large and shared display which allow multiple visitors to gather around and collaborate with each other to interact with digital contents simultaneously, which can enable them to have an awareness of each other activities and learn from each other (Dillenbourg and Evans, 2011; Fleck et al., 2009; Ha et al., 2006; Harris et al., 2009, Higgins et al., 2011; Hinrichs and Carpendale, 2011; Horn et al., 2012; Hornecker, 2010; Jacucci et al., 2010; Ma et al., 2012; Marshall et al., 2011; Rick, Marshall and Yuill, 2011; Rick and Rogers, 2008; Yuill and Rogers, 2012).

However, researchers reported that some of the visitors might avoid personal involvement and interacting with the fixed installations that have shared screens due to embarrassment or lack of familiarity with technology (Brignall and Rogers, 2003). In addition, some of the fixed installations might individualise visitors' experiences rather than encouraging collaboration and social interaction between them. For example, traditional desktop computer (computer-based interactive), kiosks, devices that accept a single input (Flagg, 1994; Heath,

Vom Lehn and Osborne, 2005; Vom Lehn, Heath and Hindmarsh, 2001). Another issue of implementing fixed installation and large shared display is that they might be of high expense for the museum and take a large physical space.

With the recent evolution of digital technologies, mobile technologies (PDAs and mobile devices) have been widely used in museums to engage visitors personally with the exhibitions and explore them (Exploratorium, 2001; Hsi, 2002). Using mobile and portable devices allow visitors to carry them and use them while they navigate in the places to receive relevant information about the exhibits. The vast majority of mobile device applications in museums are in a form of electronic guidebook for individual use or enabling visitors to use their own smartphones for interacting with the artefacts (Hsi, 2002; Tallon and Walker, 2008). However, one of the main issues of using mobile device in museums is that it might distract visitors from the exhibited artefacts as well as isolate them from other visitors (Bellotti et al., 2002; Hsi, 2002).

For each of the fixed installations and mobile technologies, different techniques and mechanisms have been used for enabling visitors to participate in museums through consuming contents, interacting with contents and creating content such as using AR and visual markers. Such mechanisms either considered enhancing personalisation or socialisation and some systems have merged the two for engaging visitors individually and with other visitors (see figure 2.2).

The most widely used technology in museums is a visual marker, usually in the form of QR codes. QR codes can support all the three different types of visitors' participation ranging from consuming, interacting to create contents. According to an online survey conducted in 2013 by the Museum Association for the UK museums, it was reported that QR codes were the most popular technology deployed by museums, at almost (63%) followed by museum-provided audio-tour (46%), mobile-optimised websites (45%) and then Smartphone apps (Android 36%, Apple 39%) (Atkinson, 2013).

The appeal of QR codes is that they provide a low-cost way to deliver a broad range of applications. Simply by scanning a marker with their smartphone, visitors can get access to additional multimedia information about artefacts, interact with the contents and to contribute to the exhibition's interpretation by leaving comments and feedback. At the same time, QR

codes are relatively cheap and easy to deploy, as no new technical infrastructure needs to be installed.

However, researchers have shown that visitors do not engage with QR codes, possibly because they are not meaningful and aesthetically less appealing. Wein (2014) found that QR code was the least preferred mechanism by visitors because they reported QR code as a difficult technology to use. This might be because visitors must shift their attention away from the artefacts to scan the codes, and to access them it is necessary to stand relatively close to them. Also, Schultz (2013) found that visitors at the Museum of Inuit Art had an awareness of QR code, but they used it very little (Schultz, 2013).

After reviewing the key technologies and mechanism that have been used in museums for enabling visitors' participation, in the following section, the three different types of visitors' participation (consuming, interacting and creating content) are discussed in more depth with providing more examples about each.

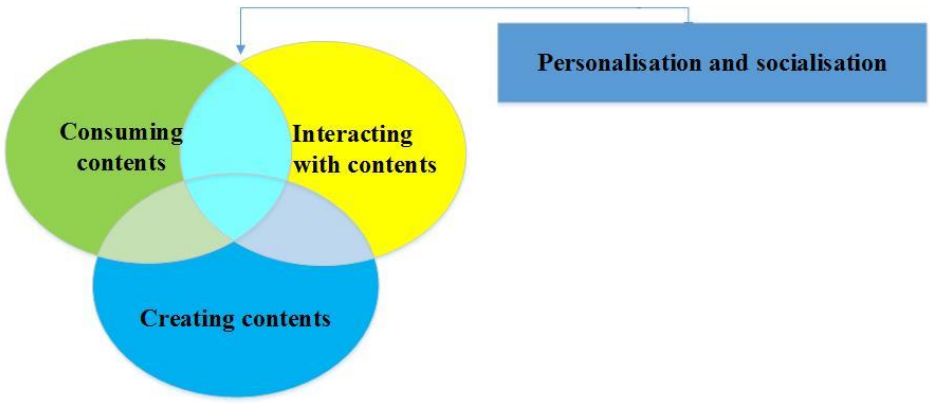


Figure 2. 2 Three main types of visitors' participation and the cross cutting aspects of them

2.3.1 Consuming contents

Traditionally museums were places to keep artefacts and present them to visitors as well as to present more information about the artefacts mainly in a form of text labels so that visitors can consume them. Thus, consuming content is the most basic type of visitors' participation in museums in which visitors are encouraged to consume information and contents that are provided by the museums about the artefacts.

Researchers have studied visitors' engagement with interpretation labels of artefacts in museums and galleries (Leichter et al., 1989; Vom Lehn et al., 2001). However, it was reported that the majority of visitors do not engage with text labels (Hein, 2002; Knudson,

Cable and Beck, 2003; McManus, 1989) and mainly they engage with artefacts rather than their interpretation labels (Falk and Dierking, 1992). These motivated museums to utilise interactive digital technologies to enrich their settings, exhibitions and visit experiences through delivering information about exhibitions and artefacts in an interactive and immersive way using mediums such as images, audio and video. In this regards, Serrell and Raphling (1992) state that it is important not only providing information about exhibits in an interactive way but also to ensure receiving information in an interactive and useful way. Museums followed three main approaches for engaging visitors to participate in consuming contents which are **providing information about objects, augmenting objects** and **displaying inaccessible objects.**

2.3.1.1 Providing information about objects

The most basic usage of technologies in museums is to provide additional factual information about artefacts and exhibitions either in response to visitors' input such as scanning a QR code or through detecting visitor's location and providing relevant information accordingly. In terms of providing information based on visitor input, a number of different technologies has been used for each of the fixed installations and mobile technologies. The most commonly used technologies are **visual markers** and **tags**.

Visual markers, usually in the form of QR codes, are most commonly used to provide additional information about exhibits through scanning them using smart devices. QR codes are a low-cost mechanism which overcomes the space restrictions of text labels and enable the incorporation of multimedia (audio, video, animations) in an easily updatable form.

Examples of this include the QR codes placed next to artworks in The Los Angeles County Museum of Art and Fort Wayne Museum of Art (BeQRious, 2012) to reveal biographical information about the artist, as well as QR codes linking to audio and video explanations of the objects on exhibit as shown in an early demonstration by the Museum in Urk, Holland (BeQRious, 2012). Elsewhere, in the Turin-Milan region, Rolando and Scandiffio (2013) developed a system to provide additional factual information about a cultural heritage site by scanning the QR codes distributed around it (Rolando and Scandiffio, 2013). In the Museum of Inuit Art, QR codes were also used to provide additional information about the objects in the exhibits (Museum of Inuit Art, 2011). In the Tales of Things project, QR codes were implemented at a gallery in Scotland in order to provide more information about objects (National Museums Scotland, 2011; Tales of Things, 2010).

Tags are another technique that have been used in museums to provide more information about objects. Examples of tags include Radio Frequency Identification (RFID) and Near Field Communication (NFC). For example, Mäntyjärvi et al. (2006) associated additional audio information about objects to RFID tags which can be accessed by scanning the physical RFID tags associated with the objects. The authors found that although visitors engaged with the way that the digital contents were revealed quickly, they found that scanning RFID required visitors to be close to the objects which is not realistic in museum environments. In the Hunt Museum in Limerick, RFID tagged key cards were also used to enable visitors to obtain additional contextual information about the artefacts and access interpretations that were created by other visitors (Fraser et al., 2004).

Alternatively, museums have used to provide more information about the objects through detecting visitors' locations and providing relevant information according to their movements in the museum. For this purpose, Location Based Services (LBS) are used to track visitors' positions and as a result, the nearby or relevant artefacts will be identified and recommended for the visitors. In the indoor setting, technologies such as infrared and Radio Frequency Systems (RFS) are used, whereas for outdoors, technologies like GPS are used (see Carle, 2013; Doljenkova and Tung, 2015; Goodrich, 2013).

To facilitate this, mobile devices such as portable electronic guidebooks and audio guides have been widely used in museums and cultural heritage sites since these devices can be carried by the visitors while navigating in the museum in order to recommend the most relevant contents according to visitors' locations or interests. The delivered contents are in a form of text but mostly in a form of audio or video related to museum objects. Researchers reported that possibly with the right design, mobile guide might increase visitors' attention to the physical artefacts particularly if the contents are delivered to visitors dynamically instead of automatically generating contents (Alfaro et al., 2005; Gammon and Burch, 2008).

Audio guide usage by museums, going back to the late of 1950s when first used for a tour of Eleanor Roosevelt's home using tape players to enhance visitors' experiences (Acoustiguide, 2014). Since then, electronic guides have become a common method to deliver audio and visual information for visitors. They can be designed in a way to automatically present contents about museum artefacts based on the visitors' positions or their preferences that are recorded in their profiles (where the profile contains stored information about visitors'

preferences). Cyberguide is the first mobile guides system with context aware features that was developed by Abowd et al. (1997) to recommend relevant contents to the visitors based on their positions while navigating in the museum.

ARCHEOGUIDE (Augmented Reality-based Cultural Heritage On-site GUIDE), is an electronic guide tour that was developed by Vlahakis et al. (2001) to provide visitors with more information about the objects and monuments of the Olympia, Greece in a form of multimedia according to the visitors' position. The HIPS, Hyper-Interaction within Physical Space, project (Not et al., 1997) at the Museum Civico in Siena and a system at the Exploratorium in San Francisco (Semper and Spasojevic, 2002) provided visitors audio messages about artefacts on hand held devices through tracking visitor position. Also, the GUIDE project (Cheverst et al., 2000) was developed to provide visitors information about a city by tracking their positions.

Other systems developed to provide information about objects based on both visitors' location and interest that are recorded in their profiles. For instance, Hippie, a mobile guide, developed by Oppermann, Specht and Jaceniak (1999) recommended more information about exhibits according to the visitors' positions and interests in the museum. Poslad et al. (2001) developed CRUMPET, a mobile system, to provide information about a city according to the visitor location, interest and pervious history of visitor interaction with the system. Petrelli et al. (1999) also developed HyperAudio, a mobile guide system, to generate audio comments about objects by identifying the physical location of visitors and the amount of time they spend in a certain location to indicate visitor interest towards objects.

Another example of recommender systems is the PEACH, Personal Experience with Active Cultural Heritage, which is a PDA-based museum tour guide where LBS was used to track visitors' positions and suggest providing information about objects that were relevant to those that the visitors already interacted with (Stock et al., 2007). CHIP, Cultural Heritage Information Personalization, is a guidance system runs on mobile devices and it was developed to enable visitors to browse contents, create their own tour and to receive recommendation about the artefacts, based on the visitor location and previous visitor rating (Wang et al., 2007, 2008). The INTRIGUE guide system also recommended contents according to groups of tourists' preferences (Ardissono et al., 2003).

2.3.1.2 Augmenting objects

Museums and cultural heritage sites have used other approaches in using technologies to further engage visitors through providing them additional information about objects in a way to show them how particular objects or places looked like in the past and AR is mainly used to facilitate this. For example, Augurscope allowed visitors to see the differences between how Nottingham Castle Green currently appears and how it appeared in mediaeval times through using 3D historical reconstruction. Augurscope utilised various positioning technologies in outdoor historical locations, such as GPS, compass, and accelerometer (Schnädelbach et al., 2006). Also, ARCHEOGUIDE, a personalised electronic guide tour, enabled visitors to reconstruct the damaged parts of the ancient places at the archaeological site of Olympia, Greece and these were viewed to the visitors using the 3D view (Vlahakis et al., 2001). Other examples of 3D reconstruction of damaged physical heritage sites and those where artefacts are missing include, ARCO (Augmented Representation of Cultural Objects) systems (Mourkoussis et al., 2002) and TODC (This Old Digital City) system (Severson et al., 2002).

A further example is the Scopify ROM system, developed by the Royal Ontario Museum in Toronto (in partnership with a Kensington company) to enable visitors to see what museum objects used to look like in the past, by adding an additional layer of objects to enable visitors to (X-ray) mummies artworks, cover the skeletons of animals with skin and to restore other ancient objects (Scopify, 2013). These affordances provide visitors with a wealth of information about objects and engage them in a way that is impossible using conventional methods.

Also, MARCH (Mobile Augmented Reality for Cultural Heritage) was developed to allow people to discover and see heritage engravings from historical caves by augmenting the captured engraving image with images drawn by experts to highlight animal engravings (Choudary et al., 2009). A further example is the Telescope which was developed by Reeves et al. (2005a) for the use at the One Rock exhibition to enable visitors to see the "unseen world" underlying the exhibition.

2.3.1.3 Displaying inaccessible objects

Many museums worldwide do not place all their collections on public view, either because they have insufficient space, they fear difficulties might arise from handling certain pieces, or due to temporary closures. Thus, they can use technologies such as AR to extend the space in

order to engage visitors with the collections through displaying and providing additional information about objects that are not on display or those objects that are hard to show their detailed features.

For example, Jevremovic and Petrovski (2012) developed the MUzzeum mobile app for the Serbian National Museum, which has been closed for more than 10 years for renovation purposes. MUzzeum enabled people who were around the museum building, to access information and see images of artefacts in a 3D view through scanning QR codes. In Egypt, Nofal (2013) implemented a mobile AR guiding tool for the Egyptian museum to enhance visitors' experiences by allowing them to see artefacts in greater detail, magnifying parts of them and explore the process of creating artworks in a 3D model (Nofal, 2013).

2.3.2 Interacting with contents

Museums have increasingly attempted to enable their visitors to become active participants through involving them in participation activities to physically interact with exhibitions and contents using interactive technologies. Interactive games in the form of treasure hunts, quizzes and puzzle activities are one of the approaches that have been used widely in museums and these either presented to visitors on large shared screens (which can facilitate more discussion and interactions amongst visitors) or on mobile devices. These activities have been widely recognised as methods for enhancing visitors' learning and promoting collaboration between them in an entertaining context (Hall and Bannon, 2006; Tselios et al., 2009).

Treasure hunts are considered popular forms of games particularly for children, to enhance their engagement with the museum objects and enhance their learning ability during visiting the museums. Treasure hunts are mainly used in a form of engaging visitors to find objects and information about them through providing a number of clues. There are a large number of studies that have focused on using treasure hunts in museums. For instance, at the Hecht Museum, Kuflik, Rokeah and Salman (2014) developed the Treasure Hunt Game Generator System to enable children to play a treasure hunt game through answering a number of questions in relation to the museum objects and finding them in the museum. Thus, the game encouraged children to observe and interact with the objects deeply in order to be able to answer the questions in a text format through scanning QR codes.

The exhibit on the 100th anniversary of the Boy Scouts in America across the Smithsonian National Museums in DC used QR codes to challenge visitors to a scavenger hunt to uncover

links between scouting and some great national treasures (Boy Scouts of America, 2010). Ceipidor et al. (2009) developed a mobile app treasure hunt game called Blåtannkoden for the use at the Oslo Norsk Telemuseum, targeting secondary school students. The game engaged the students with the museum objects through solving a series of riddles and identifying the right answer by scanning the appropriate QR code (Ceipidor et al., 2009).

Quizzes are also used in museums to engage visitors with the exhibition through answering a number of questions related to the objects. For instance, Mikalef and Chorianopoulos (2011) developed an educational MR quiz game for an Art Gallery to engage students to identify correct paintings through answering a number of questions by scanning QR codes. The authors also used a paper-based version of the quiz without a game or QR code in order to know how visitors engage with the different approaches. In total, 55 students participated in the study and they were grouped into three groups: 1st group played with the game, 2nd group played with paper-version game and the 3rd group did not play. The results showed the first group had a higher performance in the post-visit assessment (test) but had enjoyed and interacted less with the physical museum, which might be due to their high interactions with the game (Mikalef and Chorianopoulos, 2011).

Another example of the quiz format is the CoCicero, a museum guide system, that was developed for the Marble Museum in Carrera to engage visitors, both individually and in groups, to interact with the exhibits through asking them a set of questions about the museum exhibits which required visitors to collect information about the exhibits for answering the questions (Dini, Paterno` and Santoro, 2007). Hope et al. (2009) also developed the Minpaku navi, an interactive museum guide system, for families and small groups of visitors at a Japanese museum to enable them answering quizzes related to the artefacts in the museum.

Puzzle, another form of games, is also one of the approaches that museums use to engage visitors physically with the exhibits through active involvement for collecting and placing different pieces of information or objects together in order to reveal the correct answer for the puzzle. For instance, Fraser et al. (2003) developed the History Hunt exhibition for the Nottingham Castle museum in order to enable groups of family visitors to gather pieces of papers that were distributed in the museum. The paper clues were tagged to RFID which provided additional information about the objects in order to motivate visitors to find particular historic artworks related to each clue to complete the puzzle (Fraser et al., 2003).

Similarly, Kurio, a museum guide, was developed to enable small groups of visitors to gather information in the museum to fix a broken map (Wakkary et al., 2009).

In addition, Laurillau and Paternò, (2004) developed two interactive collaborative games on mobile devices, which are extensions of the Cicero game (Ciavarella and Paternò, 2003), to engage visitors with the contents of the Marble museum in Italy. The first game was in a form of a treasure hunt which was designed to enable groups of visitors to find clues in order to solve a puzzle cooperatively to find a solution. Whereas the second game was designed to enable visitors individually to discover the museum's objects and gather clues about them. Ciavarella and Paternò (2004) designed educational games to engage visitors with the museum collections through playing games individually followed by playing in groups. The games were based on shared enigmas that consisted of a series of questions about a specific topic associated with an image hidden by a jigsaw puzzle in museum. Thus, the players needed to solve the game individually to reveal one piece of the puzzle that can be shared with other players to solve the whole puzzle. Also, Cabrera et al. (2005) designed an educational mobile game for a historical museum to engage small groups of children to interact with the museum's objects order to solve a puzzle. Each group of children received different pieces of information from the other group to collaborate with each other in solving the whole puzzle.

Finally, two educational games, the Donation and the Museum Scrabble, were developed for a historical museum in Greece in order to enable groups of children to collaborate with each other to interact and manipulate information about the museum's collection. For this purpose, children were required to scan RFID through their mobile devices to obtain information and clues about the exhibits (Sintoris et al., 2010; Yiannoutsou et al., 2009).

2.3.3 Creating Contents

Creating content is one of the deeper types of visitors' participation in the museum. Traditionally, creating museum experiences and interpretations were considered curators jobs (Kotler and Kotler, 2001; Minkiewicz et al., 2014) and their roles depended on the museum types (Alloway, 1996) where in some museums curators' roles are about managing and in some others are more academic. Museums used to provide official interpretations about their objects and visitors were consuming them. Researchers argued that for every object, there

should be only one single correct interpretation which can represent the real information about the object (Stecker, 1994).

However, recently, museums have undergone a fundamental shift from presenters of objects and official interpretations to develop exhibitions that invite and encourage visitors to become active participants to create own interpretations and design interactive experiences about exhibitions both online and onsite (Falk and Dierking, 2000; Kotler, Kotler and Kotler, 2008; Mencarelli, Marteaux and Pulh, 2010; Mygind, Hällman and Bentsen, 2015; Whitehead, 2012). Overall, inviting visitors to create contents is considered the most active form of participation in museums. As a result, visitors are more likely to be engaged more deeply with the exhibition and their learning ability to be enhanced particularly with the use of digital technologies (Ciolfi and McLoughlin, 2012; Falk and Dierking, 2000). Visitors' contributions are mainly in forms of adding more information, ask questions, leave comments or to add layers of personal stories related to artefacts (Alelis et al., 2013; Golbeck, 2013; Kelly, 2012; Kidd, 2014; Røtne and Kaptelinin, 2013; Simon, 2010; Whitehead, 2012) and such contributions would turn into social objects (Simon, 2010).

Simon (2010) argues that museum interpretation should be designed in a way to provide information about artefacts and also engage visitors in a more participatory and experiential activities. In the field of the HCI, researchers have widely highlighted the importance of enabling visitors to add their own interpretations. Wright and McCarthy (2003) highlighted the importance of enabling "sense making" by visitors for emotional and aesthetic user experiences (Wright and McCarthy, 2003). In addition, the ambiguous nature of artworks invites multiple interpretations (Sengers and Gaver, 2006). The nature and representation of interpretations have also been changed from more structured pedagogic to more diverse interpretations in order to enrich visitors' experiences and enable them to make meaning of objects in their own ways which may encourage them to create their own interpretation as well (Whitehead, 2012).

Simon (2010) states that museums need to make participatory spaces in order to allow visitors to engage with the exhibition and create contents, based on exhibition context, to express their own experiences and opinions with other visitors. Museums can use different models for enabling visitors' participation in their settings (as discussed earlier in this chapter). However, it is important not to leave the aim of inviting visitors to contribute open-ended instead, aims and goals from visitors' contributions should be clearly identified and

what the outcome of the contributions should look like. In addition, clear rules and instructions should be explained at the beginning of the participations in order to prevent any misleading or inappropriate experiences and contents. Moreover, museums should be clear how they would value visitors' contributions and where and when their contributions will be integrated into the exhibition. Furthermore, it is important not only focus on encouraging visitors to participate but also to ensure how visitors' contributions would enrich other visitors' experiences and motivate them to engage in participation (Calver and Page, 2013; Simon, 2010).

Researchers highlighted that museums, which aim for visitors' participations, need to design their exhibitions and the physical environment in a way to fit the participatory activity and also to encourage visitors to participate in their own way (Black, 2005; Simon, 2010; Sweet, 2007). Salgado, Trant and Bearman (2008) identify the main parameters that should be taken into consideration before enabling visitor participation which are:

- Theme of the exhibition should fit with visitor participation.
- The format of the medium for the official and visitors interpretations should be carefully chosen (such as audio, video, image or text).
- Where to participate: onsite or online. If onsite, which method should be used: such as mobile phone, PDA or paper and pen.
- Theme of the participation should be clear whether to leave commentary messages about the exhibition or leave own personal comment.

Thus, visitors' contributions could be of benefit for enriching own experiences, enrich object interpretation, connect visitors with the collections and connect visitors with others. This later can promote social communication between visitors, promote visit experience of non-participant audience and engage people to visit the museum particularly those who do not normally visit museums (Cameron, 2008; Durbin, 2004; Hooper-Greenhill, 2007; Macdonald, 2002; Simon, 2010; Stuedahl and Smørdal, 2011; Tzibazi, 2013). As a result of visitors' contributions, it is more likely to bridge the gap between language and opinion of museum curators and public visitors' as researchers found a significant difference between expert and non-expert contributions (Bearman et al., 2005; Smith, 2004; Thom-Santelli, Cosley and Gay, 2010). However, this utility has the potential that inappropriate contents might be produced and left to public if no moderation system used by museums (Russo et al., 2008). Thus, it is important to ensure checking and managing visitors' contents to remove

inappropriate, offensive or irrelevant contents before displaying them to public (Simon, 2010).

For making interpretations, user-generated content concept has been widely used in museums particularly with the development of the new digital technologies (Bakhshi and Throsby, 2010). User generated content is the approach that is used by museums to enable visitors to contribute in creating content or museum experiences through sharing own stories and comments either physically in the place or online using social media (Sandvik, 2012; Stuedahl, 2011). With user-generated content, visitors become co-creator of contents (Witcomb, 2003) which would give them a sense of belonging to the museum members (Von Hippel, 2005).

As already discussed, visitors' participations can be made online, onsite or both. Online participation can be made using social media and blogs (see Ciolfi, Bannon and Fernström, 2008; Giaccardi, 2012; Kidd, 2014). An example of online participation is the blog in the Science Buzz website (Von Appen et al., 2006) which was created by the Science Museum of Minnesota in USA and invited visitors to leave comments or to ask questions, related to the museum objects, which will be answered by scientists and the answers can be accessed either online or physically in the museum.

However, onsite participation can be more engaging for visitors since they can observe and interact with the physical objects and then reflect to participate physically in the exhibition through making their contributions before leaving the space and forgetting what they wanted to add. Paper and pen are the most basic approaches that have been used in museums to invite visitors to contribute by writing their comments and questions about exhibition or to share their personal experiences about exhibitions and leave them on comment boards for public view (Adams et al., 2004; Madden et al., 2013). This simple technique can have a high impact on visitors to engage personally with the exhibition which can lead to conversation amongst them around the exhibition (Simon, 2010). However, digital technologies can have a high impact on facilitating content creation in museums. In the following section, the main technologies that have been used for facilitating visitors' participation in creating contents are explained.

2.4 Techniques for facilitating visitors' participations: creating content

For enabling visitors to participate through creating content onsite, museums have used either fixed installations or mobile devices. Fixed installations have been used in museums for inviting visitor(s) to create their own interpretation. For example, an interactive multi-touch installation was developed by Bartindale et al. (2011) for the Great North Museum, Newcastle Upon Tyne, UK in order to enable multiple visitors to contribute to the exhibition simultaneously using a digital pen to draw or to write comments which would be displayed on a screen in the museum. The authors found that visitors used the installation to leave messages to other visitors, family and friends and they learned to interact with the screen from observing other visitors. The authors also found that the hand-drawn contributions, that were displayed on a screen, highly engaged other visitors to replicate them and to make their contributions as hand-drawn.

Also, Taylor (2014) developed the Byker Lives Table, a multi-touch public interactive map based installation, in a community heritage exhibition in Newcastle, UK to engage visitors deeply with the exhibition and motivate them to participate in creating content to be displayed to public. The created content can be "pinned" to its geographically relevant place on a map screen that could be accessed by touching it on the map. The authors found that visitors mainly created contents around personal stories about the history of Byker more than adding information about Byker.

Filippini-Fantoni and Beaven (2011) also developed interactive touch screen kiosks to engage dialogue between a contemporary Chinese artist and gallery visitors. The kiosks were deployed in booths to allow visitors to ask the artist questions or answer questions related to the exhibition to reflect on their visit experiences using video recording in the booth. The questions and answers then published online in addition to the artists' responses.
Elsewhere, in the Smithsonian Museum of American History's September 11, 2001 exhibit (Jones, 2004) visitors were invited to share their experiences, memories or comments about the tragedy of September 11 either in text format using paper and pen or to record their voices through a telephone which was physically deployed in the museum. All of these memories were published online and some of them were displayed physically in the exhibit to become public memories in the museum. Other researchers have used museums objects for engaging visitors to participate. For example, in Massachusetts, the Road exhibition was

developed to engage visitors to share their comments and opinions in reflect to the Poet Jack Kerouac exhibition using a museum typewriter (Dysthe, 2013).

In addition to fixed installations, mobile devices have been used widely in museums for inviting visitors to create content about museum objects. For this purpose, different mechanisms have been used such as using **visual markers and tags (**though these mechanisms are also used in some fixed installations as well).

Visual markers, usually in the form of QR codes, are the technique that have been widely used in museums to provide additional information about objects as well as to enable visitors to contribute to exhibitions through sharing their own stories, interpretations, reflections and feedback. Although less explored, this application addresses recent museum concerns to support visitors in engaging with multiple interpretations, and creating, sharing content and connecting with each other (Simon, 2010; Whitehead, 2012). For example, Ciolfi and McLoughlin (2011) designed the Reminisce, an interactive installation that was deployed in Bunratty Folk Park in Ireland to enable visitors to participate in the park by leaving their audio recording memories and comments about the objects or about the other visitors' contents through scanning QR codes. The authors found that a large number of visitors engaged in recording their personal experiences and comments.

Similarly, Ceipidor et al. (2009) developed Blåtannkoden, a mobile app treasure hunt game, to enable secondary students to solve a series of riddles about the museum objects and identify the right answer by scanning the appropriate QR code. At this point, the students were allowed to leave their own written comments which were displayed directly on a screen in the museum (Ceipidor et al., 2009).

The Tales of Things platform (Tales of Things, 2010), which enabled visitors to tag objects with stories through QR codes, has underpinned two notable examples. Workshops and events held at the National Museum of Scotland where visitors were encouraged to attach a QR code to an object and to "record" a memory of using such an object (Speed and McDonald, 2013). The other example is QRator project that was developed for the Grant Museum of Zoology and The Petrie Museum of Egyptology, at University College London (Bailey-Ross et al., 2012). Each of RFID tags and QR codes were used to provide relevant information about museum artefacts and to involve visitors in a digital discussion by answering questions that posed by curators and leaving comments by creating own

interpretation about exhibition using static iPads or personal mobile phones. For creating contents, visitors needed to scan QRator, displayed in the museum, using the "Tales of Things" application on smartphone and visitors were highly engaged in sharing their views and comments about their visit and the exhibition.

Likewise, QR codes were installed to accompany objects at the Imperial War Museum with visitors being able to join the conversation by adding text comments to any item in the collection and reading what other people have to say (Imperial War Museum, 2012).

In terms of tags, they also have been used in museums to enable visitors to create new contents, leave comments about objects and make them available to public view (Golder and Huberman, 2005; Huberman, 2005; Trant and Wyman; 2006).

For example, Retracing the past exhibition at the Hunt Museum in Ireland was developed to engage visitors with the exhibition and encourage them to participate physically in extending the exhibition interpretation through recording their audio opinion. Thus, visitors' opinions become part of the exhibit interpretation (Bannon et al., 2005; Ferris et al., 2004). For this reason, two rooms were designed: the Study Room and the Room of Opinion. The Study Room was designed to enable visitors to access detailed information about objects using key cards that were augmented with RFID tag and by placing them on the interactive components in the exhibition, relevant information were revealed. Whereas Room of Opinion is where reflection occurred by allowing visitors and museum staff to add their personal interpretation and opinion about objects through recording their own voices using an interactive telephone that was provided. The recorded voice messages then become available for other visitors to listen to in real time through an "Interactive Radio" in the Study Room. Visitors appreciated listening to interpretations (stories and comments) of other visitors and also to take part in creating own voice comments (Ferris et al., 2004).

Finally, guided tours are also used for enabling visitors to create content. For instance, the Muse system, a handheld tour guide, was developed to enable visitors to write comments or questions about museum exhibits and leave them in the museum for other visitors (Boehner et al., 2004; Gay and Hembrooke, 2004).

2.5 Cross cutting aspects: personalisation and socialisation

Personalisation and socialisation are two main cross cutting aspects that can appear in the systems that have been developed for facilitating the three different types of visitors' participation (consuming, interacting and creating content) in museums. In the following sections, both personalisation and socialisation are explained in more depth.

2.5.1 Personalisation

Museums use different technology systems that can support personalisation to engage visitors personally with the exhibition and providing them more meaningful experiences. Personalisation is a mechanism that works based on collecting information about visitor preferences, background and behaviour then using these as basis to recommend and provide information accordingly using recommender systems. For this purpose, the system directly asks the visitors to answer a questionnaire or create a profile to define their own preferences and background (Bonnet, 2001; Cheverst et al., 2002; Vayanou et al., 2014). In addition to visitor preferences, some of the systems also track visitors' movement in the museum using LBS to track their behaviours and the time that they spent interacting with artefacts in order to recommend artefacts or contents that are similar to those that were already observed by the visitors (Opperman and Specht, 1999; Petrelli and Not, 2005).

For engaging visitors to participate in museum through consuming contents, the above techniques of personalisation have been used in many systems to deliver or recommend most relevant contents to the visitors according to their preferences (Ardissono, Kuflik and Petrelli, 2012; Bowen and Filippini-Fantoni, 2004; Damala, 2007; Hanani et al., 2001).
This form of personalisation is facilitated because museums offer a considerable amount of information about their artefacts which often overwhelms visitors and make it difficult for them to interact with all the information due to limited time of the visit. In addition, allowing visitors to add their own interpretations would further enlarge museum interpretations about the artefacts. At the same time, museums are public spaces which are visited by a large number of visitors from diverse age, interest and expertise (Falk, 2009), these make it hard to design a system for average visitors to meet their preferences.

An example of a personalised system for consuming contents is the REMIX platform, RFID-Enhanced Museum for Interactive Experience, that was developed by Karimi, Nanopoulos and Schmidt-Thieme (2011) to personalise visitors' experiences through recommending the

most relevant contents based on visitors' preferences as well as to allow visitors to access their personalised contents after leaving the museum via a web-based application.
Other recommender systems are designed to recommend the artefacts or contents that match visitors' interests and at the same time to match the artefacts that were rated (liked) previously by most of the visitors (Bohnert, Zukerman and Laures, 2012; Sarini and Strapparava, 1998).
Other systems that personalised visitors' experiences based on recommending artefacts according to visitors positions and interests are Hippie (Oppermann, Specht and Jaceniak, 1999), CRUMPET (Poslad et al., 2001), HyperAudio (Petrelli et al., 1999), PEACH (Stock et al., 2007) and CHIP (Wang et al., 2007, 2008). Details of these systems have been discussed earlier in this chapter (section 2.3.1.1 Providing information about objects).

In addition to the use of recommender system for personalisation, most of the museums facilitate the most basic form of personalisation for consuming content through enabling visitors to choose accessing contents in the format that they prefer. For instance, Rubino et al. (2013) developed Museum Assistant (MusA), a mobile multimedia guidance system, to enable visitors to select their preferred medium (e.g. video or audio) for displaying contextual information about artefacts that they have observed.
Another form of personalisation is also facilitated through engaging visitors to participate in museums to create content or experience to their companions, family or friends based on their preferences which can also promote social interactions between them. Thus, the systems that support this form of personalisation can promote both personalisation and socialisation at the same time. For instance, Fosh et al. (2014) and Fosh, Benford and Koleva (2016) used a trajectory guide system to support pairs or groups of visitors to create a personal interpretation tour, as a gift, for their companions and to each other where the contents of the tour were inspired by the exhibited artefacts and by the preferences of the companions.

2.5.2 Socialisation

Museums are informal learning places where people from different age ranges, background and expertise visit them either individually or in groups in order to learn about artefacts or to experience a day out in a social experience as a couple, groups of friends, school students and family groups which are the most common group of museum visitors (Anderson, 1995; Ciolfi and Bannon, 2003; Falk, 2009; Falk and Dierking, 1992, 2000, Falk, Moussouri and Coulson, 1998; Gammon, 1999; Grinter et al., 2002; Heath et al., 2002; Hood, 1983; Hooper-Greenhill,

1999; Kelly, 2000; Korn, 1995; Lakota, 1976; Rosenfeld, 1980; Stocklmayer, Rennie and Gilbert, 2010; Vom Lehn, Heath and Hindmarsh, 2001).

People who visit museums as part of a group experience museums differently than individuals (Ciolfi and Bannon, 2003; Heath et al., 2002; Vom Lehn et al., 2007) and their experiences are a mix of individual and group interactions. Dim and Kuflik (2009) reported that during group visits, some of the group members may stay together throughout the visit while some other may split to experience the visit individually. Overall, social communications and interactions amongst visitors can have an impact on the overall quality of visitors' experiences and engagements with the exhibition and promote their learning (Bitgood, 1993; Blud, 1990; Ciolfi and Bannon, 2002; Cosley et al., 2008; Crowley and Jacobs, 2002; Debenedetti, 2003; Dierking and Falk, 1994; Goulding, 2000; Grinter et al., 2002; Hindmarsh et al., 2001; Leinhardt et al., 2002; Leinhardt and Crowley, 2002; Leinhardt and Knutson, 2004; McManus, 1988, 1994; Paris, 2002; Vom Lehn, Heath and Hindmarsh, 2001). According to researchers, 60% of visitor's attention is on the exhibition whereas the other 40% is on other stuff including conversation with other visitors (Falk, 2009; Lanir et al., 2013).

Regarding people who visit museums alone, some of them do not interact socially with strangers (Csikszentmihalyi and Robinson, 1990) whereas some others do interact with strangers particularly through indirect interactions such as hearing visitors' discussion and observing their behaviours (Boehner, Gay and Larkin, 2005; Leinhardt et al., 2002). Researchers state that visitors are more likely to attend places and engage in activities where there are other visitors around (Bitgood, 1992; Debenedetti, 2010; Vom Lehn et al., 2007) which can potentially enhance visitors' engagements with the exhibition, learn from it and more collaborations and social interactions amongst visitors may produce (Haywood and Cairns, 2006; Vom Lehn et al., 1999). Thus, visitors and their needs should be considered as an individual in a group (Aoki et al., 2002).

Other researchers reported that some groups of visitors might struggle to collaborate and interact socially with their companions or other visitors since most of the digital technologies in museums are designed for individual use. Thus, museums are widely utilising the digital technologies that can be used by multiple visitors instead of the individual use in order to promote collaboration and social interaction amongst visitors. Such systems can support collaborate meaning making of artefacts (Grinter et al., 2002), connect visitors with each

other through the contents (Cosley et al., 2008) and support collaboration from using the technology (Geller, 2006).
Overall, a large number of digital technologies (including fixed installations and mobile technologies) have been used by museums in order to facilitate different types of visitors' participation (consuming, interacting and creating content) and at the same time to support social interactions and collaborations amongst them.

A range of different systems has been developed for enabling multiple visitors to participate in museums through consuming contents and at the same time to promote social interactions and collaborations amongst them. For instance, Aoki et al. (2002) developed the Sotto Voce, an electronic mobile guide system, for the Filoli, a historic house in the California museum to enable visitors to consume audio description about the museum artefacts. The system was designed to enable pairs of visitors to share listening to audio guide simultaneously, collaborate and coordinate in playing audio messages and to eavesdrop on each other (with permission) to know what the companion is listening to using headsets and headphone. Raptis et al. (2005) also reported that sharing audio contents amongst users could promote social interactions.

Similarly, Suh et al. (2011) used an audio eavesdropping metaphor in designing a mobile-based guide system for tourists who visited a cultural heritage site (a historic Cemetery in Korea) in order to enable groups of visitors to control the audio contents that they wanted to listen to as well as to share their experiences with each other. In addition, the authors used a map to enable visitors to find their companions on the site and to know what other group members were doing.

Jimenez Pazmino and Lyons (2011) developed a prototype for a computer-based museum exhibit to enable groups of visitors to interact with the museum collections and access their contents collaboratively using own mobile phone devices as input for the interface.

Promoting social interactions and collaboration amongst visitors were not only facilitated through consuming contents but also through enabling visitors to play games (treasure hunts, quizzes and puzzles) collaboratively. Examples of such systems that were designed for engaging multiple visitors to play games collaboratively are the treasure hunt that was developed by Laurillau and Paternò (2004), solving quizzes to reveal pieces of a puzzle by Ciavarella and Paternò (2004), the two educational games (the Donation and the Museum

Scrabble) by Yiannoutsou et al. (2009) and Sintoris et al. (2010). See section (2.3.2 Interacting with contents) in this chapter for more details about these systems.

Also, social interactions and collaborations are considered in a large number of systems that were developed for supporting visitor participation in museums through creating contents collaboratively. For example, ArtLinks is a standalone guidance visualisation participatory system associated with a public exhibit at the Johnson Museum of Art in USA. ArtLinks was designed to promote social connections and interactions between visitors through enabling them to create their own contents about the exhibit using tags, comments and audio recordings and presents these to other visitors on a screen to reflect on them as well as the system was presenting the connections between the contents of the visitors (Cosley et al., 2008). Hazelden et al. (2013) also developed WeCurate, a multiuser interactive system for a museum, to support interactions between groups of visitors through inviting them to collaborate in creating a virtual exhibition of a collection of images inspired by the museum archive.

An extension of the ArtLinks system is the MobiTags, a mobile social guide system, runs on iPod and it deployed at the Johnson Museum of Art at Cornell University in USA. MobiTags developed to enable visitors to add interpretation physically about collections using tags and visualises them on a screen to the public. In addition, MobiTags also included an extended version of the handheld tagging of ZoneTag (Ahern et al., 2006) in order to enhance social interaction amongst visitors through enabling them to rate tags that created by previous visitors (Cosley et al., 2009; Thom-Santelli, Cosley and Gay, 2010). The authors noticed that MobiTags motivated visitors to observe the exhibition better, supported visitors' navigations in the museum and enhanced social connections among visitors. However, they found that expert visitors were more engaged in making high quality contributions than novice visitors and they negatively rated the contribution that were made by novice visitors which resulted in less contributions by them.

Other studies used a tag as a mechanism to bridge the gap between interpretations of curators (expert) and public visitors which can be useful for enhancing social communication between the two. For instance, a folksonomy system was developed to enable public people to add their own interpretation about museum artefacts online through social tagging (Smith, 2004). The author found that there was a significant difference between curators and public visitors' interpretations. Similarly, the study that was conducted at the Metropolitan museum of Art in

New York also found a significant difference between curators and public visitors' interpretations (Bearman et al., 2005). For minimising this in the mentioned museum, the Steve.museum, an online collaborative system, was developed to provide diverse vocabularies to support visitors, with limited expertise, in describing artefacts (Trant and Wyman, 2006).

2.6 Reflection on technology use for supporting visitors' participation in museums

By reviewing the key literature in this chapter, it becomes clear that there are a number of different ways that visitors can be engaged in different types of participation including consuming, interacting and creating own contents. Digital technologies, in forms of fixed installations and mobile technologies, have been designed and widely used in museums to support the different types of visitors' participation. Fixed installations are mainly used for engaging multiple visitors with the exhibition at the same time such as using table top, interactive displays, tangible and multi-touch displays or for single visitors' usage such as individual kiosks. However, fixed installations are usually expensive and take physical space in the museums. Mobile technologies are more widely used in museums to engage visitors with the exhibitions through using devices such as audio guide and mobile phones. Their usages are more flexible since they are portable and mostly less expensive compared to fixed installations. From reviewing the two cross cutting aspects: personalisation and socialisation, it seems that these two aspects are important to be considered and supported when designing new systems and experiences (either fixed installations or mobile technologies) to enable different types of visitors' participation in museums.

Overall, the most widely used technology in museums is visual markers, usually in the form of QR codes because they are relatively cheap, durable, robust and do not require high infrastructure. QR codes can support all the three different types of visitors' participation ranging from consuming, interacting to creating contents. As already discussed, an online survey conducted in 2013 reported that QR codes were the most popular technology deployed by museums (Atkinson, 2013). However, researchers found that visitor engagement with QR codes can often be low because of the lack of meaningful, limited aesthetic quality and for scanning QR codes, visitors need to shift their focus away from the actual artefacts (Schultz, 2013; Wein, 2014).

An alternative visual marker for QR codes are artcodes, aesthetic visual markers, that have a number of features which make them suitable technology to address the issues of QR codes. Artcodes, a new computer vision technology, was developed by Meese et al. (2013) which recognise visual codes based on their topology rather than geometry which give users a great flexibility to create varying designs that are highly aesthetic and meaningful. The codes can be embedded in the images and they can be linked with mixed digital contents that can be revealed using machine-readable devices such as mobile phones.

Meese et al. (2013) found that designers were able to draw decorative patterns as artcodes to augment ceramic bowls and menus with digital contents in relation to the food preparation. The authors deployed the interactive ceramic bowls and menus in a Thai restaurant in London and they found that artcodes enhanced the dining experience of people (Meese et al., 2013). A further study by Benford et al. (2015, 2016) has shown that players were easily able to create and associate their own progressively personalised layers of digital contents with the Carolan acoustic guitar in order to augment it (Benford et al., 2015, 2016).

From this discussion, it seems that artcodes can address the issues with QR codes as well as to support all the three different types of visitors' participation in museums in an interactive and engaging way. Therefore, a promising research direction is to explore how artcodes can support different types of visitors' participation (consuming, interacting and creating content) in museums and galleries. Firstly, the visual appearance of artcodes may encourage visitors to reveal the associated digital contents behind them which might be useful for engaging visitors' participation through consuming contents. In addition, due to the different interactions that artcodes support, they can be used for engaging visitors to participate in interactive activities such as puzzles for exploring more information about museum artefacts. Furthermore, the process of drawing physical artcodes can promote visitor creativity to draw meaningful artcodes and create digital layer of contents for them in order to contribute to the interpretation.

The main research question of this thesis, therefore, is **how to enable different types of visitors' participation in museums and galleries using aesthetic visual markers?**

This question is going to be explored through three main practical studies that address the following sub-questions:

1. **How can visitors be enabled to interact with aesthetic visual markers to explore artefacts?**
    a. How can visitors be enabled to reveal digital layers of content about museum artefacts using aesthetic visual markers?
    b. How can visitors be enabled to access visitors' contributions using aesthetic visual markers?
    c. How can visitors be enabled to explore the relationships between museum artefacts using aesthetic visual markers?
2. **How can visitors be enabled to contribute content to the exhibition using aesthetic visual markers?**
3. **What is the role of curators throughout the process of visitors' participations?**

In the next chapter, the sub questions (a and c) of the first question will be answered.

Chapter Three: Exploring Visitors' Interactions with the Aesthetic Visual Markers –a System for Exploring Relationships between Artefacts

(The work in this chapter was presented as a full paper at the 2018 NordiCHI conference)

This chapter focuses on exploring the opportunities for involving visitors into two types of participation activities. First, to engage visitors to reveal and consume additional information about museum artefacts through scanning visual representations of the artefacts. Second, to engage visitors with the exhibits through a novel interaction of exploring the relationships between artefacts by physically manipulating visual representations of artefacts and scanning them to reveal the digital information about their relationships.

This chapter begins by providing a brief overview about the study's aim followed by reviewing the key related work about the technologies and techniques that have been used in museums to enable visitors to explore relationships between artefacts. Then, a particular focus is given to review the key literature about the technologies that have been developed for augmenting physical paper map with additional digital layers of information. The chapter then describes the design experience of the study followed by reporting the two pilot studies in which an iterative design experience was carried out to improve the design prototypes. The final user study then is described followed by reporting the main findings and the key discussion of the findings.

3.1 Study Overview

Information about museum exhibits has traditionally been presented to the visitor through interpretive labels. However, previous studies show that visitors often do not engage with text labels located on walls, or with printed materials (Hein, 2002; Knudson, Cable and Beck, 1995). Templeton (2011) suggests this might be because printed materials provide limited information, and in particular do not typically identify an artefact's relevance within a collection or its relationships to other exhibits.

For this purpose, digital technologies have been widely used for providing additional information about artefacts such as using audio guide and visual markers. Visual markers, usually in the form of QR codes, are most commonly used as this is a low-cost mechanism to overcome the space restrictions of text labels and enable the incorporation of multimedia (audio, video, animations) in an easily updatable form. QR codes allow visitors to reveal

digital contents about artefacts by scanning markers with their smartphone. QR codes can also be used to add more interactivity through playing games such as quizzes and treasure hunts. However, according to the researchers, visitor do not engage with QR codes because of the lack of the meaning, they are aesthetically less attractive and visitors need to shift their focus away from the artwork to scan them (Wein, 2014). In addition to these, representing relationships between museum artefacts can be more challenging through using QR codes.

Overall, representing additional information about relationships between artefacts in an interactive way, however, becomes more challenging for the museum even though there are some traditional mechanisms by which museums reveal exhibit relationships. Museums commonly utilise stands and display cabinets to show items from their collections; by grouping artefacts in separate displays, taxonomies can be made visible or comparisons enabled with respect to particular highlighted features (Knudson, Cable and Beck, 1995). However, physical arrangements are fixed, and thus typically present only the canonical order. Other approaches including direct questions to visitors to think about possible links between artefacts and write the answers on small papers. For example, the Comparisons, an exhibition that was developed by the Hirshhorn Museum and Sculpture Garden in USA, motivated visitors to find links between every two artefacts through asking them questions to think about the possible relationship between them and report their answers (The Comparisons, 1992).

Making exhibits interactive through the use of technology has the potential to enable more flexible, dynamic and richer presentations, e.g. revealing relationships according to different authoritative perspectives, or allowing visitors to curate their own taxonomies without disrupting the experiences of others. In the next section, a detailed review of the literature will be discussed in relation to the approaches that have been used in museums for viewing the relationships between artefacts.

3.2 Related work

There is a lot of previous work on the use of digital technology to allow museum visitors to access digital content about physical artefacts, including the use of mobile devices with visual markers (e.g., BeQRious, 2012), RFID (e.g., Semper and Spasojevic, 2002), GPS (e.g., Schnädelbach et al., 2006) and AR (e.g., Schmalstieg and Wagner, 2005). However, there are less systems that explicitly focus on revealing relationships between artefacts. From reviewing the literature, the main approaches that have been used for providing information

about artefacts that are linked to each other are categorised into two high level categories which are trajectory and overview as outlined below.

3.2.1 Trajectory

In this approach, visitors walk from item to item and their experience is tailored based on what they have seen so far and/or suggestions are made about related objects to visit. Thus, this approach usually involves exposing semantic relationships between artefacts as the visitor navigates the venue while adapting the experience based on context. An early representative example is ILEX (Oberlander et al., 1997), which generates labels for objects dynamically based on the expertise level of the user and what objects have already been seen. The aim was to deliver a more coherent and educational visit, that treats the exhibition experience as a conversation where links between exhibits are discussed.

HIPS (Oppermann and Specht, 1999), a later version of the system, also uses individual visitor's history to adapt the media, but additionally draws on a model of preferences and interests to present appropriate media and interesting relationships between exhibits. Kovalenko et al. (2015) developed Living Museum, a mobile tour guide application, for the British Museum in order to assist visitors to explore the linked objects in the museum by recommending relevant objects to visitors based on their preferences and movements. More recently, Gicquel, Lenne and Moulin (2013) tested a system that allows users to explore semantic links between artworks, while also engaging in pedagogical tasks set by teachers (or curators) (Gicquel, Lenne and Moulin, 2013). They suggest that the constrained tasks help learning, while the freedom to explore beyond the tasks is pleasing.

An alternative is the use of a portable object to enable visitor identification and to accumulate a record of the visit. This is exemplified in Assembling History project (Fraser et al., 2003) where RFID tagged paper clues were used to provide more information about objects and to enable visitors in making connection between their activities, the displays and the history of the museum. Overall, this class of systems provides visitors with support in large, complex museums where the information can be overwhelming by helping visitors gradually build up an understanding over the course of a visit.

3.2.2 Overview

In this approach, visitors can see an overview of (part of) the collection and manipulate items to discover relationships between them. This approach involves providing a central point where visitors can organise their visit to the museum, reflect on objects, or cooperate with other visitors to understand their experience of the museum collection. Examples of the former include the use of mobile devices to realise applications, such as recommender systems, and tagged portable artefacts, enabling visitors to accumulate a record of their visit and support their identification as they move around the site. To realise this, technologies such as interactive tabletop surfaces and AR installations could be used.

Examples of researches about overview approach include the study that was carried out by Ryall et al. (2004) as they developed an interactive tabletop, on which a large number of words were displayed to allow a group of visitors to collaboratively assemble words to create poems. On the other hand, the Combination Machine, part of the Retracing the Past exhibition (Ferris et al., 2004), enabled visitors to place objects, represented through RFID tagged keycards (with name and image of object shown on the card), together into a trunk, to reveal some fictional and some possible connections between them, thus priming visitors' imagination about objects. Another example was developed by museum staff using the ARTECT system, which allows visitors to move physical markers (QR codes) representing objects on a table, with sounds played whenever two objects were placed close together (Koleva et al., 2009). Such systems more explicitly focus on highlighting relationships between artefacts, and they seem to inherently encourage social interaction.

While the two mentioned approaches have their benefits particularly the overview approach as it allows direct comparison between objects and supporting collaboration, it has been underexplored in the museum domain, possibly because of the space and cost requirements of some of the technologies such as typical AR and tabletop installations. Therefore, to enable visitors to explore the possible relationships between artefacts, this chapter proposes a novel inexpensive approach, which involves visitors physically manipulating visual representations of artefacts and scanning with their mobile phone different groups or sequences of items in order to reveal digital information about their relationships. To explore this interaction mechanism, collaborations with a museum were taken place to develop an interactive paper map, on which visitors can place tangible representations of artefacts and scan the resulting arrangements. The detail of the study is discussed in the following sections.

3.3 Museum setting

For this study, an interactive installation was developed for the University of Nottingham Museum of Archaeology. The museum was established in 1933 when a Roman pottery specialist Felix Oswald donated a collection of findings from his excavations at the Roman settlement of Margidunum in Nottinghamshire. The museum is compact, consisting of one gallery of approximately 100m2. The majority of the museum objects are pottery and metalwork items that were used by local people. The collection ranges from the Palaeolithic to the post-medieval period, including some Bronze Age artefacts (Museum of Archaeology Collections, 2018).

The museum has 13 cabinets, each containing multiple artefacts that either share a common purpose (e.g. in figure 3.1 left- the artefacts are culinary), or a common era (e.g. figure 3.1 right). The museum employs printed descriptions and labels within display cabinets (see figure 3.1) to help explain the relationships, though the information is fairly limited and the museum has not previously used technology to enhance the presentation of artefacts. Visitors are encouraged to discuss the exhibits with volunteers or curators who are often stationed in the gallery.

Figure 3. 1 Cabinet showing individual artefact labels and a description of their common purpose (left) and cabinet with different artefacts from the Bronze Age (right)

During interviews, the museum curators expressed a desire to be more flexible in highlighting common purposes and time periods, and to reveal additional types of relationships, such as common geographical origins. The museum provides a printed map of the local area (figure 3.2) mounted on a wall. It is possible for visitors to refer to this map to contextualise the place names mentioned on labels, and to compare the places associated with artefacts, but

anecdotal evidence provided by the curators suggests that most visitors find this task complex or laborious.

Figure 3. 2 The regional map provided by the museum, showing place names, borders and rivers

Collaboration with the museum aimed to retain the physical organisation of the artefacts (and thus the canonical order presented by the curators), while introducing technology that allows visitors to explore alternative relationships between artefacts, including common purpose, time period and location of discovery/use.

3.4 Design of the interactive map

Reviewing the previous work highlighted the advantages of both trajectory and overview technologies, however the benefits provided by an overview approach aligned best with the setting of the museum. The compact nature of the museum means that visitor trajectories are short, and that a central installation is easy and quick to access. In addition, discussion between visitors and staff is encouraged within the gallery, and previous overview technologies have enabled and enhanced social interaction.

Responding to the museum's wish to allow visitors to explore multiple types of relationship between artefacts, including geographical context, it was decided to use the existing regional map (figure 3.2) as the basis for a prototype installation, and to extend it with interactive visual markers as a way of adding hidden layers of dynamic digital information that can be revealed by visitors who experiment by physically reconfiguring the map and markers.

Artcodes technology (Artcodes website, 2018) was used to represent artefacts on the map in which users can scan them to reveal the digital contents. The artcodes were drawn manually on separate pieces of card, and converted into codes, according to the procedure proposed by Meese et al. (2013), to be placed on the map manually by users. Figure 3.3 shows a visual artcode that is linked to a digital content about a sword. Furthermore, the technology also supports more complex spatial interactions where users can scan sequences or groups of related visual markers in order to reveal a digital narrative (as demonstrated in Thorn et al. (2016)).

Before going into the detail about the prototype of the artcodes, it is worth noting that a number of researchers used different technologies, such as AR and RFID, to enhance and augment paper maps since they provide fairly limited information. For example, AR has been used for augmenting paper maps with 3D digital contents to provide additional information about location in an interactive way. Morrison et al. (2011) developed a mobile AR map, MapLens, to augment a paper map with real time information about locations in which a magic lens was used over the paper map. The author found that the interface supported users collaboration and bodily configurations around the maps. Grammenos et al. (2011) also developed PaperView, an augmented reality tabletop map for a museum in Greece, to augment the physical surfaces of a map with digital layer of contents about cities using paper cards in which the map worked when visitors placed cards on the map and visitors highly engaged with the approach.

Other examples about researches that augmented static paper map with digital contents include (Bobrich and Otto, 2002; Fitzmaurice, 1993; McGee and Cohen, 2001; McGee, Cohen and Wu, 2000; Reitmayr et al., 2005). However, using AR technology is expensive and requires users to stay close to the physical objects to place a mobile phone camera or app on the physical objects to access digital contents which is not easy for people in public places. Other researchers used tags such as RFID, for augmenting paper maps and books with digital contents which can be revealed by using mobile phones with RFID reader (see Reilly et al., 2005; Rohs et al., 2007; Want et al., 1999). Reilly et al. (2006) developed Marked-up Maps, static paper maps, and augmented them with RFID tags where information about regions can be revealed by placing a handheld computer or mobile device, which are equipped with RFID, above each region on the map.

With all of these approaches, visitors are not involved in physical activities in order to reveal the digital contents about the paper maps while in this study, the author aims for enabling visitors' to interact with the paper map physically to explore the relationships between artefacts. The mechanism for supporting this is described below.

Figure 3. 3 An artcode sketched on a shape and colour-coded piece of card, representing a particular artefact

3.5 Design of the artcodes and the interactive map

For this study, 11 artefacts from the collection were selected and cards with artcode visual representations were created (e.g. figures 3.3 and 3.4). These artefacts were chosen to encompass a range of geographical origins, purposes, and eras, with some artefacts related in each case. For instance, two coins were chosen, which are similar in purpose and geographical origin, but from a different time period (figure 3.4); three pieces of pottery were also chosen which belong to the same time period but were manufactured in different ways using different materials (such as iron and clay) (figure 3.5).

Figure 3. 4 Visually similar artcodes that represent 2 coins (note the slight visual variation)

Figure 3. 5 Artcodes representing 3 potteries from the same time period but manufactured in different ways

In the study by Thorn et al. (2016), a large wall mural had artcodes permanently embedded within it, which could be scanned individually, in sequence or in groups. To meet the aim of allowing visitors to reconfigure and experiment with the map, the markers in the prototype were separate pieces of card that could be attached and detached from different positions on the map using Velcro. To encourage experimentation, a puzzle format (Maldonado, 1996) was mimicked: the artcode cards were cut into different shapes and these shapes were outlined on the map, hinting at the correct geographical locations for the artefacts. The borders of the cards and outlines of the shapes on the map were also colour-coded to further emphasise the suitable locations (figure 3.6).

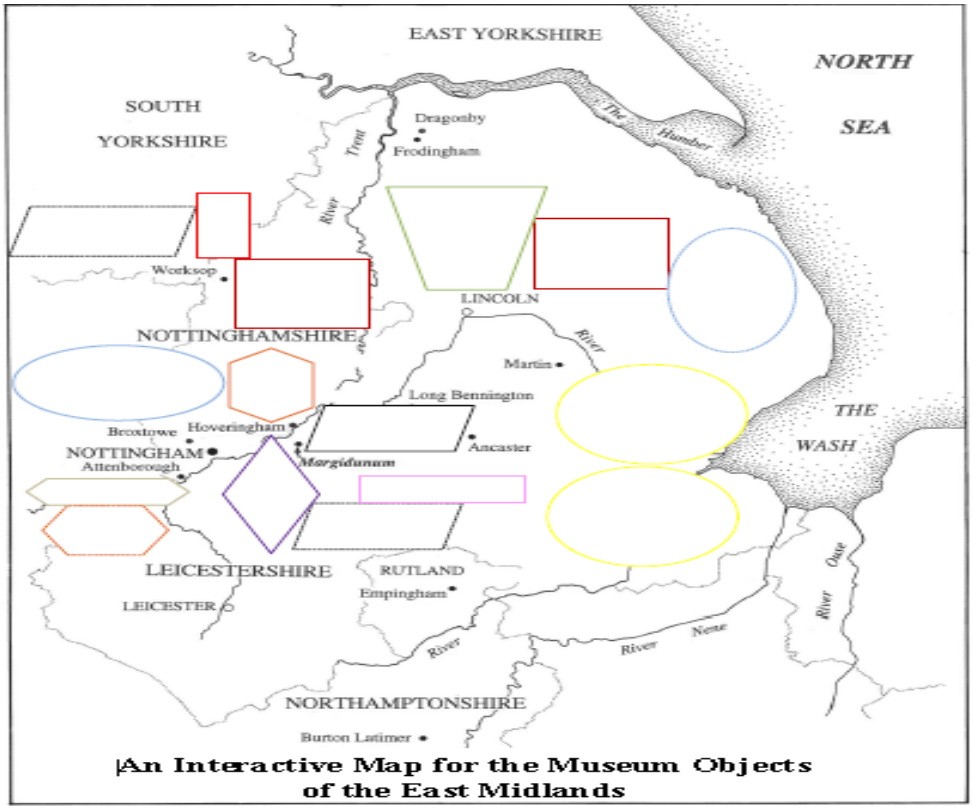


Figure 3. 6 The prototype map with the colour coding and different shapes

The installation was set up with all cards detached from the map and laid out on a nearby table (see figure 3.7) providing a visitor with several options for accessing digital content. Visitors might consider the shapes of the cards and artefacts represented on them, and think about their possible locations on the map before attaching one and then scanning it "on location". Alternatively, a visitor might ignore the map and scan a card as it sits on the table. In either case, scanning an individual card revealed background information about the artefact which presented in a text format supported with image of the artefact and/or image of the cabinet that includes the artefact. For example, scanning the "Mounted Warrior" card (figure 3.8 left) individually reveals the background information about it (figure 3.8 right).

Figure 3. 7 Table arrangement (left) All the cards on the table (right)

Figure 3. 8 "Mounted Warrior" card (left) Revealed digital content (right)

A visitor might also attempt to scan multiple cards. Scanning a group of cards *simultaneously,* if those artefacts were related by common purpose, would reveal information about that relationship. Figure 3.9 shows how the digital content link changes when two related cards are brought into the Artcode app's viewfinder simultaneously, from information about one particular coin (the "Hand of God coin") to information about how ancient coins in

general were manufactured and used. Note that a visual hint is overlaid on the bottom of viewfinder to indicate that one artcode is suitable for inclusion in a pattern group by showing the "+" sign (figure 3.9 left) and to show that a pattern group is complete (figure 3.9 right). A video content can be revealed by clicking on the digital content link on the app screen (figure 3.10).

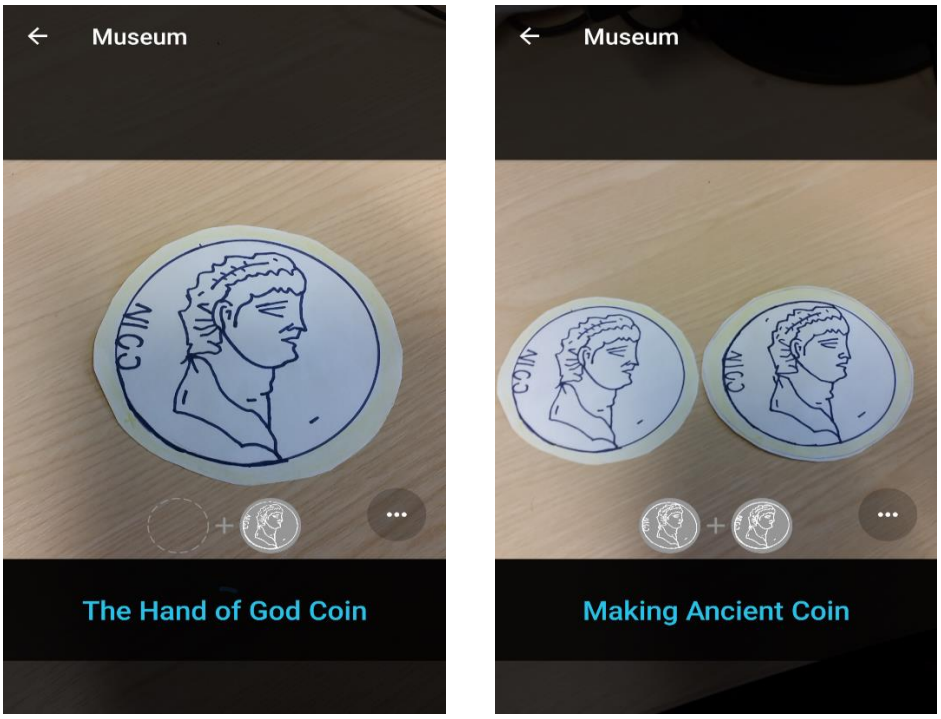


Figure 3. 9 One artcode forming the start of a pattern group (left), and scanning a second simultaneously to complete the pattern group (right)

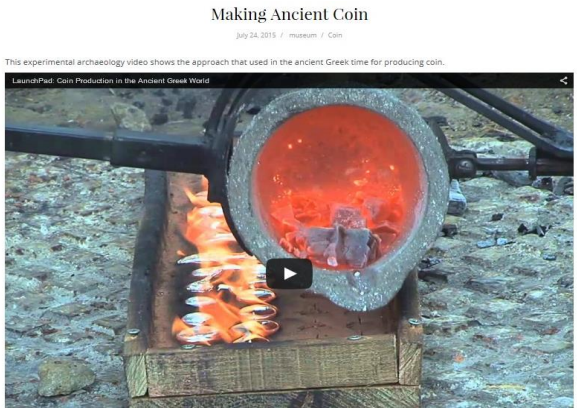


Figure 3. 10 Screenshot of an experimental archaeology video of making ancient coins

Scanning multiple cards *sequentially*, if those artefacts had a temporal relationship, would reveal information about that relationship. Figure 3.11 shows how the digital content link changes from information about one coin (the "earliest coin brought to Britain") when one card is in the viewfinder, to information about how coins changed from one era to the next.

Note that visual hints are also provided in this case, indicating when an artcode has been scanned that could be part of a pattern path by showing the ">" sign (figure 3.11 left), and when a pattern path has been completed (figure 3.11 right).

Figure 3. 11 One artcode forming the start of a pattern path (left), and moving to scan a second to complete the pattern path (right)

Using the 11 cards in the prototype, a user could create 8 valid pattern groups and 7 valid pattern paths (in addition to scanning all 11 individually). Therefore, there were 26 unique pieces of digital content that could be revealed. These took the form of text and images or audio and video. To guide visitors how to interact with the installation and how to scan particularly pattern groups and paths, printed instructions were provided on the reverse side of the cards in addition to providing hints on the app screen (+ and > signs: see figures 3.9 and 3.11).

This final design of the map, artcodes and digital content was reached after iteration in response to 2 two-hour pilot studies: one with 7 PhD students (4 male, 3 female, recruited from the author's University network) and another with 5 members of museum staff (1 male, 4 female) (figure 3.12). In both cases the participants were given a demo of how to interact with the installation using the Artcodes app, then observed for 30 minutes while they freely interacted with the installation, then were brought together for a 30-minute focus group.

The first pilot study with the PhD students revealed issues of the visual appearance of the map as it comprised a lot of information and the shapes were not colour coded. In addition, some of the participants had issues to know which artcodes can be scanned in pattern groups and paths. Responding to these two issues, the colour coding was added to both the paper map and the artcodes as well as the (+ and >) signs were used to appear on the screen viewfinder to support visitors in recognising pattern groups and paths further. The second pilot study with the museum staff conducted to test the refined prototypes with them and the findings revealed that the staff understood that the visual design of the map was interactive and they understood how to scan individual cards, as well as pattern groups and pattern paths. The results suggested that the iterative design process had improved the fundamental usability of the map, making it suitable for use in a research study.

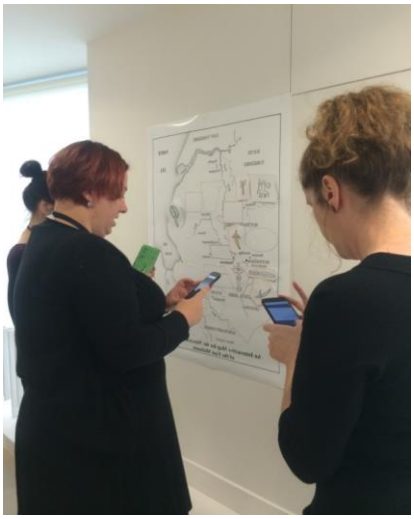


Figure 3. 12 Museum staff interactions with the digital contents

3.6 User study

The improved interactive map prototype was deployed in the museum in order to evaluate the technology in an authentic rather than a laboratory context, to increase the chance that the responses might resemble those by visitors in a real museum visit.

3.6.1 Participants

With the prototype installation situated in the museum, four studies were carried out with 16 participants (5 male, 11 female). The participants were recruited through adverts in the museum, the university email network, advertising through the university note boards, and using snowball sampling via the author's social media network. 6 of the recruited participants were individuals without social connections to other participants; the remaining 10 consisted

of two separate groups of friends. 7 participants were between 20-29 years old, 6 were aged 30-39, 2 were aged 40-49 and 1 was over 60 years old.

To provide a variety of social configurations for study, the participants were divided into four study sessions. In the first session, one participant was allowed to interact with the installation privately. The second session consisted of two pairs of friends (4 participants in total). The third session consisted of two pairs of friends and two unconnected individuals (6 participants in total). The fourth session consisted of two pairs of friends and one remaining unconnected individual (5 participants in total).

3.6.2 Method

At the start of a study session, participants were introduced to the research context and a short demo was provided by the author to explain how to interact with the map, artcodes and the mobile app. This demo highlighted the interactional possibilities, but no specific tasks were given to the participants. They were asked to complete a consent form and provided with smartphones, pre-installed with Artcodes app. The participants were allowed 1 hour to freely interact with the installation and with each other; participants were also encouraged to walk away from the installation into other parts of the museum if appropriate.

The interactions with the installation were continuously video recorded, using a fixed video camera placed a short distance away. In addition, photos were taken by the author whenever participants walked away from the installation, e.g. to look for artefacts elsewhere in the museum. After the session, there was a 1-hour focus group discussion, led by the author and starting with a round-table recap of what each participant did during their experience, that was recorded using a single fixed audio recorder.

3.6.3 Analysis

The video recordings of interactions with the installation and the (transcribed) audio recordings of the focus group discussion were analysed thematically (inductive) and coded to generate an understanding of what was seen to happen, combined with what participants thought and said about their experience. Inductive thematic analysis allows data to be analysed and create themes according to codes, rather than fitting data into pre-established themes (Boyatzis, 1998; Frith and Gleeson, 2004; Patton, 1990). The author began by coding audio and video with participant identifiers, which then made it possible to consider the sequence of interactions of each participant separately. The timelines were then segmented and coded first by what component of the installation (or wider museum) the participant

interacted with (incl. the construction of pattern groups and paths), then by any social interactions the participant was involved in. Finally, these codes were revisited and additional codes were added where the purpose of those interactions was apparent.

3.7 Findings

The analysis of the focus group audio recordings affirmed that the interactional possibilities of the installation were understood by the participants, despite the brief introduction provided to the participants and the novelty of the technology. Some participants related this to the meaningful aesthetic of the cards, e.g. P9 (female, 25) reported: "*an artcode actually is a picture; you relate that [picture] to the objects, so if you find a picture [you think,] 'ok definitely I am going to find information I want'.*" Some explained that the common visual signifiers of the map and cards encouraged them to affix cards to the map, e.g. P9 stated: "*I think the shapes work well because it's more visual, especially for children. I think shapes and colour are probably the best option*."

Others stated that the physical process of arranging cards and/or the aesthetic of the cards give hints about how the artefacts might be related, before even using the Artcodes app. For instance, P10 reported: *"The map does for both: you get information about the [individual] object, and then the relationship in terms of [other] objects."*

Although all participants appeared to understand the interactional concepts, they explored those possibilities in different ways. At a high level, the analysis focused on two categories of behaviour: **exploration of relationships between artefacts** in the museum collection, and **social collaboration between visitors** to the museum. Within these categories, participants expressed a range of distinct interaction strategies. These strategies highlight opportunities for improving and extending the design of museum installations, and for further research.

3.7.1 Strategies for exploring artefact relationships

Participants could reveal relationships between artefacts by simply placing cards on the map (revealing geographical relationships), or by physically configuring cards into appropriate groups or sequences and scanning them using the Artcodes app (revealing digital content about relationships in purpose and era). All participants created at least 5 pattern groups and/or pattern paths. The majority of participants (12 of 16) created more pattern groups than pattern paths, while one participant scanned an equal number of pattern groups and pattern paths (4 of each). In total, the participants scanned pattern groups 75 times and pattern paths 56 times.

Looking beyond these headline results, the analysis revealed that the participants differed in terms of whether they explored the cards before affixing them to the map, and in the extent to which they planned the physical configuration of cards and map in advance of using the Artcodes app. Three main strategies were identified:

3.7.1.1 Inspection

3.7.1.2 Strategic configuration

3.7.1.3 Experimental configuration

Each of these three strategies is explained in more detail with examples below.

3.7.1.1 Inspection

All participants began their experience by scanning an individual card to reveal background information about the individual artefact represented by the card. From the analysis, the author developed an understanding of a particular strategy of "inspection" that participants engaged in to familiarise themselves with the artefacts represented by the cards, before attempting more complex interactions later in their experiences.

7 participants' inspections began at the table where the cards were originally laid out. Of these, most went on to inspect further cards on the table, with one participant (P3 male, 34) spending 5 minutes scanning all cards one-by-one on the table (figure 3.13), systematically accessing the associated digital content (additional background information about each of the associated artefacts). Once P3 scanned all cards individually, he spent 3 minutes fixing all the cards to appropriate locations on the map (using the coloured shapes on the map as a guide) (figure 3.14) aiming to understand how all the artefacts were related geographically. Only then did P3 attempt scanning pattern groups and pattern paths (figure 3.15).

Figure 3. 13 P3 scanning cards on the table in an inspection strategy

Figure 3. 14 P3 fixing all cards on their corresponding shapes on the map, before forming pattern groups and paths

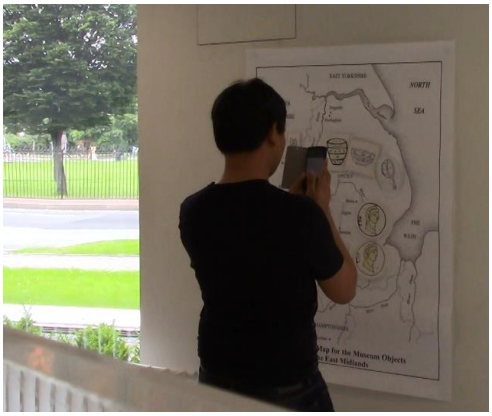


Figure 3. 15 P3 attempting scanning artcodes in pattern groups and pattern paths

Most participants undertook less exhaustive inspections of the cards, typically scanning 6-10 individual cards before attempting to form pattern groups or paths. P3's particularly exhaustive inspection behaviour might be expected: he was the lone participant in the first study session and so could interact at a pace that was comfortable to him. In the other sessions, participants had the pressure of sharing the space and cards with each other. In these sessions it was regularly observed individuals moving away from the map or table and resorting to inspection of individual cards in order to "give up their space" to other participants. For example, P11 (female, 62 years old) moved back from the map to scan cards that had been left on the table because the space near the map had become too crowded for her to comfortably interact with the artcodes on the map (figure 3.16). She continued to inspect individual cards at the table until the map became accessible. In the focus group P12 (female, 22) stated: "*There were more people on the map already so it is easier and quicker to [interact] on table. Otherwise I will use the map."*

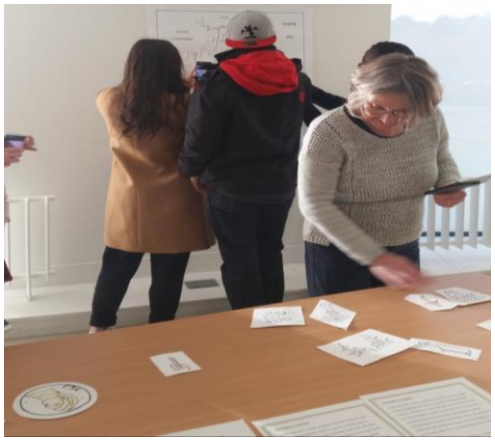


Figure 3. 16 While other participants crowd around the map, P11 retreats to inspect cards at the table

In these cases inspection was employed as a strategy to cope with the physical and social pressures of sharing the space, rather than to initially familiarise the participant with the digital content attached to the cards.

All participants carried out a form of inspection behaviour then progressed to exploring pattern groups and paths by either **strategic** configuration of the cards and map, or adopting an **experimental** approach to configuring the cards and map.

3.7.1.2 Strategic configuration

The analysis suggests that, as a result of inspection, some participants developed a clear model of how cards might be combined to reveal relationships. These participants identified commonalities in the artcodes (e.g. picking out several artcodes that visually represented weapons) or in the shape and border colour of the cards, and deliberately combined these cards on the map with an expectation of the relationship between the artefacts.

Two pairs of friends (P2-P5) exhibited strategic configuration behaviour particularly clearly. For these participants, inspection involved discussing the aesthetics of the cards to reach a consensus on how the cards might be grouped by common features. Once a consensus was reached, they fixed them to the map to form pattern groups and used the app to validate their choice. These two pairs formed pattern groups much more frequently (15 times) than pattern paths (8 times).

For participants who conducted strategic configuration, the in-app hints were used to **confirm expectations**. For example, P5 (female, 29) started her experience by placing a pair of cards on the map that matched shapes and were near to each other on the map; assuming that these were related, she then attempted to scan them as a pattern group and was rewarded by seeing the "+" hint on the app viewfinder to confirm that this was a valid pattern group, allowing her

to open content explaining the relationship. She repeated the same approach for another 3 groups of artcodes, before attempting to form any pattern paths (see figure 3.17).

A skew towards pattern groups is a characteristic of all participants that was identified as **strategic**: physically collecting cards with common features, then scanning them simultaneously is the quickest and simplest way to use the Artcodes app to check for a relationship. In the focus group, participants in general talked about instinctively thinking of artefacts in terms of groups, whereas valid pattern paths were explained by most participants as being more complicated to form, and the analogy of "sequences" of artefacts as more difficult to understand.

Figure 3. 17 P5 (in the left) placing a pair of cards on the map that matched shapes and were near to each other on the map (left and middle) followed by scanning them in pattern groups (right)

3.7.1.3 Experimental configuration

Five of the participants started their experiences straightaway by placing cards on the map without identifying cards that could be related to each other, and without physically collecting cards with similar features. Instead, their configuration of cards and map appeared arbitrary, and their interactions were characterised as **experimental** (figure 3.18). These participants did all reveal relationships between the artefacts, but this appeared to happen as a result of coincidence.

During experimental configuration of the map and cards, participants depended on the in-app hints to **guide** the process of trial-and-error, trying to form and scan pattern groups and pattern paths at an almost equivalent rate. Of the participants that were identified as experimental, valid pattern groups were formed 54 times, whereas pattern paths were scanned 44 times.

To summarise, three common types of behaviour identified that helped participants to understand relationships between artefacts. All participants began with a period of inspection, then adopted a strategic or experimental approach to configuration of the map and cards.

Some participants took a break, e.g. to avoid a crowd around the map or to walk around the museum to view physical artefacts, but usually returned to continue their adopted approach to configuration at the map. However, throughout the three strategies, it was noticed that when participants interacted with the digital contents of particular artefacts, the majority of them motivated to walk around the exhibition to find the actual physical artefacts (figure 3.19).

Figure 3. 18 P4 (right) placing cards on the map without identifying cards that could be related to each other and using the app to guide her whether the cards can be linked or not

Figure 3. 19 Participants walk in the exhibition to look at actual artefacts of the collection while interacting with digital contents

3.7.2 Strategies for collaboration

Although features of the installation were not designed explicitly to encourage social interaction, the analysis highlighted extensive social interaction between friends and unrelated participants. Behaviours such as cooperating and interrupting tasks, talking, smiling and gesturing to each other were regularly observed in the video, and described in the focus group. A particular category of social interaction – collaboration to understand and use the installation – was common, and within this category, three distinct strategies identified:

3.7.2.1 Sharing the interaction space

3.7.2.2 Adopting interaction roles

3.7.2.3 Sharing a reaction to the "reveal"

These strategies are explained in more detail below.

3.7.2.1 Sharing the interaction space

Three study sessions involved groups of 4, 5 and 6 participants, and in these cases the limited interaction space around the map encouraged the participants to develop a mechanism for sharing the space.

Two pairs of participants adopted a similar approach. They shared the space by dividing the map into halves, allowing a pair to interact with the map simultaneously, with each partner interacting with one half, then alternating to interact with the other. For example, two friends (P4+5) stood at either side of the map, roughly divided the available cards between them, and started fixing their cards on their side of the map. Staying on their sides of the map, each friend then scanned individual artcodes, and tried to form their own pattern groups and pattern paths. Once both were satisfied, they swapped sides. This behaviour happened because each of those participants wanted to have an individual experience to interact with the map in their own way.

Despite aiming to allow private interaction, this behaviour often evolved into collaboration. Among both pairs who divided the map, we noticed that partners intervened whenever they noticed each other trying to scan invalid pattern groups or pattern paths. For example, P4 (female, 43) (figure 3.18) intervened in P5's attempts to form a pattern group containing a "comb" card and "iron bowl". P5 said to P4 that she thought *"... if I put [any cards] together I can scan them."*, prompting P4 to explain how to look for the in-app hints and the shapes and colours of the cards and map to see whether such a configuration was possible.

Most participants were less formal about dividing the space, and tended to cooperate fluidly as a group to interact with the map. Earlier in Inspection, it was described how some participants retreated from the map to the cards at the table to avoid crowds. In the session of 6 participants, the physical movement of participants around the installation to share the interaction space was most obvious. Initially, this group attempted to allow each individual to carry out inspection, by taking turns to fix a card to the map and scan it, afterwards retreating to the table to allow room for others. However, this behaviour became less organised when the group wanted to move on to forming and scanning pattern groups and pattern paths, where a split between strategic and experimental participants become obvious. These

participants interacted with the map at a different pace, and the space around the map was sometimes monopolised by experimental participants (figure 3.20), while strategic participants retreated to collectively plan what pattern groups and pattern paths they hoped to scan.

Figure 3. 20 Experimental participants sharing the space

3.7.2.2 Adopting interaction roles

During the multi-participant study sessions, 10 participants were observed collaborating by assigning each other complementary roles. Most commonly, one participant would adopt the role of fixing cards to appropriate places on the map while others would scan the newly-fixed artcode. For example, two participants (P13+16) collaborated closely throughout their session: P13 almost always chose and placed cards on the map, while P16 waited to scan the cards that she placed (figure 3.21).

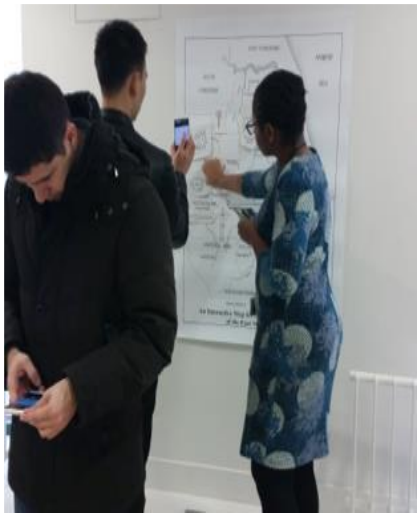


Figure 3. 21 P13+16 dividing roles of placing and scanning

In some cases such as P13+16, participants adopted specific roles for the whole session. In other cases, the analysis revealed that participants swapped roles, sharing the experience of

interacting with the installation from different perspectives. For example, P15 (male, 35) stated: "*I scanned few of the artcodes that she placed on the map and other time she was scanning the ones that I placed. I think it is a natural interaction of using one thing at the same time especially when trying scanning a group together*."

3.7.2.3 Sharing a reaction to the "reveal"

Members of the multi-participant sessions were regularly observed watching each other. However, particular situations piqued the interest of nearby participants, and encouraged more direct forms of social interaction.

Some of the content revealed by scanning artcodes contained audio (2) or video (6): participants were not asked to bring headphones to the study sessions, so audio was played loudly from participants' mobiles, usually attracting each other's attention. In the focus group discussion, participants highlighted the video content as a reason for their social interaction, and said that anticipation of sharing the "reveal" encouraged them to stay together and sometime to sit on the floor to focus on watching the video (figure 3.22). For related participants, interactions and digital content that could easily be shared were important. For example, P10 described the difficulty in keeping a large family engaged in a museum: "*If I am coming with my family we would like to share; the best part is the video, because everybody will be there, including the little one.*"

Figure 3. 22 Sharing the "reveal" encouraged participant to stay together and sometimes to sit on the floor to focus on watching the video

The relatively complex process of one participant forming and scanning pattern groups and pattern paths also created anticipation among bystanders, who would often wait to see if the participant was correct, and what content they would be rewarded with. Some bystanders would copy this demonstration to access the same hidden content for themselves. However, some participants were confused about how seemingly similar configurations of cards would reveal different content. For example, P10 and P7 shared the interaction space, forming pattern groups and pattern paths from the same configuration of map and cards. Having

apparently scanned the same cards as P7, P10 looked at P7's phone screen and asked "*How did you get the video*?". By retracing their actions, they determined that P7 had formed a slightly different pattern group that, to her delight, P10 then copied (figure 3.23).

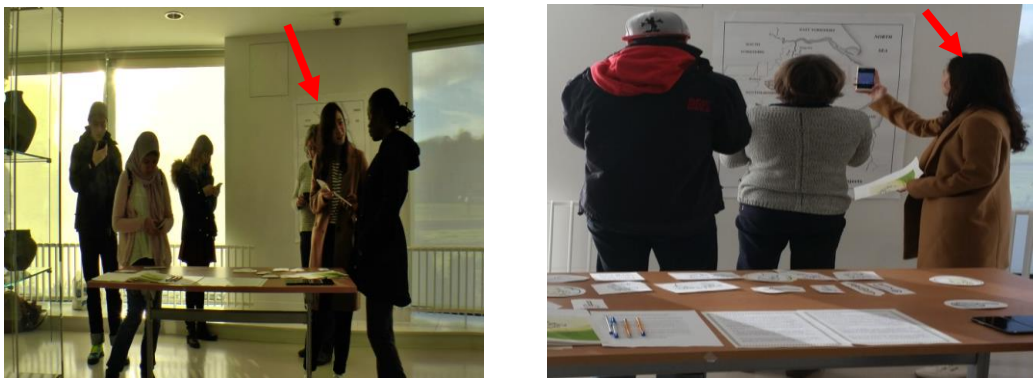


Figure 3. 23 P10 asked P7 how she obtained the digital content and, based on P7's explanation, P10 copied p7 scanning to obtain same digital content

3.8 Discussion

This study aimed to learn about the response of visitors to an installation designed to allow them to experiment with the relationships between exhibits. It was considered that the adopted overview approach worked well: participants developed understanding of relationships between artefacts and socially interacted with each other. The findings demonstrate that it is a good fit to this particular museum setting. In larger museums, an overview installation such as the map prototype of this study might be complemented by a trajectory based system to help visitors find the physical artefacts, and explore relationships further when they are away from the installation.

Furthermore, the findings provide insights into the benefits of combining physically-configurable interactive markers, a mobile scanning app and rich digital content.

3.8.1 Supporting individual differences in interaction

Previous literature shows that museum visitors have different preferences for exploring collections. The installation of this study was designed to give freedom in exploring relationships between artefacts. The findings show that participants pursued 3 distinct strategies. These results demonstrate some ways that future interactive installations can accommodate these differences.

Inspection was an important strategy that formed part of all participants' experiences helping them understand each artefact in detail. The digital content revealed during inspection gave participants extra hints about what relationships artefact might be a part of. It is suggested

that it is important to enable a phase of inspection as it supports the further exploration of artefact relationships.

In comparison to inspection, the installation encouraged a more active approach to understanding the relationships between artefacts. Both strategic and experimentation approaches motivated users to physically configure the cards by placing them on the map to explore the relationship between artefacts. This was appreciated by visitors, as P11 (female,62) summarised: "*Sometimes you can go around in places you know you are passive as a person just walking around whereas this feels much richer experience because you are going to take so much in different ways.*"

Benford et al. (2018) also highlighted the benefit of enabling users to physically configure artcodes stickers on a hybrid paper-advent calendar, to reveal digital contents about the calendar and allow augmenting the calendar with an additional layer of digital contents about Christmas that can be created progressively by the manufacturer, distributor, shops and consumer.

3.8.2 Overcoming barriers to engagement

However, engagement with physically configurable, interactive installations can also be problematic. In the prototype, revealing a relationship was typically a three-step process, involving scanning an artcode, placing the card on the map, then forming a pattern group/path. Visitors can encounter interaction barriers in each of these steps.

Step 1: interacting with a visual marker (artcode)

Previous studies of the use of QR markers show that people might not scan a QR code in the first place because they are not sure what it will do (Schultz, 2013; Wein, 2014); if they never scan a code, they can't begin to reveal a relationship. It is suggested that the interactive marker needs to reflect its purpose and the use of artcodes, in this study, appear to address this issue.

Step 2: configuring the markers and map

Colour and shape coding the borders of the cards and outlines on the map were essential in emphasising suitable locations and combinations. This feature emerged as a result of the first pilot as without it some participants were afraid to try creating pattern groups/paths. Design needs to constrain the possibilities for configuration, to convey that experimentation isn't endless and strategy is possible.

Step 3: confirming pattern groups/paths

Because people were confident in configuring the map, sometimes they created valid groups/paths, but most participants still relied upon the in-app hints to give them confidence and to understand why they were right or wrong. Positive feedback was successfully designed, but overlooked negative feedback. P1 (male, 34) suggests the need for explaining what went wrong or what artefacts are not related:

"*There should be information because there is no point to continue scanning if they are not related because I was still holding."*

Regarding scanning in pattern groups and pattern paths, it was discovered that participants used the pattern group option the most. This result might be because the design of the interactive map encouraged people to move the artcodes around and group them together to take pictures of them. Thus, it is concluded that the pattern group mechanism is a more natural form of interaction for this study design. This finding differs from the study reported by Thorn et al. (2016) where pattern paths were used more frequently than pattern groups. This result arose, because the designers of the study materials had embedded the artcodes statically in a large illustrative display, so they were not movable, making pattern paths a more natural interaction to explore. In addition, it is important to consider that pattern paths scanning require visitors to move from one artcodes to other(s) which may result in making issues of moving freely particularly if the space is crowded.

3.8.3 Importance of social interaction

A lot of social interaction was observed, even though some of participants did not know each other. The design was not targeted to enable specific types of social interaction. However, as previous studies show, public displays/installations that allow a group of people to gather round and afford the "entry and access points" that was identified by (Hornecker, Marshall and Rogers, 2007) motivate and attract more people to join in and maximise the opportunity for social experiences (Brignull and Rogers, 2003; Izadi et al., 2005; Snibbe and Raffle, 2009). The overlapping between visitors that may happen around an installation/display can influence visitors' engagement with the installation/display furthermore (Marshall et al., 2011; Peltonen et al., 2008). The findings reveal 3 different strategies for collaboration and the associated benefits.

As it was highlighted already by Vom Lehn, Heath and Hindmarsh (2001), visitors observed others to understand how to use the installation. Even with all the hints in the app, described

in the previous section, some participants still preferred to/relied upon learning from others through observing others thus they became as spectators (Reeves et al., 2005b). Social interaction also helped people to access more of the content. In this study, participants interacted with one another to understand why they revealed different relationships (see Strategies for Collaboration). Without this sort of interaction, these participants may have missed out on this extra content. This is particularly useful for visitors who are driven to maximise their experiences (to "complete" the installation). Generally speaking, it is useful to encourage social interaction as a means of ensuring that visitors access as much of the hidden digital content as possible.

Future research can explore how further opportunities for social interaction can be designed in to ensure that these benefits are realised. For example, in-app hints could be provided to bring people together who are working towards similar pattern group/paths. However, interactive systems should be designed in a way to enable visitors to have control over their experience to select whether they wish to interact individually or with others and whether they wish to complete all activities or a subset.

3.9 Conclusion

In this chapter, the design and study of a physically configurable map, which allows museum visitors to explore relationships between artefacts were discussed. The findings showed that participants engaged in different strategies for exploration of relationships between artefacts in the museum collection (inspection, strategic and experimental configuration), and for social collaboration (sharing the interaction space, adopting interaction roles and sharing a reaction to the "reveal"). Subsequently, the benefits of supporting individual differences in interaction, overcoming barriers to engagement and encouraging collaboration highlighted. Thus, this chapter has met its aim about the mechanism to enable visitors' participation in museums through using aesthetic visual markers in order to enable visitors to consume content (research question 1-a) and to involve them in interactive activities (research question 1-c). Therefore, the next goal will be to involve visitors in more advanced participation activities through enabling them to create own hybrid contents and how subsequent visitors will engage with them which will be addressed in the next chapter.

Chapter Four: Exploring Consumption and Content Creation through Aesthetic Visual Markers

(The work in this chapter was presented as a full paper at the 2018 DIS conference)

Museums and galleries are increasingly engaging visitors with their exhibitions and contents through enabling them to consume content, involve in interactive activities such as game and to contribute to the exhibition through creating own contents. For this purpose, visual markers, usually in the form of QR codes, are most widely used as this is a low-cost mechanism to overcome the space restrictions of text labels and support multimedia contents in an easily updatable form. QR codes can also be used to enable visitors to contribute to exhibitions by sharing their own stories and feedback (e.g: Bailey-Ross et al., 2012; Imperial War Museum, 2012; Speed and McDonald, 2013; Tales of Things, 2017; Whitehead, 2012). However, visitor engagement with QR codes in museum settings can often be low with the aesthetic appearance, ease of use, enjoyability and distance identified as the main contributing factors (Schultz, 2013; Wein, 2014) as well as visitors cannot customise QR codes.

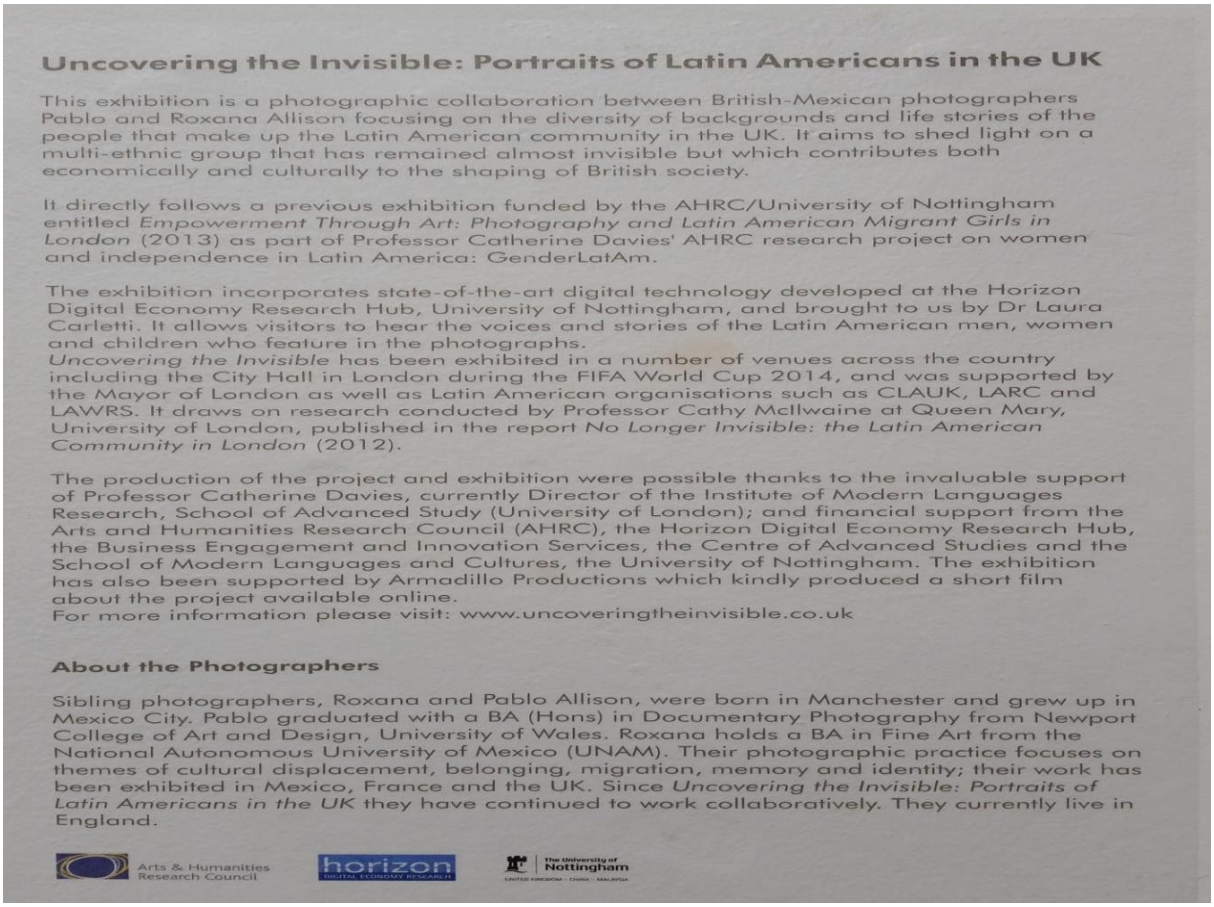
This chapter, therefore, explores the application of artcodes to support visitors' participation through consuming and creating content. More specifically, this chapter aims to explore the application of artcodes visual makers as labels for photographic portraits, exhibited in an art gallery, to provide complimentary information in a form of audio recordings in order to explore how visitors engage with these artcodes where the codes can be designed to be more aesthetic and meaningful. In addition, the chapter explores artcodes as a mechanism for enabling visitors to contribute their own reflections to the exhibition by drawing a marker and linking it to an audio comment as previous researches have shown that people can easily understand the drawing rules and create interesting designs (Meese et al., 2013; Thorn et al., 2016). Visitors' hybrid contributions were then displayed within the exhibition space in order to find out how subsequent visitors engage with them versus their interactions with the official markers.

The chapter describes the study approach, setting and study procedure to explain the main methods used for recruiting participants and how the collected data was analysed. The chapter then demonstrates the main findings of both using artcodes as a label for providing

more contents and as a mechanism for contributing to the exhibition followed by discussing the key findings in relation to the literature.

4.1 Study overview

For this study, it was decided to augment the "Uncovering the Invisible" photography exhibition, which was due to be displayed at the Nottingham Lakeside Arts gallery (figure 4.1). Created as a collaboration between British-Mexican photographers Pablo and Roxana Allison, it focuses on the diversity of backgrounds and life stories of the people that make up the Latin American community in the UK[2], representing them in 22 portraits (figure 4.2). Each portrait presents a photograph of a person and a label with a short description about them. In addition, audio recordings were available of the migrants featured in the photographs talking about their experiences of living in the UK.



Uncovering the Invisible: Portraits of Latin Americans in the UK

This exhibition is a photographic collaboration between British-Mexican photographers Pablo and Roxana Allison focusing on the diversity of backgrounds and life stories of the people that make up the Latin American community in the UK. It aims to shed light on a multi-ethnic group that has remained almost invisible but which contributes both economically and culturally to the shaping of British society.

It directly follows a previous exhibition funded by the AHRC/University of Nottingham entitled *Empowerment Through Art: Photography and Latin American Migrant Girls in London* (2013) as part of Professor Catherine Davies' AHRC research project on women and independence in Latin America: GenderLatAm.

The exhibition incorporates state-of-the-art digital technology developed at the Horizon Digital Economy Research Hub, University of Nottingham, and brought to us by Dr Laura Carletti. It allows visitors to hear the voices and stories of the Latin American men, women and children who feature in the photographs.
Uncovering the Invisible has been exhibited in a number of venues across the country including the City Hall in London during the FIFA World Cup 2014, and was supported by the Mayor of London as well as Latin American organisations such as CLAUK, LARC and LAWRS. It draws on research conducted by Professor Cathy McIlwaine at Queen Mary, University of London, published in the report *No Longer Invisible: the Latin American Community in London* (2012).

The production of the project and exhibition were possible thanks to the invaluable support of Professor Catherine Davies, currently Director of the Institute of Modern Languages Research, School of Advanced Study (University of London); and financial support from the Arts and Humanities Research Council (AHRC), the Horizon Digital Economy Research Hub, the Business Engagement and Innovation Services, the Centre of Advanced Studies and the School of Modern Languages and Cultures, the University of Nottingham. The exhibition has also been supported by Armadillo Productions which kindly produced a short film about the project available online.
For more information please visit: www.uncoveringtheinvisible.co.uk

About the Photographers

Sibling photographers, Roxana and Pablo Allison, were born in Manchester and grew up in Mexico City. Pablo graduated with a BA (Hons) in Documentary Photography from Newport College of Art and Design, University of Wales. Roxana holds a BA in Fine Art from the National Autonomous University of Mexico (UNAM). Their photographic practice focuses on themes of cultural displacement, belonging, migration, memory and identity; their work has been exhibited in Mexico, France and the UK. Since *Uncovering the Invisible: Portraits of Latin Americans in the UK* they have continued to work collaboratively. They currently live in England.

Arts & Humanities Research Council horizon The University of Nottingham

Figure 4. 1 Description of the "Uncovering the Invisible" exhibition

[2] http://www.uncoveringtheinvisible.co.uk/about-the-project

Figure 4. 2 Placement of the portraits and markers in the gallery

This presented the author with an opportunity to explore the use of more aesthetic and meaningful visual markers as a mechanism for visitors to access the voice of each person featured on a portrait. Thus, 12 of the 22 portraits were augmented with artcodes to trigger the associated audio recordings. The markers were created by a professional designer to represent the maps of the countries where the people came from. Figure 4.3 shows two examples and figure 4.2 shows their placement. In terms of the Artcodes app, a publicly available version was used (artcodes website, 2018), which allows experiences to be created by specifying a set of codes and linking each one to a URL. An experience of the "Uncovering the Invisible" was defined in the Artcodes app and linked each of the 12 codes to the corresponding audio file on YouTube (where the voice recordings were already publicly available). By using the app and scanning an artcode while browsing the exhibition, visitors could access the associated audio (see figure 4.4).

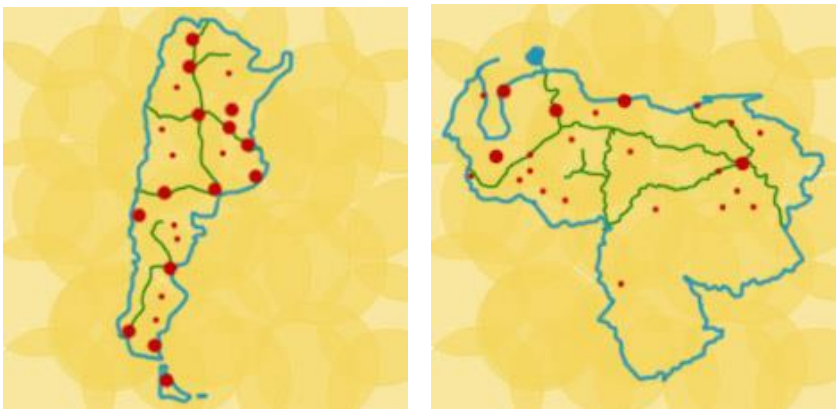


Figure 4. 3 Artcodes representing the maps of Argentina and Venezuela

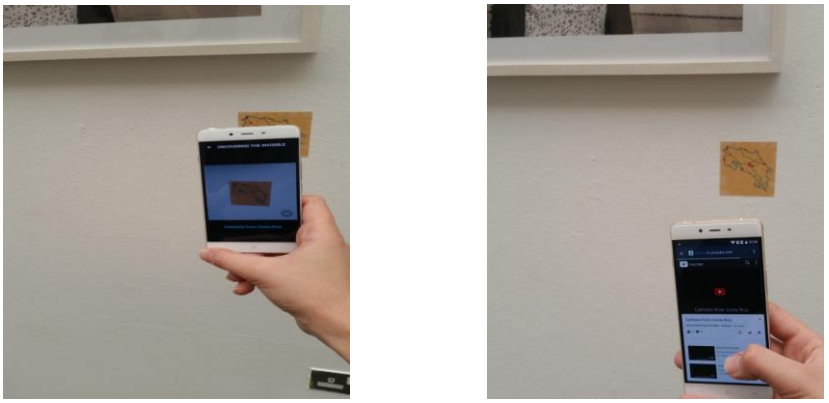


Figure 4. 4 Scanning an Artcode label (left) and voice recording on YouTube (right)

In addition to augmenting the exhibition with artcodes, gallery staff and the photographers also saw the benefit of enabling the visitors to contribute to and grow the exhibition by sharing their own stories of life in the UK and reactions to the portraits. This enabled the author further to explore how visitors would engage with a visual marker technology, which allows them to design the visual appearance of the marker as well as the digital content it links to, and then how subsequent visitors interact with these additions to the exhibition. The drawing approach of artcodes promotes visitor's creativity and previous research has shown that the rules are easy to understand and follow, with a variety of interesting designs created (Meese et al., 2013; Thorn et al., 2016).

The app also supports participants in drawing their own artcodes and linking this to digital content. To create their own drawing, which incorporates a valid code, visitors could use the Artcodes app functionality for testing (figure 4.5, left), which highlights the detected regions and displays the code. They could record their audio comment through an audio recording app on the smartphone and then upload it in the Artcodes app, associating it with an artcode (figure 4.5, right) either by manually writing the code or scanning the picture (which automatically detects and displays the code). The user could choose to share their contributions publicly or with selected people through SMS or social media (the audio file is uploaded on to a server in either case).

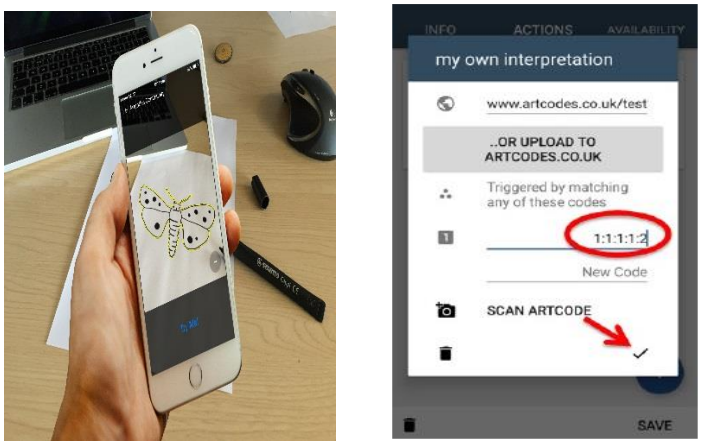


Figure 4. 5 Testing an artcode (left) and associating an audio file with a code (right)

4.2 Study approach, setting and study procedure

4.2.1 Study approach and setting

Overall, the study followed the UCD approach to involve visitors in the process of designing the contributions in "in the wild" (Crabtree et al., 2013) in order to investigate visitors' behaviours, engagements and challenges with artcodes in a natural way out of the lab setting. The study was carried out, as described above, at the Nottingham Lakeside Arts gallery where the "Uncovering the Invisible" photography exhibition was displayed in the Wallner gallery, a small and open gallery next to the café. The Lakeside Arts gallery is a public gallery where it is located at the University of Nottingham and it runs a number of different programmes including exhibition, workshop, performance and talks annually for adults, children, family and school children. In addition, the gallery has a friendly environment that consists of exhibitions, workshop halls, meeting rooms and a cafe for people to sit and relax.

4.2.2 Study procedure

4.2.2.1 Participants

Participants were recruited by advertising through the mailing lists and websites of the Nottingham Lakeside Arts gallery and the University of Nottingham Mexican society, as well as on physical notice boards around the University. 28 participants (11 male and 17 female) took part in the study and they were originally from different countries such as the UK, India, Malaysia and Africa. Of these 14 were aged (20-29), 11 (30-39), 2 (40-49) and 1 was over 60 years old. Participants came in groups of 2 or 3 friends apart from 4 who came alone. Only one of the participants was already familiar with the Artcodes technology.

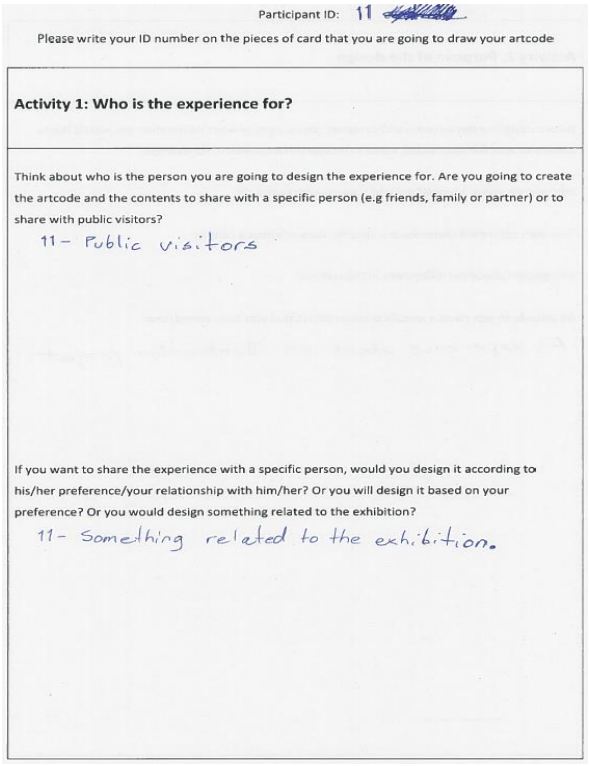
4.2.2.2 Study Structure

The participants were split across 4 evaluation sessions each lasting approximately 2 hours. On arrival participants were briefly introduced to the exhibition, the aims of the study and the app (although they were not taught how to use it), asked to complete a consent form and provided with smartphones, pre-installed with Artcodes app and connected with headphones. Then there were two distinct phases. The first part (around 40-50 minutes) involved the visitors freely exploring the exhibition (with the author available to offer assistance if needed), which after the first evaluation session also included contributions by visitors (figure 4.6). This was followed by a focus group to discuss their experiences and views on augmenting exhibits with visual markers like artcodes.

Figure 4. 6 Exhibition of visitor contributed markers

The second phase began with a demonstration of how to draw artcodes and how to use the Artcodes app to create their own hybrid artefact comprising a visual code and audio recording (figure 4.7). Participants were then provided with a worksheet to structure their creation process into the following sequence of activities: identify the aim of the artefact and who it is for (public, for specific people or private), plan the artcode design and digital content and reflect on why they have been chosen, draw the code, record the audio, create the experience in the app and finally share it (see figure. 4.8). For drawing artcodes, paper and marker pens were provided and for recording the audio, recording app was already downloaded on the smartphones and an interface was integrated in the app for playing the audio contents (figure 4.9). The main steps for creating an experience in the app are presented in figure 4.10.

Figure 4. 7 Participants are given a demonstration



Participant ID: 11

Please write your ID number on the pieces of card that you are going to draw your artcode

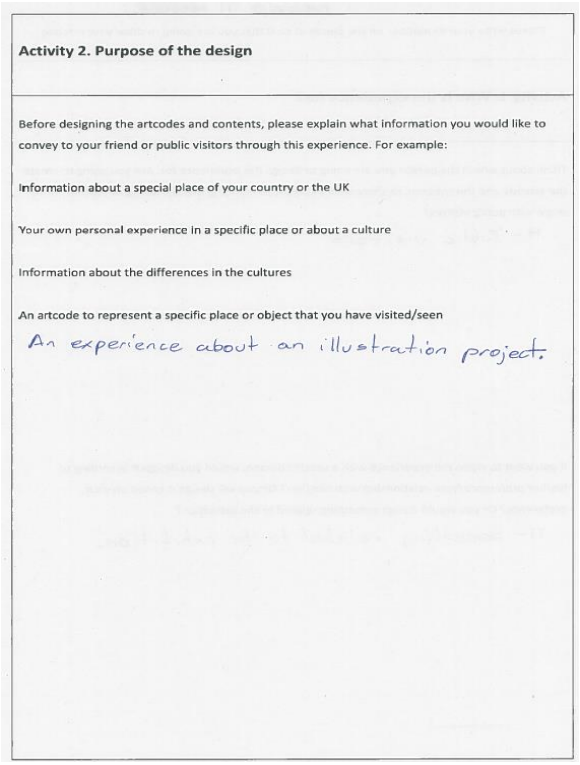
Activity 1: Who is the experience for?

Think about who is the person you are going to design the experience for. Are you going to create the artcode and the contents to share with a specific person (e.g friends, family or partner) or to share with public visitors?

11- Public visitors

If you want to share the experience with a specific person, would you design it according to his/her preference/your relationship with him/her? Or you will design it based on your preference? Or you would design something related to the exhibition?

11- Something related to the exhibition.



Activity 2. Purpose of the design

Before designing the artcodes and contents, please explain what information you would like to convey to your friend or public visitors through this experience. For example:

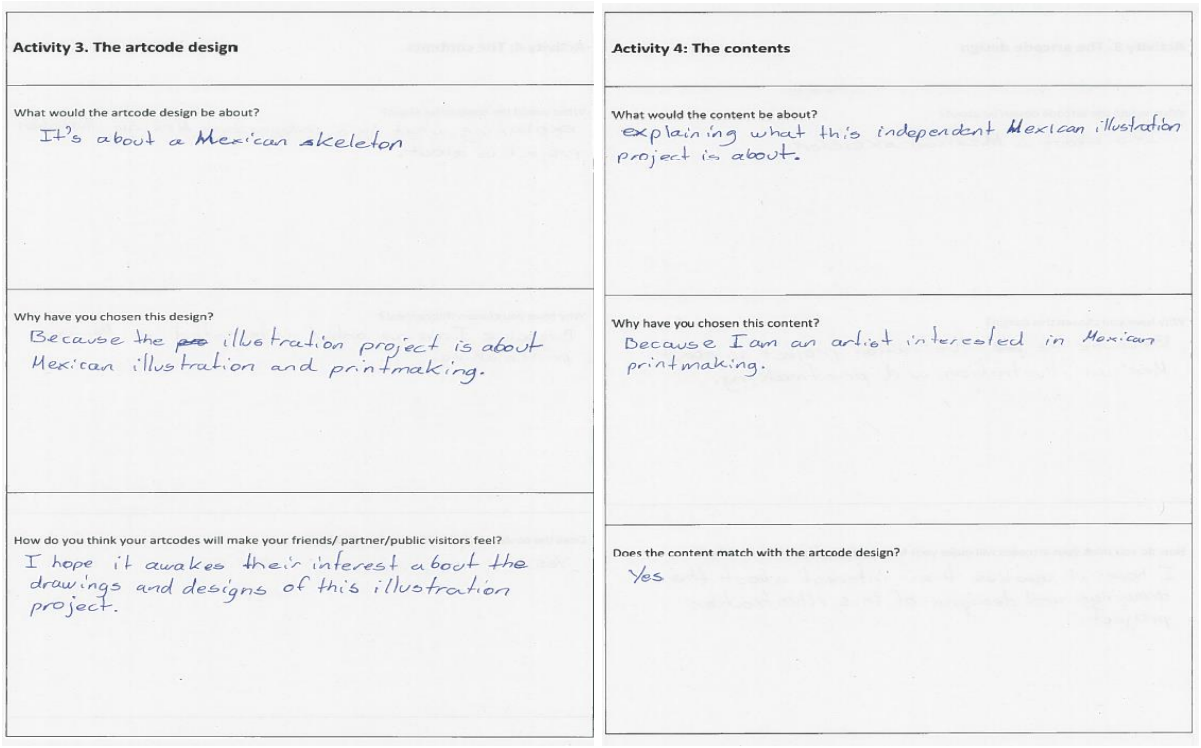
Information about a special place of your country or the UK

Your own personal experience in a specific place or about a culture

Information about the differences in the cultures

An artcode to represent a specific place or object that you have visited/seen

An experience about an illustration project.



Activity 3. The artcode design

What would the artcode design be about?

It's about a Mexican skeleton

Why have you chosen this design?

Because the ~~pro~~ illustration project is about Mexican illustration and printmaking.

How do you think your artcodes will make your friends/ partner/public visitors feel?

I hope it awakes their interest about the drawings and designs of this illustration project.

Activity 4: The contents

What would the content be about?

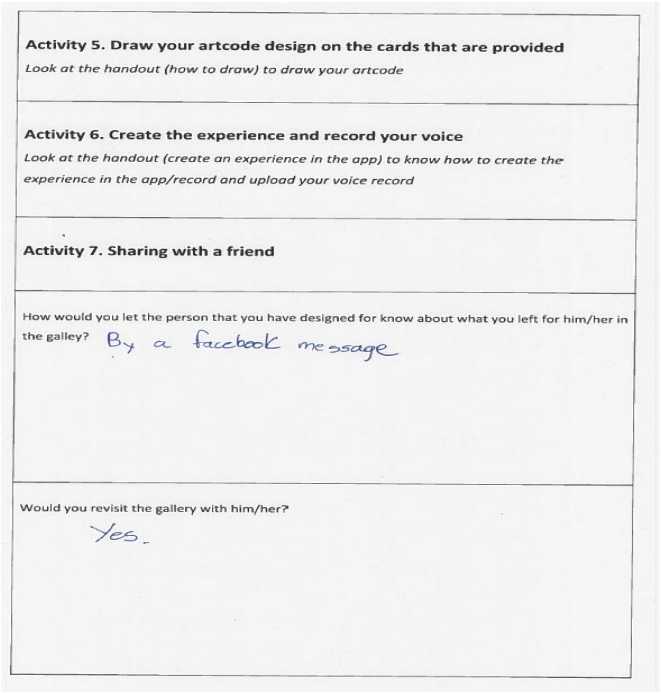
explaining what this independent Mexican illustration project is about.

Why have you chosen this content?

Because I am an artist interested in Mexican printmaking.

Does the content match with the artcode design?

Yes



Activity 5. Draw your artcode design on the cards that are provided

Look at the handout (how to draw) to draw your artcode

Activity 6. Create the experience and record your voice

Look at the handout (create an experience in the app) to know how to create the experience in the app/record and upload your voice record

Activity 7. Sharing with a friend

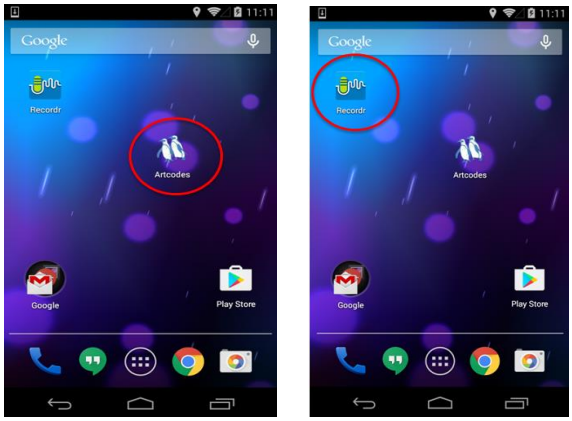
How would you let the person that you have designed for know about what you left for him/her in the galley? By a facebook message

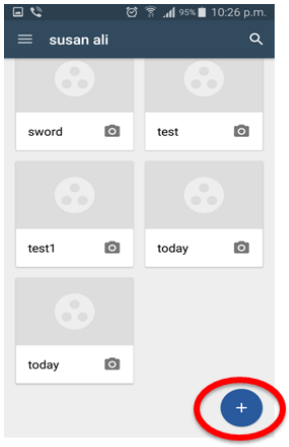
Would you revisit the gallery with him/her?

Yes.

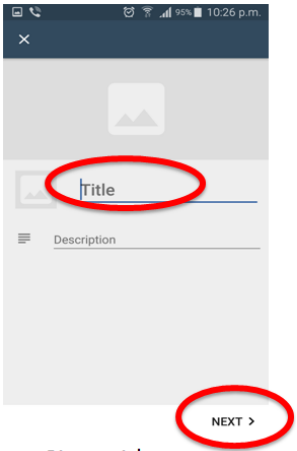
Figure 4. 8 Worksheet for structuring creation process

Figure 4. 9 Interface for playing visitors audio contents

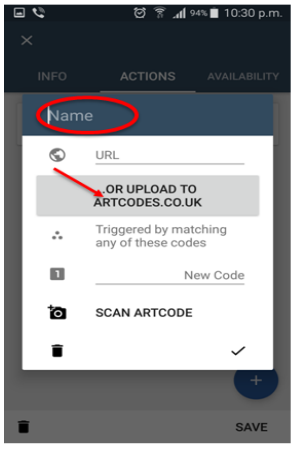




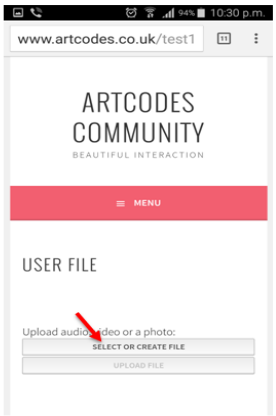
Click on the + sign to create your own experience



Give a title to your experience then click Next



Give a name to your code and then click on “Or upload to artcodes.co.uk



Click on “Select or create file”

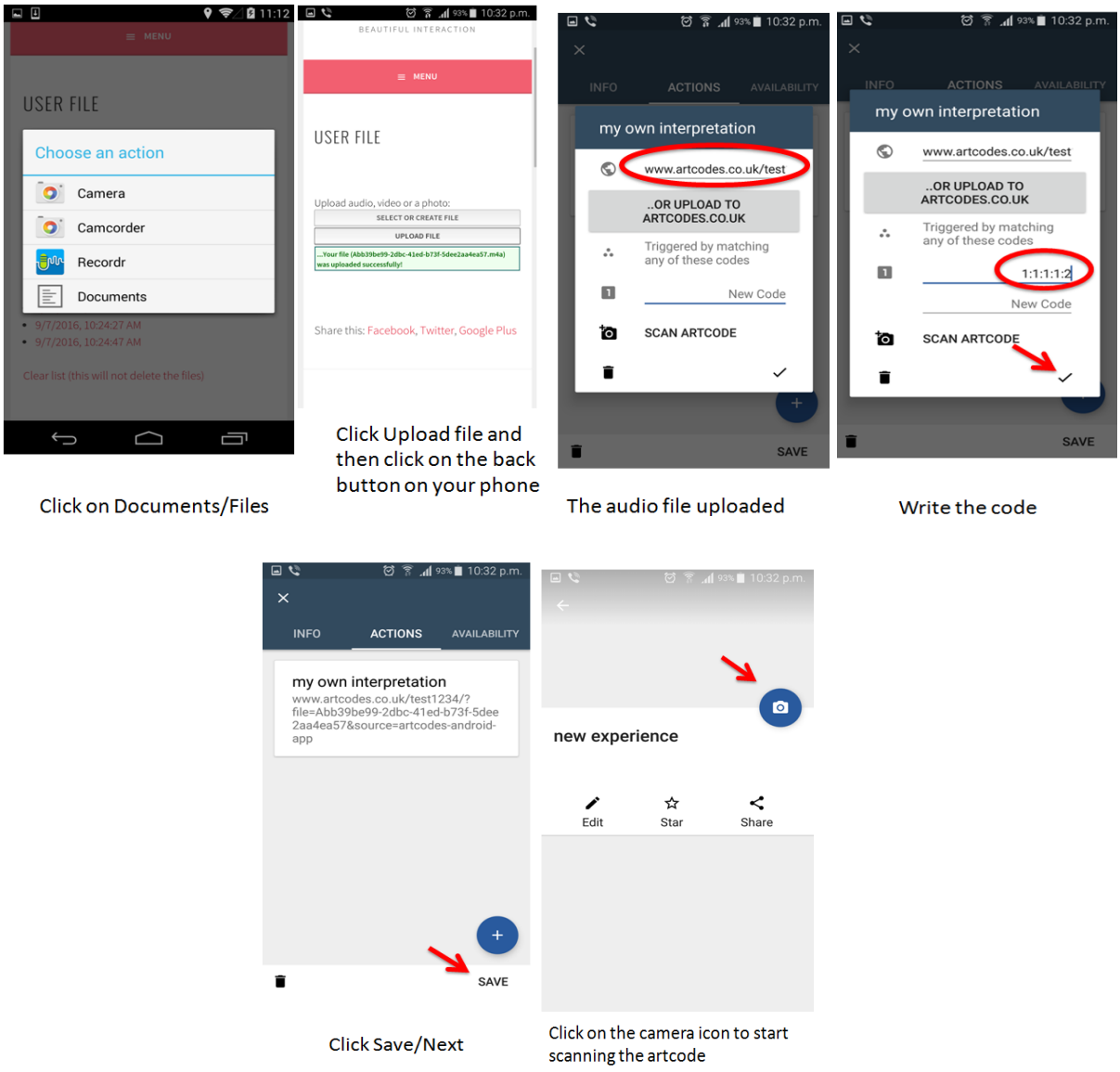


Figure 4. 10 Steps of creating an experience in the Artcodes app

Then a focus group session was carried out with the participants to gather feedback on how they felt about contributing to the exhibition in this way. After the first evaluation session ran, however, it was found that participants spent a lot of time on drawing and experimenting with different artcode designs. Consequently, even though they had all planned appropriate digital content (based on the worksheets), 11 out of 16 (that took part in the first evaluation session) only recorded audio as a means of testing that they had a working experience (e.g. “Hello” or “Testing”). The author contacted these participants to ask them if they would like to send the planned recording, so that it could be included in the exhibition and seven of them provided this. For the remaining sessions, the author swapped the order of drawing and recording audio, to check if this would make a difference and indeed, all subsequent participants made meaningful voice recordings. The hybrid artefacts were checked by the

author then they were added to the exhibition space after each session for subsequent visitors to explore (see figure 4.6). The choice of exhibiting all visitor contributions on one wall was made by the gallery staff who wanted to retain curatorial control of the presentation of the portraits.

4.2.3 Data capture and analysis

Using naturalistic observation allowed the author to collect data through field notes, photographs, video recording of the visitors' interaction with the exhibition in phase 1 (a video camera was placed in a corner of the gallery (see figure 4.11)), audio recording of the focus group sessions and the completed worksheets. The video recordings were qualitatively analysed to understand how visitors interacted with the artcodes accompanying the portraits and those created by previous participants, as well as with each other. The audio recordings of the focus group sessions were transcribed and thematically analysed through an active and reflexive process (Braun and Clarke, 2006). Data from the phase one focus group was used to complement observations with what participants' said about their interactions. Data from the phase two focus group, information provided in the worksheets and observations of this phase were combined to build a picture of what visitors created and why.

Figure 4. 11 Video camera positions

4.3 Findings

The analysis focused on the role of the visual markers in enhancing the visitors' experience of the exhibits. It is important to know how the visitors engaged with the markers, photographs and associated digital media. In addition, to know how the capabilities of the markers could be used to extend the experience beyond passive consumption to involve participants in a creative process to convey their reflections as part of the exhibition.

In the following sections, the main findings about the first phase of the study will be reported which is visitors' engagement with the exhibition and markers followed by the second phase which is designing the user generated hybrid artefacts.

4.3.1 Engagement with the provided exhibits and markers

Participants' experiences were broadly structured around three distinct phases. An initial engagement with the photograph and artcode was followed by scanning the code and then a longer engagement with both the photograph and digital content. After the initial brief engagement, all 28 participants scanned all 12 artcode labels that had been provided. The scanning phase raised a number of issues that were often manifest in terms of the physical position of participants and markers. Uncertainty in code recognition led to users reconsidering the best position and distance to scan the image. For example, delays in recognition for two markers made some participants unsure about the best distance to scan from. They were observed stepping back and forth while scanning and in the focus group P9 (female, 20-29) reported:

"*It seems that it will scan when focus like camera so you try to help camera to focus image so that is why*."

P17 (female, 20-29) also stated:

"One drawback is the speed of scanning there should do something in programming that will enhance the speed because people won't have much patient."

This was clearly noticed in the video session, for example, the episode below illustrates one of the participants trying to scan one artcode for a few minutes but it was not being recognised by the app which led him to stop scanning it.

A (annotated with red-arrow): started to scan an artcode (figure 4.12a).

After 40 seconds of waiting, he moves closer to scan the artcode (figure 4.12b).

After waiting around 50 seconds, the participant disengaged with the artcodes and turned left to find another artcodes to scan (figure 4.12c).

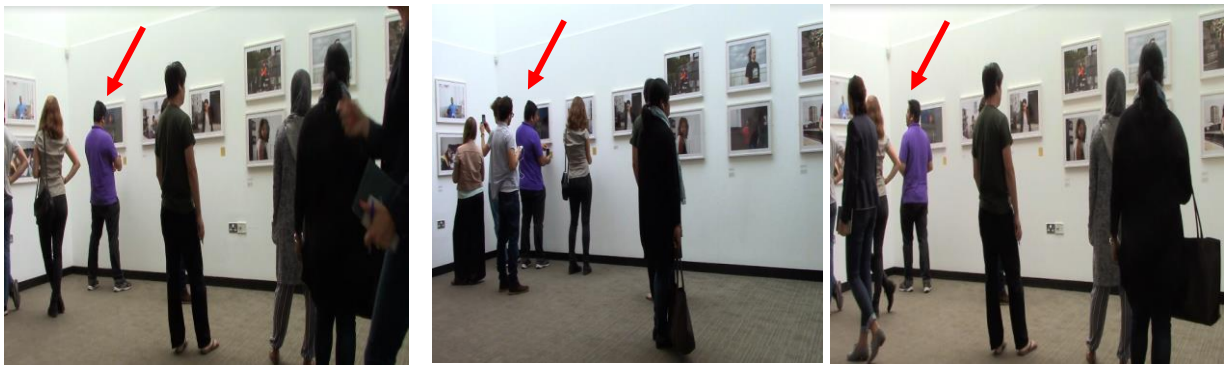


Figure 4. 12 a-c The participant is trying to scan one artcode for a few minutes but it was not being recognised then he stopped scanning it.

Positioning was also another significant issue in another way. The physical markers were placed in relation to the photographs being exhibited, with the photographs being the focus for visitor engagement rather than the markers. As a result, markers that were placed lower could also be more challenging to scan in terms of finding an appropriate position to hold the phone (see figure 4.13).

Figure 4. 13 Participants trying to scan labels

Once participants had successfully scanned a marker and accessed the corresponding voice recording, they started a deeper engagement with the photograph and digital content. This was often marked by a change in orientation to the photograph and the marker, with the photograph often becoming the principle focus for participants. The majority of visitors (20 out of 28) moved back away from the marker to a position where they could still keep eye contact with the portrait (e.g. see figure 4.14) and disengaged with the marker. This behaviour was predominately observed in the first evaluation session when the largest number of participants (16) took part. In the focus group, visitors reported that they acted in this way because they were mindful of the presence of others and wanted to make space for them to interact while they were still engaged with the portrait, e.g. P1 (male, 30-39):

"*You want to still keep eye contact with the person you are listening to but you do not need to distract other visitors. So you step back, you know, you still get this content to remember who you are listening to but to let other people get close and see the photo in more detail*."

A fragment explanation for this behaviour (figure 4.14) is explained below:

B (annotated with red-arrow): is scanning an artcode from a close distance (figure 4.14a).

Then, she moves back to start listening and smiling at another participant (figure 4.14b).

She started to listen to the audio at the same time she is looking at the portrait of the person which the audio belongs to (figure 4.14c).

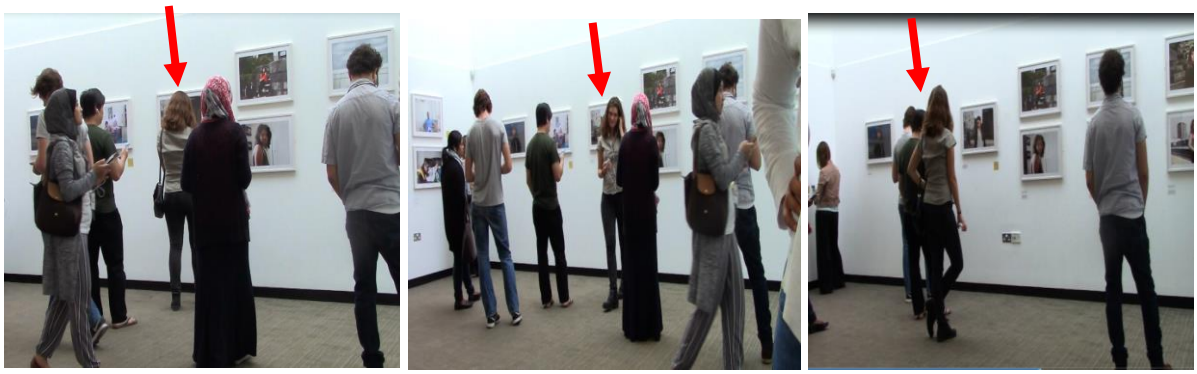


Figure 4. 14 a-c A participant is scanning an artcode from a close distance (left) and then moving back (middle) to listen to the audio voice (right)

Few of the participants (6 out of 28) remained in place close to the portrait and looked at it to listen to the audio after scanning. This was during the less busy sessions when there were not many other visitors around (figure 4.15). The remaining 2 participants moved around the space after scanning while listening to the voice recording. They explained that they were looking for the next portrait to engage with (figure 4.16). The photograph was the dominant focus of engagement for participants. Engagement with the visual representation of the code tended to be determined by the extent to which participants recognised the image. The design of the markers was effective for those who were familiar with the shapes of Latin American countries and could recognise that the labels represented maps. In these cases, the markers themselves conveyed an additional piece of information and this was appreciated. Some visitors, however, did not know what the pictures were meant to represent, e.g. P21 (male, 20-29):

"*The people [who are] like good in geography ok, but for people like me, it was just like image not map."*

Figure 4. 15 The participant stayed close to the portrait while listening to the audio content

Figure 4. 16 The participant is moving around while listening to the voice recording

4.3.2 Engagement with the provided digital content

Audio was chosen as the media for the digital content to allow visitors to focus on the photographs in the exhibit. However, as participants moved from scanning the marker to a deeper engagement with the photograph, most participants looked at the phone screen when the voice recording started to play. They reported that this was to confirm that they had the right audio for the portrait they had selected. It was also observed that most participants (18) listened to the recording at the same time as they were looking at the portrait. They did this to observe the person in more detail, get a better understanding of them and feel more connected, e.g. P28 (female, 20-29) stated:

"So I said I will enjoy the photos because that is what I am meant to look at. But also I think when you got a voice and you are looking at photo, you kind of make more of emotional link between them."

In the focus groups, there was general agreement that audio works well because it complements the visual information from the portraits. P18 (female, over 60), for instance, reported:

"*I think if the content of the exhibition was different, you know you can put another bit of video but in this exhibition just voice. I personally like to hear somebody's voice because you can hear the emotion in a voice tone."*

It was suggested that text would be distracting and tiring to read. 4 of the 28 participants also thought that video would be an engaging format for the digital content, providing further information about the person depicted in the portrait. The others, however, strongly disagreed, arguing that it would take away from the engagement with the artworks, e.g. P27 (female, 20-29) reported:

"Video, for me is like losing the point because the art is there, so if you have a video or another picture in the app, maybe you going to look at that instead of the art."

On the other hand, the other (10) participants appeared more disengaged from the portraits as they were looking at the phone screen or other portraits rather than the one that they were listening to. They explained they were looking at the phone to check how long the audio is and then to focus on listening rather than attend to the portrait. P27, for instance, reported:

"There are few reasons. In some I was looking at how long is each record and I wanted to more focus what I am hearing.". P27 behaviour was clearly observed from the video data sessions (see figure 4.17).

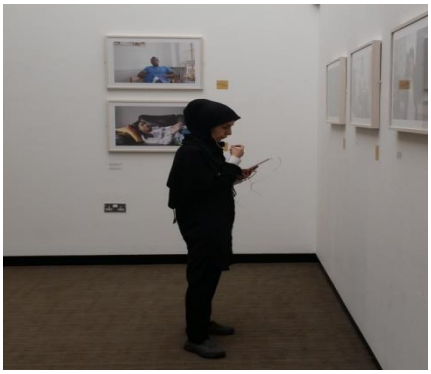


Figure 4. 17 The participant is looking at the phone while listening

In addition, this effect was amplified for some participants as the YouTube interface led them to expect a video instead of only audio**.** For example, P20 found YouTube interface not the right choice for playing audio instead to use an interface like the visitors' voice to play audio: *"I was disappointed by the audio because of the YouTube. I would prefer just how the visitors own voice that was just audio file. So I mean when you listening to it you don't expect anything else except an audio. So if it is a YouTube channel then you expect a video."*

4.3.3 Design of the user generated hybrid artefacts

In general, participants wanted to design their hybrid artefact to express something personal about themselves or to add comments related to the exhibition. Most participants (18) focused on personal expression, with 15 planning their contribution to be about their own experience of living in the UK, or about their home country or other countries that they visited and 3 wanting to share their interests. On the other hand, 6 participants planned to comment on the exhibition and their experience of it. The majority of participants (19) designed their artefact for the public, 8 for family and friends, who they hoped would visit the exhibition, and 1 participant had no target audience in mind. Half of those that focused on creating an artefact for a specific person (4 participants) specifically mentioned that their design would address the interests/preferences of the recipient.

4.3.3.1 Crafting of Markers

All participants were provided with the materials (paper and marker pens) to create artcodes and were not restricted to specific codes or numbers of regions (figure 4.18, left). Following instructions on how to draw (which were also provided as a printed sheet), all participants managed to create a valid marker, after testing them using the Artcodes app (figure 4.18, right), within 15 minutes. A few of them drew more than one artcode and some designed draft versions to learn how to draw valid patterns before designing the final marker.

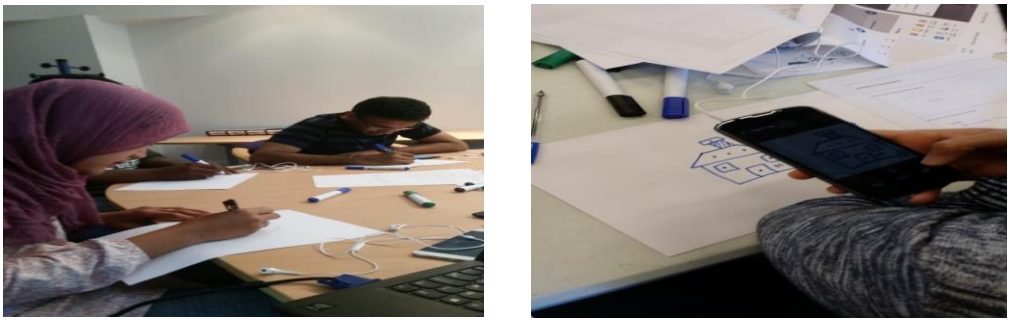


Figure 4. 18 Participants drawing artcodes (left) and checking the artcodes using the Artcodes app (right)

Most artcode designs (23) fitted the overall concept that participants had for their contribution as stated in the worksheets. For example, P17 designed a map of India (figure 4.19, top left) to share her experience of leaving India and living in the UK to study. A picture of a house (figure 4.19, top right), designed by P18 was inspired by the exhibition and was used to leave a comment about the lives of people who come to the UK, while a skeleton (figure 4.19, bottom left) designed by P11 (male, 30-39) was linked to information about Mexican illustrations. P23 (female, 40-49) created an airplane (figure 4.19, bottom right) to symbolise travel but also because her son loves them, thus personalising the illustration as her hybrid artefact was intended for a specific person – her son.

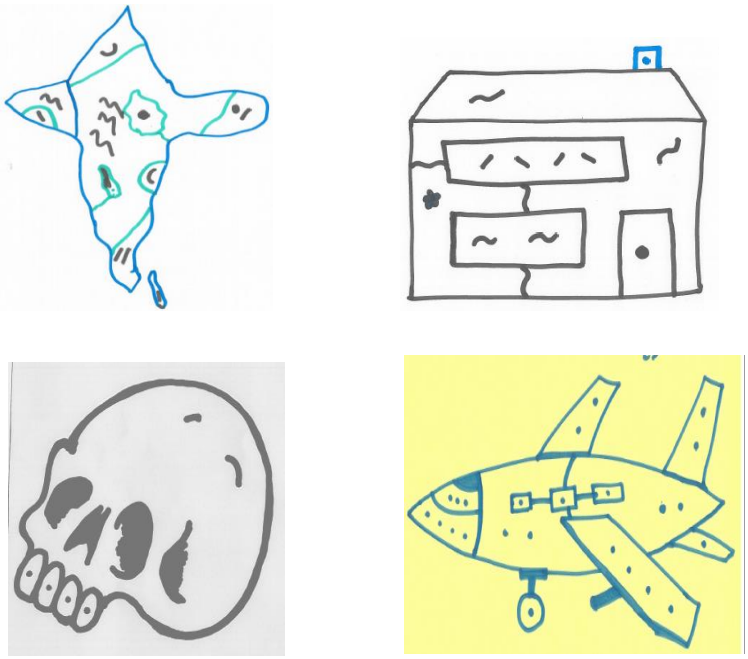


Figure 4. 19 Example artcodes created by participants

As discussed in the previous section, 4 participants did not record a purpose for their artefact so it was not possible to make a judgement in those cases. The artcode that did not appear to match was of a butterfly, designed by P8 (female, 30-39) (figure 4.20, left) whereas the stated purpose and recorded content were about life in the UK (without making a reference to the butterfly imagery).

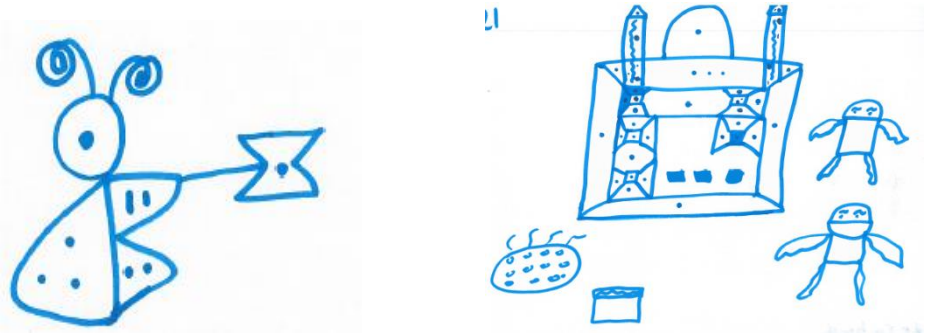


Figure 4. 20 Marker not related to the content (left) and difficult to scan (right)

Only two participants struggled to get their artcodes to scan and needed a lot of help from the workshop facilitator to make working versions. The technical issue with these designs was that there were a lot of blobs inside the regions, with most of them too close to the border to be recognised robustly by the app (e.g. figure 4.20, right) designed by P21 showing a Hyderabad temple. P23 was able to identify the issue with P21's artcode – that he struggled because he drew a complicated picture:

"It will be hard to start with complicated drawing but if you start with simple drawing, with the explanation that she gave it, will not be difficult."

4.3.3.2 Recording of Digital Content

All participants recorded their voices, in English language, using a recording app on the smartphone. As discussed in the Study structure section, during the first evaluation session 11 of the 16 participants did not initially record meaningful content. Although most provided content after the session when the author contacted them to send the planned contribution, so that it could be included in the exhibition. During the subsequent 3 evaluation sessions, all participants recorded the intended digital content, resulting in 24 audio recordings in total. Their length ranged from 0:40 to 4:18 minutes.

Participants differed in how they began the audio recording with over half providing a brief biographical introduction to themselves and giving some background information, e.g. P8 (female, 30-39):

"*Hi, I am X, a PhD student in computer science at the University of Y. I came from Bangladesh, a South Asian country...*"

Whereas the others just provided a name or started to talk about their experiences straightaway, e.g. P21:

"Hi, I would like to talk about Hyderabad..."

All participants in the first evaluation session (initially) recorded their voices in the workshop room, whereas in the other three sessions only 3 participants did so, with the others asking if they could go outside for this. Participants gave a number of reasons for this behaviour. Some were worried about noise from other participants interfering with their audio recording. Others felt embarrassed to record their thoughts in the presence of other visitors or to not be influenced by other visitors' ideas, e.g. P28:

"I am shy to take phone calls in front of people so recording my voice to me is quite unnatural thing. I think if you are in a museum or something like that you can normally find a quiet corner to talk and then come back but I don't think I would record my voice in a middle of a gallery."

This was particularly the case if they were not native speakers, as they wanted some privacy to prepare, e.g. P27:

"I didn't want to get the idea from her so I wanted to have the idea that I have in my mind and not change so I wanted to express what I have in my mind. And another issue of because English is my second language I think in Farsi and then translate what I have in Farsi..."

Despite these issues that some participants experienced with recording their voices, everyone highlighted that audio was the most suitable format to associate with the artcode markers in museum and gallery settings. Participants felt that the audio medium complements the visual information conveyed by the markers and enables them to communicate emotion in their reflections. It was suggested that providing a booth for audio recording in the museum or allowing visitors to complete the digital part of their artefact at home would address the privacy issues. There was agreement between all participants that they would prefer not to communicate their message through text. Video was suggested as an alternative, but some participants stated they would be too shy to make a video of themselves. It was proposed that providing the choice of audio or video recording might be a good solution.

The main contents of the audio record are explained in the following section in relation to the artcodes design.

4.3.4 Main themes of the audio contents

The content of each audio recording either commented on the content of the exhibition (including adding new contents) or shared personal experiences associated with the themes of the exhibition. In the following section, these themes of the digital contents are explained in more depth.

4.3.4.1 Contribute to the exhibition by adding more information to the exhibition

This theme illustrates the contents of the audio recording that were created by participants in order to more directly respond to the exhibition with their contribution building upon the content of the exhibits. The contents were either tended to add information to the exhibition or to leave comments about the exhibition and the artcodes markers. Only one participant (p11) contribution was to add more information to the exhibition where he designed a "Happy skeleton" marker (figure 4.19, bottom left) and the audio comment was:

"Happy skeleton is about the Mexican tradition of drawing funny skeletons on the 2nd of November that is the Day of the Dead."

Whereas, five participants created their audio recording for public to contribute to the exhibition by adding information and also leaving their personal comments and opinion about the exhibition. For instance, p28 designed a "photograph of a girl" marker (figure 4.21) and she reflected on the exhibition saying:

"Today I found through the use of Artcode app I was able to put a voice to the faces and that was really interesting to hear their experiences and created an emotional bond to the photos as you looked at them. You could gain more understanding of how people feel living here and what they experience being in this country. I also quite like the visitors' opinions of the art exhibition and their experiences in their country too..."

Figure 4. 21 Photograph of a girl marker

4.3.4.2 Contribute to the exhibition by adding personal experience

This theme represents the audio recordings that were created by the majority of participants (14) in order to contribute to the exhibition through sharing a new layer of personal experiences, in relation to the exhibition, with public visitors or family and friends. 12 Participants wanted to share their experiences of their own life in the UK (or comparing the UK life with home country), the participant's home country (1) and visiting other countries (1).

For example, P7 who drew the "house" marker (figure 4.19, top right) and recorded a content about family life in the UK:

"What I love about this country is a way they prioritise the family matters, so developing the work life and family. This one I love most in this country."

Another participant P15 (female, 30-39) designed a "teddy bear" artcode (figure 4.22) to symbolise social relationships and how they look like in her home country and in the UK:

"Nigeria is bubbly and lively place, the people there are full of energy, and passion and creativity and they show it. I have lived in the UK for sixteen years now. One major difference I would say that I find between people who live in the UK and Nigeria is that over here in the UK, people are a lot more conservative in terms of the social side..."

Figure 4. 22 Teddy bear marker

In addition to the experience of being in the UK, one participant (p21) wanted to share his experience about his home country, India, in which he created the digital content to share some famous places, culture, people's life and food of the Hyderabad city. He drew a "Hyderabad template" marker (figure 4.23) and stated:

"*…I would like to talk about a Hyderabad so part of India which is quite a famous and excellent place in India which like many famous things like Drama jhoot film city and Birla mandir, statues, and mini cultural heritage things. The culture differences mean like huge*

cultural differences compared to different or religions and different ethnicity. So, the main thing about Hyderabad like the people are very friendly..."

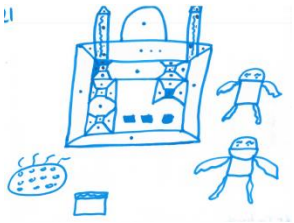


Figure 4. 23 Hyderabad template artcode

Another participant (P20) wanted to share his experience of visiting another country "Japan" and what he found interesting in there. He drew a "famous cartoon" marker since it is famous in Japan (figure 4.24). He stated:

"*...I share my experience of visiting a very country of mind Japan. So, I visited Japan about two years ago. It is a most interesting country that I have been so far. Culture..."*

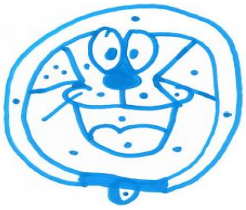


Figure 4. 24 Famous cartoon artcode

4.3.4.3 Contribute to the exhibition inspired by family and friends' preferences

This theme belongs to the digital contents that were created by four participants to share personal experiences about their own family or friends and what they prefer. Thus, they wanted to use this opportunity to pose care, concern and emotion message to family and friends. For instance, p4 designed a "cat" artcode (figure 4.25) for her daughter because she loves cats and she sings a song while drawing it. So, p4 wanted to show her daughter how she cares about her through explaining an easy and enjoyable approach to drawing:

"*I want to draw a cat for my daughter because I know she likes cats and the way we draw a cat goes with this song. And this is how to sing the song as we draw the cat. Small circle small circle biiig circle. Dear mommy dear daddy triangular. Six times six six times six thirty-six..."*

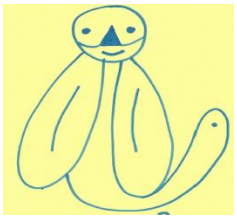


Figure 4. 25 Cat marker

4.3.5 Engagement with the visitor generated artefacts

Participants were highly engaged with the hybrid artefacts created by previous visitors (figure 4.26). These were displayed within the gallery setting as part of the overall exhibition. In the three evaluation sessions where these were exhibited, it was found that participants spent more time with them than interacting with the more formal artcode labels provided with the portraits. In the focus group discussion, they reported a number of reasons for this. All participants found the design of the visitors' markers to be meaningful and to relate to the digital audio content. They also felt a connection to these artefacts because they were created by visitors like them who had already experienced the exhibition and were curious to hear their experiences and reflections on the topic of the exhibition. The participants also appreciated points of view from different cultures and countries.

Figure 4. 26 Participants interacting with the visitors' markers

The visitors' markers also (unintentionally) turned out to be easier to interact with. The participants found the interface for playing the voice comments, which was directly integrated in the app, more convenient than the YouTube interface used for accessing the voices of the portraits. The visitors' markers were also more quickly recognised by the app due to their larger size and higher contrast. In the focus group, P23 reported:

"The other ones that were displayed, visitor voice, very unique very very very good because you just place your camera and you get the scanning."

The following example shows the speeds of scanning an artcode of the visitor artcodes:

Figure 4.27a: at (23:00) minute, a participant on the left scanned an artcode.

After 3 seconds, the app recognised the artcode and the voice is triggered so she started to listen to it (figure 4.27b).

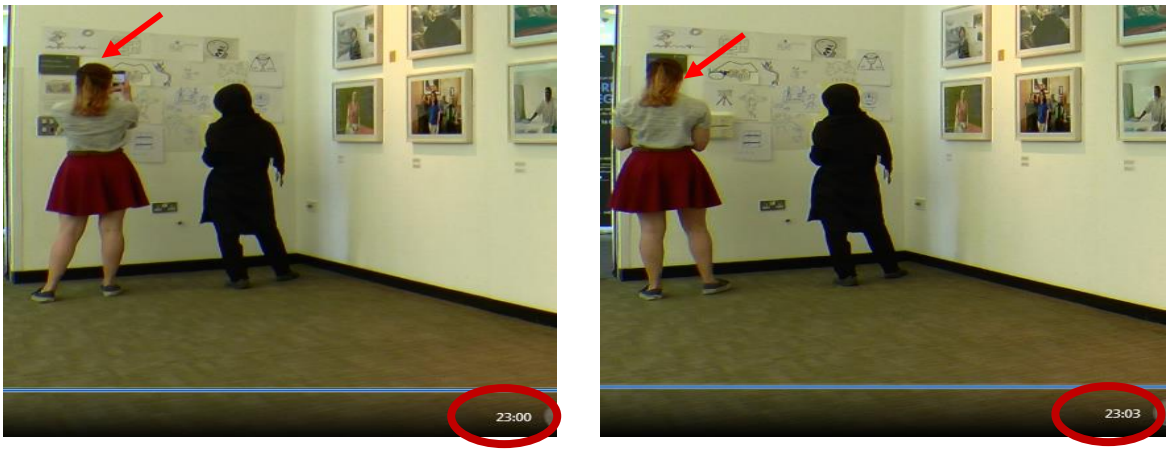


Figure 4. 27 a-b The required time for scanning a visitor's artcode

Unlike the labels, which were placed alongside exhibits, these markers were exhibited in their own right. Consequently, their position invited easy scanning. The codes replaced the photographs as the focal point for interaction. All visitors looked at the artcode design while listening to the associated voice recording.

As with the portrait markers, the behaviour of scanning and moving back was also observed. This happened more frequently, usually when there was more than one other participant nearby, as the visitor markers were all placed on one wall close to each other and adjacent standing space was limited (see figures 4.6 and 4.26).

4.3.6 Social Interaction

Although not designed for collaboration, the system enabled participants to engage in social interaction, with the overall experience being an inherently social activity. This was manifest in a number of ways during the visiting experience. People would observe others' interaction with the artcodes and use the opportunity to help each other in scanning codes. The system was also appropriated to allow shared listening of the audio content. For example, a group of three friends visited the gallery together. This group stayed close to each other throughout the visit experience. They enthusiastically engaged with the artcodes and the digital content. They approached the scanning of the codes collectively and at times they even shared the

headphone earplugs to ensure they were listening to the recorded voices synchronously (figure 4.28).

Figure 4. 28 Participants sharing the visiting experience

Another example is two friends that they visited the gallery together but they split from each other to start their interactions individually. However, it was noticed that, at some point, they were joining each other and started to speak with each other about the exhibition or stayed close to each other (figure 4.29).

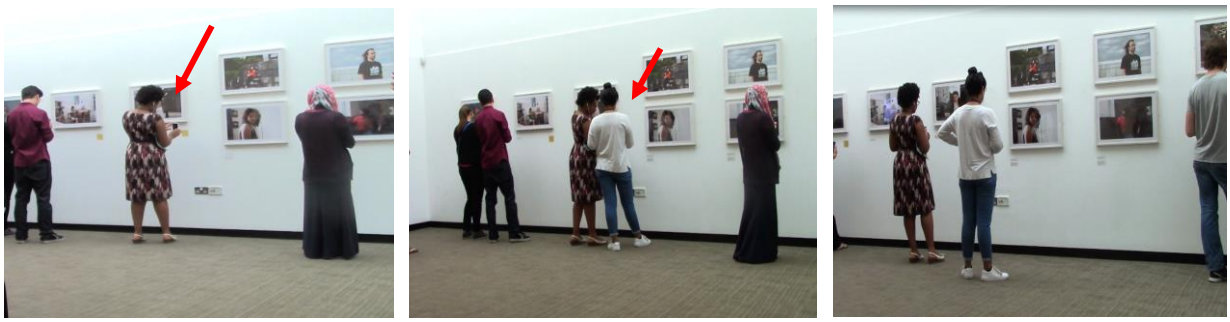


Figure 4. 29 Two friends are joining each other

The last example is the one that represents a group of three friends they also came together to the exhibition and started their experiences with the exhibition portraits individually. However, they did not re-join each other until they finished their experiences with the exhibition (even though they were still close to each other) (see figure 4.30). In the focus group discussion, this group of friends reported that they wanted to speak to each other at some points but they were concerned about others to not disturb them as explained by p25:

"*Sometimes in museums you want to talk but there are a lot of people there and may be don't have enough space to talk in front of others."*

Figure 4. 30 The participants had individual interaction with the exhibition followed by re-joining

The process of designing the markers was also engaged with as a social activity promoting collaboration between visitors. Participants were actively engaged with the others' images during the drawing process and most of them (even those who came alone and did not know the others previously), talked, looked at other participants' designs, asked questions and helped each other (figure 4.31). They reported that the activity was interesting and enjoyable, e.g. P19 (female, 20-29): "*It's nice like a puzzle and I really enjoy drawing things."*

Figure 4. 31 Participants engaged with drawing markers

4.4 Discussion

Based on the study findings, the author reflects on the lessons for using aesthetic meaningful markers as labels for exhibits and as a mechanism for visitors to craft a hybrid artefact that encapsulates a contribution to the exhibition.

4.4.1 Augmenting exhibits through labels

The placement of markers within the exhibition and their augmentation with audio commentary were viewed positively. It was found that users successfully self-managed access to markers by being mindful of the presence of others and repositioning. This is in contrast to Wein (2014) who suggests that visitors may be reluctant to engage with visual

markers, such as QR codes, because they need to be able to get close to them in potentially crowded spaces. However, this study also highlights considerations for the use of this form of label as a technique for constructing visitors' experiences that exploit their mobile devices. The study revealed that visitors engaged with the aesthetic markers at three levels – **physical placement**, **aesthetic content** and **digital content** – that are mutually supportive in shaping the experience. Issues with any single level undermine the overall experience. This effect was notable in this study in terms of the challenges for some visitors arising from the positioning of labels and the legibility of the aesthetic content. It is also important that visitors can readily engage at multiple levels and shift their focus between these levels at low cost.

4.4.1.1 Interaction with the physical placement of markers

Although it may seem an obvious point, placement needs to be considered carefully. It is critical to shaping the engagement across the other levels of interaction. Exhibitions are carefully curated and significant thought is given to the placement of artefacts in the space (Whitehead, 2012) and labels are often positioned such that they do not distract from the exhibit. One consequence of this is that labels might not be in a position that invites users to scan them easily. The ability to design markers that are aesthetically pleasing and complementary to the exhibits can potentially alleviate this problem by allowing such labels to be more prominent than QR codes. However, in this study, still it was found that the positioning of labels would occasionally offer challenges for scanning. Ng and Shaikh also previously note issues with users having to scan labels from awkward positions when they were deployed in a botanical garden in Malaysia (Ng and Shaikh, 2016). This arose from the placements of some of the labels, which were too far from the walkway. They suggest careful design of the physical labels, use of mounting stands to provide an optimum scanning distance for users, and real world testing to reveal how real users will physically engage with the markers.

4.4.1.2 Interaction with the aesthetic content of markers

Users also engaged at the level of the aesthetic content of markers. The images within the markers themselves can be used to add value to the experience of the exhibition. In the case of this study, the markers conveyed information about which country the person depicted on the portrait came from. However, the visual content needs to be designed with care to ensure that it is meaningful to users and supportive of the other levels. It was found that a number of visitors were not able to interpret the images as country maps. It can be a challenge to strike a balance in the design of labels so that they convey additional information and/or imply their

function, but are also sufficiently abstract to pique visitors' curiosity and encourage experimentation. The visual design of the label needs to be considered carefully in terms of its function in inviting visitors to scan it to engage with the digital content.

4.4.1.3 Interaction with the digital content

The augmentation of this exhibition involved the assembly and linking of digital media hosted on a commodity service. Audio was presented to users through the interface provided by YouTube rather than by a dedicated functionality in the app. This form of construction is likely to be common for marker based mobile experiences. For example, there are a number of QR code based museum applications that link to Wikipedia (Ross, 2012). However, this also introduces an interactional cost – that of understanding the change in interface, and switching back from the YouTube app or website to the Artcodes app – that makes it harder for visitors to shift their focus between the different levels involved. As it was noticed that in this study, there is potential for confusion or distraction that arises through the presentation of digital media through a third party interface and there is a need for the careful assembly of the experience.

4.4.2 Visitor crafted hybrid artefacts

As museums increasingly recognise the value of engaging visitors in a dialogue and enabling them to contribute their own interpretations (Simon, 2010; Whitehead, 2012), a range of mechanisms to support visitor contributions have been explored. These include use of social media to encourage visitor engagement (Kidd, 2014; Von Appen, Kennedy and Spadaccini, 2006; Weilenmann, Hillman and Jungselius, 2013), tagging of exhibits (Ahern et al., 2006; Cosley et al., 2009; Trant and Wyman, 2006) and specially developed interactive displays (Cosley et al., 2008; Taylor, 2014). Previous research projects, such as Retracing the Past (Ferris et al., 2004) and Reminisce (Ciolfi and McLoughlin, 2011), have shown that allowing visitors to record voice messages is a particularly effective way of sharing memories and opinions with others in the museum setting. The author builds on these mechanisms with the particular approach of visitors crafting hybrid artefacts that comprise both a voice recording and a hand-drawn physical label.

The ability to generate hybrid artefacts in reaction to the exhibition proved popular as a means of visitor expression and as an extension of the exhibition in its own right. It is interesting to note that all visitors chose to contribute new content (in effect creating a new exhibit), as outlined in the section Design of the user generated hybrid artefacts, rather than

offer reflections focusing on a specific portrait. The results raise the possibility that hybrid contributions are more rewarding for the visitor than digital tags, which previously have been predominantly used to comment on existing exhibits (Cosley, 2009; Thom-Santelli, Cosley and Gay, 2010). In turn, participants who visited the gallery when the visitor-generated artefacts were displayed, found the hybrid contributions as engaging as the curated content. However, unlike digital tags, it is important to note that hybrid contributions consume the museum's physical space. In this study, gallery space was kindly dedicated to participants to use, but for many museums space may be considered too valuable to spare for visitor contributions. Longer-term studies of hybrid artefacts as visitor contributions will need to consider how long the lifespan of a contribution should be, and strategies for rotating or retiring contributions to ensure that they do not overwhelm the museum.

4.4.3 Supporting multi-level crafting of hybrid artefacts

The importance of the interplay between the multiple levels of interaction was evident as visitors recorded digital content, created aesthetic content by drawing labels and physically placed these in the exhibition in relation to other content. People expressed themselves through a combination of the physical image and the associated digital recording. As presented in the Findings section, most artcode designs fitted the overall concept that participants had for their contribution, with the image linked in some way to the digital content. The crafting of hybrid artefacts required effort and creativity and the author suggests that consequently visitors put in more thought in the process, resulting in the generation of more interesting contributions than are usually found in an equivalent visitors' book or systems that allows objects to be tagged with text comments. Studies of maker communities have revealed that members value the pleasure of making and personal expression (Tanenbaum et al., 2013).

Allowing museum visitors to craft hybrid artefacts as a means of contributing to the museum can enable them to tap into these feelings. The findings also contrast with those of Thom-Santelli, Cosley and Gay's study (2010), which found difference in engagement between expert and novice users in leaving digital tags. Arguably this lends further support for the value of drawing (and physical crafting more generally) in engaging visitors in making meaningful contributions. However, the fact that the creation of hybrid artefacts requires a significant commitment from visitors also means that this process will require some form of scaffolding. It is important that support for crafting addresses the need to work at each of the

three levels: people need to be supported in drawing the labels, linking the digital content and potentially placement in the space.

It has been noticed from this study that dedicated sessions, facilitated by the author, work successfully. Alternatively, support for self-led creative activities could be provided in the form of a workstation with worksheets and instructions. However, the challenge of embedding sufficient contextual knowledge of the exhibit and how people relate to it, must not be underestimated. Another direction for future research is to explore the placement of visitor contributions within the exhibition. In this study visitor' drawings were displayed on one wall allocated by the gallery. These placements, worked well as all visitors chose to extend the exhibition with new drawings and voice comments rather than reflections focusing on a specific portrait. This was also the case for the 16 visitors in the first sessions, who at the point of creation, had not seen how their contributions would be displayed. In future research it would be interesting to explore if and how visitors can be allowed to be involved in the placement of their contribution within the exhibition and if this would affect what visitors create. This would further extend the role of visitors in shaping museum content but must be balanced against the need for museums to maintain overall curatorial control and moderation of content (Russo et al., 2008; Simon, 2010).

4.4.4 Scheduling within the overall visiting experience

The drawing of markers takes time, with participants experimenting with designs and then producing a final working version. It is important that this time commitment is designed for and managed as part of the overall visitor experience. It is important that this should reflect the creation of aesthetic and digital content and the physical placement in the setting. In this study case, it was found that the scheduling of marker drawing before the audio recording activity led participants to spend most of the available time on it, causing the remaining parts of the experience to be rushed, undermining the value of the hybrid artefact. Future work needs to focus on other options for enabling visitors to generate artcodes rather than just drawing them. Finally, it is also suggested that people need space to generate images and audio commentary. It is worth noting that, although many museum visits are social, people often felt the need for privacy when recording audio content. Future work can also explore what the impact would be of allowing visitors to complete their hybrid artefacts at home.

4.5 Conclusion

This study has shown that visual markers, such as artcodes, which can be designed to convey visual meaning, can be combined with mobile devices to enhance the visitor experience of exhibits, especially when linked to complimentary audio content. Issues, such as the interface for accessing the digital media, appropriate marker design and marker placement, however, need to be considered carefully to ensure smooth interaction. Directions for future work have been highlighted on the use of visual markers, which can be crafted by the visitors, as a valuable mechanism for contributing new content to an exhibition. In this study, the participants generated hybrid artefacts that were well thought-out and engaging for subsequent visitors, consisting of an image and audio comments. The author raised the question of where these contributions might be embedded in the museum, how visitors can be involved in the process of placing their contributions in the museum, and what strategies for rotating and recycling contributions need to be implemented. It is suggested that the drawing activity, which took time and effort, encouraged participants to reflect more deeply on the theme of the exhibition and focus on content that other visitors could relate to. To utilise visual markers in this way, however, requires further consideration of how, when and where to scaffold creative visitor activities.

Thus, this chapter has met its aim about the mechanism to enable visitors' participation in museums through using aesthetic visual markers in order to enable visitors to consume official and visitors contents (research question 1-a and b) and involve them in creating hybrid artefacts (research question 2). The next goal will be focusing on introducing other techniques for engaging visitors to contribute to the exhibition using different visual representations of marker and to explore how subsequent visitors will engage with them. In addition, to explore how visitors can be involved in the process of integrating their own hybrid contributions within the exhibition and what will be the role of curators in this procedure. These will be studied and addressed in the next chapter.

Chapter Five: A Further Practical Implementation of Content Creation through Aesthetic Visual Markers

The previous study that was presented in chapter 4 shows that crafting hybrid artefacts required effort and creativity from visitors which led them to put in more thought in the process. This resulted in producing more thoughtful and meaningful contributions than are usually found with other approaches such as visitors' book or systems that allow objects to be tagged with text comments. However, it seems important to explore the alternative approaches that enable visitors to create their physical markers instead of only allowing them to draw the markers from scratch since not every visitor may have enough time to draw or some may have lack of drawing skills. In addition, it is essential to consider the fact that the creation of hybrid artefacts requires a significant commitment from visitors which means that this process requires some form of scaffolding and support at three levels: people need to be supported in drawing the labels, linking the digital content and potentially placement in the space.

In the previous study (chapter 4), the author facilitated the study structure to support visitors in creating the hybrid contributions, moderated their contributions and displayed them on one wall allocated by the gallery. The placement worked well as all visitors chose to extend the exhibition with new drawings and voice comments about personal experiences rather than reflections focusing on a specific portrait. However, it is important to understand and explore how museum curators and staff could facilitate the session. More particularly, to explore how they would practically organise the sessions, support visitors to create hybrid contributions and whether they would allow visitors to integrate their own contributions within the exhibition. In addition, how and which methods will be used for integrating visitors' contributions within the exhibition.

Therefore, this chapter builds upon the previous study that was presented in chapter 4 to introduce the opportunities of enabling visitors to choose between drawing a marker or to choosing a template of pre-designed artcodes with/without comment sections to contribute physically and link them with their own digital contents in the Artcodes app. This could be useful for the visitors who have limited time to spend in the museum or they have lack of drawing skills. Thus, it would be possible to explore how subsequent visitors would interact with different visual representations of artcodes. In addition, this chapter explores the role of curators and staff in facilitating visitors' contributions using artcodes and how they would

allow integrating different visual representations of visitors' hybrid contributions in the exhibitions. Thus, overall, this chapter explores the application of artcodes to enable visitors to consume content and create content as well as to explore curators' role throughout the process of visitors' participation in the museum.

Next, the aims and objectives of this chapter are described followed by representing the study setting, approach, procedure and structure. The chapter then explains the main methods used for recruiting participants, the methods that were used for collecting data from them and the process of analysing data. Then the main findings are reported followed by discussing them.

5.1 Aims and objectives of this chapter

1- Design of visitor contribution

- Which visual representations of the markers do visitors prefer for their physical contribution (hand-drawn or selecting a pre-designed artcode) and why?
- How can the comment section on the pre-designed artcodes be used by visitors? Do they use it for drawing pictures or for writing text? In case of writing text, do they repeat the same content of the digital content or they would write new comments?
- How the choice of the physical manifestation (form) affects the nature of the digital content?

2- Curators role

- How do curators facilitate visitors' hybrid contributions (artcodes) to contribute to the exhibition through hand-drawn artcodes or selecting pre-designed artcodes?
- What is the technique that curators use to integrate visitors' artcodes in the museum? Do they allow visitors to display their own artcodes by themselves or they want to retain control over the display? Where the artcodes could be displayed? All in one place or in different places across the museum?

3- Visitors engagements with the exhibited contributions

- How can visitors interact with different visual representations of displayed artcodes (hand-drawn or pre-designed) in exhibitions?

5.2 Study setting

To discuss the study aims and objectives with museum curators and find out their opinions, a number of discussion meetings were carried out with curators of the National Videogames Arcades (NVA) museum, Nottingham Contemporary gallery and Lakeside Arts gallery. The NVA was chosen for this study since the curators expressed their interest to enable visitors to

contribute to the exhibitions using cutting-edge technology such as artcodes. In addition, NVA holds a large number of permanent interactive video games which is a challenging context to explore how visitors can engage with artcodes as labels in such a highly interactive and engaging domain and whether they would be willing to reflect on the games through leaving personal comments. Therefore, the NVA was chosen as a setting for the practical deployment of this study approach.

The NVA is located in Nottingham city and it is the UK's first cultural centre for video games that aims to promote the cultural and economic significance of games and to enhance fun, entertainment, education and game design (Parkin, 2015; Stuart, 2016). In addition to providing interactive games, the NVA allows visitors to have the opportunity to create and develop video games. The NVA museum consists of a Lobby on the ground floor, where the reception, a workshop and meeting rooms and a few game arcades are located. Moreover, the NVA consists of another three floors and on each floor there is a gallery with a large number of interactive video games (see figure 5.1).

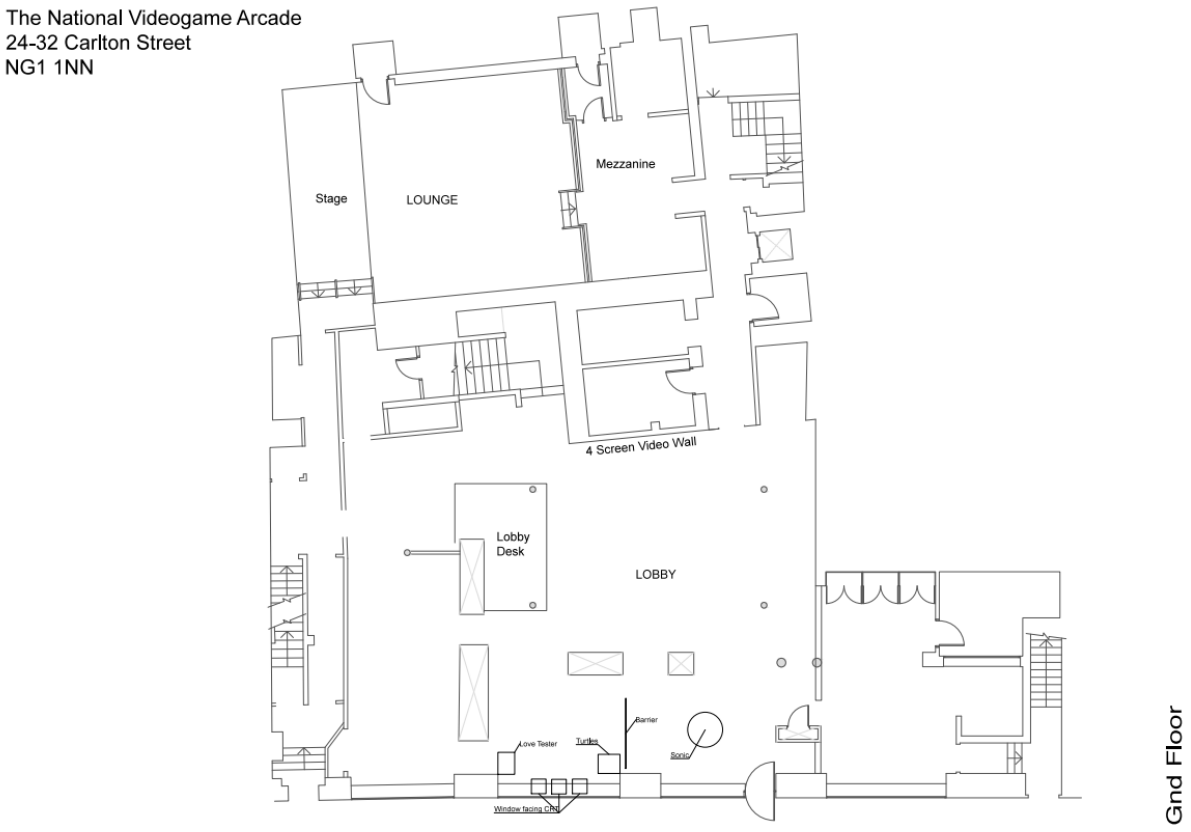


Figure 5. 1 Floorplan of the Lobby and the galleries space

The museum's artefacts were not augmented with any visual markers which make it a useful case study to explore how visitors can contribute to the exhibitions using Artcodes technology without being previously introduced to artcodes, how they work and how to access their digital contents. Before carrying out the practical study, a number of discussion meetings were conducted with the NVA curators to decide on the exhibitions where the

participants can create their contributions around and where to integrate their contributions. The curators decided to select the Lobby, in the ground floor, as a venue for enabling participants to create the contributions and Gallery Three, on the third floor as the main gallery amongst the other two galleries, to enable visitors to create contributions around its games and objects. Gallery Three consists of four main exhibition rooms, one large and three small exhibition rooms. The reason behind their choice of the Gallery Three was because it is a more controlled gallery and it includes the most popular video games which can motivate visitors to add their own layer of information to them (see figure 5.2). Staff-1(female, 33) stated:

"Gallery three gets most of our items so like an archive. It gives more choices basically so if you go to places like gallery two or one, we have got games that people have never seen before. So, they wouldn't like to talk about them, but for this study it would be nice to start with games that everybody knows like Mario. Gallery three is also more controlled than gallery one and two and gallery three became the history of video game."

Figure 5. 2 Lobby on the ground floor (left) and Gallery Three in the third floor (right)

5.3 Study design

5.3.1 Artcodes template

Following from the previous study in chapter 4, this study provides visitors more options for creating their physical contribution of artcodes in addition to hand-drawn artcodes. For this purpose, it was decided to provide visitors with pre-designed artcodes without comment section (figure 5.3, left) and pre-designed artcodes with comment section in which it allows visitors to maintain some level of personalisation to customise the design through adding an additional physical layer of input (to write comments or to draw a favourite picture) (figure 5.3, right).

Figure 5. 3 Example of pre-designed artcode without comment section (left), with comment section (right)

The decision for creating pre-designed artcodes was made because visitors might not be able to draw artcodes physically from scratch due to lack of drawing skill or not having enough time. With the pre-designed templates, visitors can have an opportunity to contribute to the exhibition physically through choosing straightforward and easy artcode templates and create digital contents for them. Thus, it is important to explore how visitors engage with the pre-designed artcodes and use them instead of restricting visitors to only one method for their physical contributions.

In terms of the visual design of the pre-designed artcodes, it was decided that a standard design be used and for this purpose, the NVA logo (figure 5.4) was used. Choosing this logo was based on the decision of the NVA museum's curators as they preferred the NVA logo to appear on all the pre-designed artcodes. From the author's point of view, a standard design for the pre-designed artcodes was also preferred in order to explore visitors' engagement in using the pre-designed artcodes compared to the hand-drawn artcodes for the physical contribution and how the subsequent visitors would interact with them once they are integrated into the exhibitions.

Figure 5. 4 The NVA logo

However, the logo represents a written text which makes it difficult to convert to artcodes with a large number of different codes. Thus, it was decided to draw a frame for the logo and make the frame as artcodes with (80) copies that are visually similar in their design but different in their codes (each frame has a unique code). Each frame was designed to consist of (8) regions and the code inside regions of each frame was different from the code of the other frames (figure 5.5).

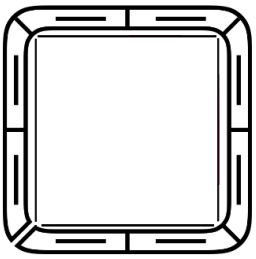


Figure 5. 5 Artcode frame with 8 regions with the code 1:1:1:1:1:1:1:1

5.3.2 Digital contents and the opportunity to modify them

Similar to the previous study, visitors were required to record their audio comment through an audio recording app on the smartphone and then upload it in the Artcodes app, associating it with a hand-drawn artcode or a pre-designed artcode with/without comment section. The nature of the audio contents needed to be around personal experiences and stories about video games, favourite computer game or coding experience. However, intentionally in this study, the order of the contribution activities was swapped back to its previous order by asking visitors to create or select the artcodes first then to record the digital contents in a booth. This was because it was intended to explore whether the order of the activities really matter when other options such as pre-designed artcode templates are provided as well as providing a booth, close to the workshop venue, for enabling the visitors to feel more relaxed to record the audio recordings in a private space (figure 5.6).

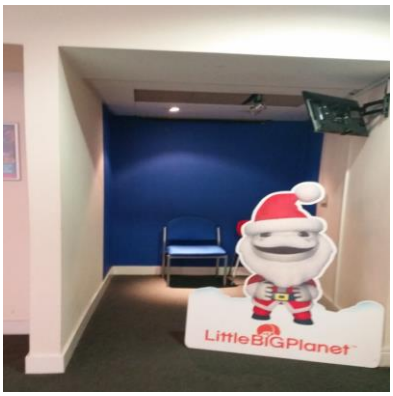


Figure 5. 6 Booth in the Lobby

In addition to providing a booth, this study offers visitors with further opportunity to interact beyond their visit by enabling them to modify the audio recordings in case they wish to update them after leaving the museum in order to create more meaningful and interesting contents. For doing so, visitors need to be provided with another copy of their artcode (either by drawing another copy of their hand-drawn artcode or by providing them a copy of their pre-designed artcode) in order to take it with themselves after leaving the museum. In addition, visitors should be provided with the URL where they can modify their own audio records using their own unique code. The unique code is produced automatically per each user when the user uploads the audio recording to associate it with the artcodes and the code appears to the user immediately (figure 5.7). In this way, only the owner of the digital content can update the audio recording using his/her own code. However, with this approach, a challenge can be raised if visitors updated their digital content to inappropriate or offensive content. For avoiding such issue, regular checking would be required to remove any inappropriate digital content. In response to the curators request, checking the artcodes (physical design and digital content) were made by the author.

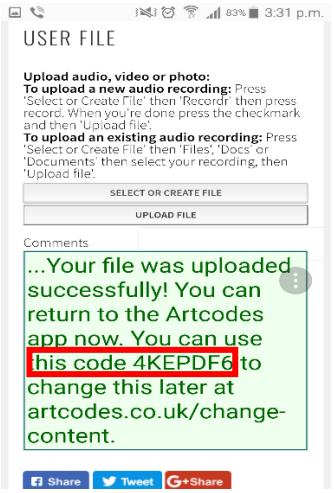


Figure 5. 7 An automatically generated code after uploading an audio recording

5.3.3 Curators role in facilitating visitors' contributions and integrating them within the exhibitions

Unlike the previous study at the Lakeside Arts gallery, for this study, it was decided to involve museum staff and visitors in the process of contributing to the exhibition instead of the author's direct communication with visitors in order to explore how this approach can be used practically by the staff. Therefore, in advance of the practical study, a number of discussion meetings were carried out with the museum managers and staff to discuss all details about the study and what is expected from the members to do during the practical

content creation session. As a result, it was decided that the content creation activity would be facilitated by two members of the NVA staff and for this purpose, the author provided them a training session about drawing artcodes and linking them with the digital contents in the Artcodes app.

In addition to the staff role in facilitating the content creation session, the curators were asked whether they would be willing to allow visitors to moderate and integrate their own contributions into the exhibitions. The curators were keen to retain curatorial control of the presentation of the visitors' contributions. Therefore, for deeper understanding of curators' approaches and strategies in moderating and integrating visitors' contributions into the exhibitions, it was decided that moderating visitors' contributions to be made by the author (due to the limited time availability of the curators at the time of this study) and integrating the contributions to be made by the curators after completing all content creation sessions.

The curators decided on using two different places for integrating visitors artcodes based on their audio recordings: artcodes with digital contents relating to objects and video games that are available in the Gallery Three would be integrated in Gallery Three. For this purpose, four methods were used which are table, game arcade, wall and cabinet. Whereas, the artcodes with digital contents relating to general game experiences (without referencing to the objects and video games of the Gallery Three) would be integrated on one wall in the Lobby.

5.4 Study approach and structure

Same as the previous studies, this study followed the UCD approach to involve visitors in the process of designing the contributions in "in the wild" (Crabtree et al., 2013) in order to explore how visitors use, interact, and approach different visual representations of artcodes and their associated digital contents practically in the museum. In addition, how curators and staff can be involved throughout the process of content creation by visitors.

5.4.1 Study Structure

The study was structured to encourage visitors to contribute to the exhibitions through creating their hybrid contributions that can be integrated into the exhibition and to explore how subsequent visitors would interact with the visitors' contribution.

Overall, the study consisted of two main phases. The first phase was workshop activities which invited visitors to create their own hybrid contributions (around 10 minutes for each visitor) and it ran over five days. Once the visitors accepted to take part in the study and

signed the consent form, they were invited, by the staff, to browse the exhibitions in the Gallery Three followed by returning to the workshop venue in order to allow visitors to create their own hybrid contribution. For this purpose, the staff provided the visitors with a demonstration of how to draw or choose pre-designed artcodes and associate them with audio recordings in the Artcodes app and the staff supported visitors to create the hybrid contributions successfully (figure 5.8).

In this study, visitors were not provided with any worksheet structure to plan their design reflections. Instead they were left to plan on the fly in order to make the process more easy, feasible and immediate. Again, for drawing artcodes, paper and marker pens were provided and an audio recording app on the smartphone was downloaded for recording audio comment which then needs to be uploaded in the Artcodes app. An interface was integrated in the app for playing the audio contents. This was followed by conducting a semi-structured interview with participants to understand in more depth their opinions and feedback about their experiences of contributing to the exhibition and how they felt about using different visual representations of artcodes.

Figure 5. 8 Staff are facilitating the workshop on creating the contribution

Once all markers were displayed in the exhibitions, the second phase of the study began which was about inviting new group of visitors freely to interact and explore the exhibition and the markers while the author was available to offer assistance if needed. The aim of this phase was to understand how visitors interact with the artcodes, which visual representation of artcodes they scan more, how different approaches of displaying artcodes affect visitors scanning attitudes and how they behave while listening to the audio contents. This exploration phase ran over 11 days. At the end of each visitors' interaction in this phase, a semi-structured interview was carried out in order to understand their opinions about their interactions in more detail.

5.4.2 Data capture and analysis

Using naturalistic observation allowed the author to collect data through field notes, photographs, video recording of the visitors' interaction with the exhibitions (in the second phase, the video camera was placed in a corner of the Gallery Three and the Lobby) and audio recording of the semi-structured interviews. The video recordings were qualitatively analysed to understand how visitors interacted with the visitors' artcodes that were integrated in the Gallery Three and the Lobby. The audio recordings of the semi-structured interviews were transcribed and thematically analysed through an active and reflexive process (Braun and Clarke, 2006).

The transcribed data of the semi-structured interviews and observations of the content creation sessions were combined to build a picture of what visitors created and why. The transcribed data of the semi-structured interviews of the second phase was used to complement observations with what participants' said about their interactions. More particularly, to understand in more depth how participants interacted with the different visual representations of artcodes and why they behaved in certain ways while interacting with the digital contents and with their companions.

The procedure of analysing the collected data started by analysing the artcodes by categorising them into three groups based on their visual designs: hand-drawn artcodes, pre-designed artcodes without comment section and pre-designed artcodes with a comment section. Then, the artcodes were classified based on their titles, which were written by the participants on the artcodes, to indicate for which purpose they were created (whether in relation to the video games of the Gallery Three or general experience). The voice records of the digital contents were analysed by transcribing them and using inductive thematic analysis to understand the actual contents and key themes from them. These transcribed audio recordings were categorised into two groups: Gallery Three contents and general digital contents then the main and common themes for each of these categories were identified. Following this approach, it would allow finding the common themes of the design rationale amongst all participants.

The audio recordings of the semi-structured interviews were transcribed and analysed thematically in order to use them in conjunction with the chosen design options and the recorded digital contents which can help in understanding the whole design rationale of each participant. Finally, the audio recordings of the semi-structured interviews were used during

watching the video recordings in order to understand participants' behaviours and experiences during the creation activities and exploring the artcodes.

After completing both phases, a focus group discussion was carried out with the curators in order to understand their choices for the settings, integrating artcodes in the Gallery Three and the Lobby and finding out what they think about possible applications of artcodes in the future.

Since the participants of the first phase of this study are not the same participants who took part in the second phase and the activities in each phase are different from each other, therefore, the findings of each phase are reported separately. In the following sections, an overview about the participants of the first phase is reported followed by representation of the main findings. Next, an overview about the participants of the second phase is reported followed by demonstrating the main findings. The chapter then reports the findings of the final focus group discussion with the NVA curators about their overall opinions of using artcodes for enabling visitors to participate in the museum and the possible future applications of artcodes in their setting followed by discussing all the findings of the chapter.

5.5 First phase of the study: Content creation activity

5.5.1 Participants' background and recruitment methods

A total of 40 participants (25 male, 15 female) were recruited to take part in the first phase of the content creation activities in five different days, which run throughout the days from (11:00-17:30). The majority of the participants (38) were real museum visitors and they were recruited through approaching them physically in the NVA and using the museum mailing list and its social media. Whereas, only two participants were recruited from the university network. Of the (40) participants, 2 were aged (less than 18), 21 were aged (19-29), 13 were aged (30-39) and 4 were aged (40-49).

The majority of the participants were partners or romantic couples (24 participants (12 pairs)) followed by groups of friends (7 participants) and (5) participants who came to visit the NVA alone and only (4) participants were family. For more information about the participants, see appendix C.

5.5.2 Findings

Each of the (40) participant had only made one contribution which involved either drawing an artcode or selecting a pre-designed artcode with comment or pre-designed artcode without comment followed by recording an audio content. Participants had decided about the content of their contributions during their tour with the staff to the Gallery Three. The majority of participants (33 out of 40) created their contributions around specific games in the Gallery Three whereas only (7) participants created their contributions about playing games in general without reference to any particular game in the Gallery Three.

All participants were able to record their audio contents successfully either in the booth or in a workshop venue (when there were no strangers around) and none of them had any issue with the app as they were easily managed to use it for linking artcodes with their audio recordings within two minutes. The whole experience of drawing or selecting artcodes, recording audio and linking them in the app took around (10 minutes) per each participant. In the interview, participants expressed their positive opinion about having such experience in museums as pa37 (male, 38) stated:

"*I enjoyed creating these things and I think people will appreciate having and listening to our different opinions rather than you come into a reception and you speak to Christine or whoever and then 2 or 3 other people per the entire gallery. Whereas if you have people who come to visit the place and leave their contents, I think it makes the whole experience a bit more worthwhile."*

Participants found it interesting to come back to the museum in the future (when their artcodes are integrated in the exhibitions) due to a number of reasons such as to see other artcodes designs and what other people shared about their game experiences. For instance, pa25 (male, 27) stated:

"I would come back to see what people said about the game I have played. Like imagine a lot of people sit down on Mario and say something that is very much similar to what other people say about it. It would be interesting to see what others said about it." Also, pa22 (male, 24) reported:

"*I think I will come back and have a look and see. I think it would be interesting to see what other people done with their designs and how they visualise their idea.*"

In the following sections, participants' design choices of the artcodes (both the physical and the digital contents) are explained followed by highlighting the main key themes of the audio recordings.

5.5.2.1 Participants choice of hand-drawn versus pre-designed artcodes with/without comment section

From analysing the data, it was found that only nine participants drew artcodes compared with the majority of the participants (31) who chose pre-designed artcodes for their contribution. Creativity and personal involvement in creating the artcodes were the main reasons that motivated those nine participants to choose drawing their artcodes. For example, in the semi-structured interview, pa23 (female, 21) described:

"*I thought it would be quite fun to draw my own and it inspires me to be more creative really. Yeah I wanted to have a go to do my own personal and I would be more involved into the study."*

Most of the participants (31) who selected pre-designed artcodes over hand-drawn artcodes for their contributions reported a number of different reasons behind their selection. The main reason was related to the simplicity of selecting pre-designed artcode over drawing artcodes which does not require spending lot of times to learn how to draw artcodes in addition to having a lack of drawing skill. For example, pa11 (male, 24) reported lack of drawing skill as a reason:

"*I am a game tech, actually I don't know arts which is why I am always very hesitant to oh drawing stuff is something I don't know."*

Pa8 (female, 38) also reported:

"*I am not a terrible drawer. It is just giving so much options. I would be here for hours deciding on best thing to do and it is just like simple we chose the pre made one."*

Of the (31) participants, most of them (17) participants chose pre-designed artcodes without comment section followed by (14) participants who chose pre-designed artcodes with a comment section. The seventeen participants reported that they chose the pre-designed artcodes without comment section rather than with a comment section because it is more immediate as it does not take time to write or draw anything in the comment section. Other reasons were related to the participants' uncertainty of what to draw or write in the comment

section, lack of confidence with handwriting and to avoid writing the same content as in the audio recording. For example, pa9 (female, 21) stated:
"*I didn't know what to draw so I just went with this option. So the audio would be enough to describe what I thought about the game.*"

Lack of confidence with handwriting and limited drawing skill were reported by pa24 (male, 29) saying:
"*My handwriting is also terrible and you wouldn't know what I was trying to write and going for drawing I know you wouldn't know what it was because it just looks like 5 years old drawing."*

In terms of the fourteen participants who chose pre-designed artcodes with a comment section, six participants only drew images in the comment section and the image presented either a video game, game device or logo of a game (see figure 5.9, left) (this was practised by four participants) or the image presented the feeling of the participant about the game and unintentionally one of the images was drawn as an artcode but it is not a valid artcode and it cannot be recognised by the app (figure 5.9, middle and right) (this was practised by two participants). See table 5.1 which represents a summary of participants' options and for more detail information, see appendix D.

Figure 5. 9 Pre-designed artocdes with an image that represents logo of a game (left), feelings about a game (middle) and feelings about a game in an artcode representation (right)

However, five participants only chose to write text in the comment section and in this regard, three of them wrote the same or summarised text of what they had already recorded in the digital content. Whereas the other two participants wrote extra information and comments about a game to complement their audio recordings (figure 5.10).

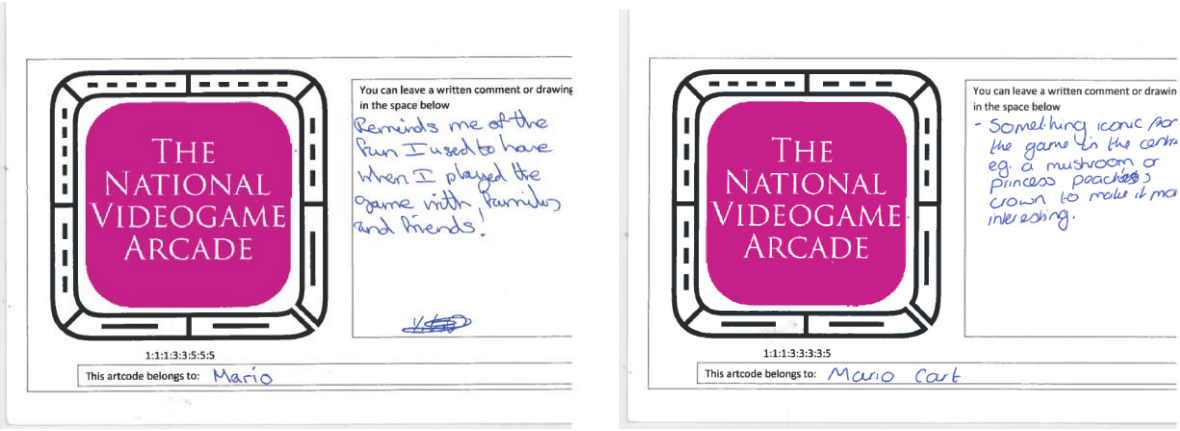


Figure 5. 10 Summarised text of the digital content (left) additional comment about a game (right)

Finally, three participants used the comment section to draw an image of a game or its logo as well as to write a text to represent the name of the game (figure 5.11).

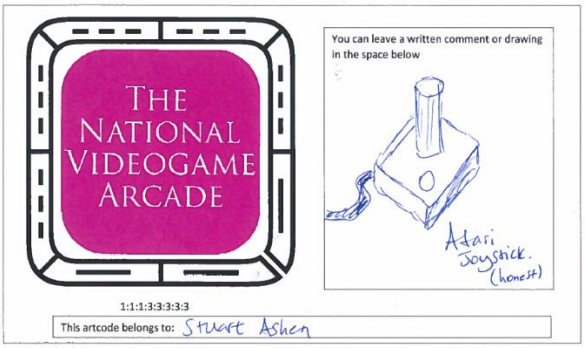


Figure 5. 11 Pre-designed artcode with a mix of drawing and written text in the comment section

In the interview, participants reported the immediacy and personalisation as the main reasons in which motivated them to choose the pre-designed artcode with a comment section as it still allows them to leave a personal touch on it without necessarily drawing an artcode image in the comment section. Pa26 (female, 29), for instance, only wrote a text in the comment section and stated:

"I wasn't feeling very creative to draw and I didn't want to draw as I am not an artist at all. So it is just an easy option I guess because I like to have things chosen before while still allowing me to add my own point."

Pa37 (male, 38) also reported:

"*Well, I am not overall artistic, but having ability to have something already fabricated at the same time being able to leave personal touch can appeal more than trying to create from scratch or having something been completely pre-fabricated. Completely pre-designed is so*

easy which is a great idea, but being also able to leave a personal touch is going to make more yourself than anything else and obviously you pick a name and everything in it."

Total no. of participants	Visual design of artcodes	Type of the comment	Number of participants
17	pre-designed artcodes without comment		
14	pre-designed artcodes with comment	image	6
		text	5
		both image and text	3
9	hand-drawn artcodes		

Table 5. 1 Participants' choices of artcodes

5.5.2.2 Drawing process of the artcodes

Overall, it was observed that it was easy for all the nine participants to draw the artcodes with a simple set of instructions that was provided by the staff on how to draw artcode and the artcode sample that was provided on the table. Participants managed to produce valid artcodes within five minutes. Amongst those nine participants, the youngest participant (pa40, female, 6), who visited the museum with her mother (pa39), was able to draw "my hand" artcode easily.

Participants reported the drawing activity as an easy process with the explanations that were provided to them as pa22 (male, 24) reported: "*I think I understood the concept quite quickly and I followed that through*."

While observing participants, it was noted that a group of three male friends (pa10-pa12) in their 20s, first and immediately chose pre-designed artcodes without comment, however, when the staff explained how to draw artcodes, they changed their mind and started to draw artcodes. In the interview, they were asked about their behaviour and they reported that the drawing process sounded complicated at first however, with the explanation that the staff provided about drawing artcodes, they found it easy to try.

For instance, pa10 (male, 24) stated:

"*At first I was a little bit confused to understand but of course after explanation I decided to try my own design because it gives you more creative freedom and gives you a chance to express your skills."*

However, all the nine participants highlighted the importance of an assistant staff in a museum to teach visitors how to draw artcodes instead of only depending on written instruction as pa23 (female, 21) stated:

"*I think I would need someone to help, it's useful to have people there to help with certain aspects of it. I find it a bit difficult to understand it first how many sections you need it, how many dots or lines you need for each section but when someone explained it to me it was easy to understand.*"

5.5.2.3 Design of the digital contents

Once participants completed drawing artcodes or selected pre-designed artcodes, they started recording their voices in the booth or in the workshop venue using a recording app on the smartphone. All participants successfully recorded their intended audio contents and their length ranged from 6 second to 2.41 minutes. Although the participants were informed about their ability to modify their digital contents, if they wished after leaving the museum, most of them (35) did not take the printed URL for updating their digital contents as they were happy with what they had already recorded. For example, pa13 (male, 30) stated:
"*I am a big believer that if it came to top of my head as I was thinking about a game then it is perfect. If I try over think, it loses all of its original purpose. So you over think and grasp a picture you trying to play, it will get other interfaces or other memories into it. I am happy with one take […] do it."*

On the other hand, only five participants took the printed URL as they showed their interest to modify their audio recordings after leaving the museum. Throughout two months, none of them actually updated their voice records.
All the audio recordings were tailored for public visitors without specifically tailoring for specific person. The content of each audio recording was either about sharing personal experiences associated with the themes of the exhibition or was about commenting on the objects of the exhibition. The majority of the audio contents (33 out of 40) were tailored around the video games and objects that were available in the Gallery Three. Whereas only seven audio recordings were tailored about video games in general without referencing to any particular game of Gallery Three (see Appendix D).
Of the 33 of audio recordings that were tailored for Gallery Three, 31 of them were associated with the pre-designed artcodes compared to only two of the audio recordings that were associated with hand-drawn artcodes. On the other hand, all the seven audio recordings

that were created to share personal experience about video games in general were associated with hand-drawn artcodes.

Overall, the contents of all the audio recordings that were created for the pre-designed artcodes (31) fitted the artcodes representations and this was possible to know from the game name that was written by the participants on the pre-designed artcodes. For example, pa32 (male, 27) wrote the name of "Firefox F7" game on the pre-designed artcode (figure 5.12) and the audio recording was about the "Firefox F7" game:

"*I can remember playing Firefox F7 with Tom Laly when I was probably about 6 or 7 probably Christmas time and it worked out to be a fantastic Christmas*…."

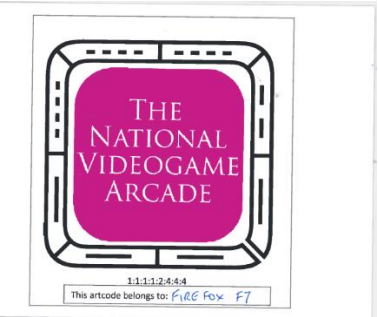


Figure 5. 12 Artcode of the "Firefox F7" game

The design of all the nine hand-drawn artcodes also fitted the content of the audio recordings. For example, pa12 (male, 21) designed an artcode to represent a character of the "Zoo Tycoon" game (figure 5.13) and the audio recording was:

"I grow up playing Zoo Tycoon with my brother on the computer…."

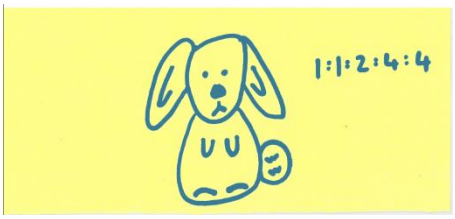


Figure 5. 13 Artcode of the Zoo Tycoon game

Although each of the 40 participants created their own digital content by recording the voices independently, three pairs of couple jointly recorded their voices to discuss their game experiences together. For instance, pa27 (male, 29) and pa28 (female, 28) jointly talked about "Guitar Hero" and created artcodes for it (see figure 5.14), and in the audio recording that belonged to pa28, for example, the couple jointly reported:

"*Pa27:We played guitar hero and you [pa28] are better than me, I don't know how to play because you got rhythm but I don't. pa28: I like guitar hero I prefer the ones with the drums and stuff because I play drums and play guitar. pa27: yeah the drum is so cool….*"

Figure 5. 14 Two artcodes for the same object in the Gallery Three by Pa27-28

5.5.2.4 Participants view about the choice of the audio medium

Almost all participants highlighted audio as the most suitable, easy and straightforward medium to associate with the artcode markers particularly for the NVA setting since it holds a large number of multimedia and visual games. Participants found that audio format complements the visual information conveyed by the markers and at the same time, it enables them to stay physically and visually connected with the video games and objects.

For instance, Pa8 (female, 38) stated:

"*I think audio works fine for here, there is already a lot of visual things going on….*"

Also pa4 (male, 29) reported:

"*Recording voice is the best option according to me because people can listen the exact voices and it is quite fast to record actually, it is just recording your voice one or 2 minutes people can listen whenever they want. If you ask them to write, it may be a bit time consuming…*"

In terms of video format, all participants except (pa20) reported that they would feel uncomfortable to record their own video for the artcodes markers as pa4 (male, 29) stated:

"*Everyone does not prefer to take their own video and see themselves on video. People like me might be shy, I will feel very shy to see myself in a photo or video. So that might be not a good idea for everyone, but some people may prefer… I prefer audio it is easier like you don't need to invest a lot of resources and the person does not know who is exactly the person talking so it is just hearing voices*."

On the other hand, one participant pa20 (male,34) described video as the most suitable medium saying: "*I like recording but better may be video recording. I am convenient with video as we are in Facebook live age*."

Finally, the majority of participants (36) highlighted text as the least preferred format for the digital contribution whereas only four participants described text as a useful medium for the digital content because they did not like to listen to their own recorded voices as pa23 (female, 21) stated:

"*I think I personally would prefer to write down because I don't like my voice recorded*."

5.5.2.5 Main themes of the audio recordings

Overall, only three participants began the audio recording by providing a brief biographical introduction to themselves and providing some background information. For example, pa3 (female, 42) stated: "*Hello, my name is Y…"*

Whereas the other (37) participants started by talking about their experiences straightaway. For instance, pa6 (male, 41) stated:

"*For Little Big Planet, there were two aspects of the game that were fantastic for the time….*"

From the thematic analysis of the transcribed audio recordings, five main themes have been identified for the audio recordings that were created for the video games of the Gallery Three and other video games in general. Three themes which are: **personal experience**, **personal interest,** and **coding experience** were created for both the Gallery Three and the general audio recordings whereas, the themes of **describing game** and r**ecommendation** were only found in the Gallery Three audio contents as explained below (see table 5.2).

Seq.	Main themes	Total number of participants	Participant's ID
Gallery Three	personal experience	16	p5,p7-p9,p16-p18,p21,p24-p31,
	personal interest	8	p12-p14,p23,p32,p33,p35-p36
	coding experience	2	p15,p22
	describing game	4	p6,p19,p20,p34
	recommendation	3	p4,p10,p11
General	personal experience	2	p3,p37
	personal interest	4	p2,p38-p40
	coding experience	1	p1

Table 5. 2 Main themes of the audio recordings

A- Personal experience

The majority of the audio recording contents (18 out of 40) were created by the participants to share their personal experiences, memories and opinions about video games. Of all the

participants, 16 participants shared their personal experiences about particular video games and objects that were available in the Gallery Three. For example, pa31 (female, 26), who chose a pre-designed artcode without comment (figure 5.15), shared her personal experience about Road land game:

"*I played the brilliantly name Road land which is a lot of fun it was nice and easy to play but I found it extremely difficult and I kept dying which is quite embarrassing as a 26 year old woman but I enjoyed very much."*

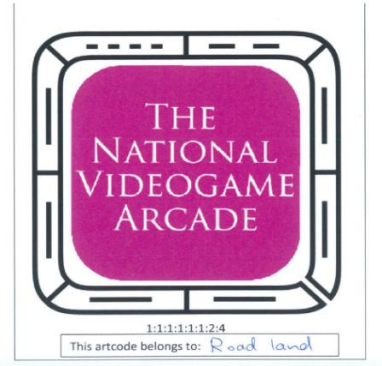


Figure 5. 15 Road land artcode

However, two of the participants created the audio recording to share their personal experiences, memories and comments about playing video and computer games in general without referring back to any video games or objects that were available in the Gallery Three. For instance, pa3 (female, 42), drew a Retro artcode (figure 5.16) and she shared her experience saying:

"*Hello, my name is Natalie and I am going to talk to you about my gaming experience. I remember playing video games when I was really young and the first game I have played was called lemonade stand way back in the eighties on my brother's zx 81 we had a commodore 64 and now gaming with my young son whose 13…."*

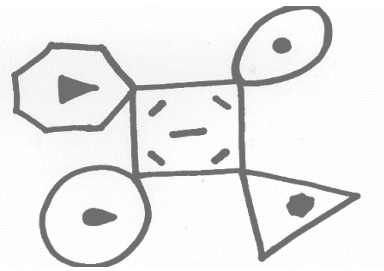


Figure 5. 16 Artcode of a Retro game

B- Personal interest

This theme belongs to all the audio recordings that were created by (12) participants to share their personal interests and favourite video games that they preferred either in their childhood or now and which part or task of the video game was more interesting for them. Eight participants shared their personal interests about video games and the favourite features of video games and objects that were available in the Gallery Three. For example, pa36 (male, 19) chose a pre-designed artcode without comment for the "New Zealand" game (figure 5.17) and he explained his interest about this game saying:

"*When I started playing the game, I thought it was quite interesting I like the art design of the game I like a pixel thing I like how the character was a chicken. I also like the idea that you didn't get hurt when you actually touch the enemies…I like a creature with shell and some other ones I cannot remember well but I like those. I also like how the design of the map, like how it was all about getting higher: you can jump on something, you can use platforms and flying a machine to get high places."*

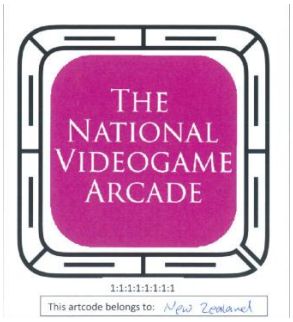


Figure 5. 17 Artcode of New Zealand game

On the other hand, four participants created their audio recordings to share their personal interest and favourite video games in general without referring to the video games that were available in Gallery Three. For example, pa2 (male, 27) designed a controller of a PlayStation as artcode (figure 5.18) and he explained his interest:

"*Hello, its John here and my favourite computer game and device is ps4 and Minecraft. I like Minecraft because its classic it feels real and it got different creatures and I like the ps4 because you get better audio and it is easy to do playing and watching."*

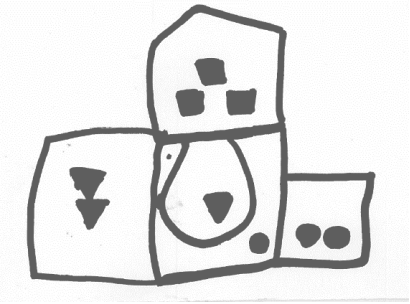


Figure 5. 18 Artcode of a controller of a PlayStation

C- Coding experience

This theme is related to the audio recordings that were created by participants to share their first coding experiences with video games when they were children, what motivated them to write code, and how this reflected on their life. Two participants related their coding experiences with the Gallery Three's video games. For instance, pa15 (male, 37) chose a pre-designed artcode with comment for a "BBC micro" game (figure 5.19) and he stated:

"*Programming on the BBC micro was a little bit interesting doing basic when you're 4 or 5 years old and programming little bit some pieces of some simple flash card type thing or doing some like little biological things, making stars appear on a screen, watching cells multiply. To be entirely honest it really puts me off coding, and now 35 years later guess what I do for living? I write code, all thanks to the BBC basically getting me into using computer and play around.*"

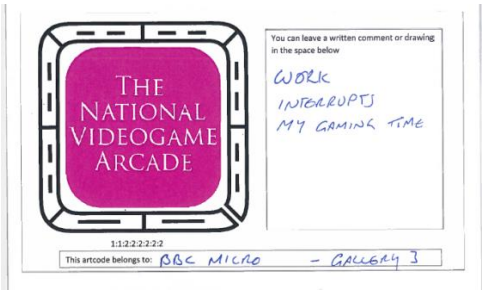


Figure 5. 19 Artcode about BBC Micro game

On the other hand, one participant (pa1, male, 16) described his experience of writing codes using video games in general without referring back to the Gallery Three's video games. Pa1 drew an artcode to represent coding symbols (figure 5.20) and in the audio recording, he stated:

"…*My first coding experiences is in python, I have been using python for two years from my computer in gcse and I think creating a game by coding relates to a culture because it can rich the culture easily by implementing everything about yourself….*"

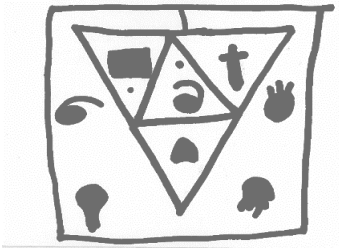


Figure 5. 20 Artcode represents a coding symbol

D- Describing game

This theme represents the audio recordings that were created by four participants in order to describe particular video games that were available in the Gallery Three. More specifically, to describe how the game works, its stages, how it looked like to play it in the past, how it has been developed over time and background information about the company that produced the games. For example, pa20 (male, 34) who chose a pre-designed artcode without comment for the "Mario Bros" game (figure 5.21) and in the audio recording, he stated:

"*Mario Bros is by Nintendo, everybody knows it and in that era Nintendo is a big game industry and Mario Bros is one of their main products. I love it because it's simply has very very varied levels so from level one and there may be almost 10 to 12 levels…Also Mario bros have already been a big character on movie on everything in that era.*"

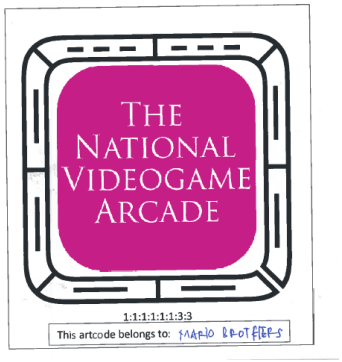


Figure 5. 21 Artcode of Mario Bros game

E- Recommendation

This theme was created based on the audio recordings that were created by (3) participants where they tried to leave their recommendations for future visitors to try playing a particular game that was available in the Gallery Three and/or to leave recommendations and suggestions for game developers to improve issues with the games. For example, pa10 (male, 24) drew an animal face as an artocde (figure 5.22) and recommended the game for future visitors to play it saying:

"*…I played Road land and It's a good game, I recommend it for people to play it."*

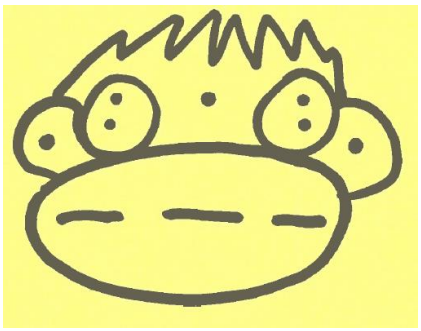


Figure 5. 22 Artcode of an animal face

Alternatively, the recommendation was for game developers to improve the efficiency of the game besides recommending the game for other visitors as pa4 (male, 29) chose a pre-designed artcode with comment section and drew a flower inside the comment section (see figure 5.23) and stated:

"*I would like to suggest to people to play this game. And the thing that it was quite complicated using the board to operate it so I think it should be better if the movement quite faster because actually press the jump it does not jump immediately. There is a lag between when you press the button and the moment where actually things happening…."*

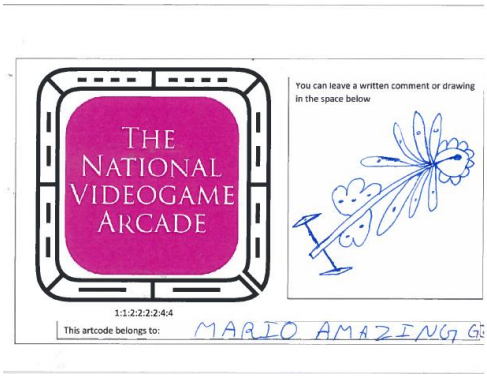


Figure 5. 23 Artcode of Mario game

5.6 Second phase of the study: Exploring the exhibition

Once all workshop sessions of the first phase were completed, all the artcodes (the visual design and their associated audio recordings) were checked by the author to ensure they are valid artcodes (they work) and they do not convey inappropriate contents. All the artcodes were working and no inappropriate contents were created. Next, the author classified the artcodes that were created for the Gallery Three video games or just general game experience by checking the name of the games that were written, by the participants, on the artcodes and checking the contents of the audio recordings.

Once this checking process finished, all the 40 artcodes were given to the NVA staff for integration and after one week, all the artcodes were exhibited. The artcodes that were created for the video games and objects that were available in the Gallery Three, were exhibited in the Gallery Three whereas the artcodes that were created to express more general game experiences were displayed in the Lobby. The curators displayed printed instructions on walls both in the Gallery Three and the Lobby in order to make visitors aware of the displayed artcodes, what they are, how to interact with them and how to download the Artcodes app. In the following section, integrating the artcodes into the Gallery Three and the Lobby are explained in more details.

5.6.1 Integrating artcodes into the Gallery Three and the Lobby

5.6.1.1 Gallery Three

As discussed earlier, the Gallery Three was chosen for this study to enable participants to create their contributions around its games and objects because, according to the curators, it contains a large number of the popular video games and it is a more controlled space. For integrating the contributions that were made for the Gallery Three video games and objects, the curators decided to exhibit them by themselves in the Gallery Three as they were keen to retain control over displaying them.

Although (33) artcodes were created for the video games and objects of the Gallery Three, only (28) of them were displayed in the Gallery Three and the rest (5) artcodes were displayed in the Lobby. The curators were asked about this, in a discussion meeting, and they mentioned that those (5) artcodes were created for video games or objects that are not available in the Gallery Three anymore thus they displayed them in the Lobby.

From those (28) artcodes that were displayed in the Gallery Three, most of the artcodes (19) were displayed in the main exhibition room (figure 5.24) followed by five artcodes that were displayed in the second exhibition room (figure 5.25, left), three artcodes in the third room (figure 5.25, middle) and finally one artcode in the fourth exhibition room (figure 5.25, right). This exhibiting method seems like linking the exhibition rooms together, which can provide visitors a trajectory path.

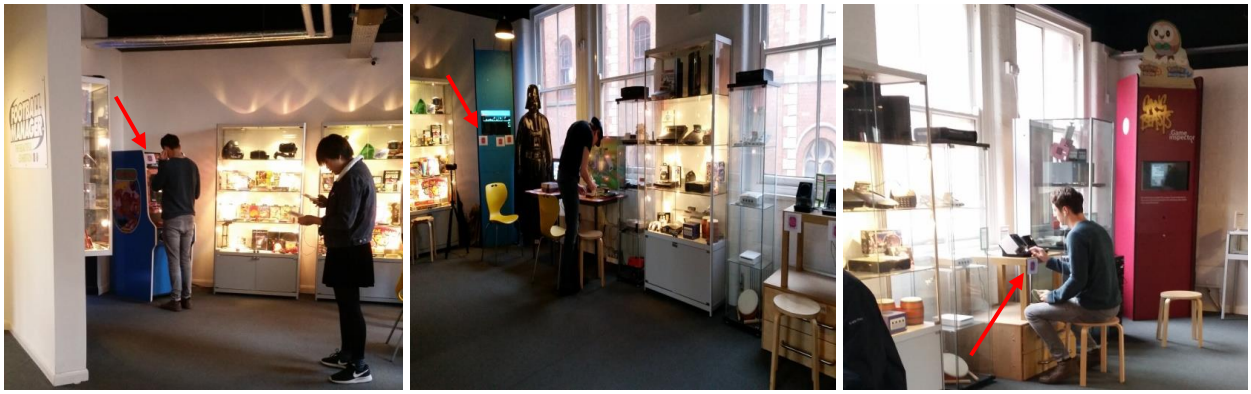


Figure 5. 24 Displayed artcodes in the main exhibition room in the Gallery Three

Figure 5. 25 Displayed artcodes in the second exhibition room (left), third exhibition room (middle) and fourth exhibition room (right)

Of the (28) artcodes, the majority of the displayed artcodes (17) were pre-designed artcodes without comment followed by (10) of pre-designed artcodes with comment and only (1) hand-drawn artcodes (table 5.3).

Visual representations of artcodes	Main room	Second room	Third room	Fourth room	Total
hand-drawn artcodes		1			1
pre-designed artcodes without comment	13	3		1	17
pre-designed artcodes with comment	6	1	3		10
total number of artcodes	19	5	3	1	28

Table 5. 3 Number of the displayed artcodes across the Gallery Three rooms

The curators used four different methods for displaying artcodes close to their video games and objects in the Gallery Three which are table of the game, game arcade, wall and glass cabinet. Of the (28) displayed artcodes in the Gallery Three, most of the artcodes (15) were displayed on tables that the games were located on both the main exhibition room and the second exhibition room since there was no wall near those games (figure 5.26, top left). Six

artcodes were displayed on the game arcade in the main exhibition room (figure 5.26, top right) followed by four artcodes that were displayed in plastic frames that were already placed on the wall in the third exhibition room (figure 5.26, bottom left). Finally (3) artcodes were displayed on the glass cabinets in the main exhibition room since they were belonging to the objects that were inside these glass cabinets (figure 5.26, bottom right).

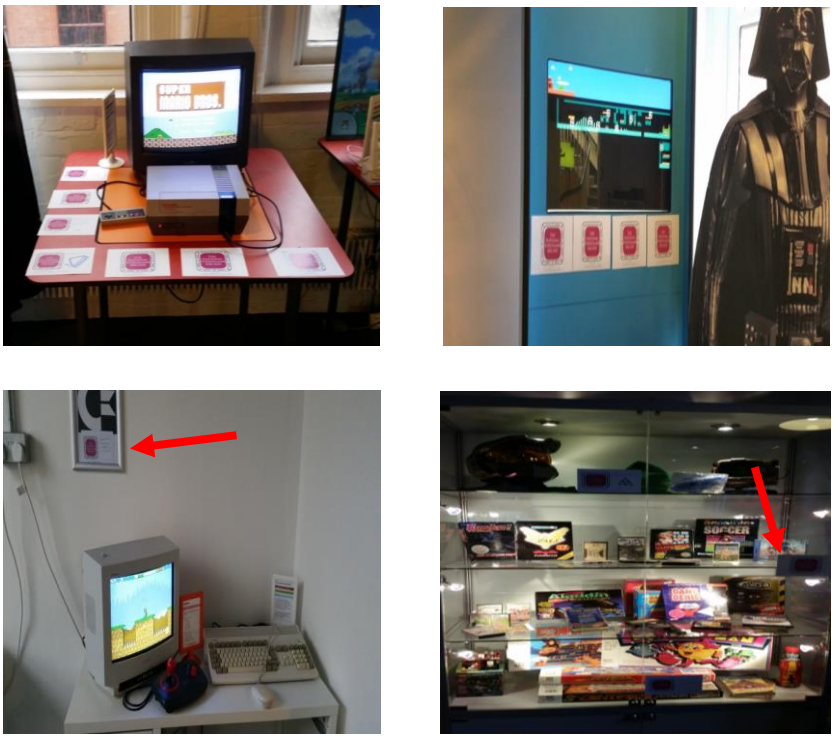


Figure 5. 26 Displayed artcodes on a table (top left), game arcade (top right), wall (bottom left) and on cabinet (bottom right)

The curators reported that they displayed artcodes close to their objects in order to enable visitors easily to know which artcodes belong to which video games or objects. Regarding the four different methods for displaying artcodes (on table, arcade, wall and cabinet), the curators reported that the availability of the physical space was the only reason behind their choices for these four different methods particularly tables as it could be a fragile place for displaying artcodes or visitors may remove them. Staff-1 (female, 33) stated:

"*It's just because if somebody want to scan a Guitar hero down in gallery 2 it might get people confusing oh it says guitar hero do you have a guitar hero here…but if it is just next to the actual object so they see it and play it so it will be really convenient. Also, the things that we look at are they on eye level, are they in front of the game, are they in a control something we can look at but the way we placed them was not strategic it was just the closest spaces we had. Just the space, there wasn't any particular thought to put them, it is just they are near to*

where the objects are. Table would be an issue. The issue that we have with Mario there is nothing else like a wall, but if you want to place on a window that is quite far away so it needs to be obvious within eye-sight. So yeah I would consider maybe if table, something like a pro lamination I think lamination probably will be a key where you can display them close so it would keep them quite clean basically."

5.6.1.2 Lobby

The curators used a wall in the Lobby for displaying all the seven artcodes that were created to share personal game experiences in general, without referring to specific games that were available in the Gallery Three. In addition, they also displayed the other five artcodes that were created for the Gallery Three video games but the games were not available there anymore which resulted in displaying 12 artcodes in total (see figure 5.27 and table 5.4).

Figure 5. 27 Displayed artcodes on a wall in the Lobby

Design representations of artcodes	Total
hand-drawn artcodes	7
pre-designed artcodes without comment	2
pre-designed artcodes with comment	3
total number of artcodes	12

Table 5. 4 Number of the displayed artcodes in the Lobby

The curators reported that the reason behind displaying the general artcodes in the Lobby and on the wall was because those artcodes were created for sharing experiences about games that were not available in the in the Gallery Three and also to allow those visitors that have not paid to be involved in interacting with artcodes. Staff-1 (female, 33) stated:

"*It was two reasons. One obviously I think is to not put in the gallery, if someone said oh have you got a specific game and we don't have it. So it would cause confusion because of the game. Secondly, it's another way to get people who have not paid for to be involved in the study or be involved in the gallery so it is a free space and the people in the lobby had*

literally just come in, don't know why they are there. And they are able to be involved in a study and also to listen to some stories and that might get them into the galleries."
The curators displayed all the three visual representations of artcodes in an order on a wall to make them attractive so that visitors could scan them as staff-2 (female, 23) stated:

"*So basically what it was, I separated them into 3 different types. So we have the drawings we have ones without a little comment and ones with the comment I separated them out and put them in order to look visually appealing. Some of them were done on yellow papers some of them on white paper, so having all the yellow ones in one column and white ones on the edge it is just separating them just to look visually appealing.*"

Once all the artcodes exhibited at the NVA for public view, both in the Gallery Three and the Lobby, the second phase of this study began which was about recruiting new groups of the NVA visitors, who have not been introduced to the artcodes before, to take part in the study. The phase was designed to focus on visitors' engagement with the displayed artcodes both in the Gallery Three and the Lobby.

5.6.2 Participant background, recruitment and data collection

In total, 46 participants (29 male, 17 female) took part in the studies that ran over 11 days of observations in the Gallery Three and the Lobby. Nine of the participants were aged (9-19), 19 were aged (20-29), 11 were aged (30-39) and 7 were aged (40-49). The majority of participants were partners or romantic couples (20 participants (10 pairs), 13 were family and friends group and 13 were single. Amongst the 46 participants, 19 participants took part in the Gallery Three studies (14 male, 5 female) over 5 days of observations. The majority of them (7) were friends followed by 6 participants who were companied by their partners. Four participants were single and only 2 participants were a family member (brothers visited with their father). Following this, six days of full observation studies were carried out at the NVA to observe how another group of participants interact and engage with the displayed artcodes in the Lobby. Twenty-seven participants (15 male, 12 female) took part in the Lobby studies and the majority of them (14) were in couples (7 pairs), followed by 9 participants who were single and 4 participants who were friends. Table 5.5 shows background information about participants.

Gallery Three

Seq.	Participant ID	Gender	Age	More Information
1	pb1	Male	19	couple
2	pb2	Female	19	couple
3	pb3	Male	25	single
4	pb4	Male	12	family
5	pb5	Male	9	family
6	pb6	Male	31	friends
7	pb7	Male	32	friends
8	pb8	Male	19	couple
9	pb9	Female	19	couple
10	pb10	Male	24	couple
11	pb11	Female	24	couple
12	pb12	Male	24	friends
13	pb13	Male	27	friends
14	pb14	Male	24	friends
15	pb40	Male	46	single
16	pb41	Female	34	single
17	pb42	Female	40	single
18	pb43	Male	21	friends
19	pb44	Male	21	friends

Lobby

Seq.	Participant ID	Gender	Age	More Information
1	pb15	Male	32	couple
2	pb16	Female	42	couple
3	pb17	Male	35	single
4	pb18	Male	43	single
5	pb19	Male	19	friends
6	pb20	Male	19	friends
7	pb21	Male	38	single
8	pb22	Male	31	single
9	pb23	Female	33	single
10	pb24	Male	24	couple
11	pb25	Female	24	couple
12	pb26	Male	26	couple
13	pb27	Female	26	couple
14	pb28	Female	40	single
15	pb29	Female	23	friends
16	pb30	Female	20	friends
17	pb31	Male	25	couple
18	pb32	Female	23	couple
19	pb33	Male	38	couple
20	pb34	Female	32	couple
21	pb35	Male	31	couple
22	pb36	Female	29	couple
23	pb37	Male	20	couple
24	pb38	Female	20	couple
25	pb39	Male	40	single
26	pb45	Female	11	single
27	pb46	Male	43	single

Table 5. 5 Participants of the Gallery Three and the Lobby studies

All the 46 of the participants were recruited by approaching them physically in the gallery, advertising on the NVA website and their social media. However, four of the participants pb(17,28,p35,p36) reported that before the author approach them and introduce the study to them, they looked at other participants' activities and they had interests to explore what those participants are doing but they were not sure exactly until the study was explained to them by the author (see figure 5.28).

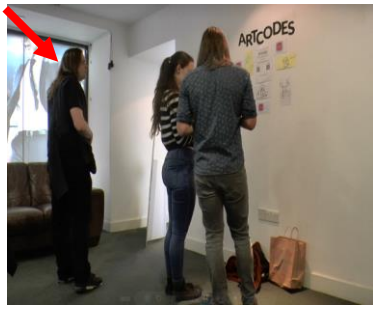


Figure 5. 28 Before participating in the study, (pb35 in the left) is looking at other participants

Once participants arrived, they were briefly introduced to the exhibition, the aims of the study followed by requiring them to complete a consent form and they were provided with smartphones, pre-installed with the Artcodes app, and headphones. Participants were allowed to freely explore the exhibition (with author available to offer assistance if needed) and this was followed by conducting a semi-structured interview with participants after completing their interaction to understand their experiences and views on artcodes in the Gallery Three and the Lobby settings.

Participants were observed and video recorded from a further distance. The aims of observations and video data for both the Gallery Three and the Lobby were similar in terms of finding out how participants approach and engage with different visual representations of artcodes and what kind of social communication might happen. In addition, it was important to find out how participants behave while listening to the audio contents both in the Gallery Three and in the Lobby because in the Gallery Three, most of the objects themselves were interactive objects (video games) which engage participants to interact with them. Whereas, in the Lobby the artcodes are displayed on a wall without having any interactive objects (video game).

5.6.3 Data analysis

The video recordings of participants were analysed by watching them carefully to understand in depth about participants' engagements, experiences and behaviours while using artcodes, how they approached and scanned artcodes, what influenced their scanning preference, how different displaying approaches of artcodes affected their scanning behaviours, what they did while listening to the audio recordings and how they communicated with their mates (if not visited alone). Also, the data of the video records was analysed in conjunction with the transcribed data of the semi-structured interview in order to understand visitor interactions and behaviours further from what was seen during the observations and what participants thought and said about their visit experiences. Following this approach, it was possible to

build an understanding of participants' engagements, interactions and behaviours towards artcodes, audio recording and each other.

To explain the analysis procedure in more depth, first, the analysis started by watching video recordings for each participant several times and writing down all the observed behaviours in terms of scanning artcodes, listening to the audio contents, what they were doing while listening, how many artcodes have they scanned, how many rooms have they visited in the Gallery Three and which artcodes visual representation have they scanned more. In addition, how long does it take for each participant experience and how they behaved with their partners. All these behaviours were written (recorded) for each participant whenever it was possible as well as screenshots were made. Following this approach allowed to have a story for each participant experience during their interactions in the Gallery Three and the Lobby.

The second step of the analysis began by looking at the photographs that were taken during the observations and looking at the field notes to add any more information to the participant visit story. After having detailed information about the above two steps of the analysis, the author drew a map diagram of the main themes from the notes and what were the common behaviours amongst participants. Finally, it becomes possible to have a set of themes for each of the Gallery Three and Lobby studies.

5.6.4 Findings

In general, participants scanned between (10-20) artcodes and they spent about (50-60) minutes in the Gallery Three and (30) minutes in the Lobby exploring the different artcodes, artefacts and interact with the digital contents. In the interview, almost all participants, except pb23, were positive about their experiences of being able to listen to other visitors' comments and opinions from scanning their physical representations. However, they highlighted that curators' interpretations would work better if the actual content of the interpretation was about adding more information to the exhibited objects. For instance, pb24 (male, 24) stated:

"*If it is information about a specific exhibit then it might be better to have a staff member, but it is interesting to listen to other visitors' comments."*

Pb43 (male, 21) also supported pb24's view saying:

"*It's very interesting like hearing everyone, different thoughts, how they played games. It is more personal than just hearing one person talking about one thing."*

In addition, the participants who interacted with the artcodes that were displayed in the Lobby, described the content of the audio recordings quite engaging as they were a mix of personal game experiences of visitors in general or in relation to specific video games. For instance, pb16 (female, 42) reported:

"*I like both, because I think I would get a little bit boring if they all just like, oh my favourite game is this. I think it is good to have a personal story or just yeah comments in general like those for the football manager one where the guy was talking about Indonesia but he said his team or his country cannot play world cup. He said I can play in football manager as his team can play which is kind of nice because that is something new for me."*

Most of the participants (13) in the Lobby preferred the contributions that were made by visitors to share their personal game experiences in general without referring back to a particular game. For example, pb29 (female, 23) said:

"*I prefer them to talk about games in general, because not everyone knows the game that is being talked about and also if I hear a game I don't particularly like it I will switch it off immediately and just say no.*"

On the other hand, only (3) participants described the digital contents that were created to refer back to specific games more interesting as it allowed them to know about people's experiences of specific games and how they played them. Pb18 (male, 43) explained this:

"*I think probably hearing somebody else personal experience of a game probably is interesting to see how the people's views were during the time that they played those games for years."*

However, one of the participants (pb23 female, 33) preferred the curator interpretations since she prefers more structured and compact interpretations:

"*Everybody goes to museum for different reasons, has different time frames and different distractions going on. So as me as an individual if I have to go through it will be very time consuming actually and sometimes you have limited time so I think it depends on the individual. For me personally I am not sure I would necessarily listen to these things unless they are from the museum.*"

Regarding the Artcodes app and using it, all participants found it easy enough to use it and retrieve the audio contents easily. Most of the participants (32) showed their interest in being

able to be involved personally, in future, to create their own contributions using artcodes and leave them to the public view. For example, pb8 (male, 19) stated:

"*I would add something to the experience add another level of comments and enjoyment. So this experience adds value to someone else as well. With this experience you get more subjective from someone you don't know*."

5.6.4.1 Participants' feedback about display approaches of artcodes

All participants engaged with the way that the artcodes were displayed in the Gallery Three and the Lobby. Participants of the Gallery Three studies described displaying artcodes next to the objects as a structured, convenient and more organised in which it gave an immediate idea of which artcodes belong to which games. Whereas displaying them all in one place would not be engaging for scanning them because they would not know which artcodes belong to which video games unless they scan the artcodes and listen to the audio contents. In addition, displaying in one place results in shifting visitors focus away from the exhibited video games and objects which are the main reasons for visiting the gallery. For example, pb12 (male, 24) reported:

"*Definitely on the machine because if it is on a wall then you go to find the corresponding machine and in this way when it is on a fixed wall there you don't know which game actually is talking about. If on the wall, you get distracted about all the codes as you need to go back to the wall. So it is better to set up in that way I think than being on a wall so when you walk around you will be distracted by other games and you would go back to the wall to find out more about games."*

Pb9 (female, 19) also stated:

"*I like they all are near the game they talk about it. It's easy to connect the two together then."*

Participants of the Lobby studies also appreciated displaying artcodes all on one wall and found it interactive in the Lobby setting since there is no video game or object there and while waiting in the reception, participants can interact with new experiences of listening to visitors' contributions.

5.6.4.2 The main themes of the findings

From observing participants in the Gallery Three and the Lobby, three main themes were identified for both settings which are: **motivations for scanning artcodes**, **exploring audio contents** and **social behaviours.** However, because the setting of the Gallery Three, which includes a large number of interactive video games, is different from the Lobby where no

video game are available, it was decided to represent the themes for each setting separately (see table 5.6). The themes are discussed in more details in the following sections:

Seq.	Main themes	Setting	Sub-themes	Sub-sub themes	Number of participants
1	Motivations for scanning artcodes	Gallery Three	exploring most of the exhibit objects		19
			exploring the preferred video games		4
		Lobby	visual representations of artcodes		26
			recommendations		10
			preferred game		9
2	Exploring audio contents	Gallery Three	approaches for accessing audio contents	by scanning artcodes	19
				from audio page	2
			behaviours while listening to audio contents	look at the artcodes, games and phone	3
				play game	2
				mix of looking at artcodes, games, phone and playing game	14
				look at partner's activity	4
				walk while listening	3
		Lobby	behaviours while listening the audio contents		27
3	Social behaviours	Gallery Three	stay together throughout the visit		10
			start individually followed by re-joining		5
		Lobby	verbal and non-verbal interaction		20
			share headphone		2
			recommendations		10

Table 5. 6 Main themes and sub-themes of the findings of the Gallery Three and the Lobby

1- Motivations for scanning artcodes

In the Gallery Three

Due to the different video games and objects that were available in the different exhibition rooms in the Gallery Three and the different methods of displaying artcodes, participant's motivations for visiting exhibition rooms and what they scanned in those rooms were varied. The main motivations for scanning artcodes were based on: **exploring most of the exhibit objects** and **exploring the preferred video games** as explained below.

A- Exploring most of the exhibit objects

It was observed that all the participants tended to visit different exhibition rooms as they had an interest to explore and interact with the objects and video games that were exhibited in all the exhibition rooms. As a result of their interactions, they also engaged with the artcodes to scan them and reveal their associated audio contents. Overall, all the 19 participants scanned at least 4 artcodes or all of them and they all scanned artcodes in the main exhibition room. However, only 11 participants had followed a sequential path to visit the other exhibition rooms for scanning artcodes in addition to the main exhibition room. Of those 11 participants, 10 participants visited the second exhibition room and scanned artcodes in there, 2 participants also scanned artcodes in the third exhibition room and finally only one participant scanned the artcode in the fourth exhibition room.

Therefore, it can be said that only (2) participants followed scanning all the displayed artcodes all over three exhibition rooms. Table 5.7 shows participants' trajectories for visiting and scanning artcodes across the four exhibition rooms in the Gallery Three.

Participant ID	**Exhibition Rooms in Gallery Three**			
	Main room	**Second room**	**Third room**	**Fourth room**
pb1	*	*		
pb2	*			
pb3	*	*		
pb4	*			
pb5	*			
pb6	*			
pb8	*	*		
pb9	*	*		
pb10	*			
pb11	*			*
pb12	*	*		
pb13	*	*		
pb14	*	*		
pb40	*			
pb41	*			
pb42	*	*		
pb43	*	*	*	
pb44	*	*	*	

Table 5. 7 Participants' trajectories for visiting and scanning artcodes across the four exhibition rooms in the Gallery Three.

For example, a couple (pb8 male, 19 and pb9 female, 19) visited two exhibition rooms in the Gallery Three and they scanned around 14 artcodes in the main exhibition room and all five

artcodes in the second exhibition room. They first started to scan one of the artcodes of the Mario game in the main exhibition room and for this purpose, they used one phone and shared the headphones together (figure 5.29, left). They started to listen to the audio content and to look at the game at the same time and once the audio content finished, they both removed the headphones and started to play the Mario game. After around (4) minutes, they moved to scan artcodes on the game arcade in the same exhibition room and each of them used a phone to scan the artcodes followed by scanning artcodes on the arcade (figure 5.29, middle). Subsequently, they both moved to the second exhibition room to scan artcodes in there and play the games after finishing listening to the audio contents (figure 5.29, right). In the interview, Pb8 explained their behaviours saying:

"*We wanted to see objects in the other rooms and to listen to what other people said about the games in those rooms as well.*"

Figure 5. 29 The couple are scanning artcodes in the main exhibition room (left and middle) and in the second exhibition room (right).

B- Exploring the preferred video games

It was observed that in addition to exploring the artcodes of different video games, four participants explicitly chose to interact and scan the artcodes that were related to particular games that they were interested in. Thus, these participants' approach for scanning artcodes was more purposely rather than exploring different games and artcodes.

For instance, pb7 (male, 32) followed this approach as he scanned all the seven artcodes, that were associated for Mario game, sequentially in the main exhibition (figure 5.30, left) and started to play Mario game while listening to the audio contents (figure 5.30, right). In the interview, he was asked about his behaviour and he reported:

"I really like Mario game too much and wanted to play it, so I wanted to listen to what the others said while I was playing it."

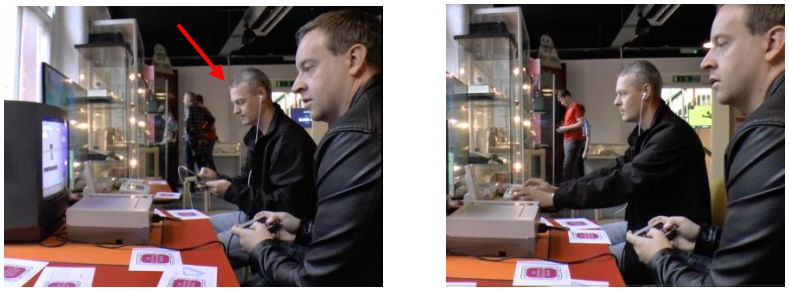


Figure 5. 30 Pb7 scanning an artcode of Mario game (left) and playing the game while listening (right)

In the Lobby

It was observed that (9 out of 27) of the participants scanned all the (12) displayed artcodes in the Lobby whereas the rest (18) participants scanned around (3-8) artcodes. In addition, the majority of participants (23 out of 27) started their first scanning with hand-drawn artcodes whereas only (4) participants started their first scanning with the pre-designed artcodes with comment and none of the participants started by scanning the pre-designed artcodes without comment. The key point of the observation was to find out what motivated participants to scan artcodes and which visual representations of the artcodes attracted them more. Participants' approaches for scanning artcodes in the Lobby were influenced by three main factors which are: **visual representations of artcodes, recommendations** and the **preferred game**. Each of these three factors are described below:

A- Visual representations of artcodes

The visual representations of artcodes were the main factor for encouraging and influencing most of the participants (26 out of 27) to choose which artcodes to scan (see table 5.8). It was observed that the majority of the participants (14 out of 27) chose to scan mix of the three design representations of the artcodes (hand-drawn and pre-designed artcodes with/without comment). The participants reported the reason for the mix scanning was that they had interests to explore the digital contents of the different designs of the hand-drawn artcodes and also to explore the digital contents of the games that the participants were interested in, as the game names were written on the pre-designed artcodes. For example, pb37 (male, 20) stated:

"I was attracted to the drawing rather than the logo, I thought it was a bit more creative. I scanned both, but I probably scanned out the drawing and then I scanned the logos, I know it has a title on it so I just go to do it based on the game that I liked most."

For example, a couple (pb24 male,24- pb25 female,24) started their experiences together by scanning almost all the displayed artcodes (hand-drawn and the pre-designed artcodes) on the wall. Pb25 started her experience by scanning the hand-drawn artcodes (figure 5.31, left) followed by scanning the pre-designed artcodes (figure 5.31, right) as she was attracted by the different visual design of the artcodes as well as the name of the game that was written on the pre-designed artcodes:

"I did the drawing first because I thought they are cool. Then, I liked to look what they said underneath so the guitar hero, oh, I played the game and then listen to that one."

Figure 5. 31 Pb25 is scanning the hand-drawn artcodes (left) followed by scanning the pre-designed artcodes (right)

Scanning only the hand-drawn artcodes was the second most followed approach by almost 12 participants, as they wanted to reveal the digital contents behind the variety and distinctive designs of the hand-drawn artcodes without trying to scan the pre-designed artcodes. For instance, pb27 (female, 26) stated:

"*I was more attracted by the visual definitely much more about the picture I think drawings are cool. I didn't even notice names or read them on the logo so just pictures.*"

Pb23 (female, 33) also had the same behaviour and reported:

"*Logo didn't really stand out very much to be honest, the other ones visually the hand-drawn ones stand out a lot more to me. It just was unappealing they all look the same and they all a little bit boring actually they were not very engaging. The thing is that it stands out as the NVA rather than what they are actually.*"

An example of this scanning approach was observed when pb22 (male, 31) only scanned all the hand-drawn artcodes one after one without scanning any pre-designed artcodes (see figure 5.32) and he stated:

"*I just wanted to see something about the pictures; some of them looked a little bit strange. So I was specifically going to the pictures. I found the pictures so attractive.*"

Figure 5. 32 Pb22 is scanning only the hand-drawn artcodes and interact with their audio contents

However, only one participant did not scan any hand-drawn artcodes, instead, he scanned the pre-designed artcodes with comments followed by scanning a few of the pre-designed artcodes without comment because he was inspired by the name of the games that were written on the pre-designed artcodes. Overall, almost all the participants who scanned pre-designed artcodes, they reported that they preferred the pre-design artcodes with the comment section (either with written text or drawing) more than the pre-designed artcodes without comment section. This was because they thought that the written text or drawing in the comment section delivered more personalised touch to them which motivated them to explore what contents could be accessed from scanning them. In addition, most of the written text on the pre-design artcodes represented the game names in which the participants have already had interest in and wanted to explore what their digital contents are about. For example, pb30 (female, 20) reported:

"*I didn't scan the one without drawing or comment really. I think its nice having like personal thing, it shows you tells you something about the person.*"

In addition to the above reason, participants described that the standard design of the pre-designed artcodes enabled them immediately to recognise them as a scannable item since most of them were familiar with the QR codes. For instance, pb16 (female, 42) stated:

"*I just scanned all the NVA stickers the logo ones and they are similar to QR and there was like a layer which is actually about scanning pictures so I think the pictures on the logo were really nice, but I think it might be hard for people to recognise they can be scanned."*

However, about 15 of the participants described the pre-designed artcodes without comment section less attractive as they seem like QR codes as pb35 (male, 31) stated:

"*If it is just a QR code and nothing in it, I do not necessarily scan it, but if it gets a picture I know it then may be worth scanning it*."

Scanning artcodes options	**Total number of participants**	**Participant ID**
mix scanning of all the three artcodes designs	14	p15,p16,p24,p25,p27,p29,p33-p39,p45
hand-drawn artcodes	12	p17,p19-p23,p26,p28,p30-p32,p46
pre-designed artcodes with/without comment	1	p18
total	27	

Table 5. 8 Number of different artcode designs that were scanned by the participants

B- Recommendations

In addition to the visual representation of artcodes, it was observed that ten participants also scanned artcodes based on the partners' suggestions. More particularly, during participants' engagement with the audio contents, when they found particular audio contents interesting, they started to suggest to the companion to scan the artcodes that related to the audio content by pointing to that particular artcode and started to talk about it with the partner. This approach of scanning was observed amongst 5 couples/friends (pb24-pb25, pb26-pb27, pb29-pb30, pb33-pb34, pb35-pb36) and the suggestions for scanning artcodes were made more than one time (between 2-3 time) between each couple.

For example, pb29 (female, 23) enjoyed listening to the audio content of "My hand" artcode thus she pointed to it and recommended her friend (pb30 female, 20) to scan it (figure 5.33, left) saying: "*The one with the little kid is so good and so nice, scan it.*". In response, (pb30) scanned "My hand" artcodes (figure 5.33, middle) and started to listen to the audio content and laughing (figure 5.33, right) saying: "*Yeah, I think we both like the one by the kid.*"

Figure 5. 33 Pb29 is pointing to an artcode and suggesting it to pb30 (left), pb30 scanning the suggested artcode (middle) and laughing while listening to the audio contents (right)

In a few cases in the middle of the participants experiences, it was observed that for both couples (pb24,pb25) and (pb29,pb30), without suggesting any artcodes to be scanned or without pointing to any artcodes and talk about them, the partners of the member of these two groups were replicating the partner activity by scanning what they have already scanned in order to listen to the audio contents. This might happen because the participants were seeing their partners engaged with the audio contents and were laughing or smiling while listening to the digital contents which motivated them to replicate by scanning the same artcodes and interact with their associated audio content.

C- Preferred game

Of the participants who scanned the pre-designed artcodes, nine of them scanned specific artcodes that were related to particular video games that the participants had interest in and this was possible to know from the game name that was written on the pre-designed artcodes. For instance, pb24 (male, 24) explained:

"*I recognised the game so it was a logo of a game. I did care about the game name, yeah, make me pay my attention to it so I scanned it.*"

Pb18 (male, 43) was the only participant who did not scan hand-drawn artcodes (based on visual representations), instead he only scanned the pre-designed artcodes in which he recognised the name of the games that were written on the artcodes and that he was interested in those games (figure 5.34). In the interview, he mentioned that he followed this approach because he used to play those games in childhood thus the name of the games on the pre-designed artcodes enabled him to easily pick up which one to scan as he reported:

"*I did Pacman and Sonic. So it was more about looking at things I recognise to see what has been said about it I guess. I did probably play it when I was young I started playing Pacman probably when I was about 6 or 7…Yeah it was more about looking at things I recognise to see what has been said about it.*"

Figure 5. 34 Pb18 (on the right) is scanning the pre-designed artcodes

2- Exploring audio contents

In the Gallery Three

Participants had different approaches for accessing the audio contents of the artcodes and different behaviours were identified during their interactions with the audio contents. In addition, the interview data revealed participants view about using audio as a format for the digital contents. Each of these aspects are explained below in more details.

A- Approaches for accessing audio contents

For retrieving any digital contents of artcodes, users are required to scan artcodes which is a typical way for accessing audio contents from artcodes that was practised by all the (19) participants. However, a couple (pb10,pb11), beside retrieving digital contents by scanning artcodes, they also accessed the digital contents of the Mario game artcodes by clicking on the audio recordings that were presented in the webpage that was used for playing the audio contents. This approach was used because in the webpage where the audio recordings were located, the most five recent audio recordings that were played previously by the same user or other users were displayed (figure 5.35).

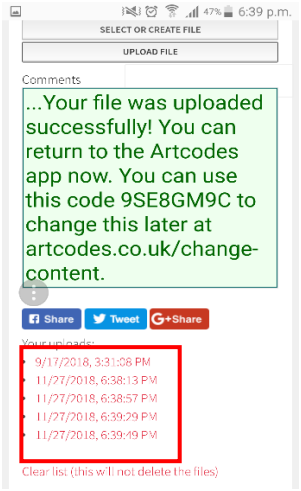


Figure 5. 35 Five most recently played audio contents appear in the webpage

For example, pb10 first accessed an audio recording by scanning artcode of the Mario game then he started to click on the audio recordings in the webpage without scanning more artcodes (figure 5.36, left) and listen to it while playing the Mario game (figure 5.36, right). Meanwhile, his partner (pb11) was close to him and she was observing him so she started to replicate him to access the audio contents in the same way. Although this approach can still provide visitors access to the contents, the visitors will not be able to know exactly the audio content that is accessed in this way belongs to which artcodes until they listen to the audio content.

This approach for accessing digital contents might be practised by those two participants because they were playing Mario game and they may wish to continue on playing it and at the same time to listen to the digital contents of artcodes that were available for the Mario game. Thus, they wanted to access other digital contents using this quick approach without necessarily scanning artcodes.

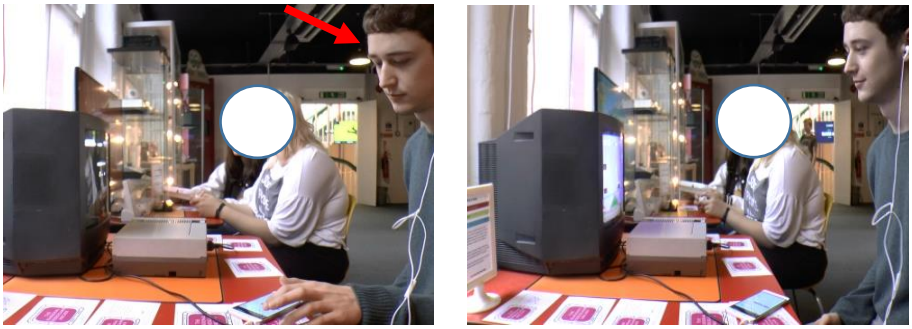


Figure 5. 36 Pb10 is clicking on one of the audio contents (left) and started listening to it while playing (right)

B- Behaviours while listening to audio contents

While participants were listening to the audio contents of the scanned artcodes, **five** different behaviours were observed which are**: look at the (artcodes, games and phone screen)**, **play game**, **mix of looking at artcodes, games, phone and playing game**, **look at partner's activity** and **walk while listening.** In this regards, participants behaved either in the same way throughout their visit or they behaved differently each time.

Three participants (pb8,pb43,pb44) started to look at artcodes, games or phone during listening to the audio contents and once they finished listening, they started to play the game or to scan another artcodes. For example, two friends (pb43 male, 21, pb44 male, 21) started their experiences together and they were listening to the audio content of each scanned artcodes and at the same time, they were looking at the artcodes, game or phone screen (figure 5.37, left). After they completed listening to the audio content, they both moved to the second exhibition room to scan other artcodes and behaved in the same way while listening to the audio contents (figure 5.37, middle) followed by playing the game after finishing listening to the audio content (figure 5.37, right). In the interview, they were asked about the reason for not playing while listening to the audio content until they finished listening to the audio content, they both reported that they found it as a distraction to listen and play at the same time as pb44 explained:

"*I get distracted a little bit. So wanted to listen and then try playing and this was really nice.*"

Figure 5. 37 Two participants are looking at the artcodes, game and phone while listening to the audio content (left), same behaviour observed (middle), playing games (right)

However, two participants (pb7,pb12) behaved similarly from the beginning of their experiences until the end as they played games while they were listening to the audio contents. For instance, pb7 (male, 32) was companied by his friend pb6 (male, 31) and he spent most of his time on playing the Mario game. While pb7 was playing Mario, he was

scanning all the artcodes that were placed on the Mario table and he was listening to them at the same time (figure 5.38).

Figure 5. 38 Pb7 scanning artcodes and listening to the audio contents while playing game

The majority of participants (14) had a mix of the above behaviours as they started to look at the artcodes, games, phone or to play games during listening to the audio content. For example, when pb3 (male, 25), who visited the gallery alone, was listening to the audio contents, he was either watching the artcodes, game, phone or he was playing the game and he had this behaviour throughout his experience (figure 5.39). Pb3 explained his behaviours in the interview saying:

"I enjoyed listening to the visitors' stories when I started to play the game but sometimes I also looked at the artcodes because I wanted to focus on the recordings. I think audio recording works well because it allows you to behave as you want really."

Figure 5. 39 Pb3 is looking at the phone while listening to the audio content (left) and playing a game while listening to the audio contents (right)

It was noticed that occasionally, during listening to the digital contents, four of the participants (pb6, pb10, pb11, pb44) were watching their mates' activities as they were playing games. They continued to look at them until the audio content was finished then they started to play games. For instance, pb44 who was companied by his friend (pb43), started listening to one of the audio content and at the same time, he was looking at (pb43) as he was

playing a game. Once (pb44) finished listening to the audio content, he also started to play a game (figure 5.40). This behaviour happened because pb44 wanted to focus on listening to the audio content, either by watching the phone and artcode or by watching his friend's instead of playing a game by himself: "*I get distracted a little bit. So wanted to listen and watch him then to try playing.*"

Figure 5. 40 Pb44 (in the left) is looking at his friend while listening to the audio content

Finally, it was observed that three of the participants, a couple (pb1,pb2) and (pb11), also were walking most of the time towards other games and artcodes during listening to the digital contents. In other words, the three participants were trying to create a specific path for themselves and to follow the path during listening to the audio contents. For example, a couple (pb1,pb2) started their interactions with artcodes together and they both were scanning artcodes and once they started to listen to the digital contents, they both started walking towards other games, artcodes and objects. They repeated this attitude twice during their visit in the main exhibition room (see figure 5.41).

Figure 5. 41 Pb1 and pb2 are walking during listening to the audio contents

In the Lobby

Behaviours while listening to the audio contents

All participants in the Lobby mainly looked at the artcodes or at the phone screen during listening to the digital content and sometimes they also looked around specifically when their family members were close to them. In the interview, participants reported that the audio content motivated them to look at the artcodes since there was no visual contents in the digital content. Thus, they tended to look at the visual design of the artcodes or to read the text on the pre-designed artcodes. Pb16 (female, 42), for instance, stated:

"*I was trying to read some of the text, especially the logo ones so I was reading some of texts. I think it is nice always when you listen, you need something to concentrate on."*

Looking at the phone screen happened because few of the participants wanted to concentrate on what they were listening to or to check the duration of the audio contents. For example, pb15 (male, 32) stated: "*I was looking at the phone while listening to it just watching the phone to know how long it takes.*"

Although some of the participants were trying to check how long the audio contents are, they reported that the duration of the content is not an issue as long as the content of the audio is interesting as pb37 (male, 20) explained:

"*I don't think it matters because I can engage with what it is as long as the content is good like a listen or watch interesting stuff."*

Regarding using headphones for listening to the audio contents, it was noticed that one of the participants pb33 (male, 38) did not use headphone instead, he was listening to the audio contents using phone speaker (figure 5.42, left). He explained his behaviour in the interview, as he was not comfortable to use that specific type of headphone. Another behaviour of using headphone was noticed as pb37 (male, 20) shared the headphone with his partner two times to share listening to an audio content that he found it interesting (figure 5.42, right).

Figure 5. 42 Pb33 is using phone speaker for listening to the audio content (left) Pb37 is sharing headphone with his partner (right)

Views of participants on the format of the digital contents both in the Gallery Three and the Lobby

The majority of the participants of both the Gallery Three and the Lobby studies reported that the audio format for the digital contents worked very well to listen to a personalised voice of other visitors. Since the Gallery Three includes a large number of visual video games, all the participants found audio as the most appropriate format in which it allowed them to listen to the audio recordings and at the same time to play a game or to look at objects instead of watching a video which can distract them. For example, pb3 (male, 25) described:

"*I think audio recording works well in this case because you can still focus on playing a game while listening to what a person said so you can get both things once. Rather than oh I am gonna watch the video and then play or I am gonna read some text then play it. To me, you can do both at once."*

In addition to the benefit of audio content enabling visitors to listen and play games at the same time, anonymising the identity of the speaker was reported by pb10 (male, 24):

"I like that the people still anonymous like I don't know what they look like so I only have their voice not see them which makes it more natural."

Whereas video for such a setting like the Gallery Three was highlighted as unsuitable digital content because watching video is more likely to overwhelm visitors and confuse them. Similarly, reading text distract visitors from interacting with the video games since it would

be hard to concentrate on reading text and play video game at the same time. For instance, pb12 (male, 24) stated:

"*I think that video would be a bit distracting, too much visual. You are trying to play a game so watching a video is quite difficult at the same time because now you can listen to the audio and play the game at the same time, but having video would be a bit distracting.*"

For the Lobby setting, audio format was highlighted as a suitable medium for the digital contents by almost (20) participants and they mostly finished listening to the whole audio contents until the end. Pb27 (female, 26) described audio:

"*I think audio is nice because it's a voice to complete an image."*

On the other hand, 7 participants (pb22-pb24,pb26,pb29,pb31,pb46) suggested video or a mix of audio and video medium for the digital contents because, unlike the Gallery Three, there is no interactive video game in the Lobby to enable participants to listen and play at the same time. Thus, video for such a setting described as more engaging and interactive medium as it was described by pb23 (female, 33):

"Maybe it is helpful to have something more visual at the same time to follow what that person is saying so I think a video would be really good."

3- Social behaviours

Same as the previous studies that were presented in the chapters 3 and 4, this study also was not designed explicitly for supporting social communication. However, a range of social behaviours was observed between participants in which few of them were only noticed in the Gallery Three but not in the Lobby and vice versa. Overall, the majority of the participants described the Artcodes technology as a tool that did not isolate them from their companions instead sometimes motivated them to communicate and interact with each other and to have conversation around the audio interpretations. For instance, pb7 (male, 32) stated:

"*I think it was good because it gives you something to talk about as someone else you spoke to."*

However, four participants described their experiences of scanning artcodes and listening to audio contents as a way that isolated them from their companions and this was mainly due to the use of the headphone. In addition, the experience was described as a one-way

communication since they can only listen to the person who is talking in the audio content. For example, pb12 (male, 24) stated:

"*I would say isolated actually, because kind of ignoring the person you are here with so yeah may be isolated actually. This kind of socialisation is one way I can hear what those people want to say, but I cannot respond to them. It is not two way conversations."*

Overall, the key social behaviours that were noticed in both the Gallery Three and the Lobby are explained below:

In the Gallery Three

Amongst the (19) participants who participated in the Gallery Three studies, (15) participants were accompanied by partners, friends or one of the family members thus a number of social behaviours were noticed amongst them. They were frequently speaking, laughing, smiling and looking at each other during scanning artcodes and listening to the digital contents. In this regards, two main behaviours were noticed as described below:

A- Stay together throughout the visit

Each of these five groups of participants (pb1-pb2), (pb4-pb5), (pb8-pb9), (pb13-pb14), (pb43-pb44) started their experiences together and stayed with each other throughout their experiences until they completed their experiences. During their experiences, they interacted with artcodes, listened to the digital contents while playing or watching games together. For example, two friends (pb43,pb44) visited the gallery together and they both started their experiences in the third exhibition room (figure 5.43, left) followed by visiting the main and the second exhibition rooms (figure 5.43, middle and right) to scan artcodes, interact with the audio contents and play games. Thus, throughout their visits, they stayed close to each other.

Figure 5. 43 Pb43,pb44 stayed with each other throughout their visit

Amongst the participants who stayed with each other throughout their experiences, only in one case it was observed that a couple (pb8,pb9) shared headphone to listen to the audio content of the first artcode that they scanned. Then they used their own headphone for the rest of their interactions with the audio contents (figure 5.44).

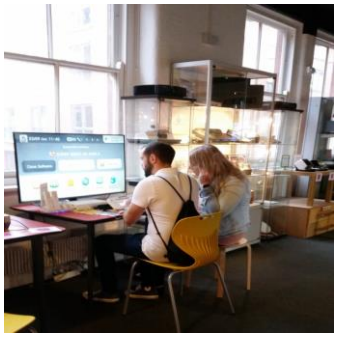


Figure 5. 44 Pb8 and pb9 are sharing the same headphone for listening to the audio content

B- Start individually followed by re-joining

It was observed that members of three groups of participants: (pb6-pb7), (pb10-pb11) and (pb12), who visited the gallery with his friends (pb13-pb14) started their interactions of scanning artcodes and listening to the audio contents individually in the main exhibition room followed by jointing their partner/friends.

An example of this behaviour is the one that was observed by pb12 (male, 24), who visited the Gallery Three with his friends (pb13-pb14) and started his experience individually. He started by approaching the “Astrowars” game and scanned its artcode followed by listening to the audio contents and at the same time, he was playing the Astrowar game. After completing listening to it, he scanned the “Firefox” artcodes and started to play it while listening to its audio content (figure 5.45, left). Meanwhile, his friends (pb13-pb14) both moved to the second exhibition room and started their experience together by scanning artcodes and listening to the audio contents (figure 5.45, middle). At this point, (pb12) followed them and joined his friends to scan artcodes, interact with the audio contents and play games (figure 5.45, right).

Figure 5. 45 Pb12 started his experience individually (left), his friends stayed together (middle), pb12 joined his friends (right)

In the interview, the participants explained that they wanted to start their visit experiences (scan artcodes, listen to the digital contents and play games) in their own preferred way without restricting themselves to their mates. Pb12 explained his behaviour saying:

"*Just I wanted to listen to the audio of the games that I liked and to play and once I finished then I went to the other room to join my friends and continue my experience."*

In the Lobby

Amongst the (27) participants who took part in the Lobby studies, social behaviours were observed amongst (21) of the participants who visited the museum with their partners (7 couples), friends or family (2 groups) and three single participant (pb28, pb45-pb46) with their family members who did not participate in the study. Overall, three main social behaviours were observed which are: **verbal and non-verbal interaction**, **share headphone** and **recommendations** as explained below**.**

A- Verbal and non-verbal interaction

During participants' interaction with the audio contents, it was observed that participants communicated and interacted with each other either verbally by talking to each other or non-verbally by looking at each other and laughing. Verbal communications were observed amongst (16) participants (6 couples, 1 group of friends and two unconnected participants whose their companions did not participate in the study). These participants described their experiences of using such a technology as a way that it enhanced their social communication and interaction with each other as pb36 (female, 29) reported:

"*It might give you something to talk about I suppose because we started to get the guitar hero because you said I don't like guitar hero and I said I like it and we started to chat a little about it probably like shared experiences."*

For example, a couple (pb15 male, 32 and pb16 female, 42) started their experiences together and throughout their experiences, they communicated with each other by speaking with each other about artcodes and audio contents and they were smiling at each other (figure 5.46).

Figure 5. 46 The couple (pb15,pb16) are interacting and speaking with each other during their experiences

However, it was observed that amongst the participants who were accompanied, 1 couple (pb31,pb32) and two unconnected men (pb17,pb18) who took part in the study together, did not verbally interact with each other throughout their experiences. They interacted with scanning artcodes and listening to the audio contents with looking at each other at some points (e.g: see figure 5.47). They explained that they could not socially communicate with each other because they needed to focus on the audio contents as Pb31 (male, 25) explained this behaviour saying:

"*I think it takes you by listening to an audio it takes away from interaction with around because you are focusing on the audio and listening to it. Whereas if you read some text you can discuss it with person with you but reading text is also a problem."*

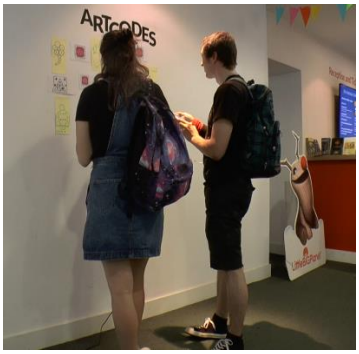


Figure 5. 47 A couple (pb31,pb32) did not directly communicate with each other throughout their experiences

B- Share headphone

It was observed that one couple (pb37 male, 20, pb38 female, 20) socially interacted with each other through sharing same headphone with each other to listen to an audio content that was interesting to them. For instance, pb37 was listening to an audio content and he was enjoying listening (figure 5.48, left) thus he shared the headphone with his partner (pb38) (figure 5.48, right). So, he did not recommend any artcodes to scan and access the content, instead he only wanted to share the moment of listening to the audio content with his partner.

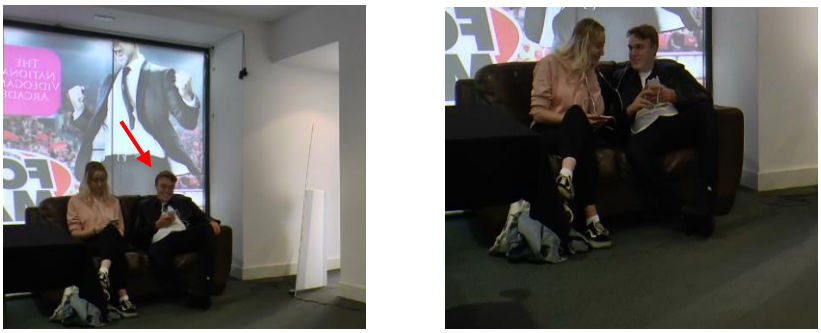


Figure 5. 48 pb37 (on the right) listening to the audio content (left) then he shared the headphone with pb38 (right)

C- Recommendations

This social behaviour is the one that has already been discussed in the **recommendations** section in the **motivations for scanning artcodes.** This theme can be mentioned here as well since it is related to direct or indirect social interactions that happened amongst participants during scanning artcodes and listening to the audio contents. This approach was observed amongst (10) participants (5 couples and friends) when a member of each group enjoyed listening to a particular audio content then he/she recommended it to the partner/friend to listen to it also through pointing to their associated artcode to scan it. Alternatively, when the participants found their partners/friends engaged during listening to a particular audio recording, they also started to replicate them by scanning the artcode that their partner/friend already scanned. After presenting all the above findings for both phases of this study (with the participants), in the next section, the main findings of the focus group discussion, that was carried out with the curators after completing all the studies, are reported.

5.7 Further interview with the NVA professional staff

As described in the beginning of this chapter, in advance of the two phases of this study (workshop and observation studies), two focus group discussion meetings were carried out with the NVA staff to discuss the study aims, how to facilitate the studies practically, which visual representations for artcode designs can be used and how to display them in the NVA.

After conducting all the studies of both phases, a focus group discussion (1 hour), which was audio recorded, was carried out with the same two curator staff (staff-1 female, 33 and staff-2 female, 23) that they were involved in the previous focus group discussions. The main reason of this focus group was to discuss the findings of both phases of the study in order to understand their opinions and motivations for possible implementations of artcodes in the future, how they facilitate using artcodes by visitors to contribute to the exhibition and how they manage content moderation and integration. From the transcribed audio recording, two main aspects were identified which are: **facilitating visitor contributions** and **possible applications of artcodes** (see table 5.9). Each of these are explained in detail below:

Seq.	Main themes	Sub-themes
1	Facilitating visitor contributions	creation venue
		human support
		visual representations and display of artcodes
		choice of the medium for the digital contents
		content modification
2	Possible applications of artcodes	using artcodes as official labels versus visitor contribution
		linking rooms or items together

Table 5. 9 Main themes of the focus group discussion with the staff

5.7.1 Facilitating visitor contributions

5.7.1.1 Creation venue

The curator emphasised that the creation activities need to take place in a location that could be accessible for everyone, such as the Lobby, even for those who did not pay. Thus, being involved in such activities might encourage visitors to pay and visit the galleries as well. In addition, the NVA galleries are too noisy due to the sound of the video games and are more crowded with visitors which make them unsuitable place for engaging visitors to craft their contributions. Staff-1 explained this:

"I would suggest maybe not doing in the galleries because they are busy, quite noisy, people might be quite shy, they have to speak in public. I found it worked very well down in Lobby

because people had a quiet space to get their thoughts. I think the creating and recording the voice would be still done in the lobby next in the exhibition space."

5.7.1.2 Human support

The staff highlighted that for facilitating the creation activities, teaching visitors how to create artcodes and using the app and checking the artcodes, they would provide a facilitator instead of using any video, virtual system or text instruction. This is because the NVA setting is full of electronic and interactive interfaces which make it hard for visitors to read, listen and look at a screen as staff-2 reported:

"*From my experience, especially in this building, people don't read or people don't look or listen to the screen they would think it is a game. With the human interaction, you are more likely to get more replies because we have a lot of electronics. When I would have people on gallery three already and get our staff to the people who are looking for the objects: do you like this object, would you like to give your memory and thought and leave a card, draw a card and then come back in half an hour and once they are checked then they can see them being displayed. That would be really engaging."*

In addition, the staff were keen to have human support for checking visitors' contributions because they do not expect that visitors would record long audio/video contents for their contributions in which it would be easy for human to check the contents quickly as staff-1 stated:

"*The contents need to be checked by human specially we are family orientated so we have to check every single piece of content because as soon as something is rude or can be rude or racist anything like that it cannot be here. So we check by our self because we are not really a museum, we are a culture centre and obviously we don't have that much content we have to check."*

5.7.1.3 Visual representations and display of artcodes

The NVA staff were asked about their opinions regarding the use of different visual representations of artcodes (hand-drawn and pre-designed artcodes with/without comment) and they reported that the three designs worked very well for visitor contributions and to engage other visitors to interact with these contributions in a more meaningful way. However, they reported that they would only allow the hand-drawn artcodes to be created on small size of cards in order to not affect the aesthetic quality of the space. In addition, they

would allow the hand-drawn artcodes to be created for the general contributions of visitors' experiences and to be displayed only in the Lobby. The staff described displaying the hand-drawn artcodes in the galleries as a challenge because the galleries are crowded places and visitors normally tend to play games instead of spending time on learning what those hand-drawn designs are as staff-1 stated:

"*In the gallery three, it needs quite a lot of explanation as people run and go what is this large drawing and may not understand them. So, I wouldn't use them in the galleries to be honest."*

On the other hand, the staff found that integrating pre-designed artcodes in the Gallery Three setting worked very well to engage visitors further with the video games and objects as staff-1 reported: "*I think in the lobby, I would use the hand-drawn one as an explanation and I will have a logo into our galleries so download the app here scan these when you walk around. So it wouldn't have to have the NVA logo, it could have the drawing of Mario it could be a flower but we would allow only the standard design in the galleries."*

In this study, the staff were keen to retain control over integrating the artocdes in the NVA by themselves. However, after they found visitors' interactions with the artcodes, they reported that in the future, they would allow visitors to display their own artcodes by themselves in order to enable them to be involved in every activity related to their contributions. In addition, the staff explained that it would be more meaningful for visitors to integrate their artcodes into the exhibitions as long as human support is used for checking the contents and guiding them how and where to display the artcodes.

Finally, the staff emphasised on using the same approaches for displaying artcodes, as in this study, by using a wall for the general contributions in the Lobby and displaying artcodes close to their associated objects in the galleries as they found these approaches engaged visitors further with the physical objects and the artcodes as well. Staff-2 reported:

"*I think on the wall for the general ones and next to objects for particular games always is good I think people will listen and then play oh I would like to share memory same as this person. So if a gentleman who did not like a Pacman so he wouldn't listen anything about Pacman."*

5.7.1.4 Choice of the medium for the digital contents

The staff highlighted that they also prefer allowing visitors to use only audio format for their digital contents if they were creating them for the galleries' objects since the galleries contain interactive objects. In this way, subsequent visitors would be able to stay connected to the objects and play games while they also interact with visitors interpretations. However, they described video as a useful format for the digital contents that are related to the static objects in the cabinet so that visitors can look at the objects and watch relevant videos. Staff-2 explained this saying:

"*If they start to listen to somebody voice, oh I am going to move to play a game while listening as already the voice is there. But with video, you will sit there and watch that person but you won't go to a game, oh I need to watch. I think for static things in a cabinet I would use video, for games I would use audio because with audio you only need to listen and you start playing games."*

On the other hand, for the Lobby, the staff reported that they would provide visitors with options either to use audio or video without providing opportunity for writing text because visitors of the NVA rarely engage with text as staff-1 explained:

"*I think video recording would be very good for the lobby but I would allow options because still some people don't like faces…I think for us it would be more video and audio rather than AR and not text at all. We know people they don't pay attention to it they don't come here to read they come here to play game they don't want to read they would go through the galleries not a library."*

Staff-2 also supported staff-1 for using video saying:

"*I think the video is more interactive than just audio to see somebody's face as they are recording memory, it can just give you an insight to see them so having video option is very nice in the lobby."*

5.7.1.5 Content modification

The staff were asked whether they would allow visitors to modify the digital content of their contributions while they are away from the museum or not. The staff reported that they would not provide visitors the opportunity of changing digital contents as this would need a lot of efforts and resources for checking the contents carefully particularly for the NVA setting as it is a popular place for teenager visitors. Staff-1 explained this saying:

"*If we ended up with 400 artcodes in the galleries and 400 people able to change their artcodes, we would have to go through and check every artcodes every day and we wouldn't be able to do that. So I wouldn't allow them to change afterwards but it is a quite good idea though."*

5.7.2 Possible applications of artcodes

5.7.2.1 Using artcodes as official labels versus visitor contribution

In terms of the possibility of using artcodes as labels for providing more information about games and objects, the staff reported that this option also works well for the NVA setting though they will create the contents by themselves instead of visitors. In addition, they would only use a standard design (pre-designed artcodes) for the labels instead of the hand-drawn artcodes to enable visitors to recognise them easily in the galleries. However, in case if there were already a displayed pre-designed artcodes for visitors' contribution, the staff stated that they would use another standard design for their artcodes labels in order to differentiate them. For instance, Staff-1 stated:

"*We can make another design for visitor content and have a separation and this is our content so I would have two different ones*." Staff-2 also supported her saying: "*We could use a square for the official content and something for memories like a cloud."*

The NVA staff suggested another usage of artcodes as official labels for guiding visitors how to use or play video games and how to display the artcodes close to the video games as staff-1 stated:

"*If you have a small artcode in that frame and you picked it you came up with how you play this game. This would be created by curators definitely because you would need to be able to physically show them how to play it. So that it would work very well in the galleries if we do videos in this way."*

However, the staff were quite keen about the usefulness of using artcodes to enable visitors to contribute to the exhibition more than using artcodes as labels for providing information about games and objects as staff-1 stated:

"*Because we [NVA] are quite interactive, I prefer the memory I think it's a very good idea and people tend to hear other people's stories, listen about it particularly in the gallery three which becomes like an archive for old video games. I think for here definitely I prefer that*

people tell us their stories why they like these though, children's contributions will be allowed under parent consent."

5.7.2.2 Linking rooms or items together

The staff emphasised that if they would use artcodes in future in their setting, they would use them again to enable visitors to contribute to the interpretation by sharing personal memories and thoughts about games. However, they were less likely to find it useful to use artcodes as a trajectory base to link different rooms or different objects in the NVA setting as it would seem more like audio tours. They also mentioned that in case of using it for linking rooms or items, they would create the contents by themselves instead of visitor's memory to provide consistent contents as staff-1 described:

"*I think we can place a trial, you can start with a gallery one explaining everything and then in the last artcodes would be to say now we move to gallery two and we would easily get people into. I think it's quite similar to audio tour. So there are two clear options I prefer the latter, I prefer them to be separate rather than linked as an audio tour. I would prefer to be more short stories about each object because audio tours tend to busy people. If we are going to use like audio tour rather than peoples' memories, I think we would curate by our self using the same voice."*

Finally, the staff also suggested another usage of artcodes for the Toastbar, a cafe on the second floor of the NVA, in order to allow visitors to create their artcodes in the Toastbar about the food and drinks and what memories they would like to leave as staff-2 stated:

"*The only other option is the Toastbar which we could put games in there, but we can also have people also explaining what their favourite food, their favourite drinks and what memory is so special. So, not just games they can describe other items of NVA."*

5.8 Discussion

The findings of both phases of the study that was reported in this chapter revealed a number of key themes related to the practical applications of artcodes in a museum context to enable visitors to contribute to the interpretations. Based on the findings, the author reflects on the lessons for using the different representation designs of artcodes for enabling visitors' contributions and how the subsequent visitors consumed these contributions and how they behaved while listening to the audio recordings in different settings. In addition, the role of

the staff in facilitating visitors' contributions and integrating their contributions into physical exhibitions.

5.8.1 Impact of the different visual representations of artcodes on visitor's approaches for crafting and interacting

The findings show that providing the three different visual representation designs of artcodes (hand-drawn, pre-designed artcodes with comment and pre-designed artcodes without comment) met different visitor's need and motivated them to craft their own hybrid contributions. The visitors' choices of the different visual designs of artcodes directly depended on the contribution purposes. In other words, the visitors who made contributions in relations to a specific game or object in the Gallery Three, predominantly chose the pre-designed artcodes without comment followed by the pre-designed artcodes with comment section and only one chose to draw artcodes manually. The main reason for their choices of the pre-designed artcodes was that they were easier, straightforward, less time consuming and did not require drawing skill. Whereas, the visitors who made general contributions without referring back to any particular games and objects that were available in the Gallery Three, mainly chose the hand-drawn artcodes. Their choice of the hand-drawn artcodes might be because they had enough skill to draw which motivated them to express their contributions through the visual design of the artcodes and also through the digital contents.

Regarding visitors engagement with the visitors' contributions, it was not possible to compare their engagement towards hand-drawn artcodes and the pre-designed artcodes in the Gallery Three setting because there was only one hand-drawn artcode. Overall, the findings reveal that visitors appreciated the pre-designed artcodes in the gallery setting more than the hand-drawn because they wanted to see something standard that can be recognisable for them as a scannable object. This was because the pre-designed artcodes were displayed in different places using different methods in the Gallery Three thus standard design would work better for the artcodes to catch visitors' eyes. On the other hand, in the Lobby where there were a mix of the hand-drawn artcodes, pre-designed artcodes with/without comment section, visitors engaged highly with the hand-drawn artcodes and preferred them compared to the pre-designed artcodes because of their different design appearances which motivated visitors to scan them and reveal their associated contents.

In summary, it can be said that from interaction points of view, the pre-designed artcodes are considered more appropriate for augmenting the existing objects with visitors' contributions

and to be displayed close to the objects. Whereas using hand-drawn artcodes for augmenting existing objects with visitors' contributions and displaying them close to the objects could be a less appropriate design choice because it might distract visitors from playing games. In addition, visitors might not recognise the hand-drawn artcodes, that are distributed and displayed in different places across the exhibitions, as scannable markers. However, for creating new contributions and without augmenting any existing objects, the hand-drawn artcodes are considered more appropriate than using the pre-designed artcodes because there are no any existing objects therefore the artcodes themselves would become the main objects for further interactions.

Therefore, the findings suggest that for future application of artcodes, the pre-designed artcodes might work better for the contributions related to particular objects and to be displayed next to the objects. Whereas, the hand-drawn artcodes could fit a setting like the Lobby where no objects were available.

With regards to the interaction phase, the findings also show that visitors' motivations for scanning artcodes depended directly on the settings. The main motivations of visitors for scanning artcodes in the Gallery Three and listening to the visitors' stories were based on exploring the exhibited objects and video games across the gallery and based on specific games that were interesting for visitors. Whereas, in the Lobby, the motivations for scanning artcodes were mainly affected by the different visual representations of artcodes followed by the name of the games that were written on the pre-designed artcodes and partner's recommendation. It is worth noting that the majority of visitors were more likely to engage with the hand-drawn artcodes to reveal the digital contents compared to the pre-designed artcodes.

5.8.2 Impact of the settings on the hybrid artefacts

The findings reveal that visiting the gallery with one of the NVA staff was an essential step in order to enable visitors to contribute to the exhibition through browsing the exhibited video games and objects and deciding on objects that they wanted to create the contributions about. The majority of the visitors contributed by reflecting on the existing games and objects of Gallery Three by augmenting them with their contributions of sharing their personal experiences with the displayed games and objects rather than extending or adding new information to the exhibitions. Whereas, the minority of the visitors decided to make their

contributions to become the main objects by sharing their general game experiences without referring back to any particular game of Gallery Three.

This finding is in contrast of the previous study of the Lakeside Arts gallery that was presented in chapter 4 in which the majority of the participants were mainly inspired to contribute to the exhibition by extending it except two of the participants who contributed to add information or leave comments about the exhibition. The reason behind this difference is that the games and objects that were exhibited in the NVA are those that most of the people have personal experiences with. Thus, the visitors were motivated to reflect to the displayed games and objects by sharing their personal experiences. Whereas, in the previous study of the Lakeside Arts gallery, visitors did not have personal experience with the exhibited objects (people's stories from Latin America) therefore they mainly tended to reflect to the portraits by extending the interpretations through sharing their own experiences about the exhibition theme rather than adding information or commenting on the portraits.

Overall, the findings show that visitors of the NVA study and the previous study, Lakeside Arts gallery, seem much more interested in sharing personal experiences rather than adding more information or commenting on the objects. Thus, these findings suggest that the nature of the settings and the exhibited objects motivate visitors to choose their contributions whether to augment existing objects or extend them through sharing their personal experiences.

5.8.3 Role of curators

The findings show evidence of the important role of curators in facilitating activities to encourage visitors to craft their hybrid contributions and integrating their contributions into the museum. However, the process of content creation activities does not necessarily need to be made through the workshop mechanism for a group of visitors but also by allowing individual visitors to participate. In both cases of using workshop sessions for groups of visitors or quick session for individual visitors, a semi private space is required to provide visitors with a quiet and private environment for creating their physical and digital contents.

In addition, throughout the process of the content creation, human support is required for assisting visitors to create contributions (drawing artcodes, digital content and using the app) particularly in the NVA setting since it is a home of a large number of interactive interfaces in which the curators described that digital instruction would be potentially less effective. Therefore, it can be said that human support could be potentially a useful approach for

engaging visitors in the process of contributing to the interpretations in settings that are similar to the NVA. However, using this approach of human support might be less effective for the traditional museums and galleries that their objects are statics.

In this study in the NVA, the visitors' contents were moderated by the author before displaying them in the Gallery Three and the Lobby. Although, technology can be used for content moderation, the findings show that the curators were keen that for such place like the NVA, it would be better that the content moderation to be made by humans because they do not expect large amounts of content to be created by visitors which will make it more easy and quick for a human to check the contents. In addition to this, since visitors' contributions consist of both visual designs and digital contents, it is important to moderate the contributions by human in order to check the visual representation of the hand-drawn artcodes as well. As far as contents are concerned, allowing visitors to modify their digital contents, after leaving the museum, might be highly engaging, however, it would make more load on curators to check them as well.

In the study presented in this chapter, the curators displayed all the visitors' contributions in the NVA by themselves because they were keen to retain control over the display in order to ensure the artcodes appear in the right places and do not affect the overall aesthetic quality of the settings. However, after the studies were carried out, the curators were more relaxed to allow visitors, in future, to display the artcodes by themselves. This was because they found that using the same strategies for displaying visitors' contributions in their settings would be easy for visitors to follow, after they would be guided by a facilitator on the display places and providing clear notes and instruction about display places.

As far as displaying visitors' contributions are concerned, the findings presented in this chapter reveal that the curators' roles were very important in choosing the most appropriate and suitable methods for displaying visitors' contributions in their settings. The curators' strategies that were used for displaying visitors' contributions across Gallery Three and the Lobby were successful from both the visitors and the staff point of view. These strategies include displaying the visitors' contribution that were created for augmenting the existing games and objects close to them. Whereas, using a wall in the Lobby for displaying the visitors' contributions that were created for sharing general game experiences and to become the actual object. These separations for displaying hybrid contributions across different settings using different methods were useful to engage visitors to interact deeply with the

visitors contributions in two levels. First, by engaging visitors with other visitors' contributions while they were playing video games or looking at objects in the gallery. Second, by engaging visitors in the Lobby, who did not pay to access the galleries, to create or interact with other visitor's contributions which could also encourage them to pay and access the galleries for further interactions.

5.8.4 Exploring digital contents of visitor contributions and its impact on social behaviours

The findings of this study show that a number of different behaviours were observed while visitors explored the digital contents of the visitors' contributions and these behaviours were directly affected by the setting where the visitors' contributions were displayed. In the Gallery Three where visitors' contributions were displayed close to the objects, visitors were engaged in concurrent activities to listen to the audio contents and at the same time to interact with the objects by playing video games, look at artcodes, objects, phone, look at mates' activity or walk around the gallery to look at other objects. On the other hand, in the Lobby, where no interactive objects were available and all artcodes were displayed on one wall, visitors focus was mainly on the artcodes while they were listening.

Therefore, it can be said that displaying visitors' contributions can be suitable for the settings that include interactive objects as well as those that do not include any interactive objects. However, in both settings, a large number of social behaviours were observed while visitors were engaged in listening to the audio recordings and these behaviours were affected directly by the setting. In the Gallery Three where the existing objects were augmented by the visitors contributions, it was found that visitors either stayed together throughout their visit or they started their experiences individually then joined the group member. In the Lobby, on the other hand, it was observed that visitors socially connected with their mates verbally by talking with each other or non-verbally by looking and smiling to each other. In addition, they interacted with each other by sharing headphone with each other to listen to audio contents or to suggest scanning particular artcodes to their companions.

Thus, it seems that enabling visitors' contributions have opened a great opportunity to enhance social interactions amongst visitors even in the cases that they wish to have some individual moments or when the visitors do not want to speak with each other.

5.9 Conclusion

This study has shown that providing visitors with different visual representations of artcodes motivated them to contribute to the exhibitions through sharing personal experiences in general or in relation to existing objects. More specifically, visitors were more likely to choose drawing their artcodes for extending the exhibition through adding an additional layer of personal game experiences in general. Whereas, the visitors found the pre-designed artcodes with/without comments more convenient to augment the exhibited objects in the exhibition by adding own personal experiences about them.

In addition, the study has shown that the subsequent visitors were highly engaged with the hand-drawn and pre-designed artcodes that were complemented with audio recordings and their display positions engaged them further to interact with the artcodes and with the exhibited video games at the same time. Thus, the curators' approaches for integrating visitors' contributions in the museum worked successfully in which the artcodes that were created for augmenting exhibited objects were displayed close to the objects whereas the artcodes that were used for extending the exhibition were displayed on their own on a wall. This study also has shown the essential role of the curators throughout the process of enabling visitors to contribute and the approaches that they used for integrating visitors' contributions within the exhibitions.

Thus, this chapter has met its aim which was about introducing different visual representations of artcodes to enable visitors' participation in museums in order to enable visitors to consume other visitors' contents (research question 1-b) and involve them in creating hybrid contributions (research question 2). In addition, the study in this chapter explored the role of curators throughout the process of visitors' participation in a museum (research question 3).

The study in this chapter completes the practical work of this thesis. The next chapter of this thesis will focus on a broad discussion of the main findings of the three studies that were reported in chapters 3,4 and 5 respectively, with relation to key literature, in order to build a model for the visitors' experiences of creating artcodes, interacting with them and integrating them into physical settings.

Chapter Six: Discussion

This research was carried out to explore how visitors can have active roles through involving them in different types of participation using artcodes, aesthetic visual markers. For this purpose, three practical studies were carried out in two museums and one gallery. The first practical study presented in chapter 3 of this thesis proposed a novel approach for exploring the relationships between artefacts through physical manipulation using aesthetic visual markers. The study took place in the Museum of Archaeology using an interactive paper map (physically configurable map), in which visitors can place tangible representations of hybrid artefacts (cards) and scan the resulting arrangements individually or in pattern groups and paths. Scanning the cards individually revealed additional information about each card whereas scanning multiple cards in pattern groups and paths revealed information about the relationships between the cards based on the common purpose or based on their temporal relationship. The findings show that participants engaged in three strategies for exploring relationships between artefacts of the museum collection which are: inspection, strategic and experimental configuration. In addition, participants engaged in three strategies for social collaboration which are: sharing the interaction space, adopting interaction roles and sharing a reaction to the "reveal".

The second study presented in chapter 4, took place in the Lakeside Arts gallery in which it explored the use of the aesthetic visual markers as labels for portraits that linked to audio recordings. In addition, the study explored the use of the aesthetic visual markers as a mechanism for visitors to contribute their own reflections (generate hybrid artefacts) to the exhibition by drawing a marker and linking it to an audio comment and how subsequent visitors interacted with the official versus visitors' markers. The findings show that participants appreciated the use of the aesthetic markers and actively engaged with them at three levels – physical placement, aesthetic content and digital content. In addition, the findings show that visual markers (artcodes) that can be designed to convey visual meaning could also be combined with mobile devices to enhance visitor's experience of exhibits, especially when linked to complimentary audio content. Furthermore, it was evident that the drawing activity, which took time and effort, encouraged participants to reflect more deeply on the theme of the exhibition and focus on content that other visitors could relate to.

This study raised the questions of how visitors can be encouraged to contribute to the exhibition by providing them more opportunities for creating the physical markers. In

addition, it also raised the questions of how visitors' contributions might be integrated within the exhibition and what would be the role of the curators in the process.
Consequently, the third study presented in chapter 5 was carried out in the NVA museum which was built upon the findings from the second study (chapter 4) in order to introduce new approaches for enabling visitors to create the physical markers, in addition to the drawing approach. Thus, the study focused on a deeper understanding of visitors' approaches and preferences for contributing to the exhibition by introducing new elements of participation to generate artcodes themselves or choose pre-designed templates for their artcodes. In addition, how these different visual representations of artcodes could be integrated within the exhibition and how the subsequent visitors interact with the displayed artcodes. Thus, the study was about a comparative exploration of what visitors preferences are in creating hybrid artefacts and interacting with them in the exhibition as well as what curators' roles are throughout this process.

The findings reveal that participants appreciated the different visual representations of artcodes. In particular, the participants who wanted to extend the exhibition by adding an additional layer of personal contents, tended to draw the artcodes themselves as the drawing provided them with more freedom to represent their experiences and to visualise their thoughts through the design. However, the participants who wanted to augment the exhibited objects by adding their own personal experiences about the objects tended to choose the pre-designed artcodes. The choices for integrating these different visual representations of artcodes across different settings were successful for engaging the subsequent visitors with the markers, digital contents, existing objects and the companions. Furthermore, the findings show the essential role of curators throughout the process of facilitating visitors' contributions and integrating them within the exhibitions. However, after completing the study, curators were more relaxed to allow visitors, in future, to display their own hybrid contributions by themselves.

Overall, this research aimed to shift visitors' roles from passive consumers to active participants throughout their visit experiences by involving them in a number of different but linked activities using artcodes technology. By merging all the findings from the three studies, three main stages of visitor participation were identified which are interaction, response and reintegration in which each of these stages consist of a number of activities. The three stages formed the co-creation cycle where visitors were involved in different types of

participation during their visit experiences (figure 6.1). The findings from the first study (chapter 3) have mainly contributed in the creation of the interaction stage in the co-creation cycle whereas the findings from the second and third studies (chapters 4 and 5) have contributed in the creation of each of the interaction, response and reintegration stages.

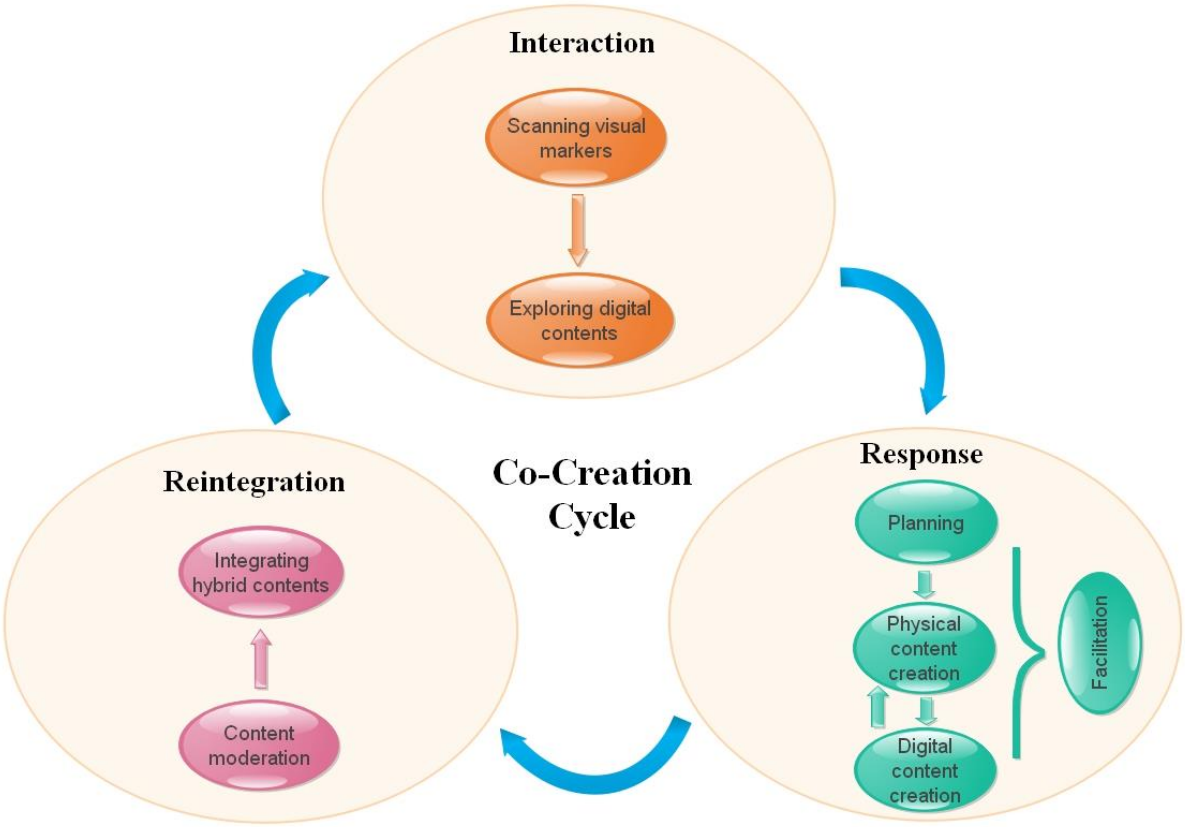


Figure 6. 1 Three stages of interaction, response and reintegration of the co-creation cycle

Each stage of the co-creation cycle consists of a number of key activities where they have been identified in the findings from the three studies (chapters 3,4 and 5). For each activity, there are a number of opportunities and challenges that need to be considered for using aesthetic visual markers in museums to enable different types of visitors' participation (figure 6.2).

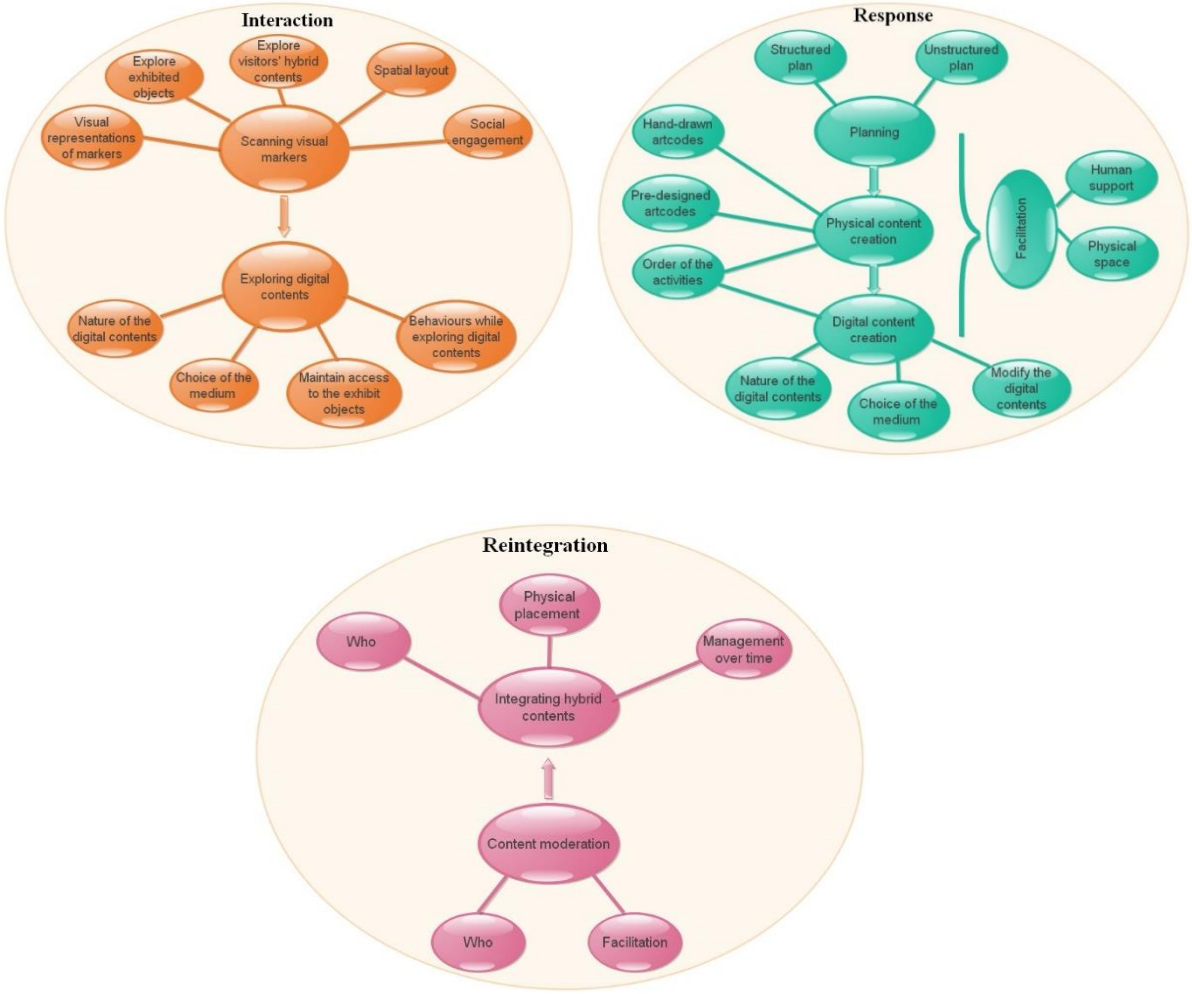


Figure 6. 2 The key opportunities and challenges for each activity in the three stages of the co-creation cycle

The three stages along with their activities in the co-creation cycle that are represented as big blobs in the top level are generic processes that can be applied to other visual marker technologies (see figure 6.1 which is a generic model). Thus, it is important to consider the three stages in case of using visual markers in museums. The key opportunities and challenges of the activities represented as small blobs in the lower level are specific to the use of the aesthetic visual markers (artcodes) (see figure 6.2 which is a specific model for using artcodes). It is worth noting that for using aesthetic visual markers, curators do not need to follow all the three stages of the co-creation cycle, instead they can use the stage that could match their requirements and goals from using aesthetic visual markers. However, following the three stages of the co-creation cycle is more likely to provide more comprehensive and interactive experiences for the visitors.

In the following sections, a detailed review of co-creation activities in museums is provided, followed by a review of the available models for engaging visitors to become reflectors, in

relation to the co-creation activity. Next, the co-creation cycle proposed in this thesis is discussed in more detail followed by a discussion on the three stages and the main activities in each stage with relation to the key literature and finally a conclusion is drawn.

6.1 Co-creation

Co-creation is a technique that has been widely used across multiple disciplines for involving people in activities, such as in industry for developing a product (Prahalad and Ramaswamy, 2000; Vargo and Lusch 2004). There are other terms such as co-design, co-production, participatory design and user generated content that are used for co-creation (Grabill, Pigg and Wittenauer, 2009; Sandvik, 2012; Stuedahl, 2011). In museum domains, co-creation refers to the interaction between museum staff and visitors or specific members of a community to develop, design and create an exhibition or activity in a shared ownership (Walmsley, 2013). Simon (2010:263) defines co-creation as a partnership between museum and public where both of them collaborate with each other, while each of them have their own unique role, to indicate their shared goals, needs and expected outcomes early. Both museum and visitors' goals would be achieved in co-creation projects where the outcome would be co-authored by both, thus, visitors would have more power in designing the contributions or exhibition compared to other forms of participations.

Over the last two decades, museums have increasingly developed projects and exhibitions to involve audiences from diverse background and expertise to participate actively in co-creation activities (either online or onsite) particularly with the use of new digital technologies (Cairns, 2013; Cunnell and Prentice, 2000; Giaccardi, 2012; Golding and Modest, 2013; Grabill, Pigg and Wittenauer, 2009; Reyes and Finken, 2012; Russo, 2011; Russo et al., 2008; Russo and Watkins, 2008; Simon, 2010; Smith and Iversen, 2014; Stuedahl, 2011; Stuedahl and Smørdal, 2011; Watkins and Russo, 2007; Watson, 2007). According to Simon (2010) and Jafari and Taheri (2014), most of the museum visitors are not only interested in consuming information and observing collections but they are also interested to participate in co-creation activities through "create, share, and connect with each other around context".

As a result of visitors active participations in co-creation activities, social interactions and learning from each other are more likely to be promoted (Simon, 2010). McIntosh (1999) and Pine and Gilmore (1998) report that visitors learn new things in museums by observing exhibitions and having active roles in participating in the museum activities. Liu (2008) also

states that museums are appropriate places for exchange of stories by allowing visitors to leave their voices for future visitors to listen to them which can enhance their learning further.

One of the benefits of co-creation in museum is its potential in supporting critical thinking, providing more power to visitors to create new contents, enabling them to learn new skills and engaging them to personalise their own visit experiences (Prahalad and Ramaswamy, 2004a, 2004b; Rogers and Rock, 2016). Providing visitors with more power or control is one of the main elements for making co-creation participation meaningful which needs to be clearly structured and explained (Arnstein, 1969; Jenkins and Carpentier, 2013; Holdgaard and Klastrup, 2014).

To give an example of museums that used co-creation projects, the Brooklyn Museum ran a co-creation project called "Click! A Crowd-Curated Exhibition". The museum invited artists to share photographs online that would fit the exhibition theme (The Changing Faces of Brooklyn) and small description about the photographs. The interesting and appropriate contributions were then displayed physically in the museum (Surowiecki, 2008).

As discussed, since involving visitors in co-creation activities in museums can promote their learning, in the following section, the main models that have been developed by researchers for learning are described, as well as the previous co-creation cycles for visitors' activities in museums followed by a highlight of the main similarities between those models and the co-creation cycle proposed in this thesis.

6.2 Similarities between the previous models and the co-creation cycle proposed in this thesis

The stages of the proposed co-creation cycle in this thesis are similar to the stages or activities of some of the previous models that have been developed to enhance people's learning and enable them to become reflectors.

Before describing the previous models, it is worth noting that a wide range of research about learning in museums have been carried out (see: Durbin, 1996; Falk, 2004; Falk and Dierking, 1992, 2000; Hein, 1998; Hooper-Greenhill, 1991; Leinhardt, Crowley and Knutson, 2003; Roberts, 1992). Learning in museums and galleries is an informal process which can happen during visitor's engagement with the exhibition where they would be provided with information and knowledge about collections using different presentations such as using

interactive system or interactive media (Biran, Poria and Reichel, 2006; Calver and Page, 2013; Goulding, 1999).

In general, museum's visitors learn from "doing, thinking, watching, reading, listening, imagining, interacting (with staff and each other)" thus learning does not only take place for visitors as an individual, it can also take place by watching, talking and looking at other visitor activity (Black, 2005). Therefore, to encourage learning, the exhibition needs to be designed in a way that support visitors as a group to interact with (Bandura, 1978; Lave and Wenger, 1991; Paris, 2002: 297; Vygotsky, 1978).

In terms of the models that have been developed for enhancing people learning and enabling them to become reflectors, Kolb (1984) proposes four stages of experiential learning cycle which need to be completed to achieve learning. These stages include active experimentation, concrete experience, reflective observation, and abstract conceptualisation (figure 6.3). Gibbs (1988) was inspired by the experiential learning cycle of Kolb (1984), he proposed the reflective cycle (figure 6.4) which consists of six stages, and he sets reflection in the core of the learning process. Gibbs (1988) claims that reflection is about learning from an experience where peoples' feeling, thinking and emotions are involved.

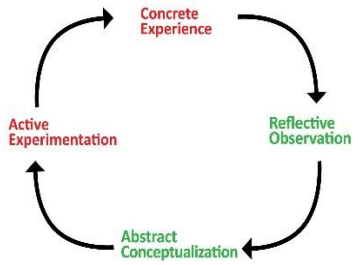


Figure 6. 3 Kolb (1984) Learning cycle

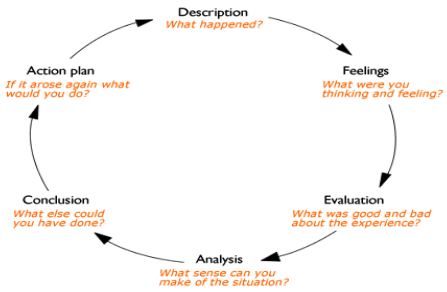


Figure 6. 4 Gibbs (1988) Reflective cycle

In addition to the above models, Dennison and Kirk (1990:4) described learning as a cycle of seeing, learning, applying and doing (figure 6.5). They also claim that learning is not always a positive experience, as it might sometimes turn to a negative experience due to lack of understanding of the contents or inability to find the content useful.

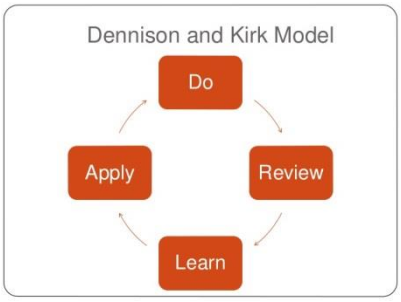


Figure 6. 5 Dennison and Kirk (1990) learning cycle

The above learning models have relatively similar stages to the proposed co-creation cycle of this thesis in which they also identify the cycle of enabling users to reflect on their learning.

In addition to the learning models, the stages of the co-creation cycle of this research seem alike to the model, as already discussed in the literature review chapter that was developed by Minkiewicz, Evans and Bridson (2014) and consists of co-production, personalisation and engagement in the co-creation in a heritage context. Furthermore, the stages of this research's cycle appear similar to the model that was developed by the National Library of New Zealand (Make It Digital Guides, n.d.) which identifies the main activities in the lifecycle of co-created digital content: selecting, creating, managing, discovering, reusing and preserving.

The top level of the co-creation cycle of this thesis has similarities with the existing described models however; the lower level of the co-creation cycle is different from the existing models as it offers novel contributions for the use of the aesthetic visual markers for enabling different types of visitor's participation in museums and galleries. Thus, the whole co-creation cycle of this thesis focuses explicitly on the participation activities where visitors can be involved and have active roles of interacting, responding and integrating in a museum visit using aesthetic visual markers. In the following section, the co-creation cycle of this thesis and its three stages are discussed in more detail by referring them back to the key literature.

6.3 Co-creation cycle

In a traditional museum visit experience, there are cyclical activities of creating, displaying and consuming content. The curators play the role of designing and creating content or experiences followed by displaying them physically in their setting for the visitors to consume them. Thus, visitors consume the displayed content, and sometimes the museum allows visitors to reflect on the contents through leaving feedback and comments to the curators. Visitors' feedback would be either commenting on the contents or they recommend

curators to create specific contents or to improve contents. In response to the visitors' feedback, curators create or improve the contents and display them for new visitors to consume them and leave feedback for the museum so that museums change contents accordingly. Thus, the curators have complete responsibilities of creating and displaying content, whereas visitors have the opportunity to consume content and leave feedback to the curators.

The traditional cycle of the visit experience has a number of advantages and disadvantages for each of the curators and visitors respectively. The main advantage of the traditional cycle is that curators have the complete control of creating, managing and displaying content that are highly interactive and have a high quality for engaging visitors and enable them to learn from the contents. In addition, the curators are the best people to understand visitors' feedback and needs to re-generate content accordingly. However, the main drawback is the passive role of visitors in creating and displaying content which might result in less engagement of the visitors in consuming the contents as well.

Therefore, it seems important to involve visitors in different types of participation activities in which they all are sequentially following each other. In response to this, this research was designed to shift visitors' roles from passive consumer to active participants throughout their visit experiences in museums and galleries while curators still played their own active roles. In other words, the aim was not to encourage curators to transfer their power and control to visitors, instead, the research aimed to enable visitors to have active roles across different activities and stages while curators still have their control of leadership on the overall process.

Based on the findings from the three practical studies of this research, three stages of visitors' participation were identified and suggested from their visit experiences which are interaction, response and reintegration in which they all formed the co-creation cycle. The model of the co-creation cycle is proposed because all the three stages are about different types of visitors' participation in museums and galleries through active involvement in a number of different activities that are sequentially following each other. In addition, the stages formed a co-creation cycle because visitors, in this research, had more active roles in a number of activities in different stages which correspond to the co-creation model of participation where visitors have more active roles compared to the contribution and collaboration models.

In the interaction stage, the participants played an active role to interact with the official and visitors aesthetic visual markers (hybrid artefacts or hybrid markers) that were displayed in the exhibitions through scanning them and interacting with their associated digital contents. In the response stage, participants reflected on their experiences by creating diverse hybrid contributions around the exhibition contents, including personal experience, private contents for family or friends and leaving comments about the objects. Finally, the reintegration is the stage where the hybrid contributions of visitors are integrated within the exhibitions after checking the contents. However, in this research, visitors had active roles in all stages except the reintegration stage as the curators were keen to retain control over the activities in the reintegration stage. Thus, indirect data was collected from the NVA staff about the possibility and approaches for involving visitor in this stage for the future applications.

Thus, by involving visitors in the co-creation cycle, they would be able to participate in multiple activities. Previous research also highlighted the benefit of designing experiences that would engage visitors into multiple layers and levels of activities that range between simple and complex (Ciolfi and Bannon, 2003; Gammon, 1999; Hornecker and Stifter, 2006). Ciolfi and Bannon (2003) also suggest that the experiences should be short, interactive, easy to use and at the same time there should be some level of complexities.

There are a number of benefits and challenges of involving visitors to play active roles in all the three stages which need careful managements from the museum to ensure a smooth and interactive experience. The main benefit of enabling visitors to have active roles in all three stages is their ability to be involved in unusual activities that are normally practised by curators. In addition, visitor's role as passive consumer would be extended to become active participant, reflector, responder and integrator. Moreover, visitors' active involvement can strengthen the relationship between visitors and museums further. However, the main challenge is that visitors may use the active roles improperly specifically in the response and reintegration stages to create and display inappropriate and offensive contributions which would have a direct negative impact on the museums and galleries. Overall, from the findings of this research, it becomes clear that there are more benefits than drawbacks in using the proposed co-creation cycle for visitors' experiences in which it can allow shifting visitors' role to be more active through the use of aesthetic visual markers.

At each stage of the co-creation cycle, visitors can reflect on their own experiences and activities in order to participate in another activity using the obtained knowledge. In other

words, visitors can become active reflectors of their own experiences in the interaction stage by choosing particular object(s) to create the hybrid contributions in the response stage which would result in enabling the visitors to interact with the exhibition more deeply.
Consequently, visitors can also become reflectors of their experiences in the response stage by involving in the reintegration stage in order to moderate and integrate their hybrid contributions within the exhibition. Again, they can become active reflectors of their experiences in the reintegration stage by engaging with the exhibition in the interaction stage. Thus, visitors' reflections can happen throughout the three stages of the cycle.

There are a number of factors that need to be considered for encouraging visitors to become reflectors of their visit experiences and participate in each stage. First, visitors need to learn something interesting during their experiences in exhibitions through gaining knowledge, information and skills. In addition, visitors need to be provided with "time, space and opportunity" where they would be able to "stand, watch and listen to other visitors" since human can learn largely from observing people's activities (Black, 2005). Finally, visitors would be more likely to become reflectors when they can find different points of views of people about the exhibition in the form of comments and opinions that were left in the exhibition or at least to know the museum is willing to welcome visitors' contributions (Black, 2005).
As a result of these, visitors would be more likely to engage actively during their interaction stage and make meaning of their own visit experiences by reflecting on and becoming active participators in making their own contributions (Black, 2005).
In the following sections, the three stages of the co-creation cycle are explained in detail by referring them back to the key literature.

6.3.1 First stage: Interaction

Interaction is the first stage of the co-creation cycle where participants started to have an active role of interacting with the displayed hybrid contributions through scanning them and interacting with the revealed digital contents. By using artcodes technology, consuming content becomes an interactive activity since it requires visitors to engage actively with the artcodes to scan them in order to reveal their digital contents. However, consuming contents became richer experiences when visitors were allowed to explore different interactions such as exploring the relationships between artefacts through physical manipulation of artcodes and scanning them in pattern groups and paths.

In the following section, the main activities of the interaction stage are discussed which are **scanning visual markers** and **exploring digital contents.** The opportunities and challenges of each activity are also highlighted (see figure 6.6).

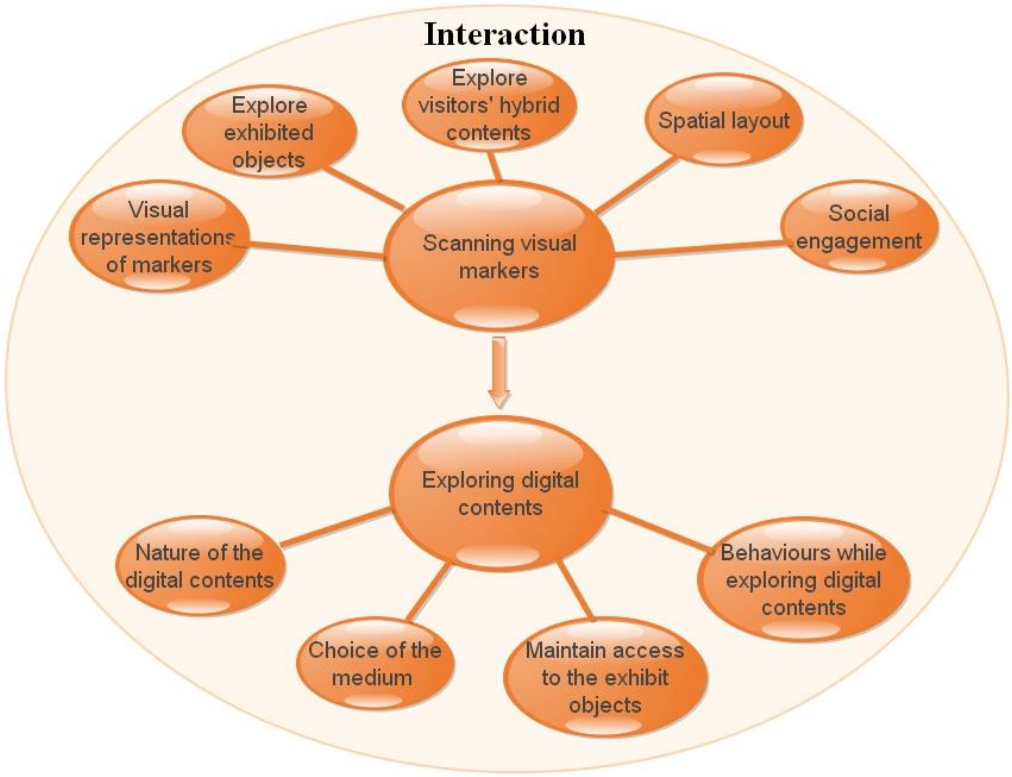


Figure 6. 6 The key opportunities and challenges of the main activities in the interaction stage

6.3.1.1 Scanning visual markers

The findings from this research reveal that participants appreciated the use of official hybrid artefacts and those that were created by other visitors that were displayed in the exhibitions to enrich the interpretation of exhibitions. Participants successfully managed to access the hybrid artefacts and they were enthusiastic to scan them while they were mindful of the presence of others and repositioning. This is in contrast to Wein (2014) who suggests that visitors may be reluctant to engage with visual markers, such as QR codes, because they need to be able to get close to them in potentially crowded spaces as well as they need to shift their focus away from the actual artefacts to scan the QR codes. Mäntyjärvi et al. (2006) also found that for scanning RFID, visitors should be close to the objects which is not realistic in museum environments. The findings also show that participants spent relatively long time interacting with the hybrid artefacts and their digital contents. Moscardo (1996) states that

interactive exhibition can have a direct impact on visitors' experiences by spending more time in interacting with the exhibition compared to the static exhibition.

Overall, based on the findings from the three practical studies that were reported in chapters 3,4 and 5, it becomes clear that the participants had different approaches for interacting with the hybrid artefacts and scanning them. Thus, it is important to support different types of explorations, interactions and configurations when designing hybrid artefacts. For this purpose, it is suggested that the designers need to pay attention to five key aspects that can motivate and influence visitors to scan the visual markers. The five key aspects are: **visual representations of markers, explore exhibited objects**, **explore visitors' hybrid contents, spatial layout** and **social engagement**. Each of these aspects are explained below.

A- Visual representations of markers

The visual representations of markers that are meaningful, attractive and quickly recognisable by the app are important factors that can motivate visitors to scan them. The findings show that participants' motivations for scanning hybrid artefacts were mainly affected by the visual representations of the markers particularly, participants were highly engaged with the hand-drawn artcodes and they were more likely to scan those that their visual designs were meaningful to them compared to the designs that were not easily understandable.

The findings from the first study (chapter 3) show that the participants engaged with the hand-drawn hybrid artefacts that were drawn for representing the museum artefacts and they found their designs meaningful which motivated them to explore more hybrid artefacts and to find the corresponding physical artefacts in the collections.

The findings from the second study (chapter 4) show that the participants engaged more frequently with the hand-drawn artcodes that were designed by other visitors compared to the official artcodes labels which represented the Latin America's maps. This is because it was not easy for every participant to recognise the design of the official labels as maps whereas they were easily able to recognise visitors' artcodes because they presented clear and meaningful visual representations.

The findings of the third study (chapter 5) also show that, when there was a mix of hand-drawn and pre-designed artcodes on display, the participants were more likely to scan the hand-drawn artcodes compared to the pre-designed artcodes. Again, this was because the different visual designs of the hand-drawn artcodes encouraged participants to scan them in

order to reveal the associated digital contents and understand visitors' aims behind the designs.

Overall, it can be said that participant' high motivations for scanning hand-drawn artcodes might be because the images within the artcodes themselves convey additional pieces of information and they can be used to add value to the experience and the exhibition. However, it was also noticed that some participants interacted with the pre-designed artcodes as well because their standard designs, like QR codes, enabled participants to recognise them as scannable markers.

B- Explore exhibited objects

Personal interest in the objects that were exhibited in the exhibitions was one of the factors that motivated participants to scan the hybrid artefacts that were created for those objects in the exhibition in order to reveal their associated digital contents. For this purpose, participants needed either to scan the hybrid artefacts individually or to make group configurations of the hybrid artefacts and scan them in pattern groups and paths.

In terms of the individual and group configuration interactions, the findings of the first study (chapter 3) show that participants had an interest in the exhibited artefacts thus they scanned the hybrid artefacts that were created for each artefact individually on the table to reveal their digital contents. This motivated participants further to explore the relationships between the exhibited artefacts through configuring hybrid artefacts on the paper map followed by scanning them in pattern groups and paths. More particularly, participants developed three distinct strategies for exploring the relationships between hybrid artefacts which are inspection, strategic configuration and experimental configuration.

Inspection was the strategy that all participants used to explore the hybrid artefacts by scanning them individually to reveal background information about them. This was followed by fixing all hybrid artefacts in appropriate locations on the map (using the coloured shapes on the map as a guide) with the aim to understand how the artefacts were related geographically. This was accomplished by scanning them in pattern groups and paths either through strategic configuration of the hybrid artefacts and map, or adopting an experimental approach to configuring the hybrid artefacts and map.

Strategic configuration was the strategy that was followed by some of the participants in which as a result of inspection, they developed a clear model of how hybrid artefacts might be combined through their commonalities or through their shapes and colour-coded, and

deliberately combined these cards on the map with an expectation of the relationship between the artefacts. The app was also used for validating the expectations for scanning the combined hybrid artefacts. Other participants followed an experimental configuration strategy to explore the relationship between hybrid artefacts arbitrarily by placing all of them on the map without identifying those that could be related to each other, and without physically collecting hybrid artefacts with similar features. In this strategy, visitors used the app to guide the process of trial-and-error.

In both strategies, pattern group was more frequently used as it was found to be more easy and natural way of scanning a group of hybrid artefacts whereas pattern path was found to be more complicated to form. This complexity could be of benefit to engage visitors deeply, particularly for those who would like activities that are more challenging. Previous researchers also suggest that the museum activities should range between simplicity to complexity (Ciolfi and Bannon, 2003).

Although instructions about using the app and the complex interactions of scanning artcodes in pattern groups and paths were provided to the participants through printed handout and on the app screen, as hints, designers need to provide more guidance through the digital contents as well. Thorn et al. (2016) also embedded instructions about interacting with artcodes in large illustrations within the digital contents. In addition to the instructions, visitors can further be supported to find a set of artcodes that can be scanned in pattern groups and paths using Xu et al.'s (2017) approach. Xu and his college developed a feature for the artcodes app to recognise artcodes in large designs through alert warning that users can receive on their phones, during scanning artcodes, to make them be aware of having hidden artcodes inside of images.

The findings of the second study (chapter 4) show that although participants had interest to explore the digital contents behind the official markers that were created for augmenting the exhibited portraits, they scanned the visitors' hybrid artefacts more frequently. In this case, the visitors' hybrid artefacts appeared as a standalone exhibition on its own because the markers delivered both images and the codes at the same time. Thus, participants tended to explore the digital contents behind these exhibited markers.

The findings of the third study (chapter 5) show that few of the participants of the Gallery Three only chose to scan all hybrid artefacts that were created for their favourite video game "Mario" and they were highly engaged with them. Whereas most of the participants tended to browse more than one exhibition room in order to explore most of the exhibited objects and reveal what other visitors said by scanning the associated hybrid artefacts. In a setting such as the Lobby, where no objects were exhibited, visitors had more interest to choose scanning the hand-drawn artcodes compared to the pre-designed artcodes as they found the design of the hand-drawn artcodes more appealing to reveal their digital contents.

Therefore, some of the participants tended to scan particular hybrid artefacts that belonged to their favourite exhibited objects. This behaviour is similar to the grasshopper behaviour that was identified in a classic ethnographic study by Veron and Levasseur (1983) as they stated that the grasshopper visitor tends to spend most of the time engaging with specific objects which is of interest and ignore the others. This behaviour was also described by Sparacino (2003) as a selective behaviour where a visitor tends to interact with an exhibition by selecting particular objects that are of his/her interest.

However, the behaviour of the participants who tended to explore most of the exhibited objects in the exhibitions and scanned their hybrid contents is similar to the greedy behaviour that was highlighted by Sparacino (2003) as the greedy visitor would like to know and view most of the exhibition as much as possible. Also, this behaviour is similar to the Ant behaviour that was identified by Veron and Levasseur (1983) in which the ant visitor would spend a large amount of time engaging with most of the exhibit and follow a certain path for movement.

As participants had different approaches for configuring cards on the map for exploring the relationships between artefacts as well as to scan hybrid artefacts of the existing objects thus, the designers need to consider these different behaviours and support them in order to engage visitors deeply with the hybrid artefacts and the exhibited objects.

C- Explore visitors' hybrid contents

The findings of both the second and third studies (chapters 4 and 5) reveal that the participants were highly motivated to scan visitors' hybrid artefacts in order to reveal their experiences, stories and comments.

The findings of the second study (chapter 4) show that although there were official and visitors' hybrid artefacts that were displayed in the exhibition, participants had more interest to interact with the visitor hybrid artefacts and scan them more frequently, than the official hybrid artefacts. This was because participants felt more personally connected to those artefacts as they were created by visitors like them who had already experienced the exhibition and were curious to hear their experiences and reflections on the topic of the exhibition. Participants also appreciated points of view from different cultures and countries.

In addition, visitors' hybrid artefacts were drawn to represent as artefacts and at the same time the codes were embedded inside them. Thus, participants' focus was only on the hybrid artefacts without necessarily needed to shift focus away. As already discussed, participants also found the visual design of the visitors' hybrid artefacts more meaningful, their positions made them easily accessible to scan and the simplicity of the interface for playing the audio contents within the app further motivated them to scan these markers.

The findings of the third study (chapter 5) show that the participants had an interest in revealing the audio recordings of the visitors' hybrid artefacts and they engaged with them while they were interacting with the video games and objects. The findings also show that in the Lobby, when few of the participants just came to the museum or they just were about leaving the museum or when they were waiting to talk to the staff in the reception, they tended to explore what other visitors have said behind the displayed hybrid artefacts.

D- Spatial layout

The findings of the three studies (chapters 3,4 and 5) reveal the impact of the physical positions of the displayed hybrid artefacts on motivating visitors to scan them and to provide them smooth and comfortable experiences during scanning the hybrid artefacts. In addition, their physical position also offered more facilities, activities and exploration.

For example, in the first study (chapter 3) the findings show that the participants appreciated scanning artcodes on a table and they found it useful for revealing background information of them or to use the table when the space around the paper-map was not easily accessible due to visitors' interactions with it. The benefit of using a table for visual and tangible activities in

museums was also highlighted by Chieh-Wen, Shen and Chen (2008) as a means to engage visitors deeply with the exhibition contents and also to promote interactions and collaborations amongst multiple visitors simultaneously which would perhaps promote learning as well.
However, the findings show that participants found the map to be more useful for exploring the relationships between artefacts through scanning the hybrid artefacts in pattern groups and paths. Still the participants had freedom to choose where to place artcodes (either on the table or on the map) and scan them which was highlighted as an interactive point of the design. Being able to place and scan artcodes on each of the table and the map offered visitors more opportunities and explorations as they developed each of the inspection, strategic and experimental configuration strategies.

The findings of the second and third studies (chapters 4 and 5) reveal that the physical positions of the displayed official hybrid labels close to the exhibited portraits and the position of the displayed visitors' hybrid artefacts close to the exhibited video games motivated participants to easily approach them and scan them. This also enabled the participants to know easily which hybrid artefacts belong to which portraits and video games. In addition, the physical placement of the hybrid artefacts close to the exhibited objects enabled the participants to stay visually and physically engaged with the exhibited objects which further motivated participants to scan the hybrid artefacts.

However, challenges were found as in the second study (chapter 4), the official labels of the portraits were located in lower positions of the portraits which led to a delay in recognition and consequently made participants uncertain of where to scan the hybrid artefacts and from which distances. Within the time frame of this thesis, a research was carried out by Ng and Shaikh (2016) and they also noted issues with visitors having to scan labels from awkward positions when they were deployed in a botanical garden in Malaysia. The issues arose from the placements of some of the labels, which were too far from the walkway.

On the other hand, no other issues were found during participants' interactions with the displayed hybrid artefacts on a wall that were created by other visitors in both chapters 4 and 5 because they were all displayed in the centre of a wall (not too high nor too low). In fact, displaying visitors' hybrid artefacts separately on their own on a wall was found interactive for enriching visitors' experiences because they can be considered as an exhibition in itself

due to the variety of the aesthetic visual designs of the artcodes. This further motivated the participants to scan them in order to reveal the digital contents behind each hybrid artefacts. Thus, it can be said that with careful displaying approaches, visitors' motivations for scanning hybrid artefacts can be promoted.

E- Social engagement

Although this research was not explicitly designed to promote social interactions and collaborations between participants, across the studies, extensive social interactions and collaborations were observed between friends and unrelated participants during scanning hybrid artefacts and interacting with the digital contents. Overall, behaviours such as cooperating and interrupting tasks, talking, smiling and gesturing to each other were regularly observed. However, the main social interactions and collaborations that happened between participants were related to: **managing and sharing the physical space with each other**, **collaborating and helping each other**, **learning from each other**, **recommendations for scanning particular hybrid artefacts** and **maintaining engagement with each other**. Each of these needs to be considered in order to support visitors during their engagements in the interaction stage. These different behaviours are explained in more detail below:

The findings of the three studies show that participants mainly engaged with each other to manage the physical space and provide more free spaces for other visitors to access the exhibited objects and the hybrid artefacts. Thus, they were mindful of other visitors in a way that once they scanned an artcode, they moved back to make space for others to scan and interact with the hybrid artefacts.

However, in the first study (chapter 3) where the participants needed to configure the cards physically on the map, the findings show that the limited space around the map encouraged some of the participants to develop a mechanism for sharing the space by dividing the map into two halves, allowing a pair to interact with the map simultaneously followed by alternating to interact with the other side. This behaviour happened because each of those participants wanted to have an individual experience to interact with the map in their own way.

Despite aiming to allow private interaction, this behaviour often evolved into collaboration whenever they noticed each other trying to scan invalid pattern groups or paths. On the other hand, most participants were less formal about dividing the space, and tended to cooperate fluidly as a group to interact with the map to share the interaction space as each participant of

the group attempted to allow each individual to carry out inspection, by taking turns to fix a card to the map and scan it, afterwards retreating to the table to allow room for others. Vom Lehn (2006) also found that visitors make space for their companions or other visitors to view the exhibit and the display screens. However, Wein (2014) found that visitors were less mindful about making space for others during their interactions with QR codes because they needed to stay too close to the QR codes in order to scan them.

The findings also show that the participants collaborated and helped each other to interact with the visual markers including helping each other to correctly scan hybrid artefacts, group of hybrid artefacts and to use the app. In addition to the direct help, the findings of the first study (chapter 3) show that some participants collaborated with each other by assigning each other complementary roles where one participant would adopt the role of fixing cards to appropriate places on the map while others would scan the newly fixed artcode and then they swap the roles. Alternatively, participants adopted specific roles for the whole session.

The findings reveal that the participants learned by observing each other how to scan artcodes specifically when there was a group of artcodes that can be scanned in pattern groups or paths. In this regard, the design of the paper-map installation attracted more participants to join other participants who were around the installation and they learned from each other how to recognise related hybrid artefacts and scan them in pattern groups and paths correctly. In addition, the place where the paper-map was displayed and also the places that the hybrid artefacts were displayed (on the table, map, close to the objects and on the wall) all enabled them to become visible and accessible for several visitors at the same time. These motivated participants to observe other visitors while they were interacting with the hybrid artefacts, learn from them and potentially to replicate them.

The findings also reveal that in all the three studies, some participants were motivated to scan particular hybrid artefacts or even to participate in the study when they observed other participants (partners or non-related participants) engaged with particular hybrid artefacts. In response to that, participants also started to replicate them by asking the author to participate in the study or to replicate them by scanning the same hybrid artefacts or they were directly recommended by their partner or friends to scan particular hybrid artefacts because they found the digital contents interesting.

These findings are in accordance to Bitgood (1992) as she states that museum visitors tend to access places and installations in a museum where other visitors are present. Further studies also indicated that overlapping between visitors around an exhibition could influence visitors' engagement with the interactive surfaces (Marshall et al., 2011; Peltonen et al., 2008). Vom Lehn (2006) also found that visitors started to interact with objects that other visitors were interacting with. All these studies are in agreement to the concept of the "honey pot effect" that was proposed by Brignull and Rogers (2003) as they stated that the interactions that happen between a number of visitors around a public screen display can promote social interactions between visitors and improve their visit experiences. Thus, it can be said that visitors' behaviours are affected by the design and context of the exhibition as well as by the presence of other visitors. Visitors behave variously for making sense of exhibition and experiences such as walking around to look at objects, inspecting, pointing to objects, discussing with other visitors and each of these are visible to other visitors which can influence their way of interacting with the exhibition as well.

In addition to the above behaviours, the findings of the three studies reveal that most of the participants (those who were couples or in groups of family or friends, even those who did not know each other) stayed close to each other throughout their interactions of scanning the hybrid artefacts and interacting with the digital contents. Whereas in few cases participants split from their companions to experience the visit in their own way followed by re-joining. Similar behaviours were also observed by Dim and Kuflik (2009) as they found that members of a group in museums behave differently as some of them stay with each other throughout their visit and they largely interact with each other whereas other visitors separate from their companions. These two behaviours are similar to the Meerkats and Lone wolves behaviours that have already identified by Dim and Kuflik (2015). Meerkats are the visitors who stay next to each other during their engagement with the exhibition. Lone wolves are the visitors in which a member of the group separates from others and experiences the visit alone.

This finding (visitors who stayed together throughout their visit or they split at first) is in agreement with two behaviours that were highlighted by Fosh, Benford and Koleva (2016) as they found that visitors either stayed together throughout the visit, split up from their companions or stayed together followed by repeat split and re-join. However, other researchers found that it is difficult for group members to maintain a balanced engagement

with museum contents, interpretation and to stay connected with their companions (Tolmie et al., 2014).

Therefore, it is important to consider that for enabling visitors to interact actively with hybrid artefacts and scan them, the physical space should be designed and structured in a way to allow multiple visitors to interact with the exhibition simultaneously which could potentially promote social interactions and collaborations amongst them.

6.3.1.2 Exploring digital contents

Overall, in all the three studies, participants' interactions and engagements were not only observed during scanning the hybrid artefacts, but they also experienced a deeper engagement once they successfully scanned the hybrid artefacts and accessed the corresponding digital contents. Participants' engagements with the digital contents was not an independent activity of interacting with digital contents on their own, but it was a joint activity of interacting with the digital contents and at the same time interacting with the hybrid artefacts, exhibited artefacts and other visitors.

The findings of the three studies (chapters 3, 4 and 5) show that participants were highly engaged and interacted with scanning hybrid artefacts in order to reveal their associated digital contents and they enjoyed interacting with them. However, the findings also reveal the key essential aspects for engaging participants with the digital contents and maintaining their interest to continue on exploring more digital contents. The key aspects are: **nature of the digital contents**, **choice of the medium**, **maintain access to the exhibit objects** and **behaviours while exploring digital contents**. Therefore, for engaging visitors to access the digital contents and enabling them to enjoy interacting with them, designers need to consider these key aspects carefully when designing digital contents. Each of these three aspects are discussed in more depth below.

A- Nature of the digital contents

Although it seems obvious, it is quite important to design the nature of the digital content carefully in order to ensure visitors would enjoy interacting with the digital contents and they would be motivated to explore more digital contents. The findings of all the three studies (chapters 3,4 and 5) show that the nature of the digital contents (either providing additional information or visitors contents) was interactive which motivated the participants to engage with and explore more digital contents.

The findings of the first study (chapter 3) show that the digital contents that were created for the individual artefacts were formative and interactive at the same time as they delivered additional background information about the artefacts while they were also supported with images of both the exhibited artefacts and the cabinets that they were placed in. In addition, the nature of the digital contents that were created for revealing information about the relationship between artefacts, either based on their common purpose or by the temporal relationships, were highly appreciated by the participants and they found such information about the museum's artefacts as unexpected but useful. In particular, the findings show that participants' engagements become deeper when they found that scanning a particular set of hybrid artefacts in pattern groups or paths resulted in revealing a particular digital content that was different from the digital content that was accessed by scanning the same set of hybrid artefacts but in a different technique. This technique led to deeper discussions amongst the participants about the interactions, scanning opportunities and different digital contents.

The findings of both the second and third studies (chapters 4 and 5) reveal that the participants highly appreciated interacting with the audio contents that were created by other participants to share their own stories and experiences in relations to the exhibition's themes. More particularly, they interacted with the contents of the audio recordings in which they either delivered participant's own experiences in relation to the exhibited objects or to add more information/ leave comments about the exhibited objects.
In the second study (chapter 4), the findings also show that participants engaged with the digital contents of the official labels which were about life experiences of people from a specific community (Latin America) as well as being able to reveal what other visitors have reflected on the portraits. However, they found the visitors' reflections on the portraits more engaging as they delivered personal experiences about the visitors from different perspectives, diverse countries and cultural background instead of only Latin America. Thus, the visitors' contents gave the participants a sense of being emotionally and personally linked to each person in those audio records.

In the third study (chapter 5), the findings show that participants of the Gallery Three appreciated interacting with the contents of the audio recordings that were particularly tailored by other visitors to share their own stories and experiences around particular video games. More specifically, while the participants were playing particular video games, they enjoyed listening to what other visitors said about their preferred video games. However, in

the Lobby, where there were no interactive objects and the artcodes were displayed on their own, participants found listening to other visitors' audio contents about general video game experiences interesting. They were able to link what they were listening to with what the visual design of the artcodes looked like particularly with the hand-drawn artcodes.

B- Choice of the medium

The findings of the three studies (chapters 3,4 and 5) show the importance of choosing the most suitable and effective medium for the digital contents based on the exhibition context and the nature of the digital contents. The findings also show that the careful selection of the medium alongside with the useful and interactive digital contents provided a rich experience for the participants by allowing them to interact with the exhibited objects and at the same time with the digital contents.

In the first study (chapter 3), mixed mediums of text, image, audio and video were used for delivering the background information about the individual artefacts and also for delivering information about the relationships between artefacts. Using text medium worked successfully as it allowed participants to obtain more knowledge about the artefacts while using images (image of the artefacts and image of the collection which holds the artefacts) alongside the text worked highly engaging. This was because the image of the artefact enabled participants to know how the actual exhibited artefact looks like while the image of the cabinet helped them to know where to find the actual exhibited artefact (that they just saw its image by scanning its corresponding hybrid artefact) in the museum. This resulted in engaging visitors to become more active by interacting with the digital contents and at the same time walking around the museum to find the exhibited artefacts in order to start their deeper interaction. The video was also found to be quite interactive as it enabled the participants to obtain deep knowledge about the relationships between artefacts.

In the second and third studies (chapters 4 and 5), the audio was the only medium that was used for the digital contents that were about visitors' own contributions to share their personal stories and experiences. In both studies, the findings show that the audio medium worked effectively as it matched with the context of the exhibitions and it enabled participants to interact deeply with the digital contents through listening to the voice of the visitors while they were talking about their stories and experiences. In addition, listening to the audio contents motivated the participants to stay visually and physically connected and interacted

with the exhibition. Moreover, the audio medium for the digital contents also allowed participants to stay physically and emotionally engaged with their companions and with the non-related participants while they were listening to the audio recordings.

However, video medium for the digital contents was also suggested by some of the participants of both the second and the third studies (chapters 4 and 5) particularly for the Lobby setting in the NVA (chapter 5) since no interactive or visual objects were available in those settings. Thus, those participants thought that video medium could be more engaging as they can see the face of the people who shared their own experiences.

In the first study (chapter 3) where headphone was not provided to the participants for interacting with the audio and video contents, the findings show that participants found using the smartphone's speaker for interacting with the digital contents engaging and they enjoyed listening to them. It was observed that during participants engagement with watching video contents, other bystander participants were also motivated to listen and watch the video and to know how they accessed such video contents. This behaviour was explicitly found when participants tended to explore relationships between artefacts through scanning same set of artcodes but they were surprised how the digital contents were different and that was because they either scanned the artcodes in pattern groups or paths. Therefore, most of the participants engaged in conversations with the other participants to ask them how they revealed such video contents. In this regard, Woodruff et al. (2001) found that visitors were able to communicate with their companions and also to interact with the exhibit by using only the guidebook's speaker.
Thus, it can be said that even though it is thought that using speaker (rather than headphones) for watching the video could be inappropriate in a museum setting as it may disturb other visitors, the findings of the first study (chapter 3) revealed the opposite. The findings show that using speaker can be a useful approach for engaging visitors to further explore more contents, interact with the contents more deeply and to communicate with other visitors.

In the second and third studies (chapters 4 and 5) participants were provided with the headphone to listen to the audio contents and the findings show that few of the participants used to listen to the audio contents through the smartphone's speakers. On the other hand, the majority of the participants used the headphones for interacting with the audio contents and

some of them used to share listening to the audio contents with their companions through sharing headphone earplugs.

Thus, it can be said that although using headphone can isolate visitors from their companions, in fact, it can be a useful approach for engaging them to interact socially with their companions through sharing headphone earplugs.

Overall, it is important to choose the medium for the digital contents carefully in order to ensure that smooth and effective experiences are provided to the visitors. In addition, using suitable and appropriate interface for representing the digital contents is quite important which needs to match exactly the medium of the digital contents. For example, for representing audio contents, the interface should give visitors a sense of playing audio contents rather than interfaces like YouTube as it will give people a sense of expecting a video content.

C- Maintain access to the exhibit objects

Enabling visitors to maintain access to the physical objects while interacting with the digital contents is quite important which can be facilitated through choosing the medium carefully for the digital contents.

The findings of the first study (chapter 3) show that even mixed medium of text, image, audio and video were used for delivering information about individual artefacts and information around relationships between artefacts, participants still were able to stay engaged with the exhibited artefacts and the hybrid configurations. This was because the nature of the digital contents and the way the information were presented in the digital contents, motivated participants to interact with each of the digital contents, hybrid artefact, location of the hybrid artefacts on the map, configuration of the hybrid artefacts and the physical layout of the exhibited artefacts in the museum.

The finding of both of the studies that were reported in chapters 4 and 5 show that participants were able to stay visually and physically engaged with the exhibited objects and at the same time explore what other visitors have said about the exhibited objects through listening to their experiences and stories. This was again facilitated through using audio as the medium for the digital contents to enable participants to stay visually connected (as it was noted in the second study-chapter 4) and physically connected through playing video games (as it was observed in the third study-chapter 5).

A research during the time frame of this thesis was carried out by Ryding and Løvlie (2018) to explore the application of artcodes labels in a museum setting to provide more information about the monuments in the museum of Yugoslavia in Belgrade, Serbia (figure 6.7) using text and image mediums. Despite visitors' engagement with the artcodes, the majority of them found that their attention shifted away from the exhibited monuments as a result of reading the text on the phone screen.

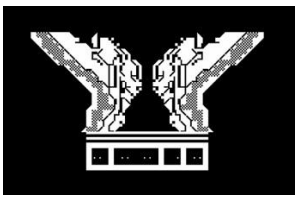


Figure 6. 7 An artcode that represents a monument

D- Behaviours while exploring digital contents

Overall, the installation and the displayed hybrid artefacts enabled participants to stay close to each other, talk to each other, listen to the audio contents using headphones and occasionally using speakers to listen to stories of other visitors.

Participants' behaviours during their interactions with the digital contents were directly affected by the context of the exhibition, nature of the digital contents and choice of the medium for the digital contents. Thus, it is important to consider each of these three aspects for designing visitors' experiences in order to ensure successful engagement and interaction of the visitors with the digital contents and their surrounding environment.

The findings of all the three studies (chapters 3,4 and 5) show that during the participants' interactions with the digital contents, a number of behaviours were observed. For instance, it was observed that while participants were interacting with the digital contents, they stayed visually connected with the digital content, hybrid artefact and the exhibited artefacts. In this regard, the nature and the medium of the digital contents affected the way in which the participants behaved.

For instance, in the first study (chapter 3) the mixed media of the text, image, audio and the video engaged the participants to interact with the digital contents, look at the images and walk in the museum to find the exhibited objects that match the images in the digital contents. In addition, they started to engage with the video and at the same time communicate socially with others about the ways that they accessed the contents.

Researches have already identified that museum visitors are more likely to enjoy their experiences when they can have information about the museum layout and also find the major objects (Bitgood, 1992; Brida, Meleddu and Pulina, 2012). In larger museums, this installation approach might be complemented by a trajectory based system to help visitors find the physical artefacts, and explore relationships further when they are away from the installation.
In the second study (chapter 4) where audio was used for supplementing the hybrid artefacts, the findings show that during listening to the audio contents, participants mainly stayed visually connected with the hybrid artefacts, the exhibited objects and walk around to look at other hybrid artefacts. For this purpose, they either stayed close to the hybrid artefacts and the exhibited objects or they moved back further to make space for others while they can still be visually connected to them.
In the third study (chapter 5), since the audio medium was used, the same behaviours as the second study were observed in addition to participants' active and physical engagement of playing video games while listening to the audio contents as they were interested to explore what other people said about the video games that they were playing.

In addition to all the above behaviours, a number of social behaviours were also observed during participants' interactions with the digital contents. In the first study (chapter 3), the findings show that frequent social interactions and discussion were observed amongst the participants whenever they accessed different digital contents by scanning the same hybrid artefacts in pattern groups and paths. In addition, participants were allowed to interact with the audio and video contents through the smartphone's speaker which led most of them to engage socially with each other by looking at each other smartphone and start discussion with each other around the video contents. However, in the second and the third studies (chapters 4 and 5) 7 participants were also able to communicate socially with their companion through sharing the headphone earplugs in order to listen to the audio contents synchronously.

Also, the findings of the first and the second studies (chapters 3 and 4) reveal that when participants scanned an artcode and they started to interact with the digital contents, they moved back to create a free space for others to access the hybrid artefacts. This behaviour allowed other visitors to easily access the hybrid artefacts and potentially communicate socially with each other. Researches have shown that the physical movement of visitors and

their body orientation can have a high impact on groups of visitors' collaboration and make meaning (Steier, 2014; Vom Lehn, Heath and Hindmarsh, 2001).

Overall, it can be said that the audio medium can be a useful mechanism for engaging visitors with the objects and to promote social interactions amongst them. In the literature, many researchers developed novel techniques for enabling visitors to attach pre-curated audio contents to physical objects in the exhibition in order to engage them deeply with the exhibition and socially with their companions. For example living room (Pugliese, Politis and Takala, 2015), ec(h)o (Hatala and Wakkary, 2005b), Hippie (Oppermann and Specht, 2000) and LISTEN (Zimmermann, Specht and Lorenz, 2005). Aoki et al. (2002) also developed Sotto voce, an audio guidebook, to enable visitors to share listening to the same audio contents at the same time through eavesdropping on each other's audio contents in order to enhance their social awareness and interactions (Grinter et al, 2002). Other researchers like Raptis et al. (2005) also found that sharing audio contents amongst users could promote social interactions. Thus, from these discussions, it seems useful to design technologies that allow groups of visitors to share interact and access the digital contents synchronously.

Finally, although the findings of both studies in chapters 4 and 5 show that participants repeatedly communicated and collaborated with each other directly or indirectly, they were also connected socially with the people, who created the hybrid artefacts and left them in the museum and gallery. However, this type of connection is one-way which can be promoted by designing the visit experience for engaging visitors to make conversation and dialogue with each other by responding to each other's contributions and making their own hybrid contributions (McKay and Monteverde, 2003).

6.3.2 Second stage: Response

Response stage is the second stage of the co-creation cycle and follows the interaction stage. In the response stage, participants of the second and third studies (chapters 4 and 5) had an active role to reflect on their experiences by interacting with the exhibited objects and hybrid artefacts in the interaction stage and creating their own hybrid contributions (physical and digital contents).

Overall, for enabling visitors to become active responders, it is important to allow them to browse the exhibition first in order to obtain some knowledge about the setting and objects. This would motivate them to choose the object(s) to create their hybrid contributions around.

In both studies (chapters 4 and 5), participants were allowed to visit the exhibitions prior to inviting them to the response stage where the creation of the hybrid contributions took place. This made the participants to become enthusiastic and active participators during the interaction stage to observe the exhibitions carefully in order to decide on selecting objects/hybrid artefacts of the exhibition, in their mind, to create the contribution around. Since they interacted with the exhibitions, observed other visitor interactions and had a fresh memory of what was exhibited, participants gained knowledge which motivated them to become responders to reflect on their own visit experiences and the exhibition by creating their own hybrid contributions.

The findings of the second study (chapter 4) show that visiting the exhibition where visitors' hybrid artefacts were displayed was useful to motivate participants to reflect on the exhibition and visitor's contents by creating their own contributions. This was because participants found the visual design of visitors' hybrid artefacts meaningful and easy to draw artcodes as there were artcodes that were created even by children. This gave participants more confidence to create their own contributions in addition of their engagement to use the app. Moreover, the visitors' hybrid artefacts inspired participants to think about their own experiences or comments in relation to the exhibition for their own contributions. Finally, physical placement of visitors' contributions in the exhibition further engaged participants to create useful contributions, as they already knew how their contributions would be valued and integrated into the exhibition. However, the findings of the third study (chapter 5) show that allowing the participants to browse the exhibition enabled them to reflect on the exhibition and become active responders without being introduced to any displayed hybrid artefacts.

Thus, it can be said that whether the exhibition is associated with hybrid artefacts or not, visitors should be allowed to browse the exhibition to obtain knowledge about it in order to enable them to reflect on the exhibition theme by creating their own hybrid contributions. Browsing the exhibition prior to the response stage enables visitors to use their newly gained knowledge and skills in combination with their personal interests and expertise to develop new contents and experiences for the exhibition (see Falk and Dierking, 1992; Hall, 1997; Hein, 1998; Hooper-Greenhill, 1991; Karp and Lavine, 1991; Ledwith, 2005; Levine, Kern and Wright, 2008; Matusov and Rogoff, 1995; Moon, 2013; Sandell, 2007). As a result of the visit, visitors would be able to understand their own interests and identify the way that would

be best for further engagement (Duschl, Schweingruber and Shouse 2007; King and Tran 2017).

Sengers and Gaver (2006) also state that the ambiguity of the exhibited objects makes them open to multiple interpretations instead of a single closed interpretations. In this research, the exhibited objects, the diverse visual designs of the artcodes and the nature of the digital contents all invited participants to reflect by creating their own hybrid contributions.

Therefore, the findings from both studies reveal that participants were able to become active reflectors on the exhibitions through their visit to the exhibition that were either supplied with official labels (hybrid artefacts), both official and visitors' labels or not supplied with any hybrid artefacts. Thus, the author argues that by enabling visitors to become active reflectors on an exhibition and create their own contributions using artcodes, they should be introduced to the exhibition, its contents and how and where their own contribution will be integrated into the exhibition but not necessarily need to be introduced to artcodes in the exhibition.

However, visitors might not be able to reflect on their experiences of the interaction stage immediately to create their own hybrid contribution due to not having enough time. Thus, it would be useful to allow them to become active responders after leaving the site by providing them with copies of the aesthetic visual markers so that they can create the digital contents for them.

In the response stage, artcodes technology offered participants quite a unique and unusual opportunity of involving participants in multiple activities of creating contributions through drawing or choosing pre-designed artcodes and linking them with their own audio recording in the app. This is unlike the traditional way of visitors' contributions which are either allowing visitors to leave physical contents such as comment board and visitors' book or digital contents such as social media content. In particular, crafting valid hybrid artefacts required effort and creativity from participants, which made them put more thought into the process, resulting in producing more interesting contributions compared to the visitors' book or systems that allows objects to be tagged with text comments. As a result of these, participants would end their visit experiences not only by leaving their hybrid contributions in the exhibitions but also by gaining skills and knowledge about using new technology like artcodes.

In this regard, it is worth noting that although both physical and digital content are required for making a hybrid object, the nature of the physical object itself could be different as it can be either a fixed object or a more flexible object. To explain this further, a fixed physical object can be turned into a hybrid object following 2 steps: first by embedding an artcode design into it; second, by augmenting the artcode design through linking it to digital content. Example of this is the Carolan guitar in which decorative patterns in a form of artcodes were drawn on it and the artcodes were linked with digital layers of personal contents of the people who played the guitar (Benford et al., 2016). Alternatively, hybrid object can be produced by creating artcode design and augmenting it with digital content without embedding the artcode design on fixed objects. Example of this sort of hybrid objects are those that were created in this PhD work either by the author (the artcodes artefacts in the first study in chapter 3) or by the visitors (hybrid contributions in the second and third studies in chapters 4 and 5).

However, the main drawback of allowing visitors to contribute using artcodes technology is that inappropriate hybrid artefacts (both physical and/or digital contents) might be created which need a regular and intensive moderation to be made by the curators to remove them. In addition, allowing visitors to create hybrid artefacts means that physical contents are produced that need to be displayed in the exhibition. This could raise a challenge for museums and galleries because physical contents take physical space and at the same time the design of the physical contents needs to fit the overall design and layout of the exhibition in order not to affect the aesthetic quality of the space. Details about contents moderations and their placement will be discussed in more detail in the next stage (reintegration).

The findings from both the second and third studies (chapters 4 and 5) reveal that inviting participants to contribute by sharing their own experiences or leaving comments was a useful mechanism for engaging them to contribute. The majority of the hybrid contributions were created for public visitors and few were tailored to family and friends based on their interests. This reflects Simon's (2010) suggestion that participants should be allowed to participate based on their interest and the participation should not be open-ended instead, it should be clearly indicated what the goal of the participation is and how the outcome should look like.

The findings from the second study (chapter 4) show that the participants responded to the exhibition through creating hybrid contributions to share a new layer of personal experiences and stories, in relation to the overall exhibition theme, which resulted in extending the exhibition. Whereas, the participants of the third study (chapter 5), in addition to extending

the exhibition through sharing personal experiences, they also mainly tended to contribute to the exhibition through augmenting the exhibited objects by leaving their own comment and personal experiences about the existing objects.

To explain the response stage in more details, the main key activities that need to be considered in this stage are **planning**, **physical content creation**, **digital content creation** and **facilitation** as explained below (see figure 6.8).

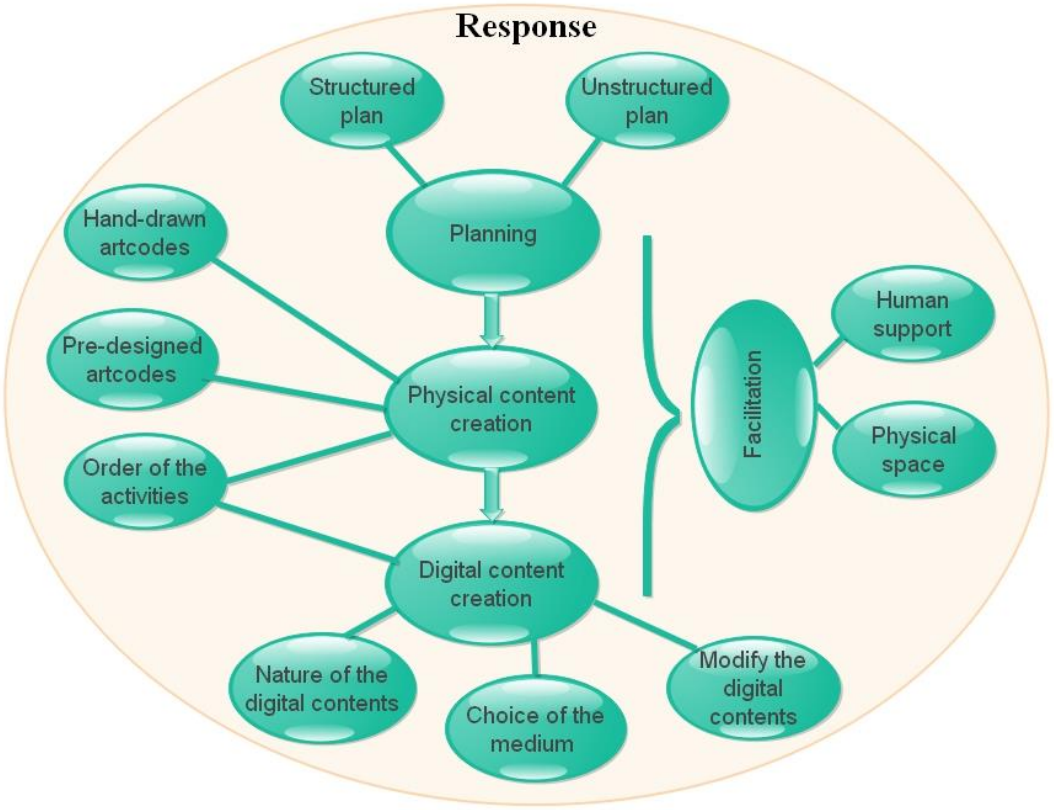


Figure 6. 8 The key opportunities and challenges of the main activities in the response stage

6.3.2.1 Planning

Although planning is an activity that can happen in all stages of the co-creation cycle, in the response stage, planning is particularly important for facilitating visitors' contributions using artcodes. These contributions consist of both physical and digital contents which need careful structuring. The first activity of the response stage, just after the interaction stage, started with the planning process of the hybrid content creation in order to facilitate participants' reflections which took place following a structured or non-structured plan. Overall, both structured and non-structured plans worked by enabling participants to reflect but for different purposes.

In the second study (chapter 4), after interacting with the exhibition, the participants were required to fill the worksheets, that were provided to them, in order to make a structured plan for their contributions. This prompted them to think about what their contributions should be about, what the physical design and the digital content should be and what the link between them should be. The findings show that the structured plan worked successfully for enabling visitors to create hybrid contributions where they extended the exhibition through sharing new layers of personal experiences (digital contents) and linking them with hand-drawn markers.

In the third study (chapter 5), the participants were not provided with worksheets for planning their hybrid contributions creation, instead, they were allowed to create the hybrid contributions straightaway. In addition, human support was provided to the participants to instruct and clarify how they can make their contributions. The findings show that without making any structured plan but providing human support, the participants were able to create meaningful hybrid contributions for augmenting the existing objects through sharing their personal stories or comments about those objects and linking them with hand-drawn or pre-designed artcodes. Thus, it seems that structured worksheet planning is useful for making hand-drawn artcodes whereas for the pre-designed artcodes, structured worksheet planning is not required. In addition, when human support is provided, worksheet planning is not necessary anymore.

6.3.2.2 Physical content creation

In general, participants designed physical markers (artcodes) for their contributions to share personal experiences and interest or to make comments about the exhibitions. With a simple set of instructions, participants managed to produce valid artcodes within several minutes and use the app easily. The findings from the second and the third studies (chapters 4 and 5) show that using artcodes, aesthetic and meaningful visual markers, as a mechanism for crafting hybrid artefacts in the response stage promoted visitors' motivations to contribute to the exhibitions through creating their own hybrid contributions. In addition, the findings from both studies reveal that participants engaged highly in drawing their artcodes in order to add a new layer of contents to the exhibition, without referring back to any exhibited artefacts and this resulted in extending the exhibition. The hand-drawn artcodes particularly can be a useful technique for adding new contents to the exhibition because it allows visitors to represent their content and imaginations through the physical design of the markers in addition to the digital contents.

Drawing has previously been identified as an activity for engaging people deeply with the museums' exhibitions. Clements and Wachowiak (2010) state that the drawing activities in museums would allow visitors to express their own thoughts, experiences and ideas in relation to the exhibition context visually instead of writing text which can result in promoting their understanding and engagement with the objects further.

In the Rijksmuseum Museum in Amsterdam, visitors were required not to use their mobile phone or any camera to take photos of the artefacts, instead, they were invited to draw and sketch the artefacts by themselves using pen and paper which resulted in engaging visitors deeply with the exhibition and explore the detail of the artefacts (Shepherd, 2015).

Bartindale et al. (2011) also developed a fixed multi-touch interactive installation for the Great North Museum, Newcastle Upon Tyne, UK in order to enable multiple visitors to contribute to the exhibition interpretations simultaneously using a digital pen to draw or to write comments which would then be displayed on a screen in the museum. The authors found that visitors mainly left messages for family and friends and the hand-drawn contributions, that were displayed on the screen, inspired other visitors to replicate them by creating their own hand-drawn contributions. Vom Lehn et al. (2007) found that visitors highly engaged with the digital drawing using touch screen and their drawing activities motivated other visitors, who were observing them, to engage in drawing their own contents as well.

However, the findings from the third study (chapter 5) reveal that although participants had interest in drawing artcodes and producing interactive artcodes, providing more options like pre-designed artcodes with/without comments were highly appreciated. In particular, participants chose the pre-designed artcodes with/without comments for their hybrid contributions to augment the existing objects through sharing their personal experiences around those objects. In addition, the pre-designed artcodes with comment section allowed the participants to add a physical input to the templates either through drawing a picture or writing a text in the comment section to add a personal touch to them.

Thus, it can be said that using pre-designed artcodes can be particularly useful when the aim of the contribution is not for adding new layer of contents to the exhibition. Instead, the aim of the contribution is to add comments and opinions about the exhibited artefacts. In addition, the pre-designed artcodes are not only useful for the visitors who do not have enough time to

draw or those who have limited drawing skills, but they can also be useful for meeting the need of the visitors who tend to leave comments on the existing artefacts without necessarily designing artcodes. This reflects Simon's (2010) claims as she suggests that although involving visitors to participate in creating experiences, exhibits and contents from scratch can be highly democratic, some visitors may not be willing to participate since they may feel uncomfortable or lack confidence to share their unique contents. Thus, visitors can be involved in participation project that does not require them to create contributions from scratch (Simon, 2010).

From this discussion, it is proposed that for inviting visitors to contribute using aesthetic visual markers, they need to be provided with the drawing artcodes option as well as choosing the pre-designed artcodes with/without comment. This would offer visitors more opportunities to contribute and it can meet visitors' diverse needs (either to add new layer of contents or to leave comments about exhibited artefacts).

6.3.2.3 Digital content creation

In both the second and third studies (chapters 4 and 5), participants created the digital contents by recording their own voices to share their experiences and stories or to leave comments about the existing artefacts. However, the findings from both studies show that a number of key aspects affected participants' approaches for creating the audio recordings in which they need to be considered for enabling participants to contribute digital contents. The key aspects are: **order of the activities, nature of the digital contents, choice of the medium** and **modify the digital contents**. Each of these aspects are discussed in more depth below.

A- Order of the activities

The findings from the first session of the second study (chapter 4) show that most of the participants failed to record meaningful digital contents because they were more enthusiastic to draw valid artcodes and spent most of the available time on this activity which led them to pay less attention to record meaningful digital contents. In addition, privacy was another issue for recording less meaningful contents as there was no a private space for recording voice. For minimising these issues, the iterative design process was found successful where the order of creating physical and digital contents were swapped which resulted in the recording of more meaningful digital contents by the following participants.

In the third study (chapter 5) the order of creating hybrid artefact was intentionally swapped back to the previous version to create/choose physical contents followed by recording audio

contents in a semi-private booth. The findings show that the private booth was quite useful because it enabled visitors to create meaningful hybrid contents even though the order of the creation activities were switched back to the previous order.

Despite the fact that many museum visits are social, it is important to consider that for engaging visitors to create meaningful audio contents, they should be provided with a semi-private space to record meaningful audio contents. Thus, the order of the activities for creating hybrid contents does not really matter as long as private space is provided for recording the audio contents.

It is worth noting that facilitation that was carried out by the museum staff in the third study (chapter 5) was also another factor for engaging visitors to record meaningful audio contents. They guided participants in each stage to create physical markers and then instructed them to go to the booth for the recording of voice contents. Thus, the staff facilitation was a structured procedure for directing participants into the activities of content creation and moving from one activity to another. This was an effective technique that motivated the participants to further record meaningful audio contents.

B- Nature of the digital contents

Participants' motivations for creating digital contents was not just to create independent pieces of digital contents and leave them in the exhibition, rather, their motivation was to create meaningful digital contents that could fit the design of the physical marker and together complement each other to fit the exhibition and enrich its interpretations. Overall, the findings from the second and the third studies (chapters 4 and 5) show that participants who created meaningful audio contents for their physical contributions as well as those who chose to draw the artcodes managed to create audio contents that matched the design of the artcodes. In this regards, artcodes provided the participants a unique opportunity of creating hybrid artefacts that their visual designs and digital contents could complement each other to convey more comprehensive and meaningful contents to the exhibitions.

As already discussed, participants created audio recordings for the physical contents to add new layer of contents which resulted in extending the exhibition or to share their personal experiences and comments to augment the existing artefacts. Overall, the three main factors that affected the nature of the digital contents that the participants created were: **exhibition context**, **visual representations of the markers** and **placement**. Each of these factors need to be carefully considered in order to motivate visitors to create meaningful digital contents.

The context of the exhibition was the main factor that influenced the participants of both studies (chapters 4 and 5) to design the nature of the audio recordings accordingly either to extend the exhibition or to augment the existing artefacts. More particularly, the findings of the second study (chapter 4) show that the participants had personal experiences that fitted the exhibition context which motivated them to reflect on the exhibition through sharing their new layer of the personal experiences and stories. Whereas, in the third study (chapter 5), the participants had personal experiences and stories or comments which were exactly about the exhibited objects and that motivated them to add their experiences or comments about those objects.

In addition to the exhibition context, it seems that the nature of the digital contents also influenced by the visual representations of the markers. The findings from the second study (chapter 4) show that the participants chose to extend the exhibition by adding their own new layers of content in order to share their own personal experiences and stories that can fit the exhibition context. For this purpose, they chose to create the hybrid artefacts through designing new visual representations of artcodes and linking them to the audio contents. The created hybrid contents were then displayed in the exhibition on their own which seemed as a standalone (more detail can be found in the next stage of the reintegration). From these findings, therefore, it seems that creating new hand-drawn artcodes are more suitable for representing new layer of digital contents that can extend the exhibition (to seem as a new standalone exhibit) rather than commenting on the existing objects.

Whereas, the findings of the third study (chapter 5) show that the majority of the participants chose to augment the existing objects in the gallery by sharing their own experiences and stories or comments about the existing objects. For this purpose, the participants chose to create the hybrid artefacts through selecting the pre-designed artcodes and linking them to the audio contents. On the other hand, several participants chose to add new layers of their personal experiences in general, without referring back to any particular existing objects, which resulted in producing a new exhibition on their own. For this purpose, they chose to create the hybrid artefacts through designing new visual representations and linking them to the audio contents. From these findings, therefore, it seems that the pre-designed artcodes are more suitable approaches for enabling visitors to leave their personal experiences, stories and comments about existing objects which would result in augmenting them.

It is worth noting that few of the participants in the second study (chapter 4) created their hybrid contributions to comment on the hybrid contributions of previous visitors. Simon (2010) also suggests the usefulness of allowing visitors to contribute based on each other contributions. In addition to visitors' participations, it could be beneficial in the future to involve museum staff in the response stage as well, in order to enable them to create their own hybrid contributions or to answer visitors' questions and integrate them into the exhibitions. This would allow another way of communication between visitors and staff which might further enhance audience experiences and motivate them to contribute**.**

C- Choice of the medium

It is important to consider choosing the medium of the digital contents carefully in order to match with the exhibition context and the nature of the digital contents (objective of the contributions). Black (2005) highlights the importance of choosing a medium carefully for representing information to the museum visitors in an effective way. For this purpose, choosing the medium should depend on the objective of the content presentations and audience anticipation.

For both the second and the third studies (chapters 4 and 5), audio medium was chosen to enable the participants to create their digital contents by recording their own voices and this was appreciated by the participants. The decision for choosing audio medium was made because it fitted well with the exhibitions' contexts as well as with the nature of the digital contents which was about enabling the participants to share their personal experiences or leave comments around the exhibitions' contents. Thus, voice recording would make the digital contents more interesting as it allows more personal touch and emotional sense to be delivered in addition to the contents. Moreover, audio contents could be a more natural medium for participants' hybrid contributions as the audio contents would potentially complement the physical designs of the markers. As a result, the subsequent visitors in interaction stage can engage visually with the exhibited objects and the visitors' hybrid artefacts while they can listen to the stories of other visitors and emotionally connect with them and hence ensure a smooth and interactive visit experience.

In the previous researches, audio medium has been highlighted as the most effective medium for enabling visitors to share their memories and opinions with others in the museum settings. For example, the Retracing the Past (Ferris et al., 2004) and Reminisce (Knudson, Cable and Beck, 1995). An example of a study in which visitors were asked to participate in the

exhibition through sharing their audio experiences is the one by Salo, Bauters and Mikkonen (2017). The authors developed a soundscape, an audio story platform, to enable visitors to contribute through creating their own stories about artefacts in a format of audio contents to augment museums physical objects and they highly engaged with recording their own voices to share the stories.

The findings from both studies (chapters 4 and 5) also show that the participants highly engaged with the audio medium and they found it convenient and easy for sharing their experiences, stories and leaving comments. In addition, they described audio as a medium which it helped their anonymity and led them to share their personal experiences more confidently compared to the video as their personal identity would be revealed. Furthermore, there was agreement between all participants that they would prefer not to communicate their message through text.
Finally, it is thought that the choice of the medium should be based on the curators' decision in order to ensure the most suitable medium is chosen for the digital contents according to the context of the exhibition and the nature of the digital contents.

D- Modify the digital contents

When museums and galleries allow visitors to contribute, it is important to consider allowing them to modify their digital contents after the visit which can lead to producing more interactive and meaningful contents after further reflection as well as allowing the digital contents to be up to date. However, this can raise a major issue for staff of museums and galleries as they would need to regularly moderate visitors' digital contents to remove any inappropriate contents that may be produced.

In the third study (chapter 5), the participants were allowed to update their digital contents after leaving the museum, however, the findings show that no modifications were actually made. Interviews with the curators also reveal that if they implement artcodes in their settings in the future, they would not allow visitors to modify their digital contents after leaving the museum. The curators stated that it would increase their workload to check digital contents regularly.

Although enabling visitors to change their own digital contents was not welcomed by the curators, it is still proposed here in order to provide visitors this opportunity because artcodes have a portable feature which make them applicable for allowing visitors to modify their associated digital contents after leaving the museum through having a copy of their own

artcodes. In addition, visitors might be enthusiastic to create more meaningful and useful digital contents for their artcodes while they are in the museum but they may not have enough time to do so. Alternatively, not every visitor might be happy with the digital contents that they created during their visits which can motivate them to create more useful contents later on or to create progressive digital contents over time. Thus, museums and galleries can allow digital contents modifications by keeping the original digital contents so that they are not updated immediately. The updated digital contents can be saved in a pending server and then visitors can be invited onsite to check the updated digital contents for reliability and meaningfulness. If the checking passed, then the update to be taken in place so the visitor can receive a notification about it.

6.3.2.4 Facilitation

Facilitation is an important aspect that needs to be considered for enabling visitors to engage in all activities of the three stages of the co-creation cycle. In the interaction stage, visitors need facilitation in order to have a smooth experience and rich interaction with the existing objects and the hybrid artefacts in order to motivate them to reflect on the exhibition. However, facilitation is particularly important in all activities of the response stage due to the complexity of the hybrid artefact creation. Two main aspects need to be considered for facilitating hybrid content creation which are: **human support** and **physical space**.

In this research, human support was provided to instruct and guide the participants on how to interact with the exhibition in the interaction stage and to encourage them to reflect on creating their own hybrid contributions. In the response stage, the role of the human support becomes more important to facilitate creating hybrid contributions by the participants by helping them to draw valid artcodes or choose pre-designed artocdes, record their voices and use the app for linking those two together.

In the second study (chapter 4), the facilitation was made by the author whereas in the third study (chapter 5) the facilitation was carried out by two of the NVA staff. However, the findings from both studies show that the participants, who knew each other and those who did not, interacted socially and collaborated with each other frequently during the process of drawing artcodes, making them valid and linking them with the audio contents in the app. Overall, it can be said that for co-creation activities in museums and galleries, it seems important to involve a human support in order to facilitate hybrid content creation. This could

ensure that the process of the hybrid content creation would be interesting, unforgettable and less complex.

Interviews with the NVA curators reveal that they also preferred human involvement for facilitating visitors' contributions to the exhibition rather than using technology to provide instructions. Human support can be more engaging and useful when such a technology like artcodes is used for inviting visitors to create hybrid contributions. In addition, in a setting like the NVA, where a large number of interactive video games are available, visitors are less likely to engage with digital instruction for creating hybrid contributions. It also seems that using written instructions for this purpose may not be useful enough to engage visitors to contribute and produce meaningful contents since drawing artcodes and using the app need some knowledge and skills that need to be facilitated by human. However, for other types of museums and galleries, probably they might not prefer the human resource. Thus, choosing the suitable method for facilitation depends on the setting of the institutions.

The second important point in facilitating hybrid content creation is to consider where the content creation activities could take place and this can be done by providing a physical space for allowing visitors to create hybrid contributions. Researchers reported that in co-creation activities, some visitors do not prefer the presence of others around them as they found this to affect their own personalised space and thinking which lead them to avoid crowded spaces (Han et al., 2010; Machleit, Eroglu and Mantel, 2000; Machleit, Kellaris and Eroglu, 1994; Minkiewicz, Evans and Bridson, 2014).

However, the findings from the second and the third studies (chapters 4 and 5) show that providing a specific place, which can accommodate groups of people, in the Lakeside Arts gallery and the NVA museum were useful as they enabled the participants to sit together and create meaningful physical markers. At the same time, providing the space allowed them to engage and interact socially with each other and exchange ideas and opinions about the designs, look at each other activities as well as help whenever they needed explanations about drawing artcodes. Thus, for such activities that need thinking, designing and drawing, it would be useful to provide a place where it can accommodate multiple visitors at the same time to create their physical contributions. For creating digital contents, semi-private places like a booth needs to be provided in order to provide visitors more privacy to share their experiences and stories easily.

In both studies, the activities of the content creation by the participants were carried out through organising workshop sessions where more participants took part in the activities. However, the content creation activity does not necessarily need to be in a workshop style instead, it can be made as an ongoing activity. Both the workshop style or an ongoing activity could be useful mechanisms for encouraging visitors to contribute and at the same time, stay socially connected with their companions or non-related visitors to help each other in drawing valid artcodes and using the app. However, it seems that for enabling visitors to create hybrid contributions, it would be beneficial to advertise the dedicated sessions for the content creation activities in order to enable multiple visitors to participate: the process of the hybrid content creation can be a useful mechanism for engaging visitors with their companions and other visitors.

6.3.3 Third stage: Reintegration

Following the response stage, reintegration is the third and final stage of the co-creation cycle where the participants' hybrid contributions are moderated and integrated within the exhibitions. Participants' hybrid contributions consist of both physical and digital contents which needed to be moderated as well as integrated within the exhibition. In the second study (chapter 4), the author moderated and integrated participants' hybrid contributions into the exhibition following the instructions of the curators. On the other hand, in the third study (chapter 5), initially it was intended to involve the participants in this stage in order to allow them to moderate and integrate their hybrid contributions within the exhibitions. However, the curators wanted to retain their control over the activities of the reintegration stage and for this purpose, the contents' moderations (both physical and digital contents) were performed by the author (in response to the curator's request). Next, the curators checked the physical design of the artcodes in order to appropriately present and display them physically in the museum in an interactive way.

Interestingly, interview with the NVA curators reveal that, after they saw the participants' interactions with the hybrid contributions, they changed their minds and express their willingness to allow visitors to be involved in the reintegration stage in the future implementation of artcodes. Therefore, it is important to consider enabling visitors to create meaningful and appropriate hybrid contributions in the response stage which can make the curators to trust the participants and their contributions and potentially to involve them in the reintegration stage.

Overall, in a traditional museum experience, curator's role is to check, arrange and display contents that are created by themselves or by visitors thus visitors are not usually involved in this stage. However, when visitors are involved to contribute to an exhibition, it becomes reasonable to involve them in the process of content moderation and integrating them within the exhibition following the curators' instructions in order to enable them to know whether their contributions would be displayed and how. This would provide them a sense of being fully involved in completing the co-creation activities of creating, moderating and integrating their own contributions. As a result, they would put more efforts on their contributions to create valuable contents, as they would not leave them for curators to moderate them and decide on whether to display them or not.

In general, for involving visitors in the reintegration stage, two key aspects need to be considered in order to ensure that meaningful and interactive contributions would be displayed effectively. The key aspects are **content moderation** and **integrating hybrid contents** as explained below in more depth (see figure 6.9).

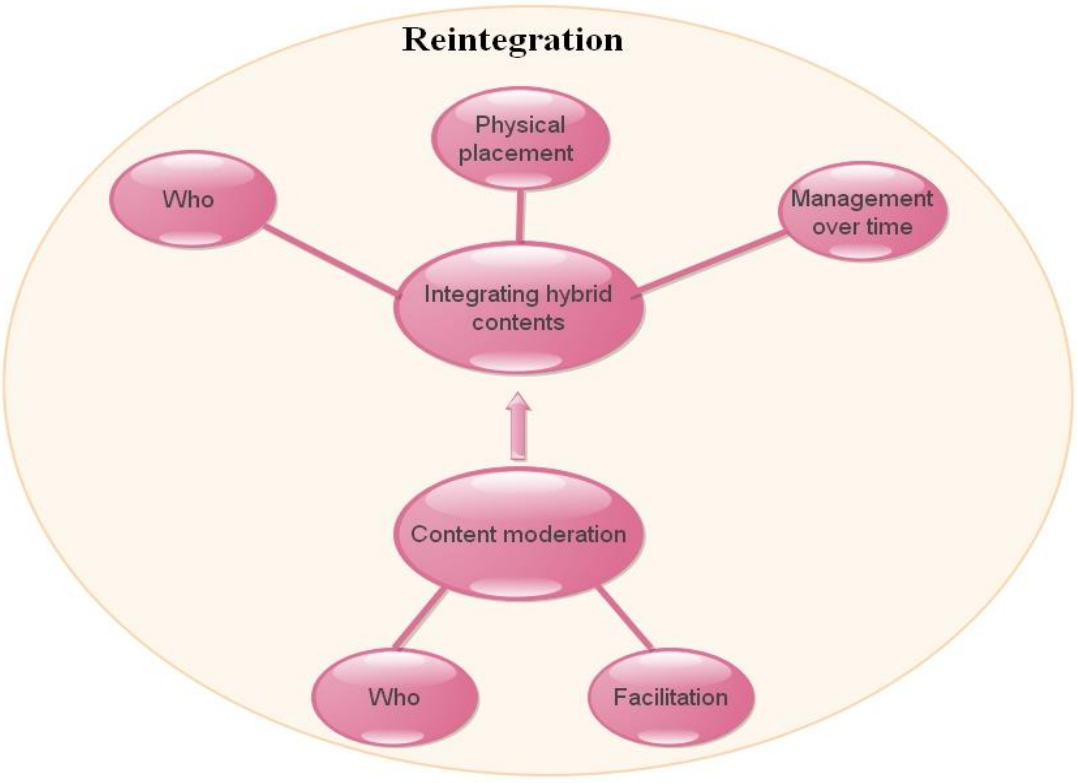


Figure 6. 9 The key opportunities and challenges of the main activities in the reintegration stage

6.3.3.1 Content moderation

In the second and third studies (chapters 4 and 5), all participants' hybrid contributions were checked by the author to ensure reliable, meaningful and relevant hybrid contributions and valid artcodes are created before displaying them. The checking was focused on the design of the artcodes, nature of the digital contents and whether they matched each other or not. For both studies, the author did not account for the inappropriate hybrid contents to be produced and no such contents were produced. However, long period deployment of inviting visitors to create their hybrid contributions raises the fear of inappropriate hybrid contents to be produced.

When developing exhibitions that invite visitors' contributions, a challenge of producing and leaving inappropriate or meaningless contents arise. There are some museums and galleries that display visitors' contents without any moderation. This could be an interesting approach for encouraging more visitors to contribute and to build a trust relationship with visitors. However, it might also not be very applicable for every museum and gallery since they are always keen to ensure meaningful, relevant and appropriate contents are displayed to the public which in turn ensure that the museum will not lose their visitor's trust on the exhibitions and contents.

Fundamentally, for minimising and limiting inappropriate and less relevant contribution by the visitors, museums need to maintain some facilitations before and during the hybrid content creation. From the beginning, museums need to clearly indicate their aims and goals from inviting visitors to contribute and what kind of contributions are allowed to be produced (both physical and digital contents). In addition, museums should provide dedicated space and human supports for enabling visitors to create meaningful and valued hybrid contents. Moreover, building trust with visitors and respecting their abilities and efforts are also quite important for encouraging visitors to leave useful and interesting contents for the exhibition and for other audiences to engage with.

Although all the above strategies for minimising inappropriate contents need to be considered in the response stage, they are linked directly to the content moderation activity in the reintegration stage. The museums which facilitate all the above strategies for minimising inappropriate contents, by visitors, are more likely to end up with having meaningful contents that can match the criteria of the content moderation.

Most of the museums and galleries moderate visitors' contributions by themselves which result in producing more loads on staff while these can be made by visitors themselves. Simon (2010) suggests that for moderating visitors' contributions before display, staff members should not be the only key people responsible for this process instead this can be extended to visitors by involving them actively in identifying the inappropriate contents.

Reflecting on Simon's (2010) suggestion, the content moderations can be turned into a participation activity by inviting visitors to participate in the process of checking their own hybrid contents or to involve other visitors. This mechanism is widely practiced by online platforms that encourage users to contribute by "flagging" the contents that are created by other users which seem inappropriate so that the staff would only review the flagged contents.

Overall, it seems that enabling visitors to moderate their own hybrid contributions would be useful since they know their own motivations and aims behind the design of the physical markers and the digital contents which may be hard for the curators or other visitors to understand. However, this can be a challenge as the visitors who created the contents are less likely to find their own contents as inappropriate, or they may intentionally want to leave inappropriate content or they might not have enough time to check their own contents.

Therefore, it appears beneficial to enable visitors to check each other's hybrid contributions because they already know how to create hybrid contributions and they are more likely to identify issues of the hybrid contributions of each other. However, the risk of this approach is that visitors may wrongfully or intentionally report other visitors' hybrid contents as inappropriate. This further proves the importance of the curator's involvement in the process of content moderation to ensure meaningful and relevant contributions are displayed. Thus, it is argued that visitors should be involved in the process of hybrid content moderation in order to give them a sense of participation in moderating the contents. This should be followed by involving curators to decide on choosing the hybrid contributions that can be displayed in the exhibition. More research needs to be carried out in order to explore hybrid content moderation in more depth.

6.3.3.2 Integrating hybrid contents

Two main approaches for integrating participants' hybrid artefacts within the exhibitions were explored in the thesis which were specified by the curators as they were keen on retaining control over displaying visitors' hybrid artefacts.

In the second study (chapter 4) and after obtaining permission from the curators, the author displayed participants' hybrid contributions (hand-drawn artcodes) on a wall in the exhibition. On the other hand, in the third study (chapter 5) the curators were involved in displaying all participants' hybrid contributions in order to understand their approaches in displaying those contributions (hand-drawn and pre-designed artcodes with/without comment). The curators displayed participants' hybrid contributions in two different places: in the Gallery Three and the Lobby. Participants' hybrid artefacts that were created for the Gallery Three's objects were displayed close to the existing objects and four places were used which are: on table, game arcade, cabinet and wall. The more general hybrid artefacts which did not relate to an object in the exhibition were displayed on a wall in the Lobby.

The findings show that participants appreciated both approaches of displaying visitors' hybrid artefacts. The approach of displaying hybrid artefacts close to the existing objects of the Gallery Three was interactive for participants as they were able to know which hybrid artefacts belong to which video games. In addition, displaying the hybrid artefacts close to the objects enabled the participants to easily approach the hybrid artefacts and scan them while they were still interacting with the existing objects. Moreover, the approach of displaying visitors' hybrid contributions close to their objects across different exhibition rooms was useful for motivating several participants to visit the less interactive and popular exhibition rooms (third and fourth exhibition rooms in the Gallery Three) to explore the video games and the visitors' hybrid contributions.

Displaying visitors' contributions close to their objects in the Gallery Three reflects Simon's (2010) opinion that visitors' contributions to be displayed close to their objects. Other researchers also found that visitors highly engaged with interpretations and information that were displayed close to the original objects in the exhibition since such approach allows visitors to stay connected with the objects and engage with them (Ciolfi and Bannon, 2003; Hornecker and Stifter, 2006).

Using a wall for displaying visitors' hybrid artefacts was also appreciated by the participants as they found visitors' hybrid artefacts as an exhibition in itself that integrated and extended

the exhibition because they conveyed physical and digital contributions of visitors who have already experienced the exhibitions. Moreover, using the wall for displaying visitors' hybrid artefacts in the Lobby was also useful because this allowed participants, who did not pay, to interact with those hybrid artefacts which might be useful to motivate them to visit the galleries and explore other exhibitions and visitors' hybrid contributions. Black and Skinner (2016) highlight the benefit of displaying samples of exhibitions in the ground floor of the museums and galleries in order to engage visitors with these samples of objects which can motivate them to visit the exhibitions.

The findings also show that displaying participants' hybrid artefacts (hand-drawn artcodes) on their own was useful for extending the exhibition due to their diverse visual design representations whereas the pre-designed artcodes with/without comments were more engaging when they were displayed close to the objects. Interview with the NVA curators about their displaying choices also reveals that they described the pre-designed artcodes with/without comments to be more suitable for augmenting existing objects because they have a standard design which can be recognised by visitors, even in a busy exhibition. In addition, their small size and design would fit exhibitions and would not affect the overall aesthetic quality. Due to the diverse visual designs of the hand-drawn artcodes, they might be more useful to be displayed in exhibitions on their own to extend the exhibition context which may lead visitors to interact with them and make discussions around them.

However, displaying visitors' hybrid artefacts would raise challenges of presenting and rotating them when the number of produced hybrid contributions grow over time. "Recency" method could be a useful approach to ensure that new visitors' contributions are displayed and at the same time the available space is not overcrowded with huge number of these contributions. To explain this further, there are two main approaches that are used by museums and galleries for physically displaying visitors' contributions which are based either on "recency" or quality (Simon, 2010). "Recency" is the approach in which the most recent contributions of visitors would be displayed in the centre and the older ones would be displayed on a second layer or they will be archived. This approach could engage more visitors to contribute to the exhibition, as they would be able to see their contributions immediately on display.

In the second approach, visitors' contributions would be displayed based on their qualities, however, this approach may lead to less motivation for visitors to create contributions as they

may fear being able to create a high quality contribution. For both approaches, visitors should be informed, from the beginning of their participation, how their contributions would be evaluated and when and where their contributions would be displayed in the exhibitions. In cases where the contributions are not displayed immediately, the participants should be informed when their contributions would be displayed and whether they will be notified or not.

However, for displaying visitors' contributions, aesthetic appearance of the whole exhibition need to be highly considered in order to prevent affecting it negatively. Thus, it is important that the aesthetic quality of visitors' contributions match the overall appearance of the exhibition which would result in encouraging more visitors to contribute. Simon (2010) argues that visitors' contributions on display should match and be aesthetically on a similar level to the official labels of the museum in order to look consistent with the overall display. Otherwise, visitors would be less engaged to create their own as they would think that their contributions would not be of value for displaying them in the exhibition. This matches with the findings in the second study (chapter 4) where the official and visitors' markers were all manually drawn.

In the Denver Art Museum's Side Trip exhibition, the museum created the official labels using handwriting in pen on cards and they also asked visitors to contribute to the exhibition using the same approach which motivated a large number of visitors to contribute (Simon, 2010). Elsewhere, in the Lowell National Historical Park in Massachusetts (2007), the Road exhibition was designed by using Jack Kerouac's original typewritten manuscript to invite visitors to leave their contribution about the exhibition so that the exhibition and visitors' contributions would be integrated with each other. For this purpose, the typewriter was used with a chair and a table in order to allow visitors to sit and write their contribution which resulted in a high interaction and engagement of visitors (Simon, 2010).

In addition to the aesthetic quality, Whitehead (2012) states that for integrating visitors' contents and interpretations into exhibitions, there should be a clear distinction between official contents and interpretations of exhibitions and visitors' contributions by presenting them differently. The second study (chapter 4) reflected Whitehead's (2012) suggestion as the design quality of the participants' hybrid artefacts, the place and approach that were used for displaying them in the exhibition were all made in a way that will make them different from the official label. Here the official hybrid artefacts were maps of Latin American

countries (which were similar to hand-drawn) whereas visitors' hybrid contributions were diverse visual design of hand-drawn artcodes. In addition, the official labels were displayed close to each objects whereas participants' hybrid contributions were all displayed on a wall. As a result, the findings show that it was easily possible for participants to identify and differentiate between official labels and visitors' contributions.

6.3.3.3 Involving visitors in the integrating activity

Although the approaches that were used in this research for displaying hybrid artefacts of visitors were found suitable, interactive and engaging, it is reasonable to consider enabling visitors, after content moderation, to integrate their own or each other's hybrid contributions within the exhibition following the curators' instructions. Alternatively, it is reasonable to invite other visitors to participate in integrating visitors' hybrid contributions into exhibitions. Again, this would provide opportunities for those visitors who did not make contributions but would like to be involved in the displaying activity which might motivate them to participate in the other stages of the cycle.

Artcodes have a feature that consist of physical and digital contents in which the physical markers need to be integrated into the exhibitions which could be performed by the visitors. This can further enrich visitors' experiences, as they will be involved in another participation activity, beyond creating and checking content activities, which can give them a sense of completing their experiences. As a result, visitors will be involved actively in all stages of the co-creation cycle (interaction, response and reintegration). Involving visitors in the integration activity reflects Simon's (2010) claim as she proposes to enable visitors to display their own contribution into the exhibition in order to gain a sense of completing content creation activity.

This could give visitors a feeling that their contributions are valued which can strength their relationship and trust with the museums and galleries. In addition, visitors can feel more relaxed and less controlled and at the same time curators can still maintain their control in a less formal way. Also, hybrid artefacts' moderation, rearranging and displaying them all are new skills and thus should be part of the whole process of participation in the co-creation cycle. As a result, visitors would be more likely to describe and recommend their own contributions and positions in the exhibitions to family or friends to visit them since they know where and when their hybrid contributions are displayed.

Despite the benefits of involving visitors to integrate their hybrid contributions into exhibitions, challenges also arise. The main challenge could be the case where the content moderation was made by a visitor, without a curator involvement, who intentionally tended to allow inappropriate hybrid contents or non-working artcodes to be displayed. Alternatively, some visitors may intentionally remove appropriate hybrid contributions of other visitors from the exhibition. Another challenge could be displaying hybrid contributions in places other than those that are specified by the museums and galleries.

These challenges could be addressed by providing clear instructions about places and methods for displaying hybrid contributions in which visitors should follow. In addition, visitors' involvement in displaying hybrid artefacts should not be extended to remove, rotate or change the place of the hybrid artefacts that are already displayed. Instead, they should be allowed to leave comments for the museum staff if they identify issues with the displayed hybrid artefacts or if there are too many hybrid artefacts on display for too long.

Overall, using artcodes mechanism for visitors' hybrid contributions, raise questions about the lifetime of the hybrid artefacts and how long to leave them on display and when the rotation process should be made in order to display new hybrid artefacts. What should happen to visitors' hybrid contributions when they are rotated? Should they be archived? For how long should they be kept? Also, how ethical consideration should be managed when visitors take a photo of the physical design of the artcodes or wanted to share the digital contents? How copyright can be considered for the digital contents that are created by visitors for a particular person? How sharing the hybrid contributions of visitors can be managed both online and onsite? All these questions need to be researched and explored in detail in future studies.

6.3.3.4 Summary of reintegration stage

This research reveals (based on two of the NVA curators) that they are keen on retaining their control over the content moderation and integration activities to ensure the context and aesthetic quality of the space is not affected. However, the research also reveals the importance of curators' roles in controlling the structure of the whole process of content moderation and integration of visitors' hybrid contributions. Their control in these activities would ensure integrating the visitors' hybrid contributions which are in line with the exhibition context and potentially can enrich the experiences of the subsequent visitors.

From these discussions, therefore, it becomes clear that curators have an important role to ensure maintaining smooth and meaningful experience of visitors' involvement in the content moderation and integrating the contributions within the right places of the exhibitions. The reason of this is that content moderation by visitors needs to be made according to the criteria that set out by the curators such as which hybrid artefacts should be considered as appropriate for displaying and which ones should be rejected. In addition, curators' instructions for the places and methods for displaying the hybrid contributions within the exhibitions are very important in order to guide visitors about the most suitable places for displaying their hybrid contributions. Otherwise, visitors may integrate their hybrid contributions in wrong places which will negatively affect the interactivity of the exhibition and potentially affect the interaction of the subsequent visitors' experiences.

It might also be possible to remove the reintegration stage from the co-creation cycle by shifting checking hybrid artefacts into response stage and integration activity into either the response or the interaction stage. However, from the above discussion, it seems better and also important to keep the reintegration stage in the co-creation cycle in order to make the activities of this stage open not just for the visitors who created hybrid artefacts but also for those visitors who did not create any contributions but they can be involved in these activities.

Therefore, the author argues that in using artcodes to invite visitors to contribute, the role of the curators should not be completely shifted to visitors nor to stay completely with curators, instead, the role should be shared between visitors and curators with the overall control to be retained by the curators throughout the process.

In the literature, there are also researchers who strongly believe that when visitors' are involved in contributing to exhibitions, curators should retain their full control over the whole procedure of checking and displaying the contributions. Researchers also argue that museum curators should retain their control of editing the final contents that are created by visitors or members of communities and selecting the interesting ones for display to the public (Dubin, 1999 reprinted in Watson 2007: 221). From the museum perspective, Mulhearn's (2008) interview with Mark O'Neill (Head of Arts & Museums, Glasgow) reveal that giving visitors full control of checking and displaying their contributions mean that less relevant contributions would be created for the exhibitions which would lead to unsuccessful experiences (Mulhearn, 2008: 23).

Other researchers believe that museums and galleries need a good leadership for their exhibitions and projects by the curators in order to control the process of visitors' contributions but in a less formal way. For example, Gobillot (2009) states that curator's role as a manager or leader should not only be about directing visitors to certain activities instead they should help visitors to contribute in their own way (Gobillot 2009: 5). Govier (2009) argues that having a professional leadership would potentially engage more non-professional audience to have confidence to participate in contributing to the museum because they would know that their contents are going through a checking process before displaying to public even if the checking process is not run by professional staff.

Jagodzińska (2017) argues that visitor's active role in participation activities should be encouraged but within a "limited extent" as the curators were mainly concerned with retaining their power on visitor participation. Simon (2010) also calls for leadership in participation, co-creation and collaboration projects, but in a comfortable way where different tasks could be shared between visitors and staff. This is the view that this research also supports to allow curators to retain their overall control and leadership over the process of involving visitors to moderate and integrate their hybrid artefacts.

6.4 Conclusion

The discussions reveal the potential use of aesthetic visual markers in museum and gallery settings in order to enable visitors to play an active role in a number of different activities that are linked to each other. The different activities formed different stages which are interaction, response and reintegration and each activity has a number of opportunities and challenges that need to be considered carefully. All the three stages formed the co-creation cycle where visitors can interact with the exhibition, reflect on it by creating their own hybrid contributions and moderating and integrating contributions into the exhibition.

Therefore, this thesis proposes the co-creation cycle as a model for enabling visitors to become more active during their engagement and participation in different activities using aesthetic visual markers. The activities in the three stages of the co-creation cycle are generic process and can be applied to the use of other visual marker technologies in museums and galleries. The key aspects of the opportunities and challenges for each activity are specific to the use of the aesthetic visual markers in museums and galleries.

The co-creation cycle could be of benefit in promoting revisiting as well. Carù and Cova (2007) argue that people who are actively engaged in participating in museums and galleries activities are more likely to visit these places more frequently. In addition, this thesis highlights the essential roles of curators throughout all the three stages of the co-creation cycle when aesthetic visual markers are used.

As discussed already, by involving visitors actively, they developed new expertise and skill for being an active participant to explore complex interactions, reflect on their experiences and respond to these by creating aesthetic visual markers. All these are the benefits for teaching them knowledge and skills that normal visitors do not have.

Finally, a common benefit for involving visitors actively in the co-creation cycle using interactive visual markers is the social collaborations and interactions that happened repeatedly throughout the three studies. Although using systems that promote social interactions are useful for museum and gallery settings, they might also be challenging for some settings due to the noise that could be produced which might disturb other visitors.

Chapter Seven: Conclusion

This thesis has explored the different ways in which aesthetic visual markers can be deployed in museums and galleries in order to enable different types of visitors' active participation from consuming content, interacting with the content to deeper involvement of creating content. To explore these practically, three studies have been carried out. The first study that was represented in chapter 3 explored how to enable visitors explore the relationships between museum artefacts through spatial interaction using aesthetic visual markers over a paper map. The study's findings have shown that the approach was effective in engaging visitors to actively explore the relationships between artefacts through tangible interactions (fixing cards on a paper map) and scanning the resulting configurations in pattern groups and paths. Thus, the study explored how aesthetic visual markers can be used for enabling visitors' participation in museums through consuming and interacting with the contents.

The second and third studies that were represented in chapters 4 and 5 involved visitors in creating their own hybrid contributions using aesthetic visual markers and interacting with these contributions. The studies' findings have shown that visitors chose to draw artcodes to extend the exhibitions by sharing their personal stories and experiences, whereas pre-designed artcodes were mainly used for augmenting the existing artefacts by leaving personal experiences, comments and opinions. The findings have also shown that subsequent visitors engaged highly with the hybrid contributions and their placements in the exhibitions. In addition, the studies' findings have revealed the essential roles of curators and staff throughout the process of facilitating visitors' involvements in contributing to the exhibitions using aesthetic visual makers and displaying their hybrid contributions physically in the settings. Thus, the studies explored the approaches that can be used for enabling visitors' participation using aesthetic visual markers to consume and create hybrid contributions.

The findings from the three studies have shown that visitors can be involved in a number of different types of participation activities using aesthetic visual markers. As a result, the findings have contributed in identifying three stages of visitors' active participation which are interaction, response and reintegration forming a co-creation cycle. Previous research has focused mainly on a linear interaction visit which consists of visitor interaction with exhibition and possibly leaving feedback to museum staff. This is followed by staff engagement in creating new contents or improving them and representing them to the visitors

to consume. The co-creation cycle, proposed in this thesis, involves visitors actively in different activities in three sequential stages. However, visitors were not involved in the final reintegration stage of the proposed cycle due to curators' preference to retain control over this stage. It is worth noting that the first two studies in chapters 3 and 4, were passive museum settings (i.e. before the study, the exhibits were not interactive) whereas the third study in chapter 5 was carried out in a setting where technologies were already used to provide an interactive visitor experience. The findings of all the three studies have shown evidence that artcodes can be successfully used in different settings and contexts.

The rest of this chapter is structured to answer the research questions of this thesis and highlight the contributions of both the HCI and museum communities. Finally, the limitations of the research are highlighted and the opportunities for future researches are proposed for expanding the scope of this thesis followed by a conclusion of the chapter.

7.1 Answering the Research Questions

How to enable different types of visitors' participation in museums and galleries using aesthetic visual markers?

The findings of all the three studies that were represented in chapters 3, 4 and 5 have revealed that aesthetic visual markers are useful mechanisms for deepening visitors' engagement with exhibitions and enable their participation in three stages of activities which are interaction, response and reintegration forming a proposed co-creation cycle. The co-creation cycle is suggested as a model to conceptualise visitors' participation in museums and galleries by enabling them to interact with and create their own hybrid contributions using aesthetic visual markers. Thus, the research proposes a cyclical model of co-creation that describes the different stages where visitors can be involved from interaction stage to engage deeply with the displayed hybrid artefacts that were created by designers and other visitors. Visitors can reflect on their own experiences in the interaction stage by being involved in the response stage and creating their own hybrid contributions. Visitors' hybrid contributions then need to be moderated and integrated within the exhibition which are the main activities of the reintegration stage.

The co-creation cycle was suggested to inform museum researchers and practitioners to know how visitors can participate in different types of activities in museums using aesthetic visual markers, how to structure the activities and what the key opportunities and challenges for each activity that needed to be considered are.

This question has been explored through three main studies that addressed the following sub-questions:

1. **How can visitors be enabled to interact with aesthetic visual markers to explore artefacts?**
    a. How can visitors be enabled to reveal digital layers of content about museum artefacts using aesthetic visual markers?

The finding from the two studies that were presented in chapters 3 and 4 reveal that using aesthetic visual markers as labels to augment the existing artefacts with digital layer of contents were effective for engaging visitors deeply with the exhibited artefacts of the exhibitions and motivated them to explore information about the rest of the artefacts. In addition, the findings from the studies show that aesthetic visual markers engaged visitor interaction at three levels: physical placement of the markers, the aesthetic design of the markers and digital content and each of these are important to be considered in designing visit experiences in order to enable visitors to easily shift their focus between these levels while they still engaged with the actual artefacts.

To explain these levels briefly, placement of the aesthetic visual markers should not distract visitors from the exhibition; instead, they should be used as a means of engaging visitors with the exhibition further and to complement it. Thus, their positions should not be in places that are hard to access such as too low, too high or expose to direct light. In addition, the aesthetic visual markers should be placed close to the existing artefacts that were created for in order to enable visitors to stay visually and physically connected with the existing artefacts.

For the aesthetic visual appearances of the markers, designers should make sure the designs are meaningful to the public visitors, match exhibition context, reflect the nature of the digital contents and do not affect negatively the aesthetic quality of the exhibition. Thus, the visual design needs to be considered carefully in terms of its function in inviting visitors to scan it and to be motivated to interact with the digital content. In terms of the digital contents, the nature of the digital contents and choosing the right medium are essential to ensure delivering interesting contents smoothly. Also, the digital contents should not be provided to visitors by third party interface instead, it should be integrated within the app and presented through suitable interface that could match the medium of the digital content. Each of the text, image, audio and video all were effective mediums for delivering background and factual

information about existing artefacts whereas audio medium is the most effective medium for the digital contents to deliver personal stories and experiences about existing artefacts.

Overall, the research reveals that the aesthetic visual markers that were augmented with digital contents and their suitable placements engaged visitors deeply with the exhibition. In addition, visitors were mindful of the presence of other visitors during their interactions with the markers.

b. How can visitors be enabled to access visitors' contributions using aesthetic visual markers?

In the second study (chapter 4) where there were official and visitor's hybrid contributions all in the exhibition, the findings have shown that visitors engaged with both particularly with the visitors' hybrid contributions. The reasons for this was mainly because the visual representations of the visitors' hybrid artefacts were more meaningful for the visitors, the placements of all hybrid contributions in one place in the exhibition were easily accessible and the interface for delivering the audio contents was simple and convenient. In addition, visitors had interests to reveal the experiences and stories that other visitors had shared about the exhibition.

In the third study (chapter 5) where there were only visitor's hybrid artefacts displayed in the exhibitions, the findings have shown that displaying visitors' hybrid contributions (pre-designed artcodes) close to the existing objects engaged visitors highly to scan the artcodes and reveal the digital contents behind them while they were interacting visually and physically with the existing objects. The findings have also shown that displaying all the hybrid contributions of visitors that were created for extending the exhibition rather than augmenting objects, in one place appeared as a standalone exhibition which was highly appreciated by the visitors and encouraged them to scan them. In addition, displaying a mix of hand-drawn and pre-designed artcodes of visitors' contributions on one display engaged visitors to interact and scan the hand-drawn artcodes more frequently than the pre-designed artcodes and that was mainly due to the variety of the visual representations of the hand-drawn artcodes.

Thus, for engaging visitors to interact with the hybrid contributions of other visitors, designers should carefully consider the design of the markers, their physical placement in the exhibition and the nature of the digital contents.

c. How can visitors be enabled to explore the relationships between museum artefacts using aesthetic visual markers?

The findings from the first study as reported in chapter 3, reveal that using aesthetic visual markers over a printed-paper map are an effective approach to enable visitors to explore the relationships between museum artefacts through tangible interactions (involving fixing cards on the paper map) and scanning the resulting configurations in pattern groups and paths. For this purpose, the findings show that visitors engaged in three strategies which are: inspection, strategic and experimental configuration. In addition to exploring the relationships between artefacts, the study approach encouraged visitors to navigate in the museum to find the artefacts physically and to collaborate with each other during their interactions of fixing and scanning the hybrid artefacts.

However, to provide visitors with a smooth experience of exploring the relationships between artefacts using the approach of this study, designers need to ensure supporting visitors to understand how artefacts can be related to each other through physical representation of hybrid artefacts and the paper-map as well as providing sufficient hints on the app and the digital contents. In addition, there should be positive and negative feedback in the app whenever a correct or a wrong set of artcodes are scanned in pattern groups and paths.

2. How can visitors be enabled to contribute content to the exhibition using aesthetic visual markers?

The findings from the second and third studies that were presented in chapters 4 and 5 of this research reveal the effectiveness of using aesthetic visual markers as a mechanism for engaging visitors to contribute to the exhibition through crafting hybrid artefacts that comprise both a physical marker and a voice recording. The aesthetic visual markers have a potential to encourage visitors to make meaningful, thoughtful and relevant contributions to the existing artefacts by leaving comments and also extending the exhibition with new artefacts (additional layer of contents).

More specifically, the findings show that providing visitors the opportunities of choosing different visual representations for their physical contributions (hand-drawn and pre-designed artcodes) have a significant value of enriching visitors' experiences and motivating them further to contribute. The hand-drawn option was used by visitors to share new layer of contents (both physically and digitally) which resulted in extending the exhibition, whereas, the pre-designed artcode templates encouraged visitors to leave their comments about the

existing artefacts in the exhibitions in order to augment them. Visitors' contributions resulted in deepening and promoting the subsequent visitors' interactions with the exhibition. Thus, it is suggested that the hand-drawn and pre-designed artcodes be used carefully based on the context of the exhibition and the nature of the contributions. However, it is suggested that suitable medium of the digital contents be chosen by the curators in order to ensure delivering the digital contents effectively and at the same time not distract subsequent visitors from interacting with the existing artefacts.

However, issues were also raised during visitors' engagements in creating hybrid contributions which were mainly related to the time, efforts and space that need support and facilitation in various ways. Creating hybrid contributions, particularly the hand-drawn artcodes, require a significant amount of time and efforts from participants which can be considered of benefit, at the same time, since spending time and efforts encouraged participants to create thoughtful and interesting hybrid contributions in reflection to their investments. Providing space for creating hybrid contributions can also be challenging particularly for smaller museums. The other issue is related to human supports which is important and should be provided during visitors' participation in creating hybrid contribution as the process of creating hybrid artefacts need some form of scaffolding.

The findings from both studies also reveal the importance of enabling visitors to browse the exhibition, whether it is associated with hybrid contribution or not, prior to creating hybrid contributions. This quick visit to the exhibition enabled visitors to gain knowledge about the exhibition and reflect on it. In addition, the findings show that the structured plan worked successfully for enabling visitors to create hybrid contributions to extend the exhibition by creating hand-drawn artcodes and new layers of digital contents whereas structured plan is not required when visitors tend to augment existing artefacts by leaving comments and using pre-designed artcodes.

Thus, for engaging visitors to create meaningful and thoughtful hybrid contributions, they should be allowed to first browse the exhibition, then make a plan if they are required to extend the exhibition. In addition, they should be provided with opportunities to choose between hand-drawn and pre-designed artcodes and for both cases, they should be provided with enough facilitations (both human resources and physical space). Furthermore, visitors need to be informed about how their hybrid contribution would be valued by the museum

(how the process of moderating and integrating their hybrid contribution would be made into the exhibition).

3. **What is the role of curators throughout the process of visitors' participations?**

The research reveals that curators and staff play an essential role throughout the whole process of facilitating different types of visitors' participation in museum and gallery settings using aesthetic visual markers. Thus, the curator's role is important in all activities of the three stages (interaction, response and reintegration) of the co-creation cycle.

To facilitate interaction stage, curators have an important role to introduce visitors to the exhibition and to interact with the hybrid artefacts (the author performed this in the second study that was reported in chapter 4). In addition, their role is also important during visitors' interactions with the exhibition and with the hybrid artefacts in order to provide real time support whenever it is needed (this was again performed by the author in both the second and third studies that were reported in chapters 4 and 5).

Furthermore, the findings from the first study (chapter 3) show the importance of consulting the curators early in the process of designing the hybrid artefacts using the UCD approach as well as involving them in the pilot study of testing the prototypes. Thus, it seems that for designing an appropriate interaction stage and facilitating it, curators should be consulted and involved in the process of designing hybrid artefacts. The curator's involvement is also important during the interaction stage itself to support visitors during their engagements with the displayed hybrid artefacts.

Overall, the findings from all the three studies reveal the importance of consulting curators and staff not only for the interaction stage but also during the time to decide on the study aim, specifying a suitable place for the content creation activities and how to support visitors to produce them followed by choosing the best way for integrating the hybrid contributions into the exhibitions.

In the response stage, the curator's role becomes more important and necessary to support visitors in creating their own hybrid contributions. Particularly to support visitors in drawing valid artcodes and linking them with digital content in the app as this process requires visitors to have some knowledge and skills which need to be facilitated by human rather than written instructions. In addition, curators should be the key persons to decide on providing visitors the different design options of the hybrid artefacts and to choose the most suitable medium for the digital contents in order to ensure meaningful and thoughtful contributions would be

produced by the visitors. Deciding on each of these two aspects depend on the context of the exhibition, the aim of the contributions and the nature of the digital contents. In addition to the curators' involvement in the process of content creation by visitors, curators further facilitate the response stage by providing dedicated space for creating both physical and digital contents.
In the reintegration stage, the findings show that curators have an important role in specifying the criteria for hybrid content moderation and choosing the most effective place for integrating them within the exhibition. In both the second and third studies (chapters 4 and 5), the content moderation was performed by the author following the curator's instructions and the visitors' hybrid contributions of the second study (chapter 4) were integrated into the exhibition by the author again following the curators instructions.

However, in the third study (chapter 5), the curators displayed visitor's hybrid contributions within the exhibition using two approaches: they displayed the visitors' hybrid contributions that were created for augmenting existing objects close to them. Whereas, the visitors' hybrid contributions that were created to extend the exhibition through new layers of contents were displayed all in one place. The findings show the effectiveness of these two approaches for integrating visitors' hybrid contributions and how they enabled the subsequent visitors to interact highly with the displayed hybrids contributions. Particularly, displaying pre-designed artcodes close to the existing artefacts enabled visitors to stay visually and physically connected to the existing artefacts while interacting with the hybrid artefacts. Displaying hand-drawn artcodes all in one place also motivated visitors to interact with them and reveal the digital contents behind them. Displaying official hybrid artefacts close to the portrait in the second study (chapter 4) also engaged visitors to stay visually connected to the portraits while they started their engagement with the digital contents.

Although, the author argues for the involvement of visitors into the reintegration stage to perform hybrid content moderation and integrate them within the exhibition, curators should still retain their overall control over the content moderation criteria and moderation of the final hybrid contents and decide on where to display the hybrid contributions. In addition, their role is also essential for managing how sharing the visitors' hybrid contribution can be made by subsequent visitors, how to protect the copyright of the contents as well as manage visitors' hybrid contribution over time.

Thus, it can be said that curators and staff play essential roles in enabling visitors' active participation throughout the three stages of the co-creation cycle.

7.2 Summary of Contributions

From the results of the three real world case studies of using aesthetic visual markers and understanding their practical applications for enabling different types of visitors' participation in museums and galleries, a number of novel contributions have been made for the HCI and museum communities as explained below.

7.2.1 HCI

The thesis contributes to the HCI community by proposing the co-creation cycle, which consists of three stages: interaction, response and reintegration that can be used for enabling different types of visitors' participation in museums and galleries using aesthetic visual markers. The key opportunities and challenges for the activities in each stage of the cycle have been highlighted in the discussion chapter for designers and museum practitioners.

In addition, the thesis contributes a novel approach for enabling visitors to explore and reveal the relationships between museum artefacts using aesthetic visual markers. This research was presented to the HCI community as a full paper at the 2018 NordiCHI conference.

Furthermore, the thesis contributes to the understanding of the approach that can be used for enabling visitors' participation in an art gallery by reflecting on the exhibition using aesthetic visual markers to create aesthetic markers and link them with audio recordings. In addition, this thesis helps to understand how subsequent visitors would engage with these contributions versus official markers in exhibitions. This resulted in a full paper at the 2018 DIS conference which was awarded an Honourable Mention.

Another novel contribution of this thesis is the design of a method for enabling visitors' participation in a museum by creating or choosing pre-designed markers and linking them with audio comments. The thesis has also explored ways to understand how subsequent visitors would interact with the different visual representations of previous visitors' markers in different places in the museum.

7.2.2 Museums

The main contribution that this thesis has made to the museum community is about understanding and outlining the opportunities and challenges of using aesthetic visual markers in all the activities throughout the three stages of the co-creation cycle. Thus, the main lessons from the co-creation cycle is summarised here as a set of guidelines for practical implementation of the co-creation cycle in real museum and gallery settings in order to enable different types of visitors' participation using aesthetic visual markers. The thesis also contributes to an understanding of the important role of the curators and staff throughout the process of visitors' participation in museums and galleries using aesthetic visual markers. The guidelines for each stage of the cycle are explained below:

Interaction stage

- For using aesthetic visual markers, it is not necessary to follow all the three stages of the co-creation cycle, instead curators can use the stage that can best match their goals. However, following the three stages of the co-creation cycle is more likely to provide rich and interactive visitor's experience.
- The starting point of visitors' experiences in the cycle should be the interaction stage in order to ensure visitors understand the space and obtain knowledge about it.
- The visual representations of hybrid artefacts (artcodes design) should be meaningful and understandable to visitors.
- The hybrid artefacts should be displayed carefully in order to ensure smooth experience of visitors during scanning and subsequent interactions. Particularly the official and the pre-designed artcodes need to be displayed close to their existing artefacts in a way that is not too high or low in order to ensure maintaining visitors' interactions both visually and physically with the existing artefacts.
- There should be a link between the visual design of the hybrid artefacts and the digital contents, otherwise, visitors would have difficulty in making sense of the hybrid contributions and finding links/connections between the physical and digital contents.
- It is important not to deliver digital contents through third party interface, instead; the digital contents should be delivered within the app. In addition, it is important to ensure the interface for delivering the digital contents matches the exact medium of the digital contents in order to avoid any confusion. For audio contents, the interface

should clearly represent only playing audio (not to show interfaces that are used for playing video where no video is available).

- Visitors need to be allowed to interact with audio and video contents through headphone or speakers, depending on whether visitors are allowed to listen to such contents through the speakers. The headphone can work effectively for allowing pairs of visitors to stay together in exploring and sharing the digital contents with each other while it does not disturb other visitors around. Although using speaker might be a noisy option for museum and gallery environments, it helps visitors to discover new digital contents by hearing them from other visitors' devices which can potentially engage them to explore them personally and socially communicate with each other.
- Tangible configurations of visual representation of hybrid artefacts can be a useful mechanism for enabling visitors to explore the relationships between artefacts.
- For enabling visitors to explore relationships between artefacts, three steps need to be facilitated in the prototype: these include scanning an artcode, configuring the artcodes and then forming pattern groups/paths.
- To facilitate exploring relationships between artefacts, it is important to enable a phase of inspection where visitors can explore the background information about artefacts. This would further motivate visitors to explore the relationships between artefacts by using the strategic and experimental configuration. Such strategies motivate visitors physically to configure the cards, by placing them on the map and exploring the relationships between artefacts.
- Instructions and guidelines about using the app, scanning artcodes (individually or in pattern groups and paths) need to be provided through printed handout, hints on the app screen, and in the digital contents. Curators or staff also should be available, if possible, to approach visitors whenever they need support.
- There should be both positive and negative feedback during pattern groups and paths scanning. Whenever visitors scanned a wrong set of artcodes that are not related to each other, there should be a feedback in the app to advise visitors to scan another set of artcodes following the provided instructions and hints.
- Enough space around installation and hybrid artefacts need to be considered in order to support concurrent interaction of multiple visitors at the same time and enable them to easily access the hybrid artefacts. This would also result in allowing visitors to observe other visitors' activities which can further motivate visitors to interact

socially with each other, collaborate with each other to explore the hybrid artefacts and potentially may encourage them further to interact deeply with the exhibition.

- At this stage, visitors should be informed about the possibilities of being involved in the response stage to reflect on the exhibition by creating their own hybrid artefacts. This would encourage them to decide whether or not to reflect on the exhibition and pay more attention to it.
- Visitors who reflect on the exhibition should be informed on how and where their hybrid contributions will be integrated into the exhibition.

Response stage

- To engage visitors to reflect on the exhibition, they should first be allowed to visit the exhibition (whether it is associated with hybrid artefacts or not) and view it before they can make the reflection. However, having hybrid artefacts in the exhibition, particularly visitors' hybrid contribution, would be useful for motivating visitors further to reflect on the exhibition.
- Human support should be provided to facilitate the whole process of visitors' participations in the response stage for creating hybrid artefacts.
- The response stage can be made either as part of pre-organised workshop session or as an open running activity during a visit experience. However, it would be better to advertise the dedicated sessions for the content creation activities in order to enable multiple visitors to participate.
- It would be better to allow visitors to make a structured plan for their hybrid contributions if they intend to extend the exhibition by creating hand-drawn artcodes and adding new layers of personal experiences and stories. On the other hand, for visitors who intend to leave their experiences and comments about exhibited objects using pre-designed artcodes, making a structured plan will no more be necessary. In both these cases, if human support is provided, worksheet planning is not necessary anymore.
- A specific venue in the museum or the gallery should be arranged for the content creation activity. The venue needs to be quiet, comfortable and at the same time be designed in a way to invite individuals and groups of visitors to participate together.
- The medium for the digital content should be chosen carefully by the curators to match with the overall exhibition context, aim of the contribution and the nature of

the digital contents. Digital audio content works best in exhibitions where visitors are encouraged to stay visually and physically connected and interacted with the existing artefacts.

- In case of using audio and video for the digital contents, a booth should be provided to visitors to record their own voices or videos. The booth needs to be in the venue where the drawing activity is taking place or be close to it.
- Visitors should be allowed to modify the digital contents of their hybrid contributions, if they wish to after leaving the museum and gallery in order to allow useful, updated and progressive content to be created for the exhibition. This would encourage them to re-visit and engage in the cycle or to motivate them to recommend family or friends to visit the exhibition and check their contents. For this purpose, they should be provided with a copy of their physical artcodes and instructions about how and where to upload their new digital contents. However, the digital contents that have been modified should not be updated immediately, instead the new digital contents need to be saved in a pending category until they are checked.
- For the visual representation of the hybrid artefacts, visitors need to be provided with options to choose between drawing their own artcodes or choosing from pre-designed artcodes and this is based on the context of the exhibition and aim of the contribution.
- Hand-drawn artcodes are particularly useful for extending exhibition, as it would enable visitors to feel more creative to design in their own way and express their own experiences (visualise their thoughts).
- For visitors who are new to artcodes, a misunderstanding could arise either in drawing a valid artcode or they might think that they are supposed to draw an artcode instead of an ordinary picture in the comment section of the pre-designed artcodes. To minimise such cases, curators need to provide careful supports and explanations to the visitors.
- Pre-designed artcodes are more suited for augmenting the existing artefacts of exhibitions which can meet visitors' preferences for their contributions, as it was revealed from the findings, while it also addresses the curator's concern about preserving the aesthetic quality of the exhibitions that contain artefacts.
- Museums and galleries should be aware of the visual contrast between the official markers and user generated content. If the exhibition has already been augmented with official hybrid artefacts, it is important to ensure visitor's hybrid contributions

would also be in the same aesthetic quality as the official hybrid artefacts in order to encourage visitors to contribute as well.

Reintegration stage

- The role of the integrator should be shared between curators and visitors.
- Curators need to release and provide visitors with clear instructions about the process of moderating and integrating hybrid contributions.
- Moderating and integrating hybrid contributions into exhibition need to be made immediately or within a short time frame after visitors had created their hybrid contributions.
- Both the physical design of the artcodes and the digital contents need to be carefully moderated.
- The process of moderating hybrid contributions should be made within two stages, based on curators' criteria: first by the visitors who created the hybrid artefacts or by other visitors who have already created hybrid contributions; second, curators should be involved in the final decision on the hybrid contributions that can be displayed. Alternatively, the whole process of moderating and integrating hybrid contributions can be turned into a participation activity by inviting new visitors to participate which might encourage them to participate in the activities of the interaction and response stages. However, curators should still be involved in the final decision on the hybrid contributions that can be displayed.
- It would be useful if all the hand-drawn artcodes are displayed together and separated from the existing artefacts so that they appear as a standalone exhibition. Whereas, the pre-designed artcodes, that are created by visitors to leave their comments and information about the existing artefacts be displayed close to the existing artefacts using for instance, tables and cabinets.
- Allowing visitors to contribute to exhibition using hybrid artefacts and displaying them require careful management to display them following the "Recency" method and to rotate them regularly, according to the exhibition time frame, in order to ensure updating the displayed hybrid artefacts regularly.
- In case of having official interpretation labels of artcodes and visitor's hybrid contributions in the exhibition, there should be a clear distinction of the visual representation and displaying position between them.

- Careful distribution and placement of artcodes (either official labels or visitors' hybrid contributions) can be a useful mechanism to increase visitor' engagements and interests with the less interactive and effective exhibition rooms in museums and galleries and to promote their motivations to visit them.
- Displaying hybrid artefacts (hand-drawn artcodes or pre-designed artcodes) in the Lobby could be of benefit to increase visitors' engagement in such waiting areas.

7.3 Limitations

Although this thesis contributes a novel approach for enabling different types of visitors' participation in museums and galleries using aesthetic visual markers, it has a number of limitations that need to be addressed in future studies in order to understand and explore the approach in more depth.

The main limitation of this research is that the reintegration stage was not fully explored as a result of not involving visitors in moderating and integrating hybrid contributions in the exhibition due to the curators' preference to retain control of this stage. However, from what two of the curators found in terms of visitors' high interactions with the hybrid contributions and to create their own contribution, they changed their opinions and showed their willingness to allow visitors to be involved in the reintegration stage in future. Involving visitors in the reintegration stage means that visitors would be involved in all stages of the cycle which will complete their overall engagement. This could potentially lead to repeat visiting to engage in the cycle. Thus, it is important to involve visitors in the reintegration stage in the future studies and find out possible opportunities and challenges from their involvements.

Another limitation of this research is that the studies run over a certain period of time. However, it is important to run the studies over a longer time to find out how visitors would engage and behave with the approaches that were reported in this research. Would visitors be willing to come back to the museum or the galleries to engage with the activities of the cycle again and what could happen during their involvement in the cycle?

Also, the participants of the first and second studies (chapters 3 and 4) were specifically recruited to take part in the study. Thus, they may behave in certain ways to meet the author's

aims of the studies while they may behave differently if they were interacting with the approach naturally without being participating in studies.

It is essential to highlight that although carrying out studies “in the wild” are more likely to provide more real findings, there are still limitations. First, as already discussed, the findings are from studies where participants have been observed, thus, they may behave in certain ways that could be different if they were not observed. Second, the collected data is representing view, attitude and interaction of specific number of participants but not every type of visitors. Third, the author had less control over the settings and the procedure of the studies particularly, during the observation sessions, so it was not possible to rigorously compare the behaviour of different types of visitor.

Finally, it is worth noting the essential role of the facilitators in deploying the approach of this thesis in “in the wild”. In this research, the author has played varying roles throughout the three practical studies ranging from designing map prototype and artcodes, creating digital contents, designing study structure as well as collecting data followed by analysing data. In addition, the author has played the role of facilitating content creation, moderating and displaying artcodes. Therefore, it is important to know that for deploying Artcodes technology in the museum and enabling visitors to contribute using artcodes, curators need to consider each of the above roles that they would need to play carefully in order to ensure smooth, successful and interactive experiences for the visitors.

7.4 Future Work

This thesis research opens up new opportunities for future work in the field of HCI. In this section, the potential ways for expanding the scope of this thesis will be discussed based on the co-creation cycle.

First, further study needs to focus on integrating the co-creation cycle of this research practically into real visits in museums and galleries in order to find out more about visitors' interactions throughout all the three stages and how successful the cycle will be. Second, future studies should consider completing the co-creation cycle by involving visitors in the activities of the reintegration stage. In this regard, it might also be useful to extend the first study of the printed-paper map to span the whole co-creation cycle by inviting visitors to create their own hybrid contributions for the existing artefacts and identify the main

similarities and differences between museum artefacts followed by integrating them into the exhibit. Also, it might be useful in the future studies to involve curators in the response stage to create hybrid contributions around an exhibition or to answer visitor enquiries which could further enrich subsequent visitors' experiences in the interaction and response stages. More details about opportunities for future studies are explained below:

7.4.1 Integrating other technologies and mechanisms alongside aesthetic visual markers into the co-creation cycle

Regarding the co-creation cycle, there are opportunities for integrating other concepts and technologies with aesthetic visual markers to support visitors to explore the museum further. Trajectory based systems and recommender systems seem useful opportunities to be integrated into the co-creation cycle, following the trajectory model of Fosh's (2016) thesis and Benford et al. (2009) to support visitors in their experience journeys throughout all the three stages. In particular, using a trajectory based system in large museums and galleries where finding artefacts and navigation might not be quite easy. In the interaction stage, the trajectory based system can be useful for linking the existing artefacts and supporting visitors to navigate in the exhibition in order to interact with the existing artefacts and find them easily.

The recommender system can help visitors during their trajectory path to recommend similar (hybrid) artefacts to those that visitors have already explored in their visit or in their previous visits. Alternatively, it can simply recommend nearby artefacts that are similar to those that are observed by the visitors using LBS. These can help visitors to explore the relationships between artefacts further.

In the response stage, the recommender system can be used to support visitors in two levels: first, to support visitors in creating physical artcodes by presenting samples of hand-drawn and pre-designed artcodes that are created by designers or other visitors. This would work as a library of artcodes design which can provide visitors with inspiration and more ideas for creating their own artcodes. Second, to support visitors to create digital contents by providing lists of categories of possible topics to tailor their own digital contents. Finally, in the reintegration stage, the trajectory based system and recommender systems can help visitors to navigate the exhibition to find places that are specified for integrating hybrid contributions into the exhibitions and recommend other possible locations and methods that can be used, or used by previous visitors, for displaying their own hybrid artefacts.

In addition to the trajectory concept and recommender systems, it might be useful in the future studies to explore how gifting concept can be beneficial for engaging visitors to create hybrid contribution specifically for family or friends. Consequently, to find out how the family and friends would be potentially involved in receiving their hybrid gift artefacts and respond to the sender. Thus, both the gift sender and receiver could be involved in all stages of the co-creation cycle.

Another useful opportunity for future studies could be exploring how hybrid contributions could be made through fixed installations in addition to the mobile devices. This could be highly useful particularly for the drawing activity of the artcodes where visitors can draw artcodes digitally on a screen. This is because holding mobile devices might not be too convenient for every visitor, thus drawing through touch screen could be potentially useful. In addition, children might find fixed installation for drawing more engaging.
Finally, it is important to explore the applicability of the co-creation cycle for other technologies as the three stages and their activities of the co-creation cycle are generic which can be applied to other technologies as well. However, the key opportunities and challenges that have been highlighted in this research are specific to the use of the aesthetic visual markers. Thus, there is another body of research to explore how the opportunities and challenges of the activities in the three stages might change when other types of visual markers and tags are used including QR codes, RFID and NFC.

7.4.2 Extending the co-creation cycle for pre and post visit

The research of this thesis focused on the co-creation cycle during visitor experiences, however, co-creation could happen before, during and after the visit. Thus, it seems useful in the future studies to explore the possibility of using the approach of this research in online experiences in order to engage people in the co-creation cycle before and after leaving museums and galleries which could be beneficial for engaging visitors to repeat visits. In this respect, the Artcodes app needs to be extended to save visitors' activities and allow them to access them in the following visits. In this way, the stored history would become like a souvenir for visitors which can be useful during their visit and also allow them to access the contents after leaving the museum.

7.4.3 Sustainability of the co-creation cycle

Overall, using artcodes mechanism for visitors' hybrid contributions, raise questions about the lifetime of the hybrid artefacts such as the length of time to leave them on display and

when the rotation process should be made in order to display new hybrid artefacts. What should happen to visitors' hybrid contributions when they are rotated? Should they be archived? For how long should they be kept? How do sharing visitor's hybrid contributions be managed both physically onsite or online in terms of ethical consideration? How should copyright be considered? All these questions need to be researched and explored in details in the future studies to consider strategies and mechanisms for dealing with visitors' hybrid contributions over time since the co-creation cycle needs to be running which would result in producing hybrid contributions regularly.

7.4.4 Applying co-creation cycle to other domains

Finally, the approach of this thesis and the co-creation cycle are not only limited to museum and gallery setting but they are also useful to explore to see whether they could be applied to other scenarios and domains to take benefit such as for educations, libraries, leisure activities (such as festival and cinema), restaurant, café, hospital and airport.

7.5 Conclusion

In this chapter, a summary of the studies has been provided and the research questions have been answered followed by highlighting the main contributions of the thesis to the HCI and the museum communities. The limitations and future studies have been highlighted. In conclusion, it can be said that this thesis confirms the usefulness of the co-creation cycle to be used in order to engage visitors with exhibitions by involving them in different types of participation activities using aesthetic visual markers.

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Appendices

Appendix-A: Consent forms

Using Aestheticodes in the Museum – collection of consent

A short test session and interview will be used for evaluating the prototype of the interactive-aesthetic map for the University of Nottingham museum. For this purpose, you will be asked to perform a short test session to scan the artcodes (images) by the mobile devices individually, by group, continuously or from different physical distance. As a result, different information and interactions will be produced. This task will take no longer, than 15 minutes. After the task, there will be a short interview about your experience.

I have read and understand the attached information sheet, which includes information about the data to be recorded.

I understand that I can withdraw at any time by contacting the researcher at the address provided in the information sheet, and my personal data will be erased from the records.

I confirm that I am over the age of 18.

I confirm that I have read and understood the information provided above, and that I would like to take part in the task:

Name: WASAKORN LAESANKLANG

Signature: .....

Date: 19-08-15

Email: psxwl3@nottingham.ac.uk

Do you consent to any of the following usages of media collected during the task session and interview? Please tick only those that apply.

Photographs featuring you in internal project reports:	☑
Photographs featuring you in publicly-available academic publications:	☑
Photographs featuring you in project publicity	☑
Anonymised personal quotes in internal project reports:	☑
Anonymised personal quotes in publicly-available academic publications:	☑
Anonymised personal quotes in project publicity:	☑

Using Aestheticodes in the Museum – collection of consent

A short test session and interview will be used for evaluating the prototype of the interactive-aesthetic map for the University of Nottingham museum. For this purpose, you will be asked to perform a short test session to scan the artcodes (images) by the mobile devices individually, by group, continuously or from different physical distance. As a result, different information and interactions will be produced. This task will take no longer, than 15 minutes. After the task, there will be a short interview about your experience.

I have read and understand the attached information sheet, which includes information about the data to be recorded.

I understand that I can withdraw at any time by contacting the researcher at the address provided in the information sheet, and my personal data will be erased from the records.

I confirm that I am over the age of 18.

I confirm that I have read and understood the information provided above, and that I would like to take part in the task:

Name: Eleanor Ball

Signature: EMBall

Date: 8/9/15

Email: eleanor.ball@nottingham.ac.uk

Do you consent to any of the following usages of media collected during the task session and interview? Please tick only those that apply.

Photographs featuring you in internal project reports:	☑
Photographs featuring you in publicly-available academic publications:	☑
Photographs featuring you in project publicity	☑
Anonymised personal quotes in internal project reports:	☑
Anonymised personal quotes in publicly-available academic publications:	☑
Anonymised personal quotes in project publicity:	☑

Appendix-B: Information Sheet

Using Aestheticode Technology to Enhance the Experiences of Museum's Visitors – Information for test session and interview participants

Welcome to this test session, which is hosted by the Aestheticodes research project. During the task, we'll be working with Aestheticodes, a technology developed at the University of Nottingham. We'll be considering how this technology might be used to create interesting experiences.

- We'd like to take some photographs of the task, for use in internal project reports, publicly-available academic publications and also to publicise the project, but please let us know if you'd prefer not to appear in these, and we'll make sure that you aren't included.
- We will also be recording video and audio at selected points in the test session, and will make anonymous transcripts from this material. Quotes from these transcripts will be used in publications and project publicity, but only with your permission.
- We will be taking notes about what happens in the test session, and may note down any interesting observations that you make. Our notes will not include your name.
- We would like to collect any media collected during the test session to act as a record of its process. We would like to use this media in project publications, but only with your permission

We will never release your name through the research process, and any data that could identify your will be held safely and securely, in accordance with the Data Protection Act.

During this test session, you may spend some time making your own Aestheticodes and other creative products. You own the rights to these, and you can use them as you wish after the test and interview has concluded. We would like to use replicas of your work in internal project reports, publicly-available academic publications and also to publicise the project, but will only do so with your permission.

If you have any questions or concerns, please contact Susan Ali or Boriana Koleva, either by emailing {psxsaal or b.koleva} @nottingham.ac.uk, or by writing to:

School of Computer Science, University of Nottingham,
Jubilee Campus, Wollaton Road, Nottingham, NG8 1BB

Appendix-C: The NVA participants' background and their recruitment method

Participant ID	Gender	Age	Recruitment Method	Companion with
pa1	m	16	On site	single
pa2	m	27	On site	son with father pa16
pa3	f	42	On site	single
pa4	m	29	University	friend with pa5
pa5	f	27	University	friend with pa4
pa6	m	41	On site	partner of pa8
pa7	m	33	On site	partner of pa19
pa8	f	38	On site	partner of pa6
pa9	f	21	On site	partner of pa13
pa10	m	24	On site	group friend with pa11 pa12
pa11	m	24	On site	group friend with pa10 pa12
pa12	m	21	On site	group friend with pa10 pa11
pa13	m	30	On site	partner of pa9
pa14	m	20	On site	single
pa15	m	37	On site	single
pa16	m	49	On site	father with son pa2
pa17	m	22	On site	single
pa18	m	31	On site	partner of pa33
pa19	f	34	On site	partner of pa7
pa20	m	34	On site	friend with pa21
pa21	m	29	On site	friend with pa20
pa22	m	24	On site	partner of pa23
pa23	f	21	On site	partner of pa22
pa24	m	29	On site	partner of pa34
pa25	m	27	On site	partner of pa26
pa26	f	29	On site	partner of pa25
pa27	m	29	On site	partner of pa28
pa28	f	28	On site	partner of pa27
pa29	f	35	On site	partner of pa30
pa30	m	36	On site	partner of pa29
pa31	f	26	On site	partner of pa32
pa32	m	27	On site	partner of pa31
pa33	f	33	On site	partner of pa18
pa34	f	32	On site	partner of pa24
pa35	f	19	On site	partner of pa36
pa36	m	19	On site	partner of pa35
pa37	m	38	On site	friend with pa38
pa38	m	35	On site	friend with pa37
pa39	f	43	On site	with daughter pa40
pa40	f	6	On site	with mum pa39

Appendix-D: Participants design choices in the NVA study

Participant ID	Gender	Age	Artcode Option	Artcode Name	Types of Comment	Comments	Purpose of the Digital content
p1	m	16	Hand-drawn				general
p2	m	27	Hand-drawn				general
p3	f	42	Hand-drawn				general
p4	m	29	Pre-designed artcodes with comment section	Mario amazing	Draw: Write: Mix	Flowers	Gallery Three
p5	f	27	Pre-designed artcodes with comment section	Mario	Draw: Write: Mix	Heart	Gallery Three
p6	m	41	Pre-designed artcodes without comment section	Little big planet			Gallery Three
p7	m	33	Pre-designed artcodes with comment section	Pacman	Draw: Write: Mix	Text	Gallery Three
p8	f	38	Pre-designed artcodes without comment section	super Mario			Gallery Three
p9	f	21	Pre-designed artcodes without comment section	Mario			Gallery Three
p10	m	24	Hand-drawn	Animal face			Gallery Three
p11	m	24	Hand-drawn	Rampage			Gallery Three
p12	m	21	Hand-drawn	Lord dog Rabbit			Gallery Three
p13	m	30	Pre-designed artcodes without comment section	dk89 hoky donky			Gallery Three
p14	m	20	Pre-designed artcodes with comment section	Super frog	Draw: Write: Mix	Text	Gallery Three
p15	m	37	Pre-designed artcodes with comment section	BBC micro	Draw: Write: Mix	Text	Gallery Three
p16	m	49	Pre-designed artcodes with comment section	Tennis	Draw: Write: Mix	Tennis	Gallery Three
p17	m	22	Pre-designed artcodes with comment section	Mario house	Draw: Write: Mix	Mario house	Gallery Three

p18	m	31	Pre-designed artcodes without comment section	Super Mario bros			Gallery Three
p19	f	34	Pre-designed artcodes with comment section	Mario cart	Draw: Write: Mix	 Text 	Gallery Three
p20	m	34	Pre-designed artcodes without comment section	Mario bros			Gallery Three
p21	m	29	Pre-designed artcodes without comment section	Football manager			Gallery Three
p22	m	24	Pre-designed artcodes with comment section	Accommodate 64	Draw: Write: Mix	Logo Text Yes	Gallery Three
p23	f	21	Hand-drawn	Owly			Gallery Three
p24	m	29	Pre-designed artcodes without comment section	Firefox			Gallery Three
p25	m	27	Pre-designed artcodes with comment section	new Zealand map	Draw: Write: Mix	New Zealand map 	Gallery Three
p26	f	29	Pre-designed artcodes with comment section	Mario	Draw: Write: Mix	 Text 	Gallery Three
p27	m	29	Pre-designed artcodes without comment section	Guitar hero			Gallery Three
p28	f	28	Pre-designed artcodes without comment section	Guitar hero			Gallery Three
p29	f	35	Pre-designed artcodes with comment section 	Zelda 	Draw: Write: Mix	Logo 	Gallery Three
p30	m	36	Pre-designed artcodes without comment section	Mario			Gallery Three
p31	f	26	Pre-designed artcodes without comment section	Rod land			Gallery Three
p32	m	27	Pre-designed artcodes without comment section	Sonic			Gallery Three

p33	f	33	Pre-designed artcodes without comment section	Mario			Gallery Three
p34	f	32	Pre-designed artcodes without comment section	Super Mario			Gallery Three
p35	f	19	Pre-designed artcodes without comment section	Astrowars			Gallery Three
p36	m	19	Pre-designed artcodes without comment section	new Zealand			Gallery Three
p37	m	38	Pre-designed artcodes with comment section	Logo	Draw: Write: Mix	Logo Text Yes	general
p38	m	35	Pre-designed artcodes with comment section	Atari Joystick	Draw: Write: Mix	Atari control Text Yes	general
p39	f	43	Hand-drawn	Rosy			general
p40	f	6	Hand-drawn	My Hand			general