UNIVERSITY OF AMSTERDAM

UvA-DARE (Digital Academic Repository)

Assumptions and experiences

How museums communicate interactivity and how visitors engage with instruction in the museum context

Ray, C.A.

Publication date
2020

Document Version
Final published version

License
Other

Link to publication

Citation for published version (APA):
Ray, C. A. (2020). *Assumptions and experiences: How museums communicate interactivity and how visitors engage with instruction in the museum context*. [Thesis, externally prepared, Universiteit van Amsterdam].

General rights
It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations
If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: https://uba.uva.nl/en/contact, or a letter to: Library of the University of Amsterdam, Secretariat, P.O. Box 19185, 1000 GD Amsterdam, The Netherlands. You will be contacted as soon as possible.

UvA-DARE is a service provided by the library of the University of Amsterdam (https://dare.uva.nl)

Download date:10 Nov 2026

ASSUMPTIONS & EXPERIENCES:

HOW MUSEUMS COMMUNICATE INTERACTIVITY AND HOW VISITORS ENGAGE WITH INSTRUCTION IN THE MUSEUM CONTEXT

CHRISTIE A. RAY

ASSUMPTIONS AND EXPERIENCES

HOW MUSEUMS COMMUNICATE INTERACTIVITY AND HOW VISITORS ENGAGE WITH INSTRUCTION IN THE MUSEUM CONTEXT

ACADEMISCH PROEFSCHRIFT

ter verkrijging van de graad van doctor

aan de Universiteit van Amsterdam

op gezag van de Rector Magnificus

prof. dr. ir. K.I.J. Maex

ten overstaan van een door het College voor Promoties ingestelde

commissie, in het openbaar te verdedigen in de Agnietenkapel

op dinsdag 10 maart 2020, te 12:00 uur

door Christie Ann Ray

geboren te North Vancouver

Promotiecommissie:

Promotor:	prof. dr. R. Boast	Universiteit van Amsterdam
Copromotor:	prof. dr. M.S. Parry	Universiteit van Amsterdam
Overige leden:	prof. dr. J.J. Noordegraaf	Universiteit van Amsterdam
	dr. P.S. Lulof	Universiteit van Amsterdam
	prof. dr. J. Symonds	Universiteit van Amsterdam
	prof. dr. H. Ronnes	Universiteit van Amsterdam
	prof. dr. R.D. Parry	University of Leicester

Faculteit der Geesteswetenschappen

Table of Contents

Chapter 1 : Introduction 6

Chapter 2 : Literature Review 14

The Museum Context 15

Interaction (in the Museum Context) 23

Instruction (for Interaction in the Museum Context) 27

Research and Evaluation of Instruction 33

Chapter 3 : Methodology 37

Evaluating Design and Development 38

Evaluating the Museum Visitor Experience 42

Ethical Evaluation 51

Chapter 4 : Case Study 1: *The Gibraltar Touch Table*, Het Scheepvaartmuseum 53

Introduction 53

Case Study Installation: *The Gibraltar Touch Table* 65

Forms of Instruction Associated with *the Gibraltar Touch Table* 71

Results of Evaluation 75

Development Team Interviews and Analysis 75

Visitor Evaluation: Observation and Post-Interaction Questionnaire Results 88

Discussion 106

Instructional Forms Available vs. Instructional Forms Used 106

Observed Use of Instructional Forms vs. Reported Use of Instructional Forms 110

Impact of Instructional Forms on User Experience and Ability to Interact 114
Instructional Forms Used vs. Instructional Forms Users Want 118
Development Team Intentions/Assumptions vs. User Interaction Experience 121
Conclusions 124
Influence of the Installation Context on User Interaction 125
Importance of User Testing 127
Impact of Instructional Forms on the User Interaction Experience 130
Chapter 5 : Case Study 2: *The Painting Lens*, Gallery One at the Cleveland Museum of Art 132
Introduction 132
Gallery One 138
Case Study Installation: *The Painting Lens* 142
Results of Evaluation 150
Development Team Interviews and Analysis 151
Visitor Evaluation: Observation and Post-Interaction Questionnaire Results 164
Discussion 181
Instructional Forms Available vs. Instructional Forms Used 182
Observed Use of Instructional Forms vs. Reported Use of Instructional Forms 186
Impact of Instructional Forms on User Experience and Ability to Interact 188
Instructional Forms Used vs. Instructional Forms Users Want 191
Development Team Intentions/Assumptions vs. User Interaction Experience 195
Conclusions 199
Influence of the Installation Context on User Interaction 200

Importance of User Testing 201

Impact of Instructional Forms on the User Interaction Experience 203

Chapter 6 : Conclusion 206

Bibliography 215

Appendix 1 : Design and Development Team Interview Template 245

Appendix 2 : Interview Quote Approval Form Template 248

Appendix 3 : HSM Observation Template 249

Appendix 4 : HSM Post-Interaction Questionnaire (English Version) 250

Appendix 5 : HSM Post-Interaction Questionnaire (Dutch Version) 256

Appendix 6 : CMA Observation Template 262

Appendix 7 : CMA Post-Interaction Questionnaire 263

List of Figures 269

Summary 271

Samenvatting 274

Acknowledgements 277

Chapter 1: Introduction

Interaction technologies have been, and continue to be, integrated into museums and their exhibition spaces for a range of purposes, but our understanding of the impact of interaction technologies on the museum visitor experience remains limited. Researchers have been working to publish their findings on a variety of subjects that explore the relationship between interaction technologies and aspects of the museum visitor experience, including usability of in-gallery interactive technologies (e.g.: Mancini 2008; Carrozzino and Bergamasco 2010; Sen, Diaz, and Horttana 2012; Othman, Petrie, and Power 2013; Ting, Lim, and Sharji 2013; Hsu and Lin 2014), visitor engagement with in-gallery technologies (e.g.: Garzotto and Rizzo 2007; Meisner et al. 2007; Heath and vom Lehn 2008; Hornecker 2010; Schmitt et al. 2010; Ciolfi and McLoughlin 2012; Liu 2013; Schreiber et al. 2013; Li and Liew 2015), learning behaviours associated with the use of in-gallery technologies (e.g.: Clough et al. 2008; Heath and vom Lehn 2009; Sanford 2010; Pattison, Ewing, and Frey 2012; Zaharias, Michael, and Chrysanthou 2013), and social-interaction among visitors engaged with in-gallery technologies (e.g.: Heath, vom Lehn, and Osborne 2005; Hornecker and Stifter 2006; Peltonen et al. 2008; Heath and vom Lehn 2009; Hornecker 2010; Jafari, Taheri, and vom Lehn 2013). Despite growing research looking into various facets of the museum visitor experience with in-gallery interaction technologies, publications rarely examine the role of procedural instructions for interaction in relation to the user interaction experience, which is the purpose of this thesis.

Distinguished from pedagogical or didactic instruction, the kinds of instruction I refer to throughout this thesis relate more to the procedural instructions that guide visitors through the steps of interaction necessary to engage successfully, in principle, with interaction technologies presented within the museum context. In order to better understand instruction and how it relates to the interaction experiences of users engaging with in-gallery interactive installations, I evaluate interactions between museum visitors and their physical environment. Here, I define in-gallery interaction installations as being interactive technological installations that are integrated into the

physical context of a museum. To bring further specificity to my own research, I focus on touch-based interaction technologies that can best be described as touch-screens, tablets, or touch-tables. Although this definition for touch-based interaction technologies can include portable devices such as tablets or mobile phones, the kinds of installations that I evaluate are those that are integrated into their physical environment; installations that are fixed in place, though not necessarily permanent.

Touch-based interaction technologies have a long history of development and use for educational purposes, with early touch-screens entering class rooms in the 1970s and making their way to museums by the early 1980s (Frenkel 1989; Buxton 2009). In the first article that looks at museum visitor evaluation of an interactive touch-screen orientation device, Elizabeth Sharpe provided some of the earliest results relating to museum visitor preferences associated with the use of touch-based interaction technology (Sharpe 1983; Korn 1985). As time passed and technology started to evolve, interaction technology became more affordable and more widely available, often being integrated into museums as touch-screen kiosks using a form of interaction that does not require hardware such as a mouse, keyboard, or alternative button controls (Tafler 1988; Anderson 1985; Frenkel 1989; Hirumi, Savenye, and Allen 1994; Jones 1988; Sears, Plaisant, and Schneiderman 1990). The developing and expanding role of interaction technology within the museum context led to the formation of professional and academic bodies that recognise the potential for research and dissemination of information relating to interactivity, media, and technology within museums. In 1991 the International Council of Museums (ICOM) formed the International Committee for Audiovisual and New Technologies and Social Media (AVICOM), a specialised branch that focuses on supporting the use of audio-visuals and new technologies in museums (AVICOM 2010), and beginning the same year, the International Conference on Hypermedia and Interactivity in Museums (ICHIM) was first held; however, this conference series held its last event in 2007 (Archives & Museum Informatics 2007).

Jumping ahead to 2007, when the iPhone was first introduced to the world and quickly saturated the commercial market, museums begin to explore the use of mobile touch-screen interaction devices as a means for supporting informal learning or facilitating visitor engagement (Clough et al. 2008; Liu 2013; Amato et al. 2013; Othman, Petrie, and Power 2013; Kidd 2014b). Museums have since begun to explore beyond touch-based interaction technologies to sensor-based technologies, such as the RFID or NFC sensors used for visitor tracking (Hsi and Fait 2005; Mody et al. 2009; Cafaro et al. 2010; Ceipidor et al. 2013), while motion sensors like Kinect or LEAP Motion can facilitate detection of physical gestures for interacting in virtual environments (Pietroni et al. 2012; Sen, Diaz, and Horttana 2012; van der Vaart and Ray 2014). Despite so many available forms of interaction technology for museums to take advantage of, reliability and robustness of any in-gallery interactive installation remains critical due to its potential to impact the visitor interaction experience and the wider museum visit (Briggs 2000; Kollmann 2007).

Understanding the historical context for interaction with in-gallery interactive installations is important because it informs how familiar visitors may or may not be with interaction technologies, with encountering interaction technologies in museum contexts, or with interacting with technological installations within museums. The history of interaction technologies in museums also influences the kinds of interactive installations found in museums today; technologies that quickly become outdated or require frequent and/or costly maintenance tend to be avoided when the addition of new interactive installations into their exhibition spaces are under consideration.

Although museums are experimenting with and integrating more interaction technologies into their exhibition spaces, academics acknowledge that research into the impact of technology on the museum visitor experience has fallen behind and relevant research topics are being overlooked (McNamara 1986; Marty, Rayward, and Twidale 2003; Hunt 2013; Forrest 2015). Within the body of research relating to in-gallery interactive installations and museums, publications tend to examine broadly applicable subjects, like usability or interaction dynamics among users, but since evaluation is typically conducted using case study installations, it is not always possible to apply relevant

research results to other interactive installations or other museum contexts and consolidating research has similarly proven challenging (Economou 1998; Kidd 2014a; Forrest 2015). In publications that report on aspects of usability related to in-gallery interactive installations, references to *instruction* tend to emerge within the interpretation of evaluation results (e.g. Hornecker and Stifter 2006; Kortbek and Grønbæk 2008a; Ciolfi and McLoughlin 2012; Xie 2013; Germak and Khan 2017) but is rarely the central focus of presented research. Recognising the gap in research, I use this thesis to initiate a more direct discussion about the potential influence that instructions for interaction with in-gallery interactive installations can have on a museum visitor's interaction experience.

There are three aims relating to instructions for interaction with in-gallery interactive installations that I intend to achieve within this thesis. First, I propose a framework for defining and discussing forms of instruction associated with in-gallery interactive installations, establishing a consistent language for discussing instruction. Drawing on educational theory relating to instruction, together with the work of STEM researchers, Lee Carroll and Eric N. Wiebe, I identify and define four forms of instruction: *direct-static*, *indirect-static*, *direct-dynamic*, and *indirect-dynamic*. The four forms of instruction that I distinguish are a hybridisation of two contrasting sets of defining characteristics: *direct* or *indirect*, *static* or *dynamic* (Carroll and Wiebe 2004; Kirschner, Sweller, and Clark 2006; Kuhn 2007; Böttcher and Meisert 2013).

My second aim is to better understand the development process behind creating and implementing forms of instruction associated with in-gallery interactive installations. To do so, I sought out first-hand experiences from the individuals responsible. Using a semi-structured interview method (Charmaz 2006; Rowley 2012; Kallio et al. 2016), I inquired about the processes involved in developing instructions for interaction with in-gallery interactive installations. Like other museological researchers, I employed the interview method to collect qualitative responses that could offer insights into aspects such as audience or user group targeting, defining user experience goals, application of codified knowledge, and methods for presenting instructions for interaction

with in-gallery interactive installations (Economou 1998; Hudec 2004; Coffee 2007; Sanford 2010; Schmitt et al. 2010; Hornecker and Nicol 2012).

The third aim of this thesis is to explore the user experience. Using a combination of visitor observation and a post-interaction questionnaire (Berkovich et al. 2003; Bevan 2009; Pallud and Monod 2010; Schmitt et al. 2010; Sohn 2011), I evaluated the use or non-use of available forms of instruction, the forms of instruction that users claimed to use compared with forms of instruction that they actually used, the effectiveness of the available forms of instruction for achieving interaction success, and the forms of instructions that users preferred to use versus those forms that were neglected or unused.

My analysis is based on evaluation of two case study interactive installations: *the Gibraltar touch table*, in the Paintings Gallery of Het Scheepvaartmuseum, in Amsterdam (NL) (Mol 2013; Schokkenbroek 2013), and *the Painting Lens*, in Gallery One of the Cleveland Museum of Art, in Cleveland (USA) (Alexander, Barton, and Goeser 2013; Alexander 2014b; The Cleveland Museum of Art 2015c). This research demands a specific set of requirements to be met for consideration for selection as a case study. The central requirement is, obviously, the presence of an in-gallery touch-based interaction technological installation that is available for museum visitors to interact with in the exhibition space. Although many museums are integrating interaction technologies into their galleries and exhibition spaces, few museums tend to promote these kinds of technology-based experiences within their marketing or promotional materials. This seems to be especially true of the more traditional, object-based museums, which prefer to focus public promotion on their collections and exhibitions; of course, there have been some notable exceptions, including the two museums which host the case study applications (Sayare 2012; The Cleveland Museum of Art 2013a, 2015b, 2015j; Het Scheepvaartmuseum 2017b; Louvre Museum 2019; Cooper Hewitt Smithsonian Design Museum 2019). Looking first to institutions that promote their interactives as a core offering, I then sought out institutions that were willing to participate in my research. While it is perhaps natural for museums to exercise caution when opening their doors to any external researcher who may

scrutinise their operations, I stressed that the aim of this research is not to unduly criticise the case studies, the host museums, or the individuals involved in the development of the in-gallery interaction technologies I evaluate, but rather to conduct exploratory research relating to the relevant instructions for interaction.

The two selected case study installations bear a number of similarities, such as the use of touch-based interaction technology and the fixed positioning of the interactive installations within object-centric exhibition spaces, but are otherwise very different with respect to their content, purpose, and interaction design. For example, *the Gibraltar touch table* relates to a single maritime oil painting (van Wieringen 1622), while *the Painting Lens* is associated with a selection of four curated artworks that use four different painting mediums to portray an array of diverse subjects (Sano di Pietro, n.d.; Panini 1747; Picasso 1924; Mitchell 1958). It is not my intention to evaluate these two case studies for the quality of their content, but rather I seek to explore the processes behind the design and development of the instructions for each case study and to better understand the impact of instructions on the user interaction experience.

Chapter Summary

In the proceeding chapters, I set out to achieve the three aims of this thesis through detailed research, methodical evaluation, and data-driven analysis. In Chapter 2, I contextualise my research within the wider body of museological publications and provide contextual definitions for the relevant terminology that I apply throughout. Influenced by the education theory and STEM research, I present my proposal for a framework for defining and discussing forms of instruction I identify associated with in-gallery interactive installations (Carroll and Wiebe 2004; Kirschner, Sweller, and Clark 2006; Kuhn 2007; Böttcher and Meisert 2013). In Chapter 3, I provide an in-depth description of the methodology I employed to evaluate instruction associated with in-gallery interactive installations. Briefly, I apply a three-part evaluation approach that includes semi-structured interviews with members of the development teams responsible for each case study installation (Charmaz 2006; Rowley 2012; Kallio et al. 2016), observation of visitor interactions

(Serrell 1997, 2010; Yalowitz and Bronnenkant 2009; Zwinkels, Oudegeest, and Laterveer 2009; Bevan 2009; Kidd 2014a; Tzortzi 2014; Forrest 2015), and a post-interaction questionnaire offered to visitors upon concluding their interaction experience (Sylaiou et al. 2010; Sheng and Chen 2012; Gonçalves, Campos, and Sousa 2012; Forrest 2013; Zaharias, Michael, and Chrysanthou 2013; Tzortzi 2014).

In Chapter 4, I present the results of my evaluation of the first case study installation, *the Gibraltar touch table*, from the Paintings Gallery of Het Scheepvaartmuseum, in Amsterdam (NL) (Mol 2013; Schokkenbroek 2013). Similarly, I use Chapter 5 to present results associated with evaluation of the second case study installation, *the Painting Lens*, from Gallery One of the Cleveland Museum of Art, in Cleveland (USA) (Alexander, Barton, and Goeser 2013; Alexander 2014b; The Cleveland Museum of Art 2015c). I conclude with Chapter 6 by summarising the relevant findings stemming from this research, broadening the conclusions for applicability across different contexts or with different interaction technologies, and considering how the results might influence professional practice within museums.

While other researchers in the field of museology have touched upon this topic (e.g. Economou 1998; Schmitt et al. 2010; Gonçalves, Campos, and Sousa 2012; Ma et al. 2012; Barbieri, Bruno, and Muzzupappa 2017), I present this research as the first dedicated attempt to identify and evaluate the approaches museums take to communicate interaction with an in-gallery interactive installation to their visitors, and the impact of the available instructional forms on the interaction experiences of museum visitors. This research contributes to our understanding of the museum visitor experience, building on existing research about how the museum visitor experience can be influenced by in-gallery interactive installations (Goulding 2000; Chang 2006; Coffee 2007; Templeton 2011; Roppola 2012; Hanko, Lee, and Okeke 2014; Forrest 2015). Furthermore, this research reveals more about the unique nature of the museum context and how its very design can affect the behaviours of visitors, especially when interaction technologies are integrated into the museum context (Chang 2006; Koch et al. 2011; Pujol-Tost 2011; Calcagno and Biscaro 2012; Jafari,

Taheri, and vom Lehn 2013; Nielsen 2015). Although this research may be considered to be somewhat exploratory in nature, the conclusions I derive from my case study evaluations provide useful insights for museums seeking to offer their visitors the most suitable and effective forms of instruction for interaction with their in-gallery interactive installations.

Chapter 2: Literature Review

The purpose of this thesis is to evaluate a specific aspect of a museum visitor experience-related phenomena occurring within the museum context, and as such, it is useful to define the relevant characteristics of this context and its internal complexities. To frame my research and to provide context for it, I structure this literature review chapter around three main elements that influence both the museum visitor interaction experience and the design and development of instructions for interaction with in-gallery interactive installations: the museum context, interaction (in the museum context), and instruction (for interaction in the museum context).

Beginning with an examination of the museum context, I look to theoretical models for the museum visitor experience and identity-related motivations, which serve as a foundation for discussion about how influential the museum context can be on the museum visitor experience (Falk and Dierking 1992, 2013; Falk 2009, 2013). Building on this discussion, I explore the role of interaction within the museum context, including an examination of the various forms of tangible and sociocultural interactions that can occur (Goulding 2000; Heath and vom Lehn 2009; Sohn 2011; J. B. Schreiber et al. 2013; Forrest 2013, 2015; Widdop and Cutts 2012). I examine literature from the field of Human Computer Interaction (HCI), which introduces an alternative perspective to the discussion on interaction with computers by visitors in the museum context (Frenkel 1989; Grammenos et al. 2011; Ingram, Wang, and Ribarsky 2012; Pender and Lamas 2014). I look to Interaction Design (ID) as an established design process that promotes usability and user-centred design, acknowledging several museums where this approach has been applied to improve usability of in-gallery interaction technologies (Preece, Rogers, and Sharp 2002; Wiberg 2014; Bakker, van den Hoven, and Eggen 2015). Stemming from aspects of usability within the ID process, I focus the third portion of this literature review on the central theme of this thesis: instructions for interaction within the museum context.

The Museum Context

Although the term "museum context" can include spaces that serve more institutionally-oriented purposes, such as storage depots, conservation laboratories, or a myriad of office spaces, I employ the term here to refer specifically to those parts of the museum that are designed for public use, namely the public galleries and exhibition spaces designed for visitors. I aim to convey how the nature of these public spaces can contribute to and influence the museum visitor experience in different ways. In order to do this, and to form a connection to the procedural instructions related to in-gallery interaction technologies, I first explore the goals and motivations that museums have for integrating interactive technologies into their physical exhibition spaces.

The central philosophy that frames this discussion is constructivism, which proposes that museums ultimately exist to serve some form of educational function in society (Hein 1995, 1998b, 1999, 2005; Lankford 2002; Wilde and Urhahne 2008; Panasuk and Lewis 2012). Within this ideological framework, everything that a museum offers should thereby support this primarily educational function; its collections are a tool for teaching, its staff are stewards of information, and the physical space is designed to promote inquiry and engagement. The constructivist approach was borrowed from educational learning theories and adapted by museologist George E. Hein, who proposed that museums should embrace their educational role by creating learning opportunities that cater to a variety of potential learning styles (Hein 1995, 1998b, 1999, 2005). In the late 1980s New Museology emerged and adapted these constructivist ideas, putting more focus on the purposes of museums with respect to *who* they represent and *how* they are represented, in an effort to help make museums more relevant and engaging for their visitors (Vergo 1989; S. Macdonald 1990; Washburn 1991; Carr 1991). Applying a broadly constructivist perspective, it follows that the educational purposes of the museum naturally extend to its exhibitions, collections, and any other presentation of content, including any in-gallery interaction technologies that may be available. As a tool to support educational endeavours, in-gallery interaction technologies are viewed as a way to engage museum visitors with collections-related content in new, technologically-

enhanced ways that museums continue to experiment and innovate with, despite the recognised challenges relating to offering interaction technologies to a range of users, such as system maintenance and troubleshooting, and ensuring accessibility (Pujol-Tost 2011; Sundar et al. 2015; Stillwell 2017).

The presentation of in-gallery interaction technologies within museums, whether included to support constructivist learning-centric goals or some other purpose such as wayfinding or marketing, has been found to fundamentally alter the museum context by its very presence within the public exhibition space (Adams and Moussouri 2002; Pujol-Tost 2011; Hornecker 2011). Assuming a constructivist perspective whereby all in-gallery interactive installations are meant to support an educational purpose, it is necessary to explore the potential influence that the museum context can have on visitor interaction behaviours with in-gallery interactive installations. To support discussion on the museum context and how in-gallery interaction technology can alter the museum context, I would like to introduce the Contextual Model of Learning (Falk and Dierking 1992, 2013), which I use throughout this thesis as a tool for defining and discussing the museum context and the museum visitor experience in relation to in-gallery interactive installations.

Professors in free-choice learning and museum education, Lynn D. Dierking and John H. Falk developed the Contextual Model of Learning as part of their efforts to better understand the varying experiences visitors have in association with museums (Falk and Dierking 1992, 2013). Recognising the complexity of the museum environment and its influence on the experiences visitors were reporting, Falk and Dierking created the model "to help represent the common and unique strands of the museum experience; a framework designed to acknowledge, reveal, and organise its complexity" (Falk and Dierking 2013, 25). The Contextual Model of Learning breaks the museum down into three intersecting contexts that influence the experiences of museum visitors. These contexts are:

- *The Personal Context* – This context is formed by each individual visitor's personal knowledge and previous experiences that influence their interests, expectations, and motivations associated with museum visits.
- *The Sociocultural Context* – This is the context within which museum visits occur and includes both how individual visitors perceive the role of museums in society and how the cultural differences of visitors influence these perceptions. In addition, this context includes the social dynamics that influence the interactions that take place between museum visitors and museum personnel.
- *The Physical Context* – More than the varied physical environments of museums that visitors elect to enter, this context comprises the collections, displays, interaction opportunities, and the architecture of museums. (Falk and Dierking 2013)

The Contextual Model of Learning is actually an updated model of Falk and Dierking's original model, the Interactive Experience Model, but with one significant addition: consideration for how the passing of *time* influences the museum experience (Falk and Dierking 1992, 2013). According to the authors, by incorporating *time* into the model, "the visitor's experience can be thought of as a continually shifting interaction among personal, sociocultural, and physical contexts" (Falk and Dierking 2013, 29). Time is a crucial element in this updated model because it encourages the examination of the museum experience from a much broader scope than a single museum visit affords. Instead, the varied experiences of individuals accumulated throughout their lifetimes has the potential to shape and influence each successive museum visit.

The integration of in-gallery interaction technologies into the museum contexts creates additional variables within each context that need to be considered with respect to this particular examination of the Contextual Model of Learning. Researchers have found that in recent years, interaction technologies have permeated Western society and, in turn, they have entered museums, changing how visitors relate to and experience museums (Kortbek and Grønbæk 2008a; Sayre and Wetterlund 2008; Zaharias, Michael, and Chrysanthou 2013; L. Kelly 2014). Building upon the

personal context of motivations and expectations that visitors bring with them into the museum, these motivations and expectations can now also include those associated with interaction technologies. For example, it has been suggested that the pervasiveness of touch-based interaction technologies within wider society may lead museum visitors to expect any visualisation screen presented in-gallery to be capable of responding to touch-based interaction (Kidd, Ntalla, and Lyons 2011; Burmistrov 2015). The *sociocultural context* is evident in museums when visitors are faced with a range of potential social interactions associated with multi- or single-user interaction technologies. For example, studies have shown that visitors may observe others interacting with an in-gallery interactive, or they may engage with other visitors in shared interaction experiences (Heath, vom Lehn, and Osborne 2005; Kortbek and Grønbæk 2008b; Walker 2015). The impact of the *physical context* is predictably related to the physical integration of the in-gallery interaction technology into the museum environment. For example, researchers have found that the height of an interaction device or its placement along the route of an exhibition, among many other physical variables, can influence whether or not museum visitors interact with any available installations (Yalowitz and Bronnenkant 2009; Jarrier and Bourgeon-Renault 2012; Tzortzi 2014; Forrest 2015). The final element, *time*, influences the museum experiences of every individual with each consecutive visit. For example, research suggests that *time* builds the expectations a visitor might have relating to the kinds of museums where they expect to find interaction technologies, while increased exposure to interaction technologies may make visitors more confident in their decision to interact with technology in the museum context (Pallud and Monod 2010; Hunt 2013; Achiam, May, and Marandino 2014).

The Contextual Model of Learning is not the only model available that frames interpretations of the museum visitor experience within the museum context. By seeking to better understand the museum visitor experience, designer-turned-museological researcher, Tiina Roppola, identified four activities that she calls “relational processes” that are internally mediated by each museum visitor during their visit:

- *Framing* is the way visitors perceive museums and exhibits against their personal expectations or previous experiences;
- *Resonating* occurs when museum visitors feel some form of connection or relationship with the exhibition or museum environment;
- *Channelling* is the natural pathfinding or guidance museum visitors move along, through the physical exhibition space, as well as collections displays and associated content; and,
- *Broadening* takes place when the museum visitor experiences some form of personal growth gained through some kind of meaningful encounter. (Roppola 2012)

Roppola proposes these four relational processes as a framework for interpreting how museum visitors relate to the museum context, or rather, "how visitors and exhibitions find themselves in relationship with each other" (Roppola 2012, 276). Like the Contextual Model of Learning, Roppola's four relational processes considers how the context of the museum environment can influence the visitor experience, and as such, the presence of in-gallery interaction technologies within the museum context can likewise influence the relational processes. To illustrate how in-gallery interaction technology could influence the four relational processes associated with the museum visitor experience, consider the following hypothetical situation: a museum visitor may not expect to find interaction technology in the exhibition of the historical museum they are visiting (*framing* against expectations and previous experiences), yet feel compelled to interact with a touch-table on display (*resonating* towards areas of interest), and while interacting with that touch-table, exploring a range of visualisations and information related to nearby collections displays (*channelling* through the available content), this visitor gains both a greater appreciation for the collections presented in the exhibition as a result of their interaction with content accessed via the touch-table and changes their expectation for potentially encountering interaction technology in a historical museum on a future visit (*broadening* achieved through a shift in expectation and opinion) (Roppola 2012).

The four relational processes set forth by Roppola, which show how the *museum context* has the potential to influence each relational process that a museum visitor moves through during their visit, in contrast to the Contextual Model of Learning put forth by Falk and Dierking, which examines the role of the *museum context* in its own right. Critical review of each of the models acknowledges that the interconnectedness of parts within each model demonstrates the complexity inherent in the task of defining the "museum visitor experience" and each of the associated elements that have the potential to bear influence over it, including the museum context. For example, Susan B. Spero, a Museum Studies educator at John F. Kennedy University noted how Falk and Dierking's model "helps us to organize all of the variables at play in any given time in any particular institution and to offer a structure to make sense of visitor behaviours" (2013, 431). Research analyst for the Smithsonian Institution, Andrew Pekarik and Gary Shank, a professor at the School of Education in Duquesne University, acknowledged that Roppola's four relational processes are an attempt to show that museum visitor experiences "are not constituted by the components of the exhibits or the goals of the visitors, but instead by the necessary interaction between the two" (2015, 437).

Central to the museum visitor experience, yet missing from the discussion so far, is the museum visitor. Who are museum visitors? Why do they come to museums? What do museum visitors do when they get there? Though broad, these are the kinds of questions behind a great deal of visitor research within the field of museology (e.g. Coffee 2007; Dawson and Jensen 2011a, 2011b; Hanko, Lee, and Okeke 2014). Visitor studies and audience evaluation are tools that can have the potential to identify who museum visitors are and what their preferences are in relation to their museum experiences, however, determining "who" museum audiences are based on demographic data such as age, gender, ethnicity, or educational background is a contested issue among museum professionals when it leads to segmenting audiences using these categories (e.g.: Coffee 2007; Dawson and Jensen 2011a; 2011b; Werner, Hayward, and Larouche 2014). Rather than define museum visitors in this way, I apply John H. Falk's Visitor Identity-Related Motivation Model to

explore what motivates visitors to come to museums, to engage with in-gallery interaction technology, and to use or not use the associated instructions for interaction (Falk 2009, 2011).

Falk proposes that museum visitors assume one or more of the seven identity-related roles that drive their motivations relating to their museum visit, instead of dividing museum visitors into fixed groups based on sociocultural identity (Falk 2009, 2011). These roles are:

- *Explorer*: Motivated by curiosity and their interest in exploring the museum content.
- *Facilitator*: Motivated to facilitate the experiences and learning of other museum visitors within their group.
- *Professional/Hobbyist*: Motivated by feelings of personal closeness with the museum content due to their interests as a professional or hobbyist.
- *Experience Seeker*: Motivated by the perception that visiting the museum is an important experience; the museum serving as a "been there, done that" destination.
- *Recharger*: Motivated to visit the museum seeking a peaceful, reflective and/or recharging experience.
- *Respectful Pilgrim*: Motivated to visit a museum or memorial in order to pay respects to those honoured by the institution.
- *Affinity Seeker*: Motivated by a sense of personal connection or affinity to visit a particular museum, exhibition, or collection. (Falk 2009, 2011, 147–48)

Falk has faced criticism for excluding traditional demographic characteristics from his analysis of museum visitors, with detractors suggesting his method was limiting or incomplete (Dawson and Jensen 2011a, 2011b). In his defence, Falk acknowledges that museums are moving toward using more psychographic, rather than demographic, categories for defining visitors, but that his model is not intended to be used to segment museum visitors into fixed groups or meant to serve as a complete model for visitor profiling, instead serving as a tool for classifying visitors based on their motivations (Falk 2011). Within Falk's Visitor Identity-Related Motivation Model, museum visitors are not classified by a single identity-related role because visitors may have the capacity to

take on multiple roles over the course of their museum visit, depending on the varying needs of the visitor or any companions with them on their visit (Falk 2009, 2011). Through application of this model within my research, it is not my intention to pigeonhole visitors into segmented groups, but rather to use the Visitor Identity-Related Motivation Model as a tool for determining the role of motivation in a visitor's decision to engage with in-gallery interaction technology.

The potential influence of in-gallery interaction technology on these visitor identity-related motivations is, perhaps, more evident in association with some roles than others. For example, an *explorer* might feel curious to interact with an in-gallery interactive installation to see what information or content it might offer, while a *facilitator* may provide other museum visitors with some instruction or support for using an interactive installation. Alternatively, other visitor identity-related motivations may not be as easily influenced by the presence of in-gallery interaction technology, while some may even be deterred. For example, a *recharger* may find interaction technology within an exhibition space to be disruptive to the tranquil experience they desire, while a *respectful pilgrim* may similarly find the presence of an in-gallery interactive installation to be offensive or inappropriate within a memorial-type of institution.

Finally, it is important to acknowledge a small but significant terminological difference between *museum visitors* and *users*. Following the established constructivist ideology, the museological approach that I apply here focuses heavily on the *museum visitor* as an entity that museums are meant to serve or educate in some manner (Hein 1995, 1998b, 1999, 2005; Lankford 2002; Wilde and Urhahne 2008; Panasuk and Lewis 2012). I view museum visitors as dynamic, variable individuals, each bringing and taking away specific and relevant experiences relating to their museum visit. With the integration of interaction technologies into the museum context, *museum visitors* have the opportunity to become *users* of the in-gallery interaction technologies that may be available. When a museum visitor initiates interaction with an in-gallery interactive installation, he or she becomes a *user* through the act of "using" the interaction technology. This same distinction holds true within this thesis; a *museum visitor* becomes a *user* only when some form of interaction

with an in-gallery interactive installation has been attempted, but a *user* continues to be a *museum visitor* throughout their interaction experience and afterwards. Whether an attempt at interaction is perceived to be a success or failure by the *user* does not strictly matter here, rather it is the attempt at interaction that turns a *museum visitor* into a *user*.

Interaction (in the Museum Context)

Interaction has traditionally been defined as a set of reactions that occur when there is mutual influence between at least two objects (Wagner 1997; Kung-Ming and Khoon-Seng 2009). Media and communications scholar, Dongyoung Sohn builds upon this definition for *interaction* by proposing that *interactivity* relates to the *quality* of the interaction in a way that has the potential to bridge sensory, semantic, and behavioural dimensions (Sohn 2011, 1325–29). Sohn explores dimensions relating to the quality of the interaction, creating what he calls "an integrative framework to compare and evaluate interaction situations involving human actors as well as both old and new media" (Sohn 2011, 1321). The Syntactic Model of Interaction was put forth by Sohn as a tool for understanding how people perceive their interaction experience, applying sensory, semantic, and behavioural dimensions to frame interaction, whether it is related to digital media or not (Sohn 2011). He defines the following three dimensions relating to interaction quality:

- *The Sensory Dimension* is comprised of the physical environment where interaction occurs and includes the affordances within that environment that have the potential to contribute to the interaction;
- *The Semantic Dimension* relates to the recognition of the personal relevance that the interaction may have the potential to afford; and,
- *The Behavioural Dimension* is associated with the degree of control that may be exhibited in the interaction and how behaviour can influence the interaction (Sohn 2011).

In a broad sense, Sohn's model in some ways parallels Falk and Dierking's Contextual Model of Learning, wherein the *sensory dimension* puts focus on aspects of the *physical context*, the

semantic dimension of interaction relates to the *personal context*, and the *behavioural dimension* connects with elements of the *sociocultural context*. As with the Contextual Model of Learning, the Syntactic Model of Interaction attempts to provide a framework for understanding aspects of human behaviour, more specifically interaction. The Syntactic Model of Interaction, however, does not consider *context* with the same level of significance that the Contextual Model of Learning, or the research that I present within this thesis, does.

Within the wide realm of potential interactions that can occur during a museum visit, some interactions are more appropriate in the museum setting than others. For example, it is typically more appropriate for a museum visitor to look at an exhibited painting rather than attempt to touch it to feel the texture of the layered paint, although there are noted exceptions (Wecker 2015). Researchers have found that museums do not necessarily require signage to direct visitors to behave appropriately within the museum environment, as sociocultural norms generally dictate what interactions are acceptable in a given museum environment (Goulding 2000; Widdop and Cutts 2012; J. B. Schreiber et al. 2013; Forrest 2013, 2015). In their publication on interactivity and collaboration within museums, Christian Heath and Dirk vom Lehn point out that, in relation to visitor interaction with in-gallery interaction technology, there is "some variation in whether and how people use the interactive, and this can be profoundly influenced by the presence and behaviour of others who happen to be in the same area" (Heath and vom Lehn 2009, 12).The focus of my own evaluation is on two forms of museum visitor interaction: those that take place between other people, and those that take place in relation to the physical environment. More precisely, I evaluate how museum visitors interact with other people, including museum personnel and other visitors, when in the presence of in-gallery interaction technologies, but I also examine how museum visitors interact with the physical environment of the museum, especially with any in-gallery interaction technologies that may be available.

Selecting an interaction technology for integration into a museum space requires consideration for usability and Interaction Design (ID), something museums working with in-gallery

interaction technologies already recognise (Hornecker and Stifter 2006; Kortbek and Grønbæk 2008a; Ciolfi and McLoughlin 2012; Xie 2013; Germak and Khan 2017).ID lies within the field of Human-Computer Interaction (HCI) and can broadly be described as "designing interactive products to support people in their everyday and working lives […] creating user experiences that enhance and extend the way people work, communicate and interact" (Preece, Rogers, and Sharp 2002, 6). Within the context of this thesis, ID here relates to the designing of *in-gallery interaction technologies* to support *museum visitors* with their interaction experiences during their museum visit. ID incorporates a process comprising four activities, each guiding the other and repeating to the point of achieving the most optimal design (Preece, Rogers, and Sharp 2002). The first step is to establish interaction goals and determine any product requirements, which is followed by the creation of alternative design options. In the third step prototypes of the product are created, which are then evaluated with users in the fourth step, returning to any previous steps as the design process requires. According to Interaction Designers and researchers, Jennifer Preece, Yvonne Rogers, and Helen Sharp, there are three characteristics of the ID process that are complementary to the four steps:

1. There should be involvement of the target users throughout the development process;
2. Prior to commencement of the ID process, explicit usability and experience goals should be defined and documented; and,
3. It is inevitable that there will be at least one iteration of each of the four steps. (Preece, Rogers, and Sharp 2002, 13)

The ID process emphasises *usability* and *user experience goals*, calling for as many reiterations of the four steps as it takes to reach the optimal design of the product, however achieving the ID process as described may be more of an ideal than a reality, as projects are often subject to constraints relating to available budget or scheduling that influence the actual development process (Preece, Rogers, and Sharp 2002, 351). User experience goals for various products commonly include things like enjoyment, fun, entertainment, creativity, pleasing

aesthetics, emotional fulfilment, and overall satisfaction (Kaasinen et al. 2015; Preece, Rogers, and Sharp 2002). The interpretation that Preece, Rogers, and Sharpe offer proposes that "user experience goals differ from the more objective usability goals in that they are concerned with how users experience an interactive product from their perspective, rather than assessing how useful or productive a system is from its own perspective" (Preece, Rogers, and Sharp 2002, 19). As the name suggests, *user experience goals* relate to the user experience, but even professionals within HCI struggle to agree on a single, suitable definition for *user experience* for use in broad applications (Lallemand, Gronier, and Koenig 2015).

Usability, unlike user experience goals, directly relates to the functionality of an interactive product, which, with respect to this thesis, relates to functionality of in-gallery interaction technologies. To ensure a consistent interpretation of *usability* across disciplines ranging from mechanical engineering to communications, there is an ISO definition for the term, defining *usability* as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" (ISO/IEC 1998; Stewart 2009). The ISO definition links usability to effectiveness, efficiency, and user satisfaction, but the definition that Preece, Rogers, and Sharp offer includes further requirements for safety, utility, learnability, and memorability (Preece, Rogers, and Sharp 2002). Expanding on the definition for *usability* even further, HCI pioneer and usability expert Brian Shackel defines usability of an interactive system as "the capability in human functional terms to be used easily and effectively by the specified range of users, given specified training and user support, to fulfil the specified range of tasks, within the specified range of environment scenarios" (2009, 340). Although Preece, Rogers, and Sharp include learnability within their definition of *usability*, Shackel goes further to include the importance of training and user support, which is an element of usability particularly relevant to this thesis and which I explore in more depth in the third section of this chapter.

With consideration for the constructivist goals relating to museums, ID has immense potential for application within the museum sector, not only for the production of interactive

installations, but also for engineering social interactions within museums. The way ID applies a user-centred approach to afford better usability with interaction technologies naturally aligns with the visitor-centred approaches museums claim to practice, providing museums with an opportunity to take advantage of the influential nature of the museum context as a means of facilitating social interactions among visitors. The value of ID within the museum sector has already been recognised by some researchers and a small, but growing collection of publications (e.g. Hornecker and Stifter 2006; Kortbek and Grønbæk 2008a; Ciolfi and McLoughlin 2012; Xie 2013; Germak and Khan 2017). In 2008, for example, Interaction Designers Karen Johanne Kortbek and Kaj Grøbæk worked with Danish art museum, ARoS, to test and evaluate the application of ID aspects on the museum visitor experience relating to an interactive installation designed to facilitate social experiences among visitors. Kortbek and Grøbæk found that the ID principles they applied were successful in supporting communication related to the exhibited objects and in facilitating engaging interactive experiences among museum visitors (2008a, 2008b). In 2012, Human-Centred Computing scholar, Luigina Ciolfi, and Interaction Designer, Marc McLoughlin, published an article recounting their work for Bunratty Folk Park, an Irish living history museum seeking to encourage more meaningful visitor engagement through the use of interaction technologies. Ciolfi and McLoughlin report their success in creating an interactive system to support social engagement among visitors, but also acknowledge their failure to design a system that would support the interaction experiences of visitors who came to Bunratty Folk Park alone, proposing that further iterations in the ID process would yield adjustments to the design that could improve the user experience for the range of visitors who attend Bunratty Folk Park (Ciolfi and McLoughlin 2012).

Instruction (for Interaction in the Museum Context)

The following discussion explores the central subject of this thesis: instruction for interaction in the museum context. In getting to this point, I have been using the term *instruction* without much critical analysis, primarily distinguishing pedagogical instruction away from the procedural

instruction I focus on. For a more precise definition of procedural instruction, I look to the work of Engineering Psychologist, Elsa Eiriksdottir, and Experimental Psychologist Richard Catrambone, who divide their definition of *instruction* into three types, each relating to different levels of abstraction and the type of information conveyed: procedural instructions, principles, and examples.

> "*Procedural instructions* describe how to carry out the task by describing and explaining each step. *Principles* provide information about rules and regularities governing the task and task domain. *Examples* demonstrate how a single instance of the task is carried out, usually without explanations." (Eiriksdottir and Catrambone 2011, 750)

Attempting to apply this terminology to the kinds of instructions that may be found in relation to in-gallery interactive installations demonstrates that these forms of instruction are not mutually exclusive and have the potential to be combined in different ways, depending on the kinds of procedures being instructed or the learning styles preferred by the users. For example, in 2015, the Kröller-Müller Museum in Otterlo offered visitors an opportunity to try their hand at virtually reproducing portions of famous artworks in an installation called the Painting Game (Kröller-Müller Museum 2015). The instructions available to users included each of Eiriksdottir and Catrambone's three types: users were provided with the *principles* necessary for playing and offered *examples* of the artworks to be digitally reproduced within the game, as well as being offered a clear set of *procedural instructions* to sequentially guide users through the steps needed to e-mail their digital paintings to an e-mail address (Eiriksdottir and Catrambone 2011; Kröller-Müller Museum 2015). This example also highlights the connection between instruction, purpose, and motivation. In order for users to e-mail their painting, they had to have the *motivation* to seek out and follow the *instructions* that would allow them to achieve their *purpose* of e-mailing their digital creation. Detailed research into how *purpose* and *motivation* influence a user's decision to interact with an in-gallery interactive installation is not strictly within the scope of this research, however I acknowledge when users are motivated to seek out instruction to support their interaction experience.

The definition for the forms of instruction that Eiriksdottir and Catrambone offer is simply one approach to the subject of instruction that I would like to build upon by recognising the work of Lee Carroll and Eric N. Wiebe, two STEM Researchers from North Carolina State University, who consider instruction in terms of the *static* or *dynamic* characteristics of the presentation (2004). According to Carroll and Wiebe, *static* instruction is primarily text- or image-based, while *dynamic* instruction has a stronger audio-visual component and often includes audio or video (2004). Evaluating the difference between *static* and *dynamic* instructions, Carroll and Wiebe tested subjects' ability to fold three origami figures after following either *static* or *dynamic* instructions, ultimately showing how subjects who were given *dynamic* instructions were able to complete the task more efficiently, with fewer errors, and subjects were able to recall more of the instructional steps than those subjects provided with the *static* instructions (Carroll and Wiebe 2004). These results show how powerful *dynamic* instructions can be for improving user performance, but even so, the nature of the museum context has historically shown a preference for the use of *static* (and silent) presentation modes within exhibition spaces (Screven 1992; Bitgood 1996; Ravelli 1996, 2006; Whitehead 2016). In relation to in-gallery interaction technologies, however, I consider less of a strict division between *static* and *dynamic* instructional forms, and more of a spectrum within which the different instructional forms can fall. Interactive installations that employ touch-screen technology, for example, may have the capacity to present both *static* and *dynamic* forms, separately or in tandem.

In this thesis, I propose a novel approach that incorporates an interpretation of Carroll and Wiebe's definitions for *static* and *dynamic* instructional forms, in combination with a definition of instruction that is rooted within educational theory. According to the constructivist approach of educating and instructing, learning can be facilitated by either *direct* instruction, which presents complete concepts to the learner, or *indirect* instruction, wherein the learner has to determine the appropriate action based on available information that may be segmented, unstructured, or conceptual in its nature (Kirschner, Sweller, and Clark 2006; Kuhn 2007; Böttcher and Meisert 2013).

Throughout my own research, I employ a framework for defining instructions relating to in-gallery interaction technologies that pairs *direct* and *indirect* instructional forms with *static* and *dynamic* instructional forms, represented here within Figure 2.1 (Carroll and Wiebe 2004; Kirschner, Sweller, and Clark 2006; Kuhn 2007; Böttcher and Meisert 2013). I find the hybridisation of these two frameworks for defining instruction to be both relevant and suitable for application within this research, but moreover, I propose this combined framework as a means to facilitate and support discussion about instruction in relation to in-gallery interactive installations in the absence of any alternative theory relating to instruction that can be applied to a museum context.

	STATIC	**DYNAMIC**
DIRECT	*Direct-Static*	*Direct-Dynamic*
INDIRECT	*Indirect-Static*	*Indirect-Dynamic*

Figure 2.1: Framework for defining instruction associated with in-gallery interaction technologies

Of the four instructional forms that I identify, *direct-static, indirect-static, direct-dynamic*, and *indirect-dynamic*, each maintain most of their broadly defined characteristics; however, given the specific context of this research and the unique context of the museum environment within which I define these instructional forms, certain modifications are necessary. Here, I propose my own definitions for the four instructional forms relating to in-gallery interaction technologies in order to ensure a clear and consistent understanding of this critical terminology throughout this thesis.

Direct-static instructions are instructions that are made available directly to all (potential) users, but are limited to a standardised or fixed set of instructions; only the information provided is available. Within the context of this thesis, an example of *direct-static* instruction could be a small printed sign that presents a clear set of textual instructions for interaction with an in-gallery interactive. In this example, the instructions are available *directly*, without the user needing to seek

them out, but as there is no possibility for the user to get supplemental or personally-tailored instruction from the printed text, its characteristic is *static* in nature. To contrast *direct-static* instructions, ***indirect-static instructions*** require (potential) users to undertake some measure of initiative and/or interpretation to seek and to be able to follow the *static* forms of instruction that fall into this category. The *indirect* nature of an *indirect-static* form of instruction means this category can occupy something of a grey area, as it is within this category that I include things like User Interface (UI) design and the physical design of the installation context as forms of instruction that I evaluate. These instructional forms *indirectly* imply the potential for interaction, by means of suggestive imagery or context, but do not explicitly provide instructional guidance. With UI design, for example, the integration of familiar icons can inform users of potential areas of on-screen interaction, but these can still require a level of interpretation on a user's behalf to ensure the correct corresponding interaction is made. For example, a small ☒ in the top-right corner of a text window is meant to indicate where a user can touch to close the text window. For those familiar with this pervasive icon, interpreting the ☒ as a place where interaction will achieve closure of the window is natural or even expected (Archer 2014), but for those users who have little to no experience with computers or touch-based interaction technologies, the ☒ icon may be abstract or unfamiliar.

Direct-dynamic instructions are those *direct* instructions that have the potential for *dynamic* augmentation. In contrast to *static* instructional forms, and moving away from the definition of *static* instruction set forth by Carroll and Wiebe, I define *dynamic* instructions as those that can be influenced by the interactions of the user with the in-gallery interactive installation and/or other individuals, such as museum personnel or visitors. When a user experiences difficulty interacting, seeking instructional advice from a nearby museum staff member can provide this kind of *direct-dynamic* instruction to the user, based on their individual interaction needs, for example. Within this definition, I consider collaborative interaction among interacting visitors as a form of *direct-dynamic*

instruction, whereby each of the collaboratively interacting users has the capacity to instruct and inform each other during their collective interaction experience.

The final instructional form that I define here are ***indirect-dynamic instructions***, and given that this instructional form is the conceptual opposite of the preceding descriptions of other *direct* or *static* forms, I offer a supporting example. Within this research, I classify the simple and practically unconscious act of observing other visitors interacting with an in-gallery interactive installation as a form of *indirect-dynamic* instruction. When visitors observe others interacting, they are able to witness a live demonstration of how interaction works, including the possibility to observe which interactions do or do not yield a result. Using this definition, there is no *direct* contact or communication between the observing visitor and the interacting user, while the *dynamic* nature of these instructions is not determined by the observing visitor, but by the interactions of the observed user.

I use the definitions for these four instructional forms to guide my identification and classification of instructions associated with the two case study interactive installations, but I recognise that within these definitions, there is room for some debate about how to classify different kinds. Although I have provided a framework for defining instructional forms, in reality, the lines can be a little blurry between when it comes to distinguishing some instructional forms. For example, identifying an instructional form and differentiating it from others may depend on how much interpretation or communication is needed to ensure a user understands and can achieve interaction with the in-gallery interactive installation. With respect to the two case study installations and the associated instructional forms that I identify and evaluate, I include Figure 2.2, which provides examples for each instructional form that I evaluate and how I classify them.

	STATIC	DYNAMIC
DIRECT	***Direct - Static*** - Printed texts and images - Instructive attractor screens	***Direct - Dynamic*** - Museum personnel - Direct guidance from other museum visitors - Responsive systems that provide clear and immediate interaction feedback
INDIRECT	***Indirect - Static*** - Icons and symbols integrated into on-screen User Interface (UI) - Presentation and positioning of technology to suggest/infer interaction	***Indirect - Dynamic*** - Purposeful observation of other museum visitors engaging with in-gallery interaction technologies

Figure 2.2: Presentation of instruction for in-gallery interaction technologies within museums

Research and Evaluation of Instruction

The current state of research indicates that there is potential for significant contributions to be made to the field of museology, especially where it intersects with increasingly influential disciplines like Human-Computing Interaction and Interaction Design. In recent years, publications on a range of topics address museums and technology, including research into museum visitor encounters with digital collections and environments (e.g.: Wojciechowski et al. 2004; Bannon et al. 2005; Lindgren-Streicher and Reich 2007; Schmitt et al. 2010), technology-mediated learning in museums (e.g.: Knipfer et al. 2009; Kéfi and Pallud 2011; Zaharias, Michael, and Chrysanthou 2013; Feast 2014), and the potential for deploying mobile applications within museums (e.g.: Ciolfi and McLoughlin 2012; Ceipidor et al. 2013; Othman, Petrie, and Power 2013; Petrelli et al. 2013; Li and Liew 2015). With respect to research and evaluation that focuses specifically on instruction relating to interaction with in-gallery interactive installations, the current state of research reflects the limited amount of attention that instruction receives. At present, instruction is often dealt with in relation to broader usability issues associated with in-gallery interactive installation, rather than as a primary focus of evaluation efforts. Here, I present a selection of publications from recent years that show how instruction for interaction with in-gallery interactive installations has been handled and reported upon.

In 2003, Eva Hornecker and Matthias Stifter evaluated the medien.welten exhibition at the Austrian Technical Museum Vienna for use of interactives throughout the exhibition and to identify any interaction design issues (Hornecker and Stifter 2006). The researchers did not explicitly evaluate the instructions provided to visitors to inform them of how to interact with the technologies being evaluated, but their research provided insights into aspects of usability and learnability. Hornecker and Stifter acknowledged that visitors had to "figure out" how to use the in-gallery interaction technologies, relating this to visitor attention span and interaction attempts, but failed to link these observations to any available instructions (Hornecker and Stifter 2006, 138). Examining one particular interactive installation being evaluated within the exhibition, Hornecker and Stifter found that available instructions were mostly used by visitors who engaged in collaborative interaction experiences, noting that visitors "frequently went through tasks together, scaffolding each other by reading out aloud the instructions from the screen and discussing [the interaction]" (Hornecker and Stifter 2006, 140). Although the authors did not provide a detailed account of the different instructional forms available within the medien.welten exhibition, the article indicates that a range of presentation approaches were used across the different in-gallery interactives under evaluation. In particular, the authors asserted the benefit of touch-screen installations as a means for providing visibility to other visitors so that they can observe interactions of others and collaboratively engage in the available interaction experiences; a clear demonstration of *direct-dynamic* instruction (Hornecker and Stifter 2006, 142).

Computer scientists Franca Garzotto and Francesca Rizzo evaluated the visitor experience related to four interaction technologies that were offered to visitors of a temporary exhibition called *The Fire and The Mountain*, displayed at the Civic Museum of Como (Italy) in 2006. The authors noted that the in-gallery interaction technologies were designed to create immersive experiences that support group interaction among children and were evaluated for several user experience aspects, including identifying elements that supported learning, but they did not explicitly evaluate the instructions provided to guide users through their interaction experience (Garzotto and Rizzo

2007). Rather than directly analysing instructions related to any of the interactive installations, Garzotto and Rizzo noted that the kinds of technology employed can suggest or facilitate certain interactions, stating that "the shift of an interaction paradigm from an instruction-driven model (in which interaction is mediated by a textual or iconic element that expresses the meaning of the action or trigger) to a physical model is easy and natural," but that going the opposite direction can prove challenging (Garzotto and Rizzo 2007, 353). The affordances Garzotto and Rizzo recognise would be classified here as *indirect-static* instructions, as the presentation and context of the technology implies potential for interaction, but as the authors also mention use of icons, text labels, and collaborative interaction, there is evidence that other instructional forms were also used to support visitor interactions with the interactive installations.

To better understand a number of issues relating to the integration of information and communication technologies into museum exhibitions, Digital Heritage researcher Laia Pujol-Tost evaluated in-gallery interactive installations in six UK museums. She notes how museums consider the skills and motivations of their target audiences, the interaction and experience goals they define for their interactive installations, and the communications approaches museums use with their audiences during the design processes of creating in-gallery interactive installations (Pujol-Tost 2011). Pujol-Tost shows how usability issues related to interaction technologies were more often connected with UI design or missing instruction, suggesting that effective design makes use of the affordances of the museum context *and* the chosen interaction technology, leading to a more intuitive UI that could thereby reduce the need for instructional texts (Pujol-Tost 2011). Her advice for museums that may be considering integrating interaction technologies into their exhibition spaces centres on the application of *indirect-static* forms of instruction to improve the "intuitiveness of the virtual environment" without overwhelming visitors with other *direct-static* forms, like instructional texts (Pujol-Tost 2011).

Although there is a growing field of scholarship between the fields of museology, Human-Computer Interaction, and Interaction Design, among others, there continues to be little research

conducted or published on the explicit role of instruction for communicating interaction with in-gallery interactive installations to museum visitors. Broad studies in aspects relating to usability or learnability of in-gallery interaction technologies have their value, but tend to fall short of providing the kind of specific evaluation needed to more fully understand the impact that different instructional forms can have on a user interaction experience with an in-gallery interactive installation within the museum context; this is the gap of knowledge that this thesis addresses.

Chapter 3: Methodology

This thesis explores instructions for interaction that are associated with in-gallery touch-based interaction technologies through two avenues: their design and development, and how museum visitors experience them. To do this, I apply three separate but complementary evaluation methodologies; these are concisely outlined below in Figure 3.1 and described in more detail throughout this chapter.

Research Topic	Evaluation Methodology
Design and Development	Interviews with designers and museum professionals involved in the creation of instructions related to in-gallery interaction technologies.
Museum Visitor Experience	Observation of museum visitors in their interactions associated with in-gallery interaction technologies.
	Post-interaction questionnaire (with consent form) completed by willing participants after their interaction experience.

Figure 3.1: : Summary of research topics and evaluation methodologies

In order to explore the design and development processes involved in the creation of instructions for interaction, I interviewed the designers and museum professionals responsible for the development of the case study in-gallery interactive installations (Charmaz 2006; Rowley 2012; Kallio et al. 2016). Through combining the commonly used evaluation methods of museum visitor observation and post-interaction questionnaires (Sylaiou et al. 2010; Serrell 1997; Hornecker 2008; Yalowitz and Bronnenkant 2009; Bevan 2009; Zwinkels, Oudegeest, and Laterveer 2009; 2010; Sheng and Chen 2012; Gonçalves, Campos, and Sousa 2012; Zaharias, Michael, and Chrysanthou 2013; Tzortzi 2014; Forrest 2013, 2015), I investigated the behaviours and opinions that museum visitors had in relation to their interaction experiences. Following my description of the evaluation methodologies I employed, I provide an explanation of the method I used to select my two case

study installations before closing this chapter with a brief discussion about the measures I have taken to ensure my evaluation activities have been conducted in an ethical manner. I discuss the results of these evaluation activities in Chapters 4 and 5.

Evaluating Design and Development

For each case study, I interviewed key members of the development teams who contributed to the creation of the instructions for interaction. Interviews are an established evaluation approach typically used for collecting information relating to the design, development, and implementation of instructions for in-gallery interaction technologies directly from the individuals responsible for their creation (Templeton 2011; Hall 2013; Mason 2015; Underwood 2016). I employed a semi-structured interview approach, using an interview template to guide questioning through a collection of key themes I intended to cover while allowing flexibility to modify each interview based on the responses of each participant (Charmaz 2006; Rowley 2012; Kallio et al. 2016).

Interview Aims

The interview results provide qualitative data about several aspects relating to the design and development processes behind creating instructions for interaction with in-gallery interaction technologies within the museum context. The goal of each interview is ultimately to understand *how* these instructions were created and what drives the development process. I employ the use of a semi-structured interview template to guide each interview through the same lines of questioning (Rowley 2012; Kallio et al. 2016). The template for each interview includes five separate lines of questioning that address the process of designing and developing instructions for interaction. The flexibility of the semi-structured interview supports the exploratory nature of this research, allowing opportunities for gaining deeper insights by asking questions that naturally arise through the interview process, even if they are not noted on the prepared interview template (Collin-Lachaud and Passebois 2008; Rowley 2012; Kallio et al. 2016).For reference, the interview template may be found in Appendix 1: Design and Development Team Interview Template.

The first line of questioning defines the *forms* and *presentation approaches* of the instructions for interaction that museum professionals and designers employ. Instructions do not only vary in form (procedural instruction, principles of interaction, for example), but also the qualities of their presentation approach, as I propose in Chapter 2 (Carroll and Wiebe 2004; Kirschner, Sweller, and Clark 2006; Kuhn 2007; Böttcher and Meisert 2013). Referencing Table 2.2, which illustrates the different types of instruction based on their *static/dynamic* and *direct/indirect* presentation approaches, responses of the interview participants demonstrate the range of the instructions for interaction that designers and museum professionals are capable of producing.

The second line of questioning examines the step-by-step process of development: *who* was responsible *for what* and *when*. I aim to identify the moment when instructions for interaction were first considered by the design and development team, moving through the different developmental stages that the instructions evolve through, to the approval of the final design and ultimate implementation into the museum exhibition space. Using the interview responses, I have pieced together a rough timeline for the development of instructions for interaction, showing how the role of instruction fluctuates in importance throughout the development states. Identifying the roles that different team members can play during the development process, my research echoes existing literature on how the various stakeholders can influence the design and development process, as well as the final product (Bradburne 2001; Coffee 2007; Hauser et al. 2009; Walker 2015; Rutkowska et al. 2017).

In the third line of questioning, I asked interview participants about intended users, or *target audiences*, that they had in mind during the design and development of the in-gallery interaction technology and any associated instructions for interaction. I explored how the design and development team profiled and selected their target audience, defining their user characteristics and potential instructional needs (Falk 2009; Hart, Sutcliffe, and De Angeli 2013; Roussou et al. 2013; Forrest 2015; Schoemaker 2017). Interview responses show how the design and development team

members understood and dealt with interaction goals and user experience goals relating to their interactive installations, including how they tailored these goals for their target audiences.

Questions about target audience selection lead into questions about the intended user experience and interaction goals relating to use of the in-gallery interaction technology (Hall 2013; Mason 2015; Underwood 2016). Although each case study employs the same form of touch-based interaction technology, research shows that the range of possible interactions can vary and may be contingent on the defined user experience goals (Kaasinen et al. 2015; Mason 2015). Instructions may include clear interaction goals (e.g. "touch here" or "pinch to zoom"), but may also indicate user experience goals (e.g. "touch here *to learn more*" or "*learn something new* exploring our collections").

The final line of questioning explores the use of implicit and explicit knowledge during the design and development process. As an evaluation method, interviews provide an opportunity for participants to reflect upon the knowledge, experiences, or assumptions that might have influenced decisions about the forms and presentation approaches used (Hudec 2004; Rowley 2012; Mason 2015). I compare the results of the development team interviews with the results of the museum visitor evaluation to shed light on whether or not the application of codified knowledge may have influenced the user experience. Identification of effectively applied codified knowledge may help to inform best practices relating to the design and development of instructions for interaction with in-gallery interaction technologies within the museum context, just as it has with other disciplines. For example, education scholars Mohammed K. Khalil and Ihsan A. Elkhinder applied and evaluated multiple learning theories in order to determine the most effective approaches for conveying educational material within classrooms (2016), while researchers in public health led by G. Newes-Adeyi evaluated the use of an ecological model for developing a training program relating to the care of women, infants, and children in New York State (Newes-Adeyi et al. 2000; McLeroy et al. 1988).

Interview Participants and Procedure

The teams of people involved in the design and development of any in-gallery interaction technology installation vary with each project, museum, and budget. For example, projects with small or highly restricted development budgets, may limit the team to a few individuals, while larger or more complex projects may require significantly larger development teams that could include multiple external partners. In most cases, museums work with outside firms to coordinate the design, development, and installation of in-gallery interaction technologies, and as such, the development teams include a combination of both museum professionals and a range of IT and design professionals (Soren and Canadian Heritage Information Network 2005; Schokkenbroek 2013; Alexander 2014a; Huang 2014; Mason 2015).

While I have referred to development team members collectively as "designers and museum professionals" up to this point, their roles are much more diverse than this simplification implies. For example, museum professionals may include members of the curation, education, or communication departments (Soren and Canadian Heritage Information Network 2005; Goeser 2013; Mason 2015). External contributors, on the other hand, could include an even wider range of professional expertise, including interaction and User Interface (UI) designers, exhibition designers, user testing and evaluation experts, software designers and programmers, and possibly others, depending on the museum, the size of the project, and the associated budget (Heath and vom Lehn 2009; Roberts 2015).

All development team members who agreed to participate in an interview session did so with the knowledge that the entirety of the interview would be audio recorded for the purpose of this research. To support analysis of the interview responses, complete transcripts of each interview were prepared and coded to reflect the themes of this research (Atkins et al. 2008; Pattison, Ewing, and Frey 2012). All direct quotes from interview participants have been provided with their approval, provided via an approval form tailored to each interview participant (for reference, see

Appendix 2: Interview Quote Approval Form Template). Any potentially sensitive information[1] about the individual interview participants and/or the museums hosting the case studies has been redacted.

Evaluating the Museum Visitor Experience

Although museums have a long tradition of conducting visitor studies, evaluation of visitor experience with in-gallery interaction technologies is still comparatively new and, as such, best practices and standards for evaluation are still being established. As a result, I have elected to tailor my own approach to support the research aims of this thesis, drawing on two evaluation methods common to visitor research: observation and a post-interaction questionnaire (Sylaiou et al. 2010; Serrell 1997; Hornecker 2008; Yalowitz and Bronnenkant 2009; Zwinkels, Oudegeest, and Laterveer 2009; 2010; Sheng and Chen 2012; Gonçalves, Campos, and Sousa 2012; Zaharias, Michael, and Chrysanthou 2013; Tzortzi 2014; Forrest 2015). Within the field of museum studies, such tailoring of evaluation methodologies to suit the goals of the research appears to be commonplace, with certain trends predominating. In *Museums in the New Mediascape: Transmedia, Participation, Ethics*, digital media researcher Jenny Kidd argues that user evaluation of interactive interfaces tend to take place in lab-based settings, employing observation or interview techniques to collect quantitative and qualitative data, and tend to focus on aspects of usability (Kidd, Ntalla, and Lyons 2011; Kidd 2014a, 94–95; Hornecker 2008; Bevan 2009). My own research methodology improves upon this standard approach by conducting user evaluation with museum visitors within the museum context, rather than a lab-based setting, while still conforming to a traditional evaluation approach that collects both qualitative and quantitative data about the museum visitor experience. The context of the museum environment is incredibly important for understanding how museum visitors behave when

[1] In this case, "sensitive information" includes personal data, confidential financial or security information relating to the host museums, or critical remarks that could jeopardise the professional positions of the interviewees.

faced with an opportunity to engage with in-gallery interaction technology and associated instructions, and as such, this evaluation took place “in-the-wild” (Hornecker and Nicol 2012).

The combination of visitor observation and a post-interaction questionnaire ensured that I collected a combination of qualitative and quantitative data about the museum visitor experience. I observed visitors to objectively monitor the actions, behaviours, and interactions that they exhibited in relation to the in-gallery interaction technology and associated interaction instructions being evaluated (Serrell 1997, 2010; Yalowitz and Bronnenkant 2009; Bevan 2009; Zwinkels, Oudegeest, and Laterveer 2009; Kidd 2014a; Tzortzi 2014; Forrest 2015), while alternatively, the post-interaction questionnaire offered participants an opportunity to share their personal reflections on their personal interaction experience (Sylaiou et al. 2010; Sheng and Chen 2012; Gonçalves, Campos, and Sousa 2012; Forrest 2013; Zaharias, Michael, and Chrysanthou 2013; Tzortzi 2014). The collective data associated with each evaluated case study installation is analysed and discussed within Chapters 4 and 5, respectively.

Observation Aims

Observation has long been used as a method for evaluating the behaviours of museum visitors in exhibition spaces. Some of the earliest systematic observations of museum visitors were published in 1928 (Robinson, Sherman, and Curry 1928), followed by decades of subsequent methodological development that ultimately led to the development of the timing and tracking method, popularised by visitor studies specialist Beverley Serrell (Serrell 1997, 2010; Yalowitz and Bronnenkant 2009). Researchers typically use the tracking and timing methods within an exhibition space to determine how museum visitors circulate through an exhibition space and how much time is spent with each element or exhibit (Hein 1998a; Yalowitz and Bronnenkant 2009; Zwinkels, Oudegeest, and Laterveer 2009; Tzortzi 2014). The method is characterised by the selection of a visitor to be observed, followed by timed observation of that visitor’s actions as he/she moves through the exhibition space, and has been modified by researchers to observe any number of variables, including social interactions among visitors or other specific behaviours that visitors may

display within the museum context (Serrell 1997, 2010; Ryall et al. 2006; Kollmann 2007; Zwinkels, Oudegeest, and Laterveer 2009; Tzortzi 2014). I adapted this method to observe the behaviours that museum visitors displayed, tracking each on-screen interaction, as well as observing how museum visitors interacted with each other when engaging with the interaction technologies.

I observed and tracked the interactions of museum visitors to achieve three objectives relating to the aims of this thesis. Firstly, I observed *if* and *when* museum visitors elected to use interaction instructions associated with the in-gallery interaction technology. This generated data about the use or non-use of interaction instructions by museum visitors, as well as indicating the moments during the interaction experience sequence when interaction instructions may have proven most useful for the visitor. Secondly, I observed the impact of the use or non-use of interaction instructions related to the in-gallery interaction technology on the observed interaction experience of the visitor. I noted when an observed museum visitor exhibited behaviour to indicate their satisfaction or success with their interaction experience (Reeves 2011; Sohn 2011; Gonçalves, Campos, and Sousa 2012; Sillen 2015), suggesting a positive or negative effect of their decision to use or not use any available instruction for interaction. Finally, I observed the different forms of instructions for interaction that were available to museum visitors and noted which forms museum visitors elected to make use of. The data thus acquired demonstrates the preferences that museum visitors displayed for certain forms of interaction instructions, building on existing research on the museum visitor experience and providing an indication of the effectiveness of the forms of interaction instruction available (Damala et al. 2008; Hanko, Lee, and Okeke 2014; Anthony et al. 2016).

Observation Participants and Procedure

In order to avoid the Hawthorne effect, wherein recruited evaluation participants alter their behaviour due to their awareness of being a participant in an observation study (Adair 2000; Sedgwick 2012; Sedgwick and Greenwood 2015), I did not recruit museum visitors to participate in this part of the study. Instead, I employed an observation approach that was unobtrusive in order to

collect data that reflects, as much as possible, the natural interaction behaviours of museum visitors, (Serrell 1997, 2010; Falk et al. 2004; Yalowitz and Bronnenkant 2009; Sanford 2010). I used uncued observation to ensure that I did not interrupt or influence the flow of the museum visitor experience (Hauser et al. 2009; Sanford 2010; Forrest 2015), especially during moments of interaction with the in-gallery interactive installations I evaluate.

I selected museum visitors for observation based on whether they interacted with the in-gallery interaction technology, providing they appeared to be older than eighteen. This narrowed the sample of participants to intentionally exclude children and youth museum visitors. Differences in interaction behaviours between children and adult museum visitors have been noted in many studies, including several concerned with in-gallery interaction technologies (e.g.: Roussou 2004; McKnight and Fitton 2010; Rennie et al. 2010; Hornecker and Nicol 2012; van Dijk, Lingnau, and Kockelkorn 2012). While it may be likely that these user differences could extend to the use of interaction instructions, evaluating these differences are not among my research aims for this thesis. Furthermore, my decision to make use of uncued observation as an evaluation methodology prevented me from collecting the informed consent required in advance of any observation of museum visitors under eighteen years of age. Given that children and youth museum visitors naturally exist within museum exhibitions, and that research has shown that any in-gallery interaction technology holds a certain amount of appeal for youth visitors (Roussou, Oliver, and Slater 2006; Hornecker and Stifter 2006; Hornecker and Nicol 2012), I occasionally must make note of their presence in the exhibition space or in relation to adult visitors that I observe.

For each case study, I observed between 112 and 307 individual museum visitors, collecting data during observational periods spread out across the open hours of each case study museum. I collected observation data on individual visitors, but when visitors attended the museum with others, sharing their experiences with their companions or with other visitors, I made note of the social interactions visitors engaged in that may have been facilitated by the in-gallery interaction technology or any associated instructions for interaction.

As the research objectives relating to observation do not require meticulous timing of museum visitor behaviours, I adapt the tracking and timing method here to suit my particular evaluation needs, focusing primarily on tracking interaction behaviours while only timing the overall period of interaction for each observed user (Serrell 1997, 2010; Yalowitz and Bronnenkant 2009). I observed the start and end time of each participant's interaction with the in-gallery interactive installation as a measure for determining whether or not the use of interaction instructions influences the total duration of the complete interaction experience, however I did not record smaller increments of time relating to any on-screen interaction. To facilitate the tracking of museum visitors and their behaviours, I employed an observation template that included sections for observations on individual visitors, as well as a section for general or situational observances (see Appendices 3 and 6 to view the observation templates for each case study).

The templates included space for recording limited demographic observations, such as gender, estimated age, and any companions who may have been with the observed participant. Demographic data collection was limited to characteristics that could be easily collected through both observation and the post-interaction questionnaire. Following standard practice, I used a new observation template for every museum visitor that I observed to ensure each record represented the interaction experiences of an individual user who engaged in interaction (Serrell 1997, 2010; Yalowitz and Bronnenkant 2009; Moussouri and Roussos 2013). The template included lists of each possible interaction that could be made by a user, as well as detailed lists of all forms of instruction for interaction that may have been available. I tailored each list of possible interactions and instructions to each case study installation, but I also included blank spaces to allow for the observation of unexpected outcomes. In line with traditional observation techniques, I observed each participant as closely as possible, while maintaining an appropriate amount of distance to avoid any influence over interaction, to attempt to determine the sequence of interaction with the in-gallery interaction technology, explicitly noting when participants made use of any available

instructional forms during their interaction experiences (Serrell 1997, 2010; Schmitt et al. 2010; Gonçalves, Campos, and Sousa 2012; Bakker, van den Hoven, and Eggen 2015).

Post-Interaction Questionnaire Aims

To collect subjective opinions from museum visitors about their experiences interacting with the in-gallery interaction technologies I evaluate, I offered a post-interaction questionnaire to adult visitors who had experienced interaction. Like museum observation, the use of questionnaires to collect visitor opinions has a long history within museological research, and more recently related to the evaluation of in-gallery interaction technologies (e.g.: Sylaiou et al. 2010; Sheng and Chen 2012; Gonçalves, Campos, and Sousa 2012; Forrest 2013; Zaharias, Michael, and Chrysanthou 2013; Tzortzi 2014). Utilising this standard evaluation method, I employed the post-interaction questionnaire as an opportunity for participating visitors to reflect upon their interaction experience shortly after its conclusion. The purpose of the post-interaction questionnaire was to collect data exploring five themes:

1. The motivations that participating visitors had (if any) for visiting the museum and interacting with the in-gallery interaction technology;
2. The forms of instructions related to the in-gallery interaction technology that participating visitors claimed to have used during their interaction experiences;
3. Any preferences that museum visitors have relating to forms of instruction associated with in-gallery interaction technologies;
4. The perceived usability of the in-gallery interaction technology; and,
5. Any personal opinions or reflections on the experience of interacting with the in-gallery interaction technology.

The first theme provides insight into the identity-related motivations (Falk 2009, 2011) that may influence a participant's museum visit or their decision to interact with the interaction technology. My aim is to show how museum visitors who elect to interact identify themselves and

their motivations for interaction. The second and third themes address forms of instructions used during their interaction experience and the forms of instruction that users would prefer to have available with in-gallery interaction technologies. I asked participants to identify the forms of interaction they had attempted during their user experience to determine whether the use of instructions had any influence. The fourth and fifth themes focus on the ways museum visitors perceive the usability of the case study in-gallery interactive installations I evaluate, as well as offering broader opinions and reflections on the interaction experiences of the participating museum visitors. Finally, the post-interaction questionnaire serves to identify the interests of the participating museum visitors and may indicate a correlation between interest in the subject matter and duration of interaction with the case study in-gallery interactive installations.

Post-Interaction Questionnaire Participants and Procedure

The museum visitors who elected to participate in the post-interaction questionnaire agreed to do so with knowledge of the nature and purpose of the research, providing signed consent for their participation. The museum visitors who I approached about participating in the research were those whom I was able to witness interacting with the case study interactives. The questionnaire respondents were within the same sample population that I used for visitor observation; I approached only adult museum visitors, over eighteen years old, to participate in the research. Those invited to participate in this research were free to decline participation at their discretion.

The recruitment of museum visitors to participate in the questionnaire occurred within close proximity to the selected case study installations; within the exhibition space, but not so close as to create any distraction for other visitors. Recruitment only occurred after potential candidates had completed their interaction experience, ensuring each visitor who consented to participate was not influenced by the research. I did not solicit individuals to visit the museum for the express purpose of participating in this research; all candidates for participation arrived in the exhibition space of their own volition. As such, participation in this research did not influence the motives a participant

may have had for visiting the museum or their motives for interacting with the in-gallery interaction technology under evaluation.

For each case study I collected between 53 and 100 post-interaction questionnaires from individual museum visitors. As with the observational research, I offered the post-interaction questionnaire during periods spread across the open hours of each case study museum. Since participation in the post-interaction questionnaire depended on certain requirements, including age, interaction experience, and consent to participate in the research, I approached as many museum visitors who fit this evaluation criteria as possible within each post-interaction questionnaire research period. Once a visitor agreed to participate, I provided the questionnaire and waited nearby to provide any clarification or support to the participant as needed. Where multiple individuals within a pair or group of museum visitors had shared in their interaction experience and offered to participate in my research, I provided each willing participant that met the participation criteria with an opportunity to complete a questionnaire.

The front page of the post-interaction questionnaire included a standard form of consent that each participant signed prior to commencing their involvement in the research. I included information about the purpose and nature of the research, how I intended to use the results, and contact information for myself and for the Ethics Committee of the University of Amsterdam, in case any participant should wish to learn more about my research (Ethics Committee 2012; Lindeboom 2016). Each participant was required to sign and date the consent form in order to participate in the research, and each participant was free to withdraw their consent and conclude their participation in the research at any time. I did not collect any personally identifying information as part of this research and all data is anonymous. I limited the collection of demographic data to only include factors which may influence a museum visitor's motivations for visiting the museum or interacting with the case study interactive installations, such as gender, age, visitor social groupings (i.e. single visitor, pairs, groups), and ownership of a smartphone, tablet, or touch-screen computer. The demographic data collected through the post-interaction questionnaire was designed to align with

the demographic data collected through observation for comparison purposes, using an established method to show similarities or differences between data collected by observation and responses collected directly from participants (Economou 1998; Roussou 2006; Gonçalves, Campos, and Sousa 2012). Prior to analysis of the post-interaction questionnaire results, I removed all attached consent forms and provided each questionnaire with an identifying number for tracking purposes.

I restricted the post-interaction questionnaire to offer the fewest possible number of questions, employing an established strategy designed to focus the responses of the participants on only what is relevant to the research and to reduce the time required for participation (Economou 1998; Hudec 2004; Carreras and Rius 2011). In both case study museums, I offered the post-interaction questionnaire in English, as well as offering a complete Dutch translation for visitors who participated in the evaluation activities at het Scheepvaartmuseum. For the Dutch version of the post-interaction questionnaire, I worked with a native speaker to translate evaluation materials and to translate participant responses into English. The post-interaction questionnaires for the case studies can be found in Appendices 4, 5 and 7.

Although this research evaluates touch-based interaction technologies, and although there are several applications available that use this technology to support the collection of research data, I employed a traditional pencil-and-paper approach for collecting data with the post-interaction questionnaire (Fanning and McAuley 2014). I consider this to be a methodological choice, as well as a personal preference. Since this research asks participants to reflect upon specific aspects of their interaction experience with a designated interactive installation, I offered a paper questionnaire in an attempt to focus responses on their interaction experience with the evaluated interaction technology, rather than on any other potential interaction technology, even if it could support data collection. Employing a touch-screen tablet for post-interaction questionnaire collection, for example, would have required participants to engage in a wholly separate interaction experience from that which they are meant to reflect upon, potentially influencing participant responses or creating confusion about which interaction experience participants are meant to evaluate (Fanning

and McAuley 2014). Furthermore, I personally find that the input and double-checking associated with manual data entry helps create a familiarity with the data that I am not able to achieve through automated methods of data collection.

Ethical Evaluation

When conducting research that requires input from human participants, there are essential considerations that must be made to ensure the ethical integrity of the evaluation methods. In the closing section of this methodology chapter, I describe the steps taken to accomplish the described evaluation activities in an ethical manner. I follow this with a brief look at the steps I have taken to identify and avoid forms of bias in my evaluation activities and the reporting of my results. Finally, with respect to the application of my research results, I examine the necessary considerations and limitations associated with the scope and scale of the research I undertake and present.

The methodology I present here meets the standards for ethical evaluation with human participants set forth by the Faculty of Humanities at the University of Amsterdam (Ethics Committee 2012). Accordingly, the evaluation methodology and related evaluation materials were approved by the Ethics Committee prior to the commencement of the evaluation activities (Lindeboom 2016) and a complete collection of evaluation templates for each case study can be found in Appendices 1 through 7.

Identifying and Avoiding Bias

To conduct research of any kind is to risk some form or degree of bias, either in the design of the research, the manner in which it is conducted, or in the analysis and reporting of the collected data (Pannucci and Wilkins 2010). The methodology I describe in this chapter includes a number of practical measures designed to avoid potential bias, while recognising that certain forms of bias are inherent in both the methodology and the subject of this research. I audio recorded each interview and created a written transcript so that any direct quotations can be properly contextualised within the wider interview. To avoid selection bias during the observation of interacting museum visitors, I

evaluated as many visitors as possible, depending on the flow of visitors within the museum context. The most recognisable bias is also one that is entirely unavoidable within this research: the contextual bias of the museum. I conducted all research within the museum context, with museum visitors and museum staff as both participants and subjects of this research. As such, I recognise that this research may not apply to other informal learning contexts, or even to some other museum contexts. Since the subject of this research is relatively new within the cultural sector, it is not yet clear to what degree this contextual bias might apply to results relating to integrated interaction technologies in other museums or other informal learning environments. Although specific results relating to these case study installations may not directly transfer over to other presentation contexts, I acknowledge how the results can apply to broader contexts or to modes of development associated with the creation of in-gallery interactive installations, when appropriate.

Considerations and Limitations

In order to manage this research within reasonable scales of time and scope, I imposed limitations on my research that would otherwise have the potential to exponentially expand the research beyond what is possible within this single thesis. For example, the application of the methodology and results of this research are limited to the cultural sector, which also creates an inextricable contextual bias. My focus on object-based museums means that I intentionally exclude a wide range of informal learning environments from evaluation, while my focus on adult visitors means I exclude children and youth visitors from this research. Adding to this, museums are currently embracing new forms of interaction technologies that do not necessarily employ the same forms of tangible interaction I evaluate here. It may appear that I restrict and limit my research potential by the parameters that I define, but the broader issues relating to communication with museum visitors and encouraging interaction within the museum context could apply to contexts wider than those I evaluate. I do not view the parameters of the research as restrictions or limitations, but rather as potential avenues for future research.

Chapter 4: Case Study 1: *The Gibraltar Touch Table*, Het Scheepvaartmuseum

Introduction

Het Scheepvaartmuseum (HSM), also known as the National Maritime Museum of the Netherlands, is host to the first case study in-gallery interactive installation. HSM divides its collections into thematic groupings and uses narrative-rich, object-centric, or experience-based presentation styles throughout the different exhibition spaces of the museum. Throughout the various exhibition spaces of HSM, a variety of integrated interactive technologies are available for visitors to engage with, offering additional information about the collections on display, or opportunities to play games or solve puzzles. Within a more traditional, object-centric exhibition of the maritime painting collection was *the Gibraltar touch table*, the in-gallery interactive installation that is the focus of the research I present within this chapter. I examine *the Gibraltar touch table* within its exhibition context and describe the available forms of instruction intended to support the interaction experiences of visitors. I interviewed members of the development team responsible for the creation of *the Gibraltar touch table* and analysed their methods for communicating instruction for interaction with the installation to visitors through the design of the user interface (UI) and the installation context. To understand the experience of visitors who elected to interact with *the Gibraltar touch table*, I use results from both visitor observation and a post-interaction questionnaire to determine (1) the effectiveness of the available forms of instruction intended to guide the user through their interaction experience with the installation and (2) whether or not the aims set forth by the development team relating to user interaction experiences were achieved. Throughout, it is my aim to identify the ways that HSM communicated instruction for interaction with *the Gibraltar touch table* to their visitors using *static* and *dynamic* instructional forms, facilitated through the use of profiles to define and understand their target audience, the creation of an installation context

that influences user interaction, and by defining goals associated with potential user interaction experiences.

Figure 4.1: Exterior of HSM, together with replica of the East Indiaman Amsterdam (Ieremieieva 2014)

Het Scheepvaartmuseum: Profile and History

Located in central Amsterdam, HSM and its collections may be found within the building known as *'s Lands Zeemagazijn* (the Arsenal), the former storehouse of the Admiralty of Amsterdam (Het Scheepvaartmuseum 2016a). The building was originally designed by Daniel Stalpaert at the height of the Golden Age and dates from 1656, but it was not until 1973 that the building came to house the National Maritime collections, where they remain today (Het Scheepvaartmuseum 2016a).

According to the HSM website at the time this research was being conducted, the museum's mission was to show visitors how the sea has shaped Dutch culture for nearly five centuries, through the presentation of their collections in exhibits that are intended to be both stimulating and interactive (Het Scheepvaartmuseum 2017b). The collections of HSM are made up of roughly 400,000 objects divided into five major categories, each with sub-collections:

1. Ships and Technique: Collections include ship models, half-ship models, technical models, scale models, technical drawings, ship parts, and watercrafts;
2. Maritime and Decorative Arts: Collections include maritime paintings, graphics, drawings, photographs and film, ship decorations, pennants and flags, numismatics, furniture, weapons, garments, and ceramic, silver, and glass objects;
3. Souvenirs: Collections include a variety of objects classified as "everyday objects", such as tools, engines, and machinery;
4. Nautical Science: Collections include atlases, globes, maps, and instruments related to navigation; and,
5. Library: The library includes literature and publications on subjects relevant to maritime history and nautical science, as well as digital collections hosted on the Maritime Digital repository (Maritime Digital 2016).

Although this division illustrates the range of the objects within the collection, it is not indicative of *how* the museum displays and exhibits these collections to its visitors. The exhibition spaces are divided into three separate wings, each accessed through a central, glass-covered courtyard. Each wing employs a different presentation style meant to appeal to a variety of visitor interests. The West exhibition wing offers visitors a narrative-rich museum experience, with strong storytelling and gaming elements that incorporate relevant objects from the collections that are on display nearby. The Oost (East) exhibition wing, alternatively, offers a much more object-centric approach to the exhibits, whereby the collections are the focus of the comparatively traditional presentation style. The Noord (North) exhibition wing is designed to be more experience-based; for example, museum visitors can walk through the decks of a replica of the East Indiaman *Amsterdam* (Het Scheepvaartmuseum 2017a), explore the *Christiaan Brunings* steamship (Het Scheepvaartmuseum 2017f), or examine the Royal Barge, *de Koningssloep* (Het Scheepvaartmuseum 2017i). When this research was being conducted, the technological highlight of the North wing was the *Voyage at Sea*: a multi-room, interactive storytelling installation, which the museum described

as a “thrilling 25-minute virtual adventure at sea”, however this feature was removed in 2019 (Het Scheepvaartmuseum 2017c, 2019).

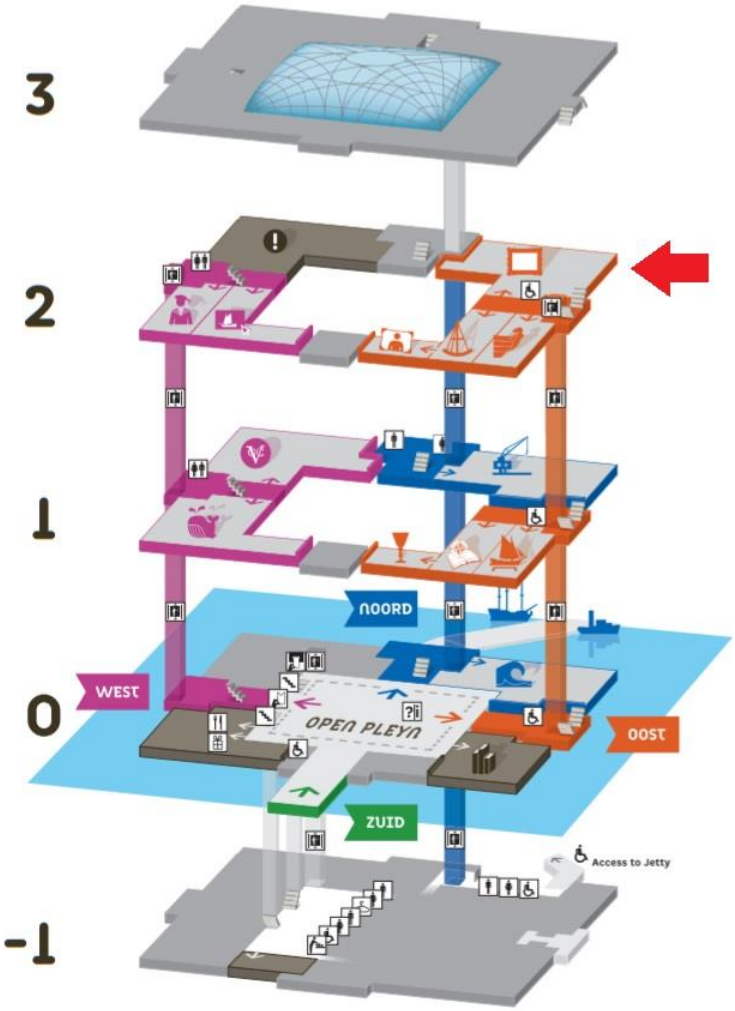


Figure 4.2: Floor plan of HSM. The location of *The Paintings* gallery in the East wing is indicated with a red arrow (Het Scheepvaartmuseum 2017c)

Between 2007 and 2011, HSM closed its doors to visitors in order to undertake significant renovations to the physical building with the intention of offering larger public spaces and better climate control for its collections, in addition to accommodating increasing visitor numbers (Het Scheepvaartmuseum 2016c). Arguably, the centrepiece of the renovation was the compass-rose glass roof over the central courtyard: a feature that cost HSM 3 million Euros from the 58 million

Euros provided by the Dutch government for the renovation (Het Scheepvaartmuseum 2016a). During this period of physical renewal, HSM also adopted an exhibition approach aimed at incorporating engaging interaction technologies into their thematic and object-oriented exhibitions (Schokkenbroek 2013).

Following the re-opening, the museum was criticised by the national funding body, De Raad voor Cultuur (The Culture Council), for prioritising its potential as a commercial entertainment venue over its role as a museum (Raad voor Cultuur 2012). This criticism was embraced by the national media when, on 25 May, 2013, a fatal shooting took place in the museum during The Amsterdam Society's "Waterfront" party, ultimately causing Mayor Eberhart van der Laan to impose a three-month restriction on renting the museum as an entertainment venue (*De Telegraaf* 2013). The fallout of the criticism from The Culture Council and the national media, together with the shooting and internal discord, culminated in a shuffling of museum staff, including the departure in 2014 of director Willem Bijlveld, who oversaw the renovation, along with a number of curatorial staff members, and finally followed by Bijlveld's replacement, Pauline Krikke, in 2015[2] (Het Scheepvaartmuseum 2014, 2015a; van Rossum et al. 2014).

Under its current management team, Michael Huijser and Vera Carasso, the outlook for the museum appears to be more stable. According to the HSM website, The Culture Council has lent its support to the plans for the direction of the museum that are being developed by the management team (Het Scheepvaartmuseum 2017e). It is not yet possible to identify the precise elements of the museum that will change to meet the standards set forth by The Culture Council, as the complete planning documents have not been made publicly available, but presumably the early statement of support from The Culture Council suggests that HSM intends to adopt an approach that puts greater emphasis on their role as a museum.

[2] Pauline Krikke left HSM in January 2016 to focus on her political career, leaving the position to be filled by Hans Gerson as interim director until the position was ultimately filled by Michael Huijser in July 2016, with the addition of Vera Carasso following in 2017 (Het Scheepvaartmuseum 2015a, 2016b, 2018).

In early 2019, the museum began taking steps towards renewing their exhibition approach once more. According to a press brief released by the museum, the redesign of the exhibition spaces will reflect a new motto recently adopted by HSM: "water connects worlds" (Het Scheepvaartmuseum 2019). While HSM continues to employ interaction technologies throughout the exhibition spaces, this renewal aims to put greater emphasis on displaying collections and highlighting the architectural features of the monumental building the museum occupies (Het Scheepvaartmuseum 2019). As a result of this most recent refurbishment, *the Gibraltar touch table* was removed from the exhibition space when its associated painting was repositioned in a new gallery[3]. Although the exhibition spaces are changing and evolving to align with a new exhibition approach, the museum that I describe and discuss throughout this chapter specifically refers to HSM as it was when this research was being carried out, in 2016 and 2017, prior to commencement of the 2019 renewal.

Digital Strategy for Interactive Exhibition Spaces

The 2007-2011 renewal period was initiated with the aim of making the building more suitable to meet the needs of a "modern" museum, prioritising interactive technologies to explore new approaches for engaging exhibition design and storytelling. HSM adopted a digital strategy that incorporates a wealth of multimedia and interactive technology elements to provide their visitors with a wide range of potential experiences. According to Linda Mol, Head of Exhibitions and Interpretation at HSM throughout the renewal period, the strategy for the exhibition spaces was to offer "*different* exhibition formats, for *different* target groups, in *different* parts of the museum building, designed by *different* exhibition design teams, creating *different* atmospheres in each of the galleries" (Mol 2013). HSM employed this strategy with the intention of offering a higher

[3] At the time of writing, HSM has not offered justification for their decision to renew the exhibition spaces, beyond that expressed in their press release relating to their new mission statement (Het Scheepvaartmuseum 2019). I refrain here from speculating about the reasoning behind the removal of *the Gibraltar touch table* or other technologies from the exhibition spaces, however it is worth acknowledging the shift HSM appears to be making away from in-gallery interactive installations and towards more traditional, object-centric displays once again.

number of variables meant to influence the museum visitor experience, providing options that could engage the variety of visitors they sought to attract. The exhibition space was intentionally divided into the experience-driven North wing, the object-centric galleries of the East wing, and the more narrative-based exhibits in the West wing, with each exhibition space designed to accommodate the needs of their associated target audience groups, which I describe below. The way that interactive technologies were meant to support this strategy is especially relevant to the research I present here, with respect to the different instructional forms that may be provided for particular user groups.

The addition of multimedia and interactive technologies into HSM exhibition spaces served as a means to two ends. Firstly, the highly visual interactive technologies were meant to bring to life the collections of the museum and the narratives related to the maritime history on display. This was particularly evident in the thematic exhibits, such as *The Tale of the Whale* exhibit in the West wing, where multiple touchscreens offered visitors an assortment of engaging games and puzzles relating to the narrative about whaling practices throughout history (Het Scheepvaartmuseum 2017j). The second way HSM used multimedia and interactive technologies was to offer visitors layered information about the collections. The depth of content that the museum offered within each exhibit varied, but the provision of interactive technologies provided visitors with an opportunity to access the available information at their own discretion. The interactive installations containing levels of informative content were especially prevalent within the object-oriented exhibition spaces, where such interactive installations were intended to serve as a means for visitors to explore available content suited to their personal interest. By layering content and by giving visitors control to choose the information or content they accessed through their interactions with a range of interactive installations, HSM aimed to offer elements in each exhibition space that met the needs of the different audiences they sought to target. For example, although *The Paintings* gallery was targeted towards an expert audience with an interest in the collections, the exhibition space also included two large touch tables and several stationary audio listening devices, going beyond the

traditional object-and-description exhibition approach (Het Scheepvaartmuseum 2017g). According to Ernst van Keulen, a member of the Education Department within HSM, “If we do it in the right way, we can help our visitors come to the Maritime Museum, not only to look at the art, but also to hear the historical stories too”, proposing that the role of technology was to support and broaden the visitor experience by providing additional information on the collections, rather than merely being a novelty added to the exhibition space in a superficial attempt to attract visitors to the museum.

While HSM also offered a number of tangible interactives that did not use any technology at all, such as the full scale, and boardable, replica of the East Indiaman *Amsterdam* that museum visitors are encouraged to explore (Figure 4.6), the museum employed a variety of interactive technologies, with touch-based interaction being the most commonly available interaction mode within HSM (Het Scheepvaartmuseum 2017a). For example, the most unique interaction experience available to HSM visitors was the *Voyage at Sea* (Figure 4.5), which combined physical interaction with multimedia storytelling in an effort to engage visitors with maritime history and provide context to the museum and its collections (Het Scheepvaartmuseum 2017l). In the *Navigational Instruments* gallery (Figure 4.3), an interactive book allowed visitors to turn the pages of a ship’s log, by means of a sensor-device placed above a physical book onto which images were projected, to hear and see the story of how the seas were navigated (Het Scheepvaartmuseum 2017d). Visitors to *The Photo Albums* exhibit were able to press physical buttons to hear audio clips of sailors relating maritime tales (Het Scheepvaartmuseum 2017h), while in *The Yacht Models*, visitors could slide a movable screen on a track around the exhibition to view information about the different ship models on display (Het Scheepvaartmuseum 2017k). Throughout the museum, touch-screens and touch tables offered visitors touch-based interactions similar to those commonly employed on smartphones or tablets, such as tap-to-select or swiping left and right. These are the kinds of interactive technologies and associated interactions that I evaluate as part of this research.

Figure 4.3: Navigational Instruments exhibit

Figure 4.4: Yacht Models exhibit (Het Scheepvaartmuseum 2017k)

Figure 4.5: The Voyage at Sea (Het Scheepvaartmuseum 2017l)

Figure 4.6: The East Indiaman *Amsterdam* (Het Scheepvaartmuseum 2017a)

Het Scheepvaartmuseum Visitor Demographics

The renewal period was an important moment for the adoption of the digital strategy employed within the exhibition spaces of the museum, but it also signalled a shift in the kinds of visitors HSM would target and the numbers of visitors who attend the museum. Prior to the renewal period, HSM saw annual visitor numbers below 200,000 per year, according to Chief Curator, Joost Schokkenbroek (2013, 156). While the renewal was meant to prepare HSM for 300,000 annual visitors, when the museum re-opened after its four-year closure, 480,000 visitors came to experience the museum in the first year of its re-imagined state (Schokkenbroek 2013, 155). Subsequent years have seen these visitor numbers decline, but HSM continues to welcome over 300,000 visitors annually (Stichting Nederlands Scheepvaartmuseum Amsterdam 2013, 2014; Het Scheepvaartmuseum 2015b).

The increase in visitor numbers is a noteworthy accomplishment for HSM, but perhaps more significant are the types of visitors who attend the renewed museum. Before re-opening in 2011, the typical HSM visitor could be described as male, around sixty years old, who is a maritime history enthusiast that seeks new information or validation of his existing knowledge (Schokkenbroek 2013,

156). The renewed museum now aimed to target three visitor groups: "the family with (grand-) children, the irregular museumgoer who could be persuaded to visit the museum through the organisation of non-museum events, and the (semi-) expert, who has a keen interest in both the individual object or artist as well as in the contextualisation of historical artefacts as part of historical phenomenons [sic]" (Schokkenbroek 2013, 156). As Mol pointed out, HSM attempted to target these visitor groups in different ways, in different exhibition spaces throughout the museum (Mol 2013). For example, *The Paintings* and *The Yacht Models* exhibitions in the Oost wing were very object-oriented and provided information targeted more towards an expert audience, while *The Tale of the Whale* and *Life on Board* exhibitions were more narrative-driven, using storytelling and gaming elements aimed at appealing to families visiting with children.

Within the HSM annual reports, visitors are only defined by the type of ticket used for entry, with tickets priced for adult, youth, or concession, as well as school groups of various levels (Stichting Nederlands Scheepvaartmuseum Amsterdam 2013, 2014). Relying on the limited description of visitors within the annual reports, it is not possible to characterise these visitors using more traditional demographic characteristics, like age, gender, or where a visitor is from. However, HSM employs an external research and strategy company, *Motivaction*[4], to regularly conduct visitor research within the museum to gain a better understanding of who their visitors are and how best to reach their target audiences. *Motivaction* conducts on-site visitor research several times each year, providing results to the museum that are used to classify visitors into predetermined visitor types, known as *personas*, which the museum uses as guidelines to design for their target audience groups within different exhibition spaces. The concept of *personas* is common in the fields of marketing and user-centred design, where knowledge of potential target audiences or users is critical for

[4] *Motivaction* brands itself as an "independent research and consultancy agency" that conducts a range of research activities into "values, motives, and lifestyles of people and organizations", extending into a variety of sectors and disciplines (Motivaction International 2018a). Within the cultural sector of the Netherlands, audience targeting and application of the *personas* approach is particularly popular, having been employed by museums such as the Van Gogh Museum (Van Gogh Museum 2017, 68; Motivaction International 2018c), Rijksmuseum Boerhaave (Rijksmuseum Boerhaave 2017; Motivaction International 2018b), and the Nederlands Openluchtmuseum (Nederlands Openluchtmuseum 2013, 12).

successfully meeting their needs, but more recently *personas* are being used by museums to attempt to understand their audiences and to tailor exhibition design and content to their needs (Rutkowska et al. 2017; Cabrero, Winschiers-Theophilus, and Abdelnour-Nocera 2016; Mara and Mara 2015; Hart, Sutcliffe, and De Angeli 2013; Roussou et al. 2013; Pender and Lamas 2013; Templeton 2011).

Based on the findings of the visitor research carried out by *Motivaction*, HSM classify their visitors into three dominant *personas*. Each *persona* is given a name to identify a group of visitors who share a similar set of characteristic traits and behaviours that may influence their visitor experience. Each *persona* includes detailed descriptions of each visitor type, which I paraphrase here based on responses provided by the interviewed development team members. "Dick" visitors are typically older, well-educated male visitors who have a particular interest in the maritime history surrounding the collections, but will not necessarily engage with any in-gallery interactive installations. "Simone" visitors are most often considered to be female adults, moderately educated, who visit the museum with others, typically their children, and who will interact with in-gallery interactive installations to support the visitor experiences of their companions. Finally, "Mickey" visitors are typically young adults who are well-educated, with an interest in visiting cultural exhibitions and events, and who feel comfortable engaging with in-gallery interactive installations. Depending on the wing or gallery within the museum, different *personas* were used as a way to define the target audiences that guide the exhibition design or content accessibility. For example, the West wing included elements directed more towards "Simone" visitor-types, while the more traditional approach used in the East wing included elements that may be more suitable for "Dick" visitor-types.

Defining museum visitors using the *personas* and designing the exhibitions to target visitors who fit within one *persona* group or another can have both risks and benefits. While the *persona* groups may be a useful tool for HSM to guide the development and design of exhibitions, interactive installations, and even marketing content, it is important to note that HSM uses these *persona*

groups merely as guidelines for understanding their broad visitor types. According to van Keulen, the *personas* are not used as a steadfast framework for classifying *all* of the visitors who come into the museum into the narrow visitor descriptions that accompany each *persona* group. Similar to visitor demographics based on age, gender, or cultural background, *personas* may likewise reduce visitors into target groups that are too restrictive for the actual range of visitor types they claim to represent (Lewalter et al. 2015). It is possible that visitors may not fit into any of the target *persona* groups, or perhaps may identify with multiple *personas*, which could influence how these visitors experience the museum during their visit. While visitors who neatly fit within one of the defined *personas* may be able to easily locate the exhibitions within HSM designed for their particular target *persona* group, entering a space designed for a contrasting *persona* may not yield the kind of engaging museum experience HSM intended.

Figure 4.7: The installation context of *the Gibraltar touch table* within *the Paintings* gallery

Case Study Installation: *The Gibraltar Touch Table*

Although HSM offers many interactive installations throughout the museum, the installation that I evaluate here is a large touch table associated with the Cornelis Claesz. van Wieringen painting, “The Battle of Gibraltar” (1622); henceforth, I refer to this installation as *the Gibraltar*

touch table. Although it was removed from the permanent exhibition in the renewal of 2019 (Het Scheepvaartmuseum 2019), *The Gibraltar touch table* offered visitors additional information related to the van Wieringen painting in an interactive manner. By selecting different information points on the touch table, referred to here as target spots, users could access short text panels that explain significant elements of the painting. For example, selection of the target spot next to the sailors retrieving the Dutch flag from the water explained the actions being depicted in the painting and their symbolic importance, while selection of a target spot over an image of burning sails explained the risks associated with on-board fires during a naval battle. According to exhibition curator, Saskia Oranje, the purpose of interaction with the target spots on the touch table "is purely to gain information … a stimulation to watch more closely to the painting, to understand what it is about." Each information window would provide users with a close-up image of the relevant portion of the painting selected, in addition to the short informational texts limited to a few sentences in length. The information offered via the target spots ranged from historical content relating to the specific battle depicted in the van Wieringen painting, to explanation of the symbolic imagery depicted in the painting, to more general information about the Dutch navy and its role in naval conquest. As *the Gibraltar touch table* was meant to offer visitors an opportunity to access curated information provided within the interactive installation, HSM presumably aimed to make this information as easy to access as possible for the visitor, in terms of both the accessibility of the language used in the available texts and with respect to the simplicity of the interaction required to access the information. That said, however, it is not within the scope of this research to comment on the quality of the informational content available or its role within the historical narrative associated with the van Wieringen painting that HSM offers.

The Gibraltar touch table was installed in *The Paintings* gallery, directly inside of the doors that provided entry to the exhibition space; it was one of the first things visitors would see upon entering the room. The van Wieringen painting and *the Gibraltar touch table* were located next to one another, allowing visitors an opportunity to view the original painting and interact with the

touch table to access the available information about the scenes depicted in the painting within the same field of view.

Figure 4.8: *The Gibraltar touch table*, in front of "The Battle of Gibraltar" by Cornelis Claesz. van Wieringen (1622)

The installation context of *the Gibraltar touch table* is significant for this research, as it had the potential to influence the visitor interaction experience with the installation, including the use or non-use of instructions for interaction. *The Paintings* gallery was situated on the second level of the East wing, so for many visitors, it was not the first exhibition space they entered when visiting the museum. With several alternative interactive experiences on offer in each exhibition space within the museum, visitors were likely to encounter other interactive installations prior to their encounter with *the Gibraltar touch table*. These two factors of the installation context may contribute to whether or not a visitor would make the decision to interact with an interactive installation. For example, if a visitor had already engaged with several other touch-based interaction technologies, interaction with another installation may seem easy to achieve and motivate interaction. Alternatively, another visitor may feel fatigued by their visit and lack the personal motivation to engage with any further interaction technologies during their visit. I recognise that the museum context plays a role in influencing visitor behaviour, especially interaction behaviours, but identifying and evaluating the precise factors that may influence whether a visitor decides to interact with an

in-gallery interaction technology or not is outside of the scope of this particular research. Instead, this research focuses on museum visitors who elected to engage with *the Gibraltar touch table*, looking at their interaction behaviours and use or non-use of related instructions for interaction, noting the influence of the installation context when relevant to any evaluation results.

The Gibraltar touch table was a free-standing interactive touch table with a 55" (138.8 cm), 1080p HD display and a 2-point optically-driven touch-based interaction overlay, installed into a table-style housing specifically designed for the installation (van Keulen, Oranje, and Kiss the Frog 2017). Hidden within the table, and accessible via a small, locked service latch, was a Windows PC that ran the application software, written in ActionScript 3/Adobe AIR (van Keulen, Oranje, and Kiss the Frog 2017).

In the interviews with members of the development team, each noted different benefits of using touch-based interaction with *the Gibraltar touch table*, including the ubiquitousness of touch-screen technology in wider society, the relatively low cost of development and maintenance, and the simplicity of the technology, in that interaction does not require additional input devices, such as a mouse or keyboard. Although technical specifications relating to the software and hardware of *the Gibraltar touch table* may not seem directly relevant to the visitor-based research I present here, the technology selected and employed by the development team is intrinsically linked with the presentation of the final interactive installation and, therefore, the interactive experiences that visitors had with it.

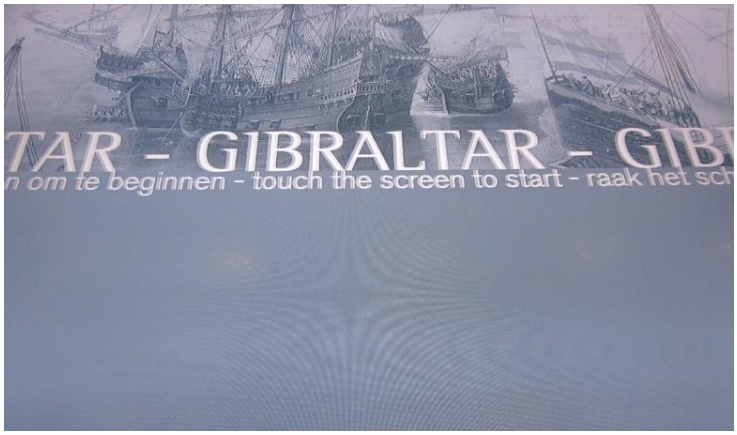


Figure 4.9: The "Touch to Start" attractor screen

According to the development team responsible for designing and implementing *the Gibraltar touch table*, the on-screen UI was intended to be clean and simple, relying on familiar icons to support user interactions with, what is meant to be, an intuitive interface. Prior to any user interaction, the touch table displayed an attractor screen that offered a single line of instruction, scrolling across the screen from left to right, alternating between Dutch and English translations of the same phrase: “touch the screen to start” (Figure 4.9). Once a user initiated interaction, a visual reproduction of the van Wieringen painting would appear on-screen, displaying fourteen separate target spots, or “hot spots”, to indicate where additional content may be accessed. It is important to note that the complete van Wieringen painting was not visible on-screen at any time, as the painting is physically larger than the dimensions of the touch table screen could accommodate. Therefore, users had to drag the on-screen image to the left or right in order to view the complete image and access all of the target spots; the reasoning behind the selection of a touch table screen that could not fit the dimensions of the full van Wieringen painting was not offered by any member of the development team. When a user would select a target spot, a text-based window appeared on-screen, superimposed over the primary image of the van Wieringen painting. A close-up portion of the painting was framed within the text-based information window, offering a closer look at the details of the painting to which the text referred. In addition to the on-screen target spots, in the top right corner of the screen, users had the possibility to select NL or EN to switch between Dutch or English languages. Finally, a small information ⓘ icon offered additional instructions for interacting with *the Gibraltar touch table*; details of this instruction panel are described in greater length below.

The installation made use of single-input touch-based interaction technology, rather than multi-touch interaction technology. This means that the installation would only respond to a single source of input at a time, limiting interactivity to either “tap to select” for opening or closing target spots and text windows, or “hold and drag” to pan the on-screen image to the left or right. This differs from the multi-touch interaction available on most commercially available smartphones and tablets, which allow users to make interactions like “pinch to zoom” that require multi-touch input

of two or more fingers to execute the interaction. Without multi-touch interaction technology, interaction with *the Gibraltar touch table* could only accommodate the interactions of a single user at a time, and only single-input from the sole interacting user. Although the large size of the touch table and its central positioning in the room allowed multiple users to view the on-screen content, control of the interactions was ultimately guided by the interactions of an individual user making single-input interactions.

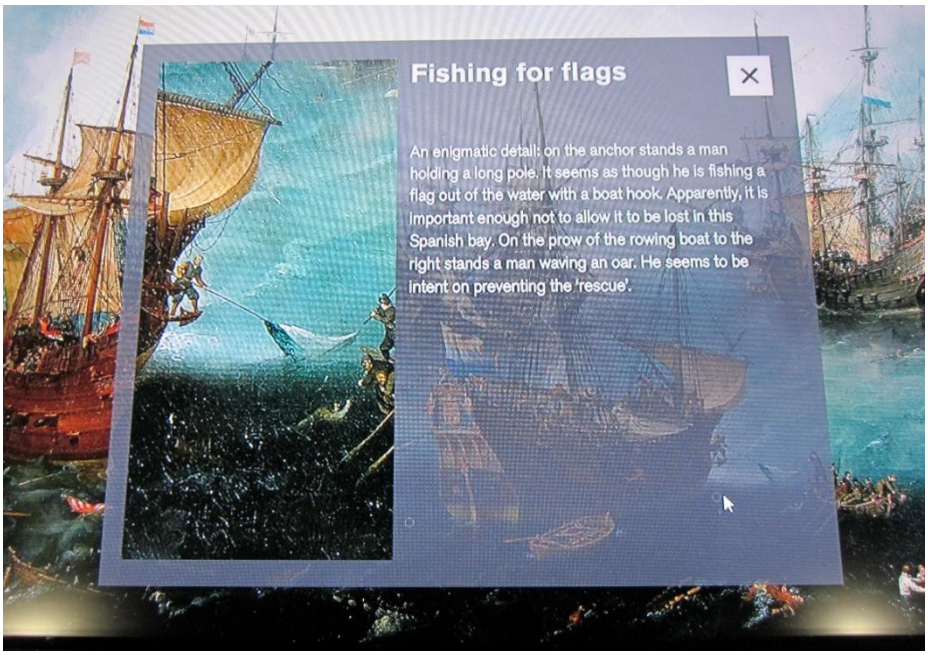


Figure 4.10: Text window of a selected target spot

The interaction experience with *the Gibraltar touch table* was non-linear, meaning that users were able to interact with as many or as few of the target spots as they choose and there was no intended sequence for which target spot should be selected and when. According to Oranje, visitor interaction with the touch table was not a necessary component of the visitor experience to *The Paintings* gallery, but rather an option for visitors to engage with at their own discretion. As she says, "we realised that not everyone would use the touch table, but watching someone else do it, that is also very nice. You can stand around it with a lot of people, that's why it is so huge." Visitors were able to approach the touch table at their leisure, before or after viewing the van Wieringen painting, or were able to move through T*he Paintings* gallery without ever interacting with the touch table,

instead perhaps watching other visitors interact and viewing the selected on-screen content, or maybe choosing not to pay any attention to the touch table at all.

Forms of Instruction Associated with *the Gibraltar Touch Table*

Here I describe the forms of instruction associated with *the Gibraltar touch table* using the four forms of instructions defined in Chapter 2; *Direct-Static, Indirect-Static, Direct-Dynamic,* and *Indirect-Dynamic*.

***Direct – Static**: The "Touch to Start" Screen*

Integrated into the UI was an attractor screen, designed and implemented with the intention of drawing visitors into interactions with *the Gibraltar touch table* through the provision of a scrolling text, which alternated between Dutch and English, offering the same instruction: "Touch the screen to start" (see Figure 4.9 above). The attractor screen only appeared when interaction with *the Gibraltar touch table* had been suspended for over 90 seconds and disappeared as soon as a user would initiate their interaction experience. As a result, when *The Paintings* gallery was busy and several consecutive visitors interacted with the touch table, it may not have been enough of a break between visitor interactions to initiate the attractor screen, effectively limiting the availability of this instructional form to visitors.

Although the attractor screen may not have been seen by all potential users, the nature of the instruction it provided was both *direct* and *static*. The instruction was plainly stated for those visitors who had the opportunity to see the attractor screen: "Touch to Start." For those visitors who initiated their interaction experience before 90 seconds had passed after the preceding user, this instructional form was not available to them. Once a visitor touched the screen and began their interaction experience, a subsequent text window appeared that explained the connection between the touch table and the van Wieringen painting, encouraging the user to explore the image of the painting on the touch table to learn more.

***Indirect – Static**: Instruction ⓘ and UI*

The UI included a small ⓘ instruction icon in the upper right corner of the touch table screen that, when selected, offered users a small window containing a limited set of two instructions for interaction: “Drag your finger to move” and “Tap to select.” Each instruction was accompanied by a small illustration that depicted the suggested interactions, prefaced by the question, “How does it work?” (See Figure 4.11 below). The ⓘ instruction option was the only form of instruction that provided complete information about how interaction worked and the possible interactions that users could make with the installation. Furthermore, it was the only form of instruction that was available to absolutely all users who chose to interact with *the Gibraltar touch table*. While the ⓘ instruction icon remained on-screen as a fixed element of the UI design, whether or not a user made the decision to access the instructional information it offers is what makes this particular form of instruction *indirect.* The use of the ⓘ instruction icon also required users to properly interpret this icon as a source of instruction, rather than as a source of information about the interactive touch table or the van Wieringen painting it displays.

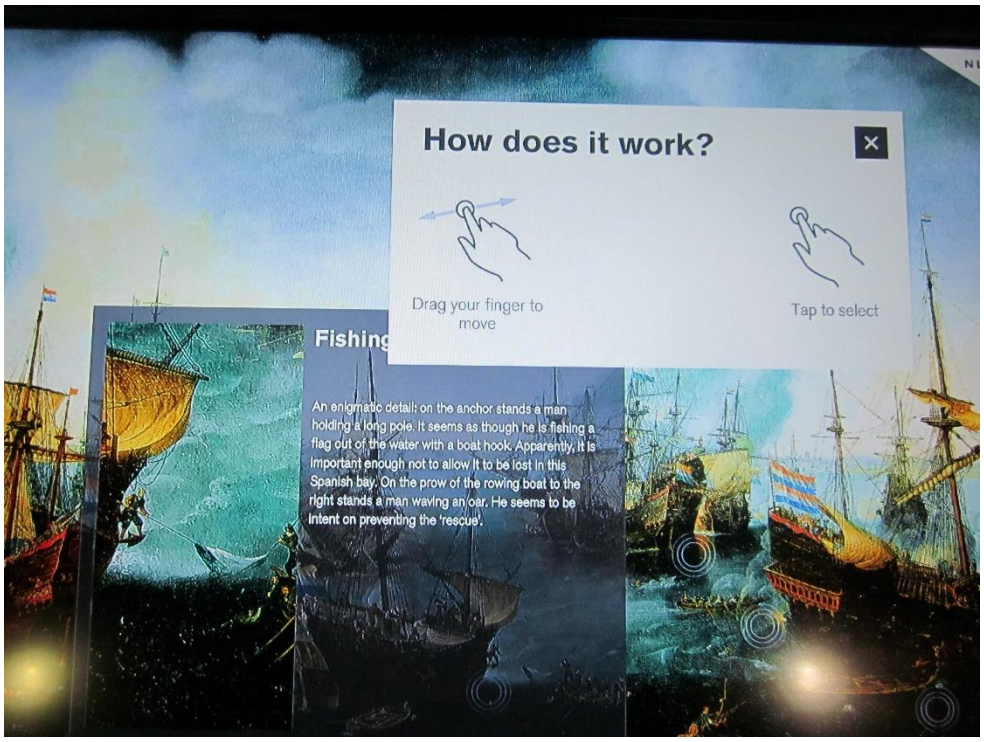


Figure 4.11: Instructions available through selection of the ⓘ

The UI included icons that were meant to help instruct users through their interaction experience with *the Gibraltar touch table*, including the familiar ☒ to close icon, found in the upper right-hand corner of text windows, and the ⓘ instruction icon described above. By relying on icons familiar to those who have experience interacting with computers, these integrated design elements could help to guide users through their interaction experience. The use of these icons relied on the assumption that users would be familiar with the icons and their function; this assumption may not have been accurate for all users who interacted with *the Gibraltar touch table*. I categorise the UI as *indirect* instruction due to the interpretation required to connect the on-screen UI with the interactions or outcomes that the UI elements may be associated with. For example, ☒ *indirectly* suggests that touching it will close the text window, but does not instruct this interaction as *directly* as a button that reads "Touch to Close" would.

Direct – Dynamic: *Collaborative Interaction and Advice from Other Visitors or Museum Staff*

The *direct-dynamic* instructions for *the Gibraltar touch table* may[5] have been available from three potential sources: collaborative interaction with other visitors, advice from other visitors, or advice from museum staff. The design of the touch table and its installation context were intended to support visitor-to-visitor collaboration, with one another and with the touch table. As a way of supporting the interaction experience with the touch table, collaborative interaction with other visitors allowed multiple users to work together through their interaction experience, learning from each other and the interactions that were or were not successful. Visitors who participated in collaborative interaction could work together to achieve interaction success, but this *direct-dynamic* instruction very rarely occurred outside of the user's visiting group.

Advice may also have been provided by other visitors who had experience interacting with *the Gibraltar touch table*, or possibly by HSM staff members. This form of instruction not only

[5] I say *may* here due to the *dynamic* nature of the instructions: depending on the availability of visitors or museum staff within close proximity to the in-gallery interactive installation, this *dynamic* form of instruction *may* or *may not* have been available for visitors to make use of, even if the development team had designed an installation context to facilitate these kinds of *dynamic*, interpersonal instructions,

required the availability of other visitors who have interaction experience, it required social interaction among visitors. Similarly, a museum staff member had to be present in *The Paintings* gallery offering instruction for interaction, otherwise this form of instruction was not available to visitors. In the case of HSM, staff members typically entered *The Paintings* gallery as guides for tour groups, limiting the availability of this instructional form to most other visitors. During gallery tours, staff members would use the touch table as a source of information during their presentation of the van Wieringen painting, effectively demonstrating the available interactions as part of the tour, but when the tour group would move on, it was not always possible for members of the group to attempt their own interaction experience without losing track of their tour group.

Indirect – Dynamic: *Watching Other Visitors*

When visitors watched other visitors interacting with *the Gibraltar touch table*, they may have indirectly made use of the *dynamic* experiences had by the interacting visitors through their observations. The museum, as a stakeholder in the design of the interaction experience, supported this form of instruction through the open design of the installation context, but because this form of instruction is based on human behaviours, the museum had little control over *when* observation of other interacting visitors occurs and *what* interactions may have been observed.

Not all visitors elected to watch other interacting visitors prior to initiating their own interaction experience. For some visitors, particularly those who visited the gallery during quieter periods, the opportunity to watch other interacting visitors may not even have presented itself. For visitors who would intentionally watch other interacting visitors prior to making their first interaction, there was no way to ensure consistency of what was being observed; some users may not have made use of all possible interactions, misguiding later users about what interactions may be possible. These characteristics are what make watching other visitors as a form of instruction both *indirect* and *dynamic*.

Figure 4.12: *The Gibraltar touch table* within *The Paintings* gallery

Results of Evaluation

Here, I lay out the results from my evaluation of *the Gibraltar touch table*. I begin by introducing the development team members responsible for the creation of *the Gibraltar touch table*, defining their roles in the development process. My analysis of the responses collected from the interviews with the development team members indicates their goals for the in-gallery interactive installation and offers insight into the development process. I follow this discussion by presenting the visitor evaluation results, beginning with an introduction of the demographic data relating to the visitors who participated in the two evaluation methodologies I conducted: on-site observation periods and post-interaction questionnaires. I present results from the combined evaluation efforts, described in Chapter 3, and offer my analysis of the impact that the different instructional forms had on the visitor interaction experience with *the Gibraltar touch table*.

Development Team Interviews and Analysis

The internal team was made up of members from the education and curatorial departments. Since HSM offers a wide variety of in-gallery touch-based interactive technologies spread throughout

the different exhibition spaces of the museum, they contracted a single development company, *Kiss the Frog*, to ensure that consistent UI and interaction design elements could be employed throughout, to create continuity and facilitate a "learning by experience" approach to interaction as visitors move from one interactive installation to the next.[6]

Ernst van Keulen, *Education Department, het Scheepvaartmuseum* is responsible for ensuring visitors to the museum are able to easily explore the collections and access any available, relevant educational information they desire. [7] As a member of the team responsible for the renewal of the museum from 2007 to 2011, van Keulen supported the adoption of interactive technologies in the permanent exhibition space as a means to engage visitors with the educational content that the collections have to offer. His role in the development of *the Gibraltar touch table* was to coordinate the educational content and ensure the usability of the interactive technology for a range of museum audiences.

Saskia Oranje, *Exhibition Curator, het Scheepvaartmuseum* worked as an Exhibition Curator for HSM from 2004, but left in 2017 to take a position as the Head of Research and Presentation for the Nationaal Archief. She was responsible for translating the scientific information held with the collections of HSM into content appropriate for the different audiences drawn to the museum. [8] At HSM, she worked with curators of the various collections departments and members of the Education Department to determine the most suitable means to convey the information relevant to the target audiences for each exhibition wing. During the renewal of the museum, Oranje was an advocate for the use of interactive technologies throughout the different galleries. She had a central role in the development of *the Gibraltar touch table*, coordinating the concept with curators,

[6] *Kiss the Frog* was the primary design agency responsible for producing the in-gallery interactive technology installations throughout the entire HSM during its 2007-2011 renewal period.
[7] My interview with van Keulen took place in a meeting room of HSM between 16:00 and 17:00 on Wednesday, 7 September, 2016.
[8] My interview with Oranje took place in the café of HSM, Restaurant Stalpaert, between 10:00 and 11:15 on Wednesday, 20 July, 2016.

designers, and the technical development team to achieve the final installation as it appeared during my evaluation within *The Paintings* gallery.

Remco Molenaar, *Project Leader, Kiss the Frog* served as Project Leader for the 18 multi-media installations that the company contributed to the museum renewal, including *the Gibraltar touch table*.[9] Molenaar has extensive experience creating in-gallery interactive installations for museum contexts both within the Netherlands and internationally, and leading the technical development team. In this role, he is responsible for communicating the needs of the museum to the technical team that designs and programs the interactive installations. With respect to the development of *the Gibraltar touch table*, his role was to work with the museum to create a concept for an interactive installation that would offer visitors an additional layer of information related to the van Wieringen painting. Molenaar oversaw the development of the interaction and UI design of *the Gibraltar touch table* to ensure the final installation provided visitors with an opportunity to easily interact with the informational layer.

Despite using the same interview template for each interview conducted, participant responses varied and naturally influenced the flow and line of questioning; as such, it was not always possible or useful to follow the template in a rigorous manner. Ultimately, the interview template provided a guideline for questioning throughout each interview. The interview template concentrates on five areas of questioning: general project development, target audiences, interaction design, instructions for user interaction, and application of codified knowledge in the final installation. In the discussion I offer here, I re-frame the interview responses using five categories that are more complementary to the responses offered by the interview participants: target audiences and target users, the installation context, the intended interaction or user

[9] My interview with Molenaar took place in a meeting room at the *Kiss the Frog* offices, between 10:00 and 11:30 on Tuesday, 23 August, 2016.

experience, the design and implementation of instructions for interaction, and user testing and evaluation.

Target Audiences and Target Users

Each of the members of the development team responsible for *the Gibraltar touch table* commented on the importance of the audience, the potential users of their installation, in the design and development process. Using the visitor research conducted by *Motivaction* and the three *persona* visitor groups HSM uses as guidelines for audience targeting, the development team were able to direct the design of *the Gibraltar touch table* to align with the specific *persona* defined for *The Paintings* gallery; the "Dick" visitor type. Oranje and van Keulen both acknowledge that the use of the "Dick" visitor type led the development team to a more traditional, object-centric exhibition approach, with less emphasis on interactive technologies and a greater focus on the display of collections. Broadly characterised as older, well-educated males with an interest in maritime history, the "Dick" visitor types may not necessarily engage with in-gallery interactive installations, hence there were far fewer interactive options within *The Paintings* gallery than in other areas of HSM. Within the available interactives, their aim was to keep the UI and interaction design simple. The focus of the development team was to create a simple interaction experience for the visitor, and to provide visitors with an opportunity to access an additional information layer about the van Wieringen painting – the primary purpose of *the Gibraltar touch table* as an in-gallery interactive installation.

While members of the development team suspected that some museum visitors may interact with *the Gibraltar touch table* simply because of the availability of the in-gallery interaction technology in *The Paintings* gallery, they also recognised that the opportunity to interact with the in-gallery technology may not be reason enough for the "Dick" visitor-types to interact. Since the "Dick" visitor type is characterised by an interest in maritime history, *the Gibraltar touch table* is a resource for additional details about the van Wieringen painting. As Molenaar says, "The [technical] setup is not something added, like 'Let's have a touch-screen in the exhibit as well.' No, it is actually

a source of information." According to van Keulen, this approach could add a new dimension for visitors most attracted by the aesthetic appeal of the collections, providing an opportunity to connect the artworks with their associated historical stories. The development team simplified the UI and interaction design to ensure the installation could be easily used by their target audience, as well as other users within the wider spectrum of visitor types.

By dividing the entire museum into different wings and galleries, each with their own targeted audience, HSM takes a unique approach to the "everything for everyone" trap that some museums fall into with their exhibition design. The *personas* they define may be broad enough to describe certain visitors to HSM, and they have proven useful as a tool throughout the design process of the renewal, but the development team recognises that their museum visitors are rarely so easily classified. For van Keulen, Falk's work related to visitor identity-related motivations (Falk 2009, 2011) has helped with his personal understanding of how visitors behave in the museum, saying, "For me, Falk helps me to understand what people do. And it helps our understanding of why things are successful and other things aren't." Ultimately, the members of the development team each acknowledged that visitors who fall within the "Dick" visitor *persona* are the target audience of *The Paintings* gallery, and to some extent, are the target users for *the Gibraltar touch table*; however, they also recognised the need to offer an in-gallery interactive installation that could appeal to wider audiences.

Understanding the identity of HSM visitors is not as cut-and-dried as their definitions of the *personas* are and requires some measure of flexibility in their interpretation and application. Reflecting upon the use of the *personas* in the development process, van Keulen remarked that "We think about them, and after a while, we found out that 'Dick' also has children, and then [the definition of the *persona*] starts to change a little bit. It is exactly what Falk tells us. He says that you have your own identity, you are a person, but you wake up in the morning and you are not going to start your day because you have an identity, you start your day doing things because you have [motivations and responsibilities]. You are still you, but here we have to behave different and we

have to make different choices; we have to shift." For van Keulen, the *personas* are a tool for broadly classifying visitors, rather than a precise method of categorising each and every visitor. Instead, he prefers to combine the prescribed *personas* with the theories of Falk to acknowledge that visitors are not so easily classified by their age, interests, or ethnicity, but rather that visitors are motivated by a multitude of factors, internal and external, that guide their behaviours within the museum (Falk 2006, 2008, 2009, 2011). In acknowledging this, van Keulen's opinions about the use of *personas* by HSM and his consideration of Falk's theories align with many of the criticisms of Falk's work, which tend to focus on how segmenting visitors into types or identities may be too reductionist, and which call for broader, more flexible categorisations of visitors that requires a more contextualised model for visitor research (Bickford 2010; Christidou 2010; Dawson and Jensen 2011b; McCray 2010; Tinworth 2011). *If* all users should be able to easily use the interactive installation, *then* the importance of designing to meet the needs of a particular *persona* group seems somewhat irrelevant to the design process relating to usability of the interactive installation.

Installation Context

Although *the Gibraltar touch table* was centred within the first exhibition space of *The Paintings* gallery, prominently placed in front of the van Wieringen painting with which it is associated, the development team viewed the interactive installation as a supplement to the more traditional museum visitor experience; visitors could enjoy *The Paintings* gallery even if they choose not to interact. Concerning the visitors who do choose to interact, the development team had realistic expectations for the range of interaction experiences that different visitors may have. As Oranje suggests, "If they touch only three [target] spots, it is OK. If they touch one, it is OK, or if they touch ten or two." The non-linear design of the content allowed users to access as many or as few target spots as they desire, providing the opportunity to interact for as little or as much time as they like. The size of the touch table and its positioning in the room also allowed visitors to *The Paintings* gallery to benefit from the on-screen content without having to interact, or they could easily move past the touch table altogether. For HSM and the development team members, this in-gallery

interactive installation offered their visitors an *opportunity* to access a deeper level of information about the van Wieringen painting, ideally without disrupting the visitor experience for those visitors who may not wish to engage with the technology.

The installation context of *the Gibraltar touch table* was incredibly important for encouraging or influencing interaction by visitors. The physical environment of *The Paintings* gallery was much more reserved, much more traditional than other parts of the museum; here, objects were on display behind a barrier and physical interaction with the exhibition environment was largely forbidden, with limited exceptions. *The Gibraltar touch table* was one such exception, whereby visitors were encouraged to touch the interactive touch-screen and explore the on-screen representation of the van Wieringen painting. The proximity of the touch table to the painting was an important aspect of the complete installation, as it allowed users to easily compare the on-screen visuals to the real painting, just by looking up; a deliberate feature of the design, according to the development team. The proximity of the touch table to the painting was even more remarkable shortly after the re-opening, when selection of an on-screen target spot would trigger adjustments in the lighting of the van Wieringen painting. Oranje and van Keulen both acknowledged that the lighting shift, though impressive, was disruptive for other visitors looking at the painting, so the museum elected to disable this feature. Even without this lighting feature, the proximity of *the Gibraltar touch table* to the van Wieringen painting created an intentionally close connection between the painting and the on-screen information.

The responses of the development team demonstrated an understanding that the installation context influenced the associated social context of an exhibition space, especially when the target audience may be less likely to engage with the available interactive technologies. According to Oranje, the design of the installation context was intended to facilitate a range of visitor behaviours. She noted that even visitors who elected not to interact with the touch table would still be able to view the onscreen content. The size of the touch table was large enough to accommodate visitor-to-visitor interaction and to allow visitors to watch others interact, without

imposing on the interactions of other visitors. This facilitated the *direct-dynamic* and *indirect-dynamic* forms of instructions described above, whereby visitors are instructed or advised in their interactions by watching other interacting visitors or by receiving advice from the other visitors or from HSM staff.

Within *The Paintings* gallery, there were eight separate audio guide trigger points, where visitors were able to initiate audio tracks on a personal listening device provided by the museum. The audio guide tour was introduced in 2015, after the renovation was completed, to provide overviews of the museum galleries in different languages. The audio guide offered visitors an opportunity to carry this piece of mobile technology with them throughout their visit, even into *The Paintings* gallery, where there were fewer interactive installations to engage with. Their introduction raised potential problems for the interactives in the gallery. As van Keulen argues, "These audio guides make people suddenly from social beings into something that can just listen. […] This whole social atmosphere in the exhibitions, where people are just listening like this, while they were planning on doing something else. We very much believe in the social interactions in the exhibitions. This is a bit disrupting." The first trigger point was placed next to an informational text panel directly in front of the van Wieringen painting, in between that and *the Gibraltar touch table*. During the observation periods, I found that 49.51% of visitors observed who engaged with *the Gibraltar touch table* also brought an audio guide with them into *The Paintings* gallery (152/307 total observed visitors). Ultimately, my observations suggest that, for visitors who were interested in the interactive technology or the informational layer that it offered, the audio guide did not seem to influence their interaction with *the Gibraltar touch table*; however, further research would be useful for understanding how visitors experience these two technologies in tandem or in sequence.

Design and Implementation of Instructions for Interaction

The responses from the interviewed members of the development team indicate that the design and implementation of instructions for interaction with *the Gibraltar touch table* were primarily influenced by three factors:

1. the touch-based interaction technology as a means of providing access to informational content,
2. the consistency of the UI and interaction design employed throughout the museum, and,
3. the simplicity of the single-input interaction design used with *the Gibraltar touch table*.

This discussion primarily focuses on the *direct-static* and *indirect-static* instructions that were integrated into the design of *the Gibraltar touch table*, with little focus here paid to the *direct-dynamic* and *indirect-dynamic* instructional forms.

To create a consistent UI design that could work across a number of interactive installations, the designers at *Kiss the Frog* drew on their years of experience designing interactive installations for museum contexts, their understanding of the target audience defined by HSM, and the interaction principles that are already commonly associated with the selected interactive technology. When asked about the design principles employed in the UI of *the Gibraltar touch table*, Molenaar suggests, "This is very much to do with the bigger parties in the world driving this market, if you like: the Googles, the Apples, the Windows… They are responsible for a lot of interaction principles, I would say." Following the established, fundamental approaches to interaction design, it was assumed that visitors who might engage with the technology would use their existing experience with touch-based interactive technologies to support a "learning by experience" approach. For example, the UI of *the Gibraltar touch table* included a small ☒ in the upper right corner that was meant to indicate to users that touching this icon would close the selected text window, the same feature that has been widely employed in Windows programming since the release of Windows 95 (Archer 2014).

The same process works by having a universal approach to the design of the different interactives across the museum. As van Keulen explains, "If I learn that the switch to change the language to English will be in the upper right corner, it will always be in the upper right corner. […] If I do something here and learned it, then the ideas for how to get information should be the same on the other side [of the museum]." This consistency of UI and interaction design was used as a means

to reduce the amount of instruction required for interaction through the repetition of design across the interactive installations throughout the museum. In many of the exhibition spaces of HSM there were touch-based interactive technologies available for visitors to engage with, the majority of them being single-input touch-screen interactive of varying sizes.

According to the interviewed members of the development team responsible for *the Gibraltar touch table*, the interaction design and elements of the UI were formed around their assumptions for the ways visitors might interact with an in-gallery touch-based interactive installation in *The Paintings* gallery. Recognising that their target audience for *The Paintings* gallery was characterised as being somewhat reluctant to engage with in-gallery interaction installations, the development team had the expectation that many visitors would still naturally attempt to interact with the screen. When asked how design was used to draw visitors into interaction with *the Gibraltar touch table*, Molenaar says, "Well, often a screen itself is already enough to draw attention… It is like a TV; if it is on, people will watch it." While the presence of technology does its part to draw visitors into interaction, the development team also included the "Touch to Start" attractor screen that served to instruct visitors on the interaction with the touch table. According to Molenaar, the attractor screen instruction was one of a few instructional redundancies incorporated into the design: "In terms of redundancy, already you have the screen attracting you, so something is happening [to draw the visitor to interact], and then you have the text also saying 'touch me and we'll have a good time.'" The "Touch to Start" screen was the only *direct-static* form of instruction that was available to visitors within *the Gibraltar touch table*, but not all visitors had the opportunity to view its instructions, as it would only appear on-screen after a 90-second period of inactivity.

Although interaction with *the Gibraltar touch table* was designed to be as simple as possible to facilitate access to the informational layer, an additional *indirect-static* form of instruction was included in the upper right corner of the touch table screen: the ⓘ information option. This small icon, which was intended to be interpreted as an indicator of additional information or instruction, opened a small window that provides two lines of instructional text, along with two accompanying

illustrations of the required interactions: “Drag your finger to move” and “Tap to select”. Without intentionally selecting the ⓘ icon, these instructions would not appear. It was assumed that most visitors would have experience with touch-based interaction technologies and would attempt interaction on their own, only accessing the ⓘ instruction option if they felt it was necessary. Molenaar suggests, “You have people who have touch-screens, but if you have someone who has never touched a touch-screen before, then he can choose that button to get to see more information.” The *indirect-static* instruction was accessed via the ⓘ icon, once again relying on the correct interpretation of existing interaction and UI design principles, while reducing the amount of on-screen text until the instructions are selected using the ⓘ icon. Although it may have been reasonable to assume that most visitors would have sufficient experience with touch-screens to interact with *the Gibraltar touch table* relatively easily, by using the ⓘ icon and placing it in the upper right corner of the large screen it could have been easily overlooked by users or possibly misinterpreted as a source of information about the painting, rather than a source of instruction.

When asked to reflect upon the design of *the Gibraltar touch table*, the interviewed members of the development team were generally quite pleased with the final installation, but acknowledge one significant shortfall; the option to swipe the on-screen image to the left and right was not immediately obvious to many users. Oranje acknowledges this oversight, saying, “If you take a look at the table, you only see part of the painting, so I thought it would be obvious that you can slide, but [based on my observations] it is clearly not obvious [to users].” She notes that this could have been remedied through the addition of arrows on the left and right sides of the screen, indicating that the image can move to the left or right to reveal more content, but there were concerns that the addition of instructional texts or icons into the UI could potentially overwhelm some users. As such, the development team elected to limit the on-screen elements to only those necessary for accessing the informational layer of content, aiming for a more “intuitive” interface design, rather than one that instructs the user through each and every step of their potential interaction experience. Assumptions made about how visitors would interpret the on-screen UI

could have been evaluated through user testing in the installation context, but according to members of the development team, there was little time or budget remaining for extensive user testing prior to the re-opening of the museum.

User Testing and Evaluation

Over the course of the development of *the Gibraltar touch table*, a limited amount of user testing was conducted by members of the development team, including paper prototype testing and limited user testing with a combination of internal HSM staff and a small number of external individuals. According to Oranje, there was little time or budget allocated for user testing during the course of the development process, saying, "We always plan to test it and somehow there is never any time, never any money. We did test all of our concepts of the exhibition with *Motivaction*. […] We did listen to our potential clients. We did not really get to test each individual installation, no. […] We do test it ourselves, and I ask people who are not involved in the development to test it. I do a little bit of testing, but I should do it more often and to a higher degree." Although Oranje recognises the importance of testing for producing a functional installation, time and financial constraints, as well as the need to ensure the usability of the many other interactive installations that were being developed for the re-opening of the museum, seem to have been the primary factors behind the lack of user testing of *the Gibraltar touch table* in its installation context. Furthermore, as HSM was also taking its first steps towards integrating such a high volume of interactive installations within their exhibition spaces during the renewal period, when *the Gibraltar touch table* was being developed, it seems likely that HSM staff were underprepared for the level of user testing required to produce each of the interactive installations throughout the various exhibition spaces of the museum. As my interviews with the development team took place a little over five years after *the Gibraltar touch table* was created and installed, the precise causes for the lack of user testing were not easy for the interviewed development team members to define, due to the time that had passed between the actual development phases of the touch table installation and the critical reflection of this specific development process that I was seeking. That said, however,

Oranje's comment suggests that allocating appropriate time and budget for user testing may still be something that HSM can improve upon within their current and future exhibitions that incorporate new interactive installations.

Speaking more generally from the technical development side, Molenaar suggested that user testing is an important aspect to achieving a functional and satisfying interaction experience, but argued that timing and financial constraints are often at the directive of the stakeholder who has commissioned their services. "Often enough, testing is the first thing that drops out if the budget is tight. We always try to do some sort of testing. I mean, we have different levels. The paper prototype is a very low-cost way of testing; it is something we do with bigger jobs as well. […] It has to do with the culture [of the stakeholder], but also the budget and seeing the importance of testing." While Oranje acknowledges the importance of user testing and her desire to conduct more user testing, and of a higher calibre than they were able to conduct prior to the re-opening of the museum, Molenaar's statement about whether the stakeholder views user testing as important is equally relevant. Given the extended development period allotted for the renewal of HSM, and taking into account the considerable financial resources available for the renewal (Het Scheepvaartmuseum 2016a), it seems that thorough user testing of the in-gallery interactive installations may not have been enough of a priority to devote the necessary time or financial resources to. With significant portions of the renewal budget directed towards preparing HSM as an entertainment venue and the installation of the compass-rose glass roof, compared to the relatively limited financial resources that would be required to conduct effective user testing, the early criticism of The Culture Council of HSM for prioritising its role as an entertainment venue, rather than as a museum, is particularly appropriate for this case study installation (Raad voor Cultuur 2012). *If* HSM had placed greater importance on prioritising user testing during the development of *the Gibraltar touch table*, then it is *possible* that usability issues that impacted the visitor interaction experience, like the interactive lighting scheme or the missing on-screen arrows to indicate the possibility to swipe the image left or right, may have been recognised and resolved prior to the re-

opening of the museum. Nonetheless, each of the development team participants seems reasonably pleased with how *the Gibraltar touch table* functioned, despite the remaining usability issues that could have been identified and avoided through user testing, suggesting that they do not consider these issues to negatively influence the functionality of the installation. However, if circumstances were such that HSM could have followed the advice of their experienced technical development company, *Kiss the Frog*, and ensured sufficient time and budget remained available for in-gallery user testing, the usability issues may have been avoided altogether.

Visitor Evaluation: Observation and Post-Interaction Questionnaire Results

The results of my visitor evaluation provide insight into the user experience interacting with *the Gibraltar touch table* and the forms of instruction that visitors do or do not use in association with their interaction experience. Through a combination of uncued visitor observations and the post-interaction questionnaire, I can show the forms of instructions that visitors used, the impact of the use or non-use of instructional forms, and indicate how the user experience did or did not align with the interaction experience intended by the development team.

The following results and subsequent analysis pertain directly to the evaluation activities conducted in *The Paintings* gallery of HSM between 11 March and 17 December, 2016. Due to the approaches that both HSM and *Motivaction*, their external visitor research company, use to define and categorise the visitors to the museum, relying on ticket purchase pricing and *persona* visitor types, it is not possible to definitively say whether or not the sample of visitors that I evaluate here is representative of *all* visitors to the museum. Furthermore, these results only relate to HSM visitors who entered *The Paintings* gallery and made intentional interactions with *the Gibraltar touch table*. Nonetheless, these results relate specifically to the sample of visitors that I evaluated through observation or through participation in the post-interaction questionnaire and, therefore, may not be indicative of visitors to the wider museum.

Between 11 and 23 March 2016, I undertook ten observation periods within *The Paintings* gallery of HSM. I spent a total of 40.32 hours on-gallery, observing visitors and collecting observation

reports on the interactions of 307 individual users. I collected post-interaction questionnaires between 24 March and 17 December 2016, over a span of 23 collection periods, requiring a total of 89.25 hours of collection time, to collect a total of 100 post-interaction questionnaires. I had unlimited access to the interactive installation during opening hours of the museum, allowing for a wide range of observation periods. The collection of the post-interaction questionnaires was delayed between April and October, due to the development of technical issues with *the Gibraltar touch table* that affected the on-screen visualisation and the interactive elements; the ⓘ instruction, in particular, was obscured by the on-screen graphic interference. Though the repair period was lengthy, creating a temporal gap between the collection of the observation reports and post-interaction questionnaires, the repairs to *the Gibraltar touch table* were such that the table retained its original appearance and functionality; no repairs to the installation were made that altered the physical appearance of the touch table or the interaction experience.

Demographic Results[10]

Total Participants:

Total Observed Users: 307

Total Post-Interaction Questionnaire Participants: 100

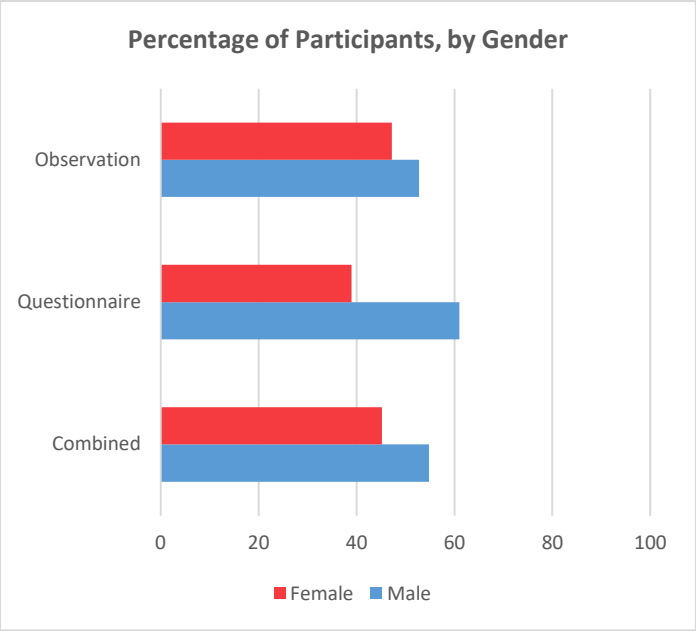
Total Combined Evaluation Participants: 407

	Observation	*Post-Interaction Questionnaire*	*Combined*
Female	145	39	184
Male	162	61	223
Total	**307**	**100**	**407**

Figure 4.13: Total number of participants, by gender

[10] For all in-text percentages, I have rounded up to show only the first decimal figure. For figures and detailed results, I have rounded up to the second decimal figure. As a result of this, some in-text totals may exceed 100%.

Gender:



Observation Results:
Female: 145 (47.23%)
Male: 162 (52.77%)

Post-Interaction Questionnaire Results:
Female: 39 (39%)
Male: 61 (61%)

Combined Results:
Female: 184 (45.21%)
Male: 223 (54.79%)

Figure 4.14: Percentage of participants, by gender

The combined results of both evaluation methods show a relatively even representation of both female and male participants, however closer examination of the results of each methodology shows greater range than the combined results suggest. Male participants outnumber female participants between 5.5% and 22%, depending on the methodological source of the result. The reason that the results demonstrate a greater number of male to female participants is not clear from this somewhat limited examination of the comprehensive evaluation results, but the subject matter of HSM, in general and with respect to the contents of *The Paintings* gallery, may be a factor.

Age:

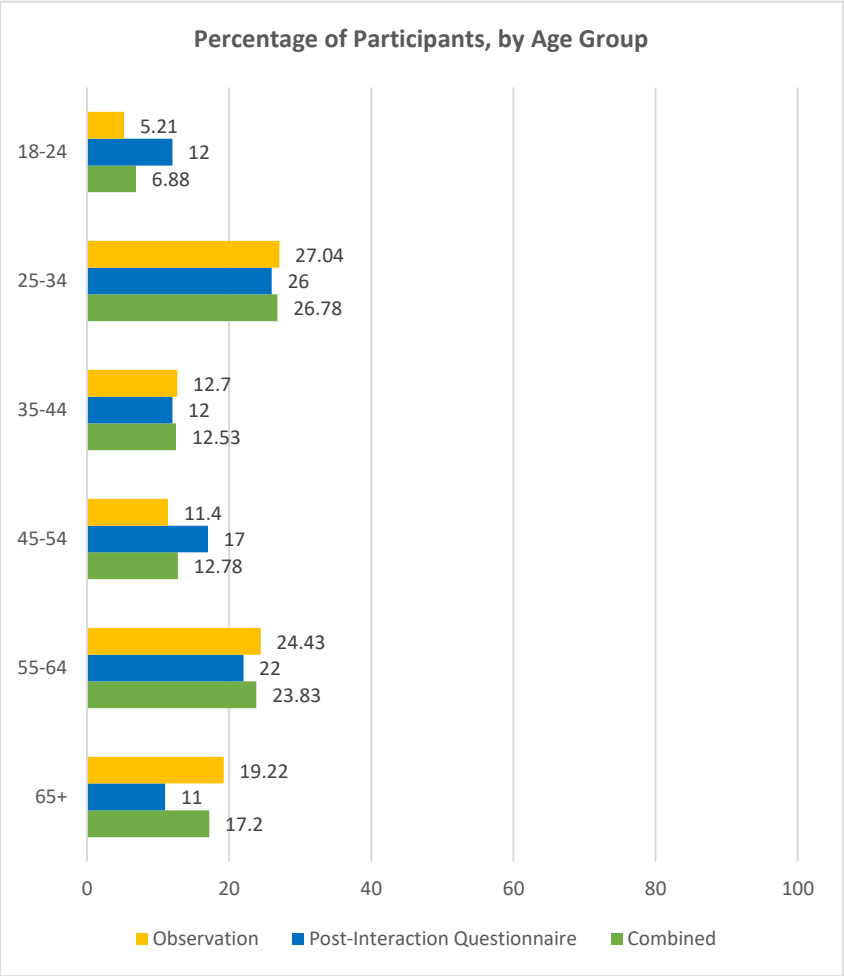


Figure 4.15: Percentage of participants, by age group

Observation Results:

18-24: 16 (5.21%)
25-34: 83 (27.04%)
35-44: 39 (12.70%)
45-54: 35 (11.40%)
55-64: 75 (24.43%)
65+: 59 (19.22%)

Post-Interaction Questionnaire Results:
18-24: 12 (12%)
25-34: 26 (26%)
35-44: 12 (12%)
45-54: 17 (17%)
55-64: 22 (22%)
65+: 11 (11%)

Combined Results:
18-24: 28 (6.88%)
25-34: 109 (26.78%)
35-44: 51 (12.53%)
45-54: 52 (12.78%)
55-64: 97 (23.83%)
65+: 70 (17.20%)

The results relating to the age of the participants show a relatively even representation; however, there are more participants in the 25-34 and 55-64 age groups, respectively, in both evaluation methodologies. The age group with the fewest percentage of participants varies across each evaluation methodology. Observation results show the 18-24 age group as having the fewest participants (5.2%), while the post-interaction questionnaire had the fewest participants in the 65+ age group (11%). Overall, the 18-24 age group is the least represented in the combined evaluation results, with only 6.9% of participants representing this demographic.

Visitor Grouping:

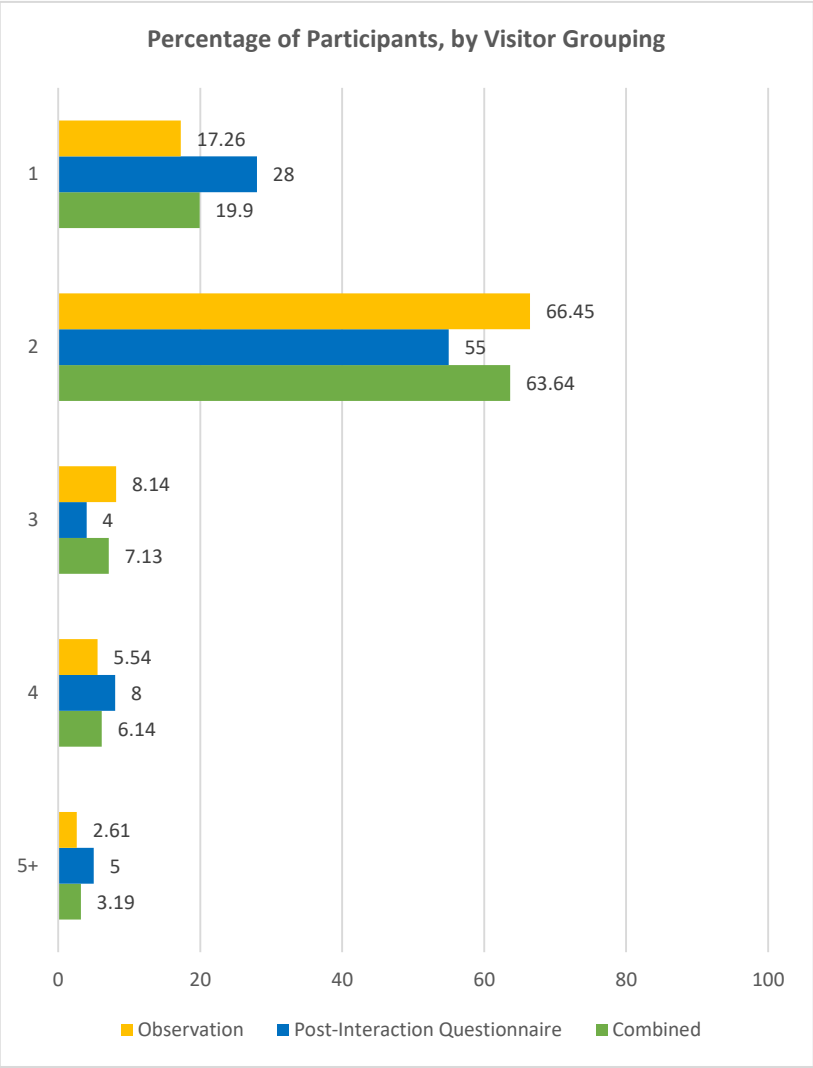


Figure 4.16: Percentage of participants, by visitor grouping

Observation Results:
1: 53 (17.26%)
2: 204 (66.45%)
3: 25 (8.14%)
4: 17 (5.54%)
5+: 8 (2.61%)

Post-Interaction Questionnaire Results:
Alone: 28 (28%)
With a Friend or Family Member: 55 (55%)
In a Visitor Grouping of:
3: 4 (4%)
4: 8 (8%)
5: 1 (1%)
6: 1 (1%)
9: 1 (1%)
16: 1 (1%)
20: 1 (1%)

Combined Results:
1: 81 (19.90%)
2: 259 (63.64%)
3: 29 (7.13%)
4: 25 (6.14%)
5+: 13 (3.19%)

To calculate the combined results for visitor grouping, I code the results of the post-interaction questionnaire to match the visitor groupings of the observation results. I add each "Alone" result to the "1" grouping of the observation results, add each "With a Friend or Family Member" to the "2" grouping, and so on. I count the "2" visitor grouping from the post-interaction questionnaire results with the "2" grouping from the observation results in the combined results; I list these results separately from the "With Friend or Family Member" to stay true to the responses from the participants.

I provide results separately here for the number of children grouped with observed users, a demographic result not explicitly collected through the post-interaction questionnaire. It may be possible that post-interaction questionnaire participants include children in their assessments of their own visitor groupings, but I do not count these separately. Although I explicitly do not evaluate museum visitors under the age of 18, I acknowledge their presence with observed adult users and recognise their potential to influence the *sociocultural context* of the museum visit for the visitors who participate in this research. The observation results for the number of children accompanying observed visitors are:

0: 282 (91.86%)

1: 12 (3.91%)

2: 11 (3.58%)

3: 2 (0.65%)

It is clear from these results that *The Paintings* gallery is not a part of the museum where visitors under the age of 18 seem to visit. Only 8.1% of visitors to *The Paintings* gallery were accompanied by children under 18 years old.

The most striking statistic relating to visitor grouping is the combined 63.6% of visitors who attended the museum as a visiting pair. A further 16.6% of participants in the combined results were in groupings of 3 or more visitors. These results demonstrate the social nature of museum visits; only 19.9% of participants visited *The Paintings* gallery alone. The results associated with visitor groupings indicate the *sociocultural context* within which the evaluation occurred, but may also influence the experience of the evaluated participants in their interaction experience with *the Gibraltar touch table*, as well as in *The Paintings* gallery.

Visitor Motivations:

Due to the unobtrusive methodology applied during the observation periods, it was not possible to discern the nature of the motivations behind their museum visit. As such, the results relating to visitor motivations come from responses to the post-interaction questionnaire. Rather

than rely on the limiting parameters of the *persona* groupings that HSM and *Motivaction* apply, I use Falk's identity-related visitor motivation types in Question 1.5, asking participants to select as many visitor types that best describe them (Falk 2009, 2011). Participants were encouraged to select as many responses as they felt applied to them and every visitor participating in the post-interaction questionnaire provided at least one response to the question on visitor identity-related motivation. Since participants were able to select as many responses as they felt applied to them, the results below include a percentage of the total participants that selected each possible response. Sorted from most to least common responses, participants of the post-interaction questionnaire self-identify as:

- Motivated by curiosity and an interest in exploring the museum collections: 79 (79%)
- Motivated by an interest in the museum collections as a professional or hobbyist: 20 (20%)
- Motivated by a personal connection or affinity to visit a particular object, exhibition or collection within the museum: 12 (12%)
- Motivated to visit the museum for a peaceful, reflective or recharging experience: 10 (10%)
- Motivated by the perception that visiting the museum is an important experience (a "been there, done that" destination): 8 (8%)
- Motivated to facilitate the experiences and learning of others I am visiting the museum with: 8 (8%)
- Motivated to visit the museum to pay respects for those who are honoured and remembered by the museum: 3 (3%)

The results show that visitors most often consider their motivation for visiting the museum as being driven by an interest to explore the museum collections. While this applies in a more general sense for 79% of participants, 20% were similarly motivated to visit the museum due to their interest in the collections as a professional or hobbyist. The motivation to explore the collections of HSM or an interest in the collections as a professional or hobbyist may also influence each participant's motivation to interact with *the Gibraltar touch table*, or any other in-gallery interaction

technology found within HSM. For these participants, *the Gibraltar touch table* may be viewed as a means of gaining more information about the van Wieringen painting, aligning with the purpose that the development team intended for the installation, being the source of an additional information layer about the painting. Certainly, motivation to explore the collections, and presumably also *content* related to the collections, may influence the *personal context* of the visitor experience. These results relate more to the motivations that participants have for visiting HSM, rather than their motivations for interacting with *the Gibraltar touch table*, but they may offer an indication for the way visitors behave within HSM and their reasons for entering some galleries over others, or their decisions to engage or not engage with the available interactive installations.

Familiarity with Touch-Based Interaction Technologies:

To offer some insight into the expectations museum visitors might have when they approach in-gallery touch-based interaction technologies, I asked participants in the post-interaction questionnaire whether or not they own a touch-based interaction device, such as a smartphone, tablet, or iPad (Question 1.3). Out of one hundred museum visitors who provided their signed consent to participate in the post-interaction questionnaire, two participants failed to provide a response to this question, as such results for this question are based on the responses of 98 participants. Of the participants who offered a response to Question 1.3, 89.8% stated that they owned some form of touch-based interaction device, indicating a high percentage of museum visitors who have existing familiarity with touch-based interaction technology (88/98 total responses). This familiarity may influence the expectations visitors have for the kinds of UI design and interactions they expect to experience during their interaction, but moreover, it may influence their decision to use the available instructions that guide interaction with the in-gallery touch-based interaction technology or not. The responses of the participants support the assumptions that the development team had about how many of their visitors would already be familiar with touch-based interaction technology, validating their decisions to design the UI using ubiquitous interface elements, such as the ☒ symbol to close text windows.

A comparatively limited number of participants indicated that they did not own any form of touch-based interaction device. In fact, only ten participants stated that they did not own any form of touch-based interaction device, amounting to 10.2% of participant responses (10/98 total responses). The participants who do not own a touch-based interaction device were primarily male (70%; 7/10 total responses), with fewer females represented (30%; 3/10 total responses). Results show that participants in the three oldest age groups were more likely not to own a touch-based interaction device than the youngest three age groups; with 90% of responses coming from participants 45 years of age and older (Age 45-54: 30%; Age 55-64: 30%; Age 65+: 30%).

Isolating the complete questionnaire responses of the ten participants who do not own any form of touch-based interaction device for separate analysis, none of the responses or comments provide any indication that these ten participants had difficulty during their interaction experience with *the Gibraltar touch table*. This may suggest that, despite not owning a touch-based interaction device of their own, museum visitors were still able to achieve successful interaction with *the Gibraltar touch table*.

Interactions with the Gibraltar Touch Table:

The duration of interaction periods by observed users ranges from less than one minute, up to twelve minutes of interaction with *the Gibraltar touch table*, demonstrating a considerable array of interaction durations across interacting visitors. The majority of observed users interacted with the touch table for one minute or less, with 102 users interacting for at least one minute, and 86 users interacting for less than one minute (combined, this is 61.2% of total observed users; 188/307 observed users). The longest interaction of twelve minutes was achieved by only one observed user (U30), who interacted for a full three minutes longer than the second longest observed interaction. Determining the mean duration of interaction is somewhat problematic because interactions less than one minute long were not recorded using smaller increments. *If* each interaction less than a minute is counted as being a minute long, *then* the mean interaction duration is 1.86 minutes long; nearly twice as long as the median and the mode, which are both one minute.

The interactions that visitors made with *the Gibraltar touch table* varies greatly across the museum visitors who were observed interacting. The total number of interactions observed across all users adds up to 3065. Dividing this number with the total number of observed users suggests that the average number of interactions per user can be estimated at 9.98 interactions (3065/307=9.98). The mean number of 9.98 interactions is higher than the median, which is 8 interactions, and higher than the mode of 6 interactions, which were made by 30 observed users. The highest number of interactions carried out by a single observed user was 43 (U163), while six observed users engaged in only a single interaction with *the Gibraltar touch table* (U15, U111, U158, U166, U223, and U280). The 9.98 interactions that the mean suggests is likely skewed by a handful of observed users who engaged with the touch table for twenty interactions or more; the results show that over 60.9% of users made 9 or fewer interactions (187/307 observed users).

During observation periods, I closely monitored and recorded the number of interactions with target spots, or hot spots, to determine how many interactions were made in order to access the informational layer offered by *the Gibraltar touch table*. Observed users were most often seen interacting with two target spots; 21.2% (65/307 total observed users). The mean number of target spots used by observed visitors is 4.2, which is higher than the median of 3 target spots, and certainly higher than the mode of 2 target spot interactions. While there were only 14 possible target spots to interact with, three observed users engaged with 15–17 target spots, suggesting that there was repeated interaction with one or more target spots. Nine of the observed users were able to interact with *the Gibraltar touch table* without touching any of the target spots, limiting their interactions to closing text windows that were open from a previous user, changing the language, or making the first interaction to move away from the “Touch to Start” attractor screen.

If the mean results of these findings can be considered to reflect the "average" observed user, then the 9.98 interactions the user is making would be achieved in 1.98 minutes, including the selection of 4.16 target spots. The table provided (Figure 4.17) offers a visualisation of the collected data showing the mean, median, and mode for the duration of observed interactions, the number of interactions observed, and the number of target spots used. The mean results are consistently higher than the median or mode results, likely influenced by some of the more extreme results, such as the user who made 43 interactions (U163), or the user who interacted for 12 minutes (U30).

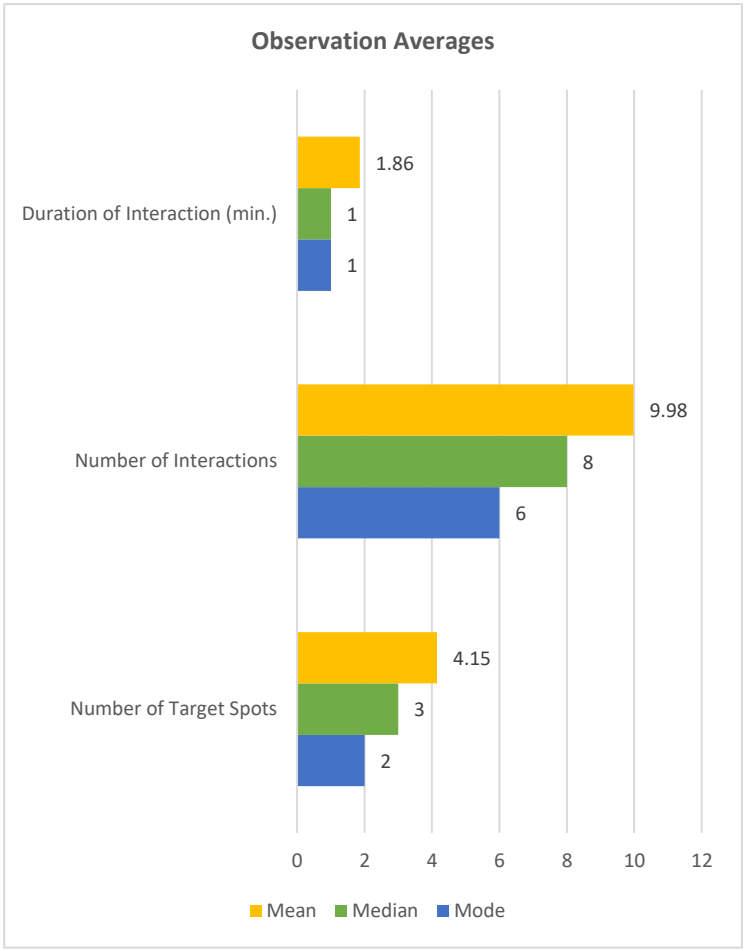


Figure 4.17: Observation averages

Use of Instructional Forms:

To examine the use of instructional forms by evaluation participants, I divide the presentation of results into the responses from participants who completed the post-interaction questionnaire and data collected from the visitor observation periods.

In the post-interaction questionnaire, I use two separate questions that ask participants to reflect upon their interaction experience with *the Gibraltar touch table* and their use of any of the available instructions. In the section of the post-interaction questionnaire that focuses on interaction with the touch table, Question 2.2 broadly asks, "How did you know how to use the touch table?" In the section of the questionnaire that looks at instructions for using the touch table, Question 3.1

asks more explicitly about *the Gibraltar touch table*, asking, "What kinds of instructions did you use with *the Gibraltar touch table*?" For both questions, participants were encouraged to select as many responses as they feel applies to their personal interaction experience.

The responses to Question 2.2 show what participants consider to have influenced their use of *the Gibraltar touch table*, identifying their inclinations towards the "Touch to Start" screen and for eschewing instructional forms to instead use a trial-and-error approach to interaction. A total of 99 participants provided responses to Question 2.2, with one participant declining to provide a response to this question. Over half of the participants identified with the response, "I saw the screen that says 'Touch to Start'" (54.6%; 54/99 responses), indicating the importance of the attractor screen as a means of instructing visitors to interact with the touch table. Participants also strongly identified with the trial-and-error approach, with 34.3% of participants selecting the response, "I tried a few things until I figured it out" (34/99 responses). The on-screen ⓘ instruction option was used by 17.2% of participants (17/99 responses). Only 5.1% of participants acknowledged seeing other visitors using the touch table (5/99 responses), and zero participants said they received instructional support from museum staff. Five participants provided written responses to this question, each of them indicating their preference for the trial-and-error approach (E.g. Q44: "Just trying."; Q50: "It was obvious."; or, Q92: "I just did it."). By adding these results to the other 34 participants who attempted a trial-and-error approach, the results show that 39.4% of participants expressed a preference for attempting interaction without relying on instructional forms, instead electing to learn by experience (39/99 combined responses).

Participant responses to Question 3.1 define more specifically which of the available instructional forms users rely on for their interaction experience with *the Gibraltar touch table*, and once again, participants show their preference for the "Touch to Start" screen and for avoiding instructional forms in favour of taking a trial-and-error approach to their interaction experience. A total of 98 participants provided responses to Question 3.1; two participants declined to provide any response to this question. As with the responses to Question 2.2, the majority of participants

indicated that they had seen the “Touch to Start” screen (57.1%; 56/98 responses). Also significant are the 43.9% of responses from participants who claimed that they did not make use of any instructions (43/98 responses). These results may suggest that some participants might not consider the “Touch to Start” screen to fall within their definition of “instructions” for interaction with the touch table. With respect to the available instructions on-screen, only 13.3% of participants claimed to use the ⓘ instruction option (13/98 responses). Only 7.1% of participants acknowledged seeing other visitors using the touch table (7/98 responses), and again, zero participants acknowledged receiving instructional support for their interaction from the museum staff. Three participants provided written responses, each indicating their preference for the trial-and-error approach (E.g.: Q24: “Just experimented”). Adding these results to the other users who acknowledge their use of the trial-and-error interaction approach, the results show that 46.9% of participants prefer to attempt interaction on their own, learning by experience rather than relying on any available instructional forms (46/98 combined responses).

Unlike the subjective responses of the participants to the post-interaction questionnaire, the data that comes from the observation periods is more objective and nuanced. To bring order to the presentation of the observation results, I arrange the results according to the forms of instructions and their application in *the Gibraltar touch table*. The results I describe now are limited to those that demonstrate use of the available forms of instructions by observed users. I offer limited analysis of the results here, reserving more in-depth cross-analysis of these results and their correlation to the interaction experiences observed for discussion following later in this chapter.

Direct – Static: *“Touch to Start” Screen*

The most obvious *direct-static* form of instruction available for *the Gibraltar touch table* was the “Touch to Start” attractor screen. Despite the timed nature of the instructional attractor screen, appearing only after 90 seconds of inactivity, the observation results show that 38.8% of observed users began their interaction experience by interacting with the “Touch to Start” attractor screen (119/307 total observed users). The opposite of this result shows that 61.2% of observed users did

not have the opportunity to view the "Touch to Start" screen upon initiating their interaction experience with *the Gibraltar touch table* (188/307 total observed users). The responses to Questions 2.2 and 3.1 of the post-interaction questionnaire, which show that between 54.6–57.1% of participants acknowledged seeing the "Touch to Start" attractor screen, differ from the observation results. The variation across these results could be due to differences in the interpretation of the questions and possible responses in the post-interaction questionnaire, or potentially signal a shift in the visitor interaction flow across the evaluation periods used for each methodology. While visitor exposure to the "Touch to Start" attractor screen seems pervasive enough, the exact influence of the attractor screen on the user experience with the touch table requires additional investigation to better understand whether or not visitors actually perceive the instructional nature of its message. Previous research on visitor attention associated with interpretive and non-interpretive labels may suggest that the availability of this instructional label on an interactive touch screen, its movement across the screen, or its competition with other visual elements or object on display within the gallery space could influence whether or not visitors actually see the "Touch to Start" label as an instruction, or if they merely overlook its instructional purpose and engage with the technology based on their assumptions or expectations that touching the screen will initiate some kind of interactive experience (Bitgood and Patterson 1993; Bitgood 1996). Presumably, those visitors who did not have the opportunity to view the "Touch to Start" screen were able to observe other visitors interacting with the touch table prior to initiating their own interaction experience, however the 90 second delay between inactivity with the screen and the appearance of the "Touch to Start" instruction may have been long enough that users who conclude their interaction experience were able to move through *The Paintings* gallery, away from *the Gibraltar touch table*, before the "Touch to Start" screen appeared for the next potential user.

Indirect – Static: *Instruction ⓘ Option, UI Design*

Similar to the results from the post-interaction questionnaire, the observation results for use of the ⓘ instruction option show that only 10.8% of observed users sought out the additional

instructional information (33/307 total observed users). This is slightly lower than the 13.3–17.2% of post-interaction questionnaire participants who claimed to use the ⓘ instruction option during their interaction experience. The demographics of the 10.8% of observed users who accessed the ⓘ instruction option show that visitors in the two oldest age groups make up over half of this sample group (57.6%; 19/33 observed users over 55 years old). These results suggest that the majority of visitors who used the ⓘ instruction option fall within age demographic that characterises the "Dick" visitor type that *the Gibraltar touch table* was designed for. The members of the development team interviewed stated that they incorporated the ⓘ instruction option to support the experiences of users who may not be familiar with touch-based interactivity, rather than suggesting that this instructional form was included specifically to benefit the "Dick" target *persona*. The results, however, suggest that "Dick" *persona* visitors who seek out this form of instruction most often may have been doing so because they are most unfamiliar with this form of touch-based interaction technology.

Although I consider the UI design to be a form of *indirect-static* instruction, using observation to evaluate the use of UI design, as an instructional form, on the interaction experience proved inconclusive for this case study. The simplicity of the target spot interaction design and the familiarity of other on-screen computing icons suggests that the majority of, if not all, users made use of both their intuition for interaction and their experiences with commonplace elements of UI design to help guide their interaction experience. The limited number of users who accessed the ⓘ instruction option may suggest that the UI design and the interaction design were simple and intuitive enough for most users to engage with *the Gibraltar touch table*, without feeling compelled to seek out further instruction for interaction.

Direct – Dynamic: *Advice from Other Visitors or Museum Staff, Collaborative Interaction with Another Visitor*

The two forms of *direct-dynamic* instructions available with *the Gibraltar touch table* had markedly different results for their use among visitors, compared to the other available instructional

forms. I begin with the results relating to instructions or advice that users were observed receiving, looking also at the results relating to advice from HSM staff members, before exploring the observation results relating to users and any collaborative interaction with other visitors.

Observation results show that remarkably few users received advice or instruction from other museum visitors to guide their interaction with *the Gibraltar touch table*; this behaviour was observed on only two occasions, relating to only 0.7% of observed users, (2/307 observed users). Interestingly, both users were within the 55-64 years age grouping, however, the extremely limited size of this sample challenges any worthwhile interpretation of the meaning of these results. It is, conversely, possible to suggest some reasons why only 0.7% of participants were observed using this form of instruction. Firstly, the more traditional nature of *The Paintings* gallery as the installation context may not have been conducive to creating an environment where visitors feel comfortable engaging with other visitors; the traditional exhibition environment of *The Paintings* gallery contrasted dramatically with the more non-traditional, interactive environments found within other gallery spaces of HSM, like those found within the more experience-based North and West wings. Furthermore, the installation context of *The Paintings* gallery was quieter and more sophisticated, encouraging an atmosphere of quiet reflection, rather than overly loquacious experiences among visitors. If visitors did not feel comfortable speaking openly with each other in the space, they may not have felt comfortable providing others with instructional support for their interaction. Secondly, the design of the installation context allowed visitors to observe one another interacting with the touch table and, since the interaction and UI design were quite simple, this may have reduced any need for visitors to engage in visitor-to-visitor interaction.

I am unable to provide results for visitors who received instructions or advice from museum staff to support interaction with *the Gibraltar touch table*, as this was never observed during the observation periods, save for a few specific examples that fell outside of the defined observation methodology. For example, when the museum offered guided tours that moved through *The Paintings* gallery, *the Gibraltar touch table* would often be used as a tool for presenting

informational content shown on-screen while discussing the van Wieringen painting. When the guide would use the information offered by the touch table, the interaction with the touch table would typically be demonstrated for the visitors. Once the tour group would move on, it may have been possible for visitors from the group to linger behind to continue their own interaction experiences with the touch table. For visitors who were not part of a tour group, the availability of instructional support directly from museum staff appears to be an exceptionally irregular occurrence, as HSM staff rarely entered *The Paintings* gallery without an accompanying tour group. Members of the security staff moved through the exhibition space regularly to monitor safety and visitor flow, but they typically did not engage with visitors unless approached.

The most frequently observed form of *direct-dynamic* instruction was the collaborative interaction that visitors engaged in within their own visiting groups. 50.8% of observed participants engaged in some level of collaborative interaction with another visitor (156/307 observed users). The basic demographics of these users show that, at 56.4% (88/156 observed users), slightly more females engaged in collaborative interaction than male users, who comprise 43.6% (68/156 observed users). As Figure 4.18 illustrates, the age group distribution of these users shows peaks

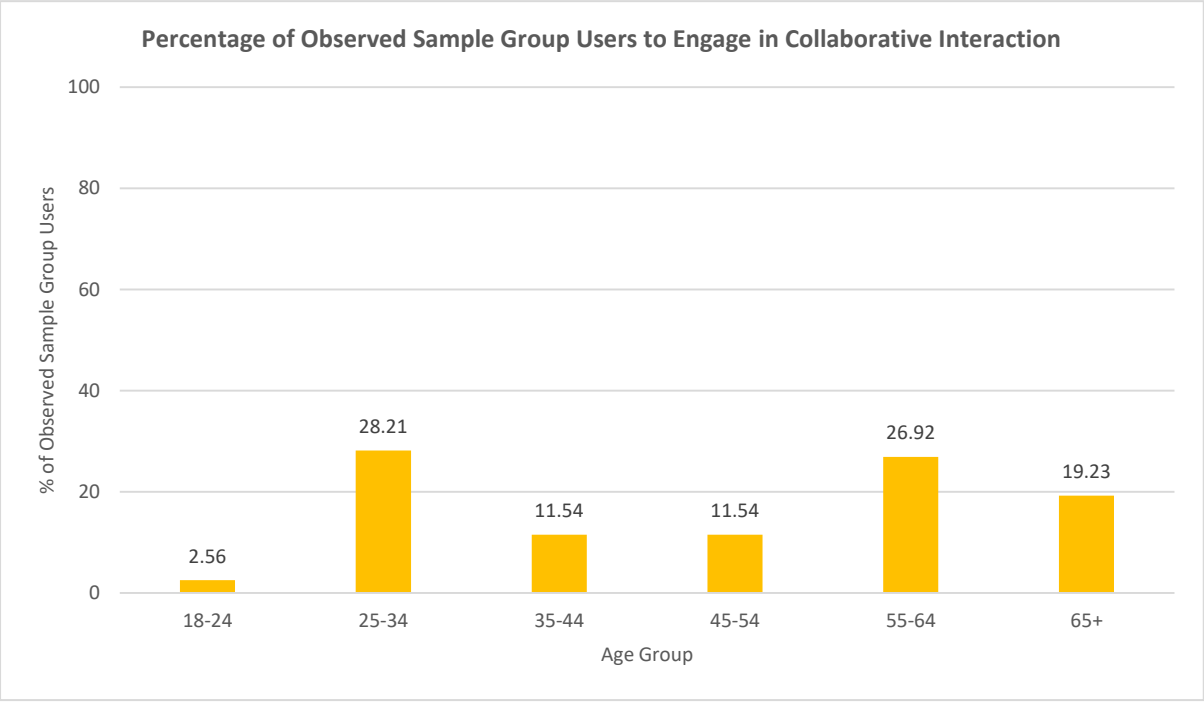


Figure 4.18: Percentage of observed sample group users to engage in collaborative interaction

among users in the 25-34 and 55-64 age groups, comprising 28.2% and 26.9% of observed users in this sample of participants, respectively (25-34: 44/156 observed users; 55-64: 42/156 observed users). Visitors in the 18-24 age group were least often observed engaging in collaborative interaction with another visitor, making up only 2.6% of observed users in this sample of participants (4/156 observed users). This age group distribution of observed users in this sample is somewhat consistent with the broader age group distribution across all observed users, as demonstrated above in Figure 4.15: Percentage of participants, by age.

Indirect – Dynamic: *Watching Other Visitors Interact*

The accessible design of the installation context and the purposefully large format of *the Gibraltar touch table* were intended to support an environment where visitors could watch one another interact with the technology. These measures contributed to the reasonable success of this instructional form, as the observation results show that the *indirect-dynamic* approach of simply watching other visitors interact with the touch table was observed in 14.0% of users (43/307 total observed users). The difference between the passive approach of watching other users interact and the much more active approach required to engage in giving or receiving instructional advice directly may be influenced here by both the *physical context* of the quieter, more traditional environment of *The Paintings* gallery, and by the arguably more restrained *social context* that *The Paintings* gallery created through the design of its installation context.

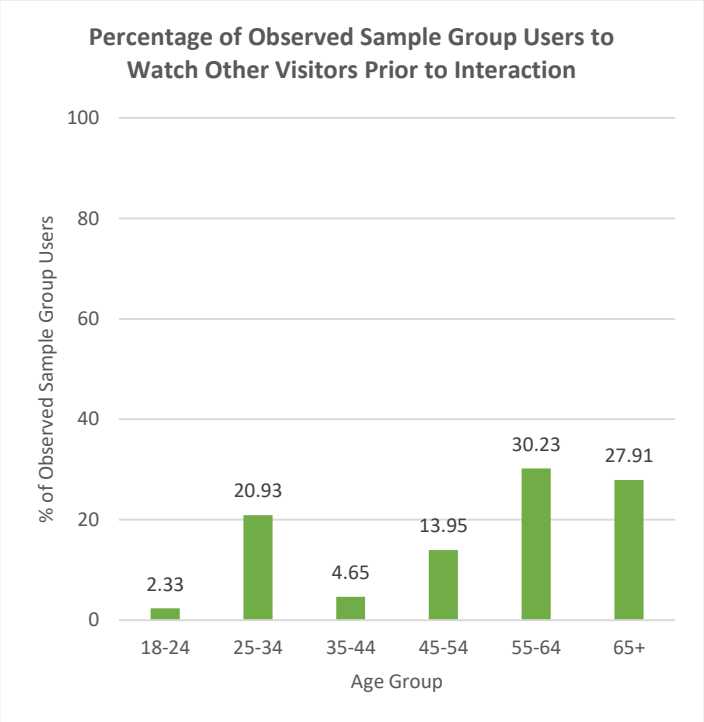


Figure 4.19: Percentage of observed sample group users to watch other visitors prior to interaction

The basic demographic breakdown of the 43 users who were

observed watching other visitors interact with *the Gibraltar touch table* prior to their own interaction shows a relatively consistent representation of sexes and age groups. There were slightly more female users observed, at 53.5% (23/43 observed users), with male users making up 46.5% (20/43 observed users). As Figure 4.19 shows, the distribution of observed users in this sample is highest in the 55-64 and 65+ age groups, with 30.2% and 27.9% of users represented, respectively (55-64: 13/43 observed users; 65+: 12/43 observed users). Similar to the age group distribution observed across users who engaged in collaborative interaction, the 25-34 age group are also well represented in their use of this *indirect-dynamic* instructional form, comprising 20.9% of users in this sample (9/43 observed users). Once again, the age group distribution of observed users in this sample is relatively consistent with the broader age group distribution across all observed users, as demonstrated above in Figure 4.15: Percentage of participants, by age.

Discussion

I use five sub-headings to act as a framework for this discussion: a comparison of instructional forms that were *available* and instructional forms *used*, a comparison of the *observed* use of instructional forms with the *reported* use of instructional forms, the actual impact of instructional forms on the user experience and their ability to interact, an examination of the instructional forms visitors used compared to the instructional forms that visitors would like to have had available, and an examination of assumptions and intentions of the development team compared with the interaction experiences of users.

Instructional Forms Available vs. Instructional Forms Used

Here, I discuss the instructional forms that were available with *the Gibraltar touch table* through their classification within two categories; *static* and *dynamic* instructions. The design of the UI, the "Touch to Start" attractor screen, and the ⓘ instruction option, are all forms of *static* instructions that the development team intentionally integrated into *the Gibraltar touch table*. Alternatively, the *dynamic* instructional forms, such as the potential for collaborative interaction,

watching other users interact, or receiving advice from other visitors or HSM staff are forms of instruction that may not have been available to all visitors who approach *the Gibraltar touch table*. In contrast to the *static* instructional forms, the museum can, and in some cases has, designed the installation context so that these *dynamic* forms of instruction could be available to visitors, but because of their *dynamic* nature, they cannot be considered reliable sources for instruction. Since the *dynamic* forms of instruction require either active or passive visitor-to-visitor interaction or behaviours, determining the impact of these instructions on the broader interaction experience of users can be complicated. Another way to consider these two categories of instructional forms would be to look at them in terms of their *social* or *personal* uses. By the definitions I propose, *dynamic* instructional forms require multiple visitors or users to function as instructional options and can, therefore, yield more *social* interaction experiences, while *static* instructions are integrated into the *personal* interaction experience and may not require other visitors or users in order to fulfil their instructional purposes for an interacting user.

Post-interaction questionnaire responses suggest that between 39.4% and 46.9% of participants that engaged with *the Gibraltar touch table* tended to rely on a trial-and-error approach to their interaction experience, while the observation results show that 21.8% of observed users did not appear to have made use of any instructional forms available (67/307 observed participants). Despite the differences in the results relating to this trial-and-error approach, which I discuss in more depth below, the results relating to the use of *static* and *dynamic* instructional forms vary and do seem to depend, to some extent, on the availability of the instructional form within the installation context. This assessment is particularly evident when examining the results relating to the *dynamic* instructional forms that call for *social* interactions among visitors. For example, the observation results show that only 0.7% of observed users received advice from other visitors to guide their interaction experience, while 14.0% of observed users took the opportunity to watch and learn from other visitors interacting with *the Gibraltar touch table* prior to commencing their own interaction experience. These two forms of *dynamic* instruction rely heavily on visitor behaviour and

the opportunity for visitor-to-visitor interaction, influenced greatly by the *social context* of the exhibition space.

In contrast, 50.8% of observed users were seen to engage in collaborative interaction with another visitor, with 97.4% of these users engaging in collaborative interaction within their own visiting group of two or more other visitors (152/156 observed users to engage in collaborative interaction). Although these results show that a very small percentage of observed visitors engaged in collaborative interaction with other visitors outside of their own visiting group, they highlight the greater likelihood that collaborative interaction is exponentially more likely to occur between visitors who attend the museum together than it is with visitors who are not already familiar with each other. The results suggest the limits of the success of the more *social* forms of *dynamic* instructions on users, namely that users prefer to exploit *social* instructional options when they can do so with visitors they are familiar with, rather than engaging with visitors with whom they have no pre-existing social relationship. However, observation of other interacting visitors, known or unknown, does seem to be more commonplace than other *dynamic* instructional forms that call for *social* interaction among potentially unfamiliar visitors. These results are consistent with other research into the *social* uses of touch-based interaction technology by multiple users within the museum context, which also found that users tend to prefer to engage in shared interaction within their social groups, to some extent avoiding interaction with visitors outside of their immediate social groupings (Peltonen et al. 2008; Chen et al. 2011).

Unlike the *dynamic* forms of instruction and their reliance on (*social*) visitor behaviour for availability, the *static* forms of instruction are more fixed in their very nature and suited better for *personal* interaction experiences by individual users, especially given the single-input touch-based interaction employed by *the Gibraltar touch table* that supports the interactions of a single user at one time. Due to their integrated design into *the Gibraltar touch table*, the ⓘ instruction option and the UI design were available to all users equally. That said, however, they still required a degree of interpretation in order for users to properly take advantage of the instructional guidance they

offered. The ⓘ instruction option, while providing users with textual and pictorial information about the instructed interactions, required that users seeking this instructional guidance would not only locate the appropriate icon amidst the visually stimulating on-screen content that the interactive installation offers, but that users would properly interpret the ⓘ icon as a source for instructional information. The responses to the post-interaction questionnaire show that between 13.3% and 17.2% of participants claimed to make use of this instructional form, while observation results indicate that only 10.8% of users actually accessed the ⓘ instruction icon during their observed interaction experience. Despite the consistent availability of this *static* instructional form, results indicate that its use was relatively limited among those visitors who interacted with *the Gibraltar touch table*.

The narrow use of the ⓘ instruction option among users could have several explanations, including the correct or incorrect interpretation of the ⓘ instruction icon and the information that it might offer, users not noticing this icon on a screen that already has multiple pulsating target spots superimposed onto the visualisation of the van Wieringen painting, or perhaps the user's preference for attempting a trial-and-error interaction approach. The precise impact of the ⓘ instruction icon on the interaction experience and how users interpret the ⓘ instruction symbol, in this and other in-gallery interactive installations, would make a compelling piece of supplemental research and could also provide deeper insight into the use of familiar icons in UI design that I am not able to infer from these evaluation results. Nevertheless, it is interesting to note that users tend to prefer *static* instructional forms that facilitate more *personal* interaction experiences over the *dynamic* instructional forms that may require *social* interactions with other visitors, with the exception of collaborative interaction. To some extent, the observation of other interacting visitors could be viewed as a kind of *parasocial* interaction approach, whereby an observing visitor may feel involved enough in the interactions of the observed user that social engagement or collaborative interaction is not necessary for the observer (Sohn 2011).

Although I include the "Touch to Start" attractor screen within the category of *static* instructional forms, due to its integration into the design of *the Gibraltar touch table*, I recognise that the availability of this instructional form is also subject to the interaction behaviours of other visitors who engage with the touch table. According to Molenaar, the addition of the "Touch to Start" attractor screen was meant to serve two purposes: to protect the touch table screen from "screen-burn", whereby an on-screen visual becomes permanently burned onto the diodes of the screen, and to attract visitors towards engaging in an interaction experience with the touch table. As the attractor screen only appeared after 90 seconds of inactivity, accessibility to this instructional form was reduced when several visitors to *The Paintings* gallery interacted with the touch table in a consecutive fashion. Despite the fact that the availability of this instructional form comes down to infrequent visitor interaction with the touch table, which is also subject to visitor flow through the exhibition space, the observation results show that 38.8% of observed users viewed the "Touch to Start" screen prior to commencing their interaction experience, and between 54.6% and 57.1% of post-questionnaire participants reported seeing this instructional form. Although availability of this *static* instructional form was subject to visitor interaction with *the Gibraltar touch table*, results suggest that it served its intended purpose for attracting and instructing visitors to interact with the touch table reasonably well.

Observed Use of Instructional Forms vs. Reported Use of Instructional Forms

Among the results I have presented, there are some discrepancies between the *observed use* of various instructional forms and the *reported use*, depending on whether the results originate from observation or post-interaction questionnaire data. In some cases, the variation in the results may be due to differences in the methodologies I employ for evaluation. For example, only 38.8% of observed users viewed the "Touch to Start" attractor screen, while between 54.6% and 57.1% of post-interaction participants included the "Touch to Start" screen among the forms of instruction they claim to have made use of. As I mentioned above, there may be many reasons for the variation

among these results, however since the availability of the "Touch to Start" screen depended on user interaction with *the Gibraltar touch table*, it is possible that the methodological approach for visitor observation may have some influence here. During observation periods, it was possible to observe the interaction behaviours of visitors who engage in shorter periods of interaction, including those visitors who would interact for less than a minute. As such, it was not uncommon to be able to observe a number of consecutive users in a row, at times without the 90-second break of inactivity that would allow the "Touch to Start" attractor screen to appear.

By contrast, the invitation to participate in the post-interaction questionnaire was extended to those visitors who engaged in an interaction experience that was approximately one minute or longer, and made with sensitivity to the experiences of the visitors being approached and the *social context* of the exhibition space for each potential participant. The results I derive from the post-interaction questionnaire may, therefore, indicate a correlation between in-gallery visitor flow, the opportunity to view the "Touch to Start" attractor screen, and the influence of the *social context* on providing an appropriate moment to approach visitors about their participation in the post-interaction questionnaire. With respect to the results relating to use of the "Touch to Start" attractor screen, there does not seem to have been any significant correlation with any of the demographic data collected using either evaluation method.

As I explained in Chapter 3, my choice to use a *post-interaction* questionnaire is due to my desire to avoid any possibility that I might influence the interaction behaviours of the participants I evaluate using this methodology. I also acknowledge that I only approached potential post-interaction questionnaire participants *after* they had completed their interaction experience with *the Gibraltar touch table* as an effort to avoid the Hawthorne effect, so that their interactions were not altered or influenced by their awareness of the subject of my evaluation or that they did not alter their personal responses to provide answers that they believed I was seeking (Adair 2000; Sedgwick 2012; Sedgwick and Greenwood 2015). For the most part, I believe this strategy was

successful and results for each methodology are relatively consistent; however, certain results relating to the use and non-use of instructional forms require further analysis.

Between the two evaluation methodologies, the observation results show that 21.8% of observed users did not appear to make use of any instructional form, while the responses from the post-interaction questionnaire suggest a higher degree of self-sufficiency among users. When asked, in Question 2.2, "How did you know how to use the touch table?" a total of 39.4% of participants provided a response indicating their preference for the trial-and-error approach, preferring not to make use of any of the available instructional options. Similarly, in Question 3.1, participants were asked more directly, "What kinds of instructions did you use with *the Gibraltar touch table*?" a total of 46.9% of participants claimed not to use the available instructions, instead opting for the trial-and-error approach, or, as one participant put it, they "just experimented" (Q24). While there is some intentional variation in the phrasing of these two questions, which may explain the different results, the post-interaction questionnaire results are still remarkably different from those of the observation periods.

The reasons for the inconsistencies between these results are not entirely evident and cannot solely be explained by the methodological differences of the data collection. Rather, I wonder if perhaps participants in the post-interaction questionnaire may have, either intentionally or accidentally, excluded forms of instruction they might have used from their responses in order to appear more self-sufficient, or technologically competent, with respect to their interaction behaviours. Alternatively, it may be possible that participants of the post-interaction questionnaire were not able to reflect upon their interaction behaviours and their use or non-use of instructional forms with the same level of accuracy and awareness employed for the data collection by the external observer during the observation periods.

The results of the post-interaction questionnaire show that participants favoured the trial-and-error approach to their interaction experience, compared to the observation results, however, there is also some discrepancy between the results relating to the use of the ⓘ instruction option

between the two methodologies. The observation results show that only 10.8% of users engaged with the ⓘ instruction option, while the post-interaction questionnaire results indicate that between 13.3% and 17.2% of participants made use of the ⓘ instruction option during their interaction experience. The variation between the observation and post-interaction questionnaire results may not be considered substantial, but it is possible that they may indicate some degree of the Hawthorne effect (Adair 2000; Sedgwick 2012; Sedgwick and Greenwood 2015). Although post-interaction questionnaire participants were not recruited for participation in this research prior to their interaction experience with the touch table, they were thoroughly informed of the nature and purpose of the post-interaction questionnaire as part of my invitation to participate in the research; the details of the research were also provided on the consent form attached to the post-interaction questionnaire that all participants signed prior to filling in their responses. It may be the case that some participants felt compelled to respond that they had used the ⓘ instruction option to somehow validate my research, however this notion is not possible to verify without having complete observation reports for each user who also participated in the post-interaction questionnaire. Unfortunately, it was not possible for me, as an independent evaluator, to simultaneously create a detailed observation record of a user's interaction experience with *the Gibraltar touch table* while, at the same time, prepare to approach potential candidates for participation in the post-interaction questionnaire without disrupting the *social context* of the exhibition space for other museum visitors within *The Paintings* gallery.

Whatever the reason behind the differences between the observation and post-interaction questionnaire results on the use of the ⓘ instruction option, it is interesting to acknowledge the way these results measure up to the results indicating user preferences towards the trial-and-error approach to interaction. As post-interaction questionnaire participants were able to select more than one response to each multiple-choice question, none of the participants who claimed to use the ⓘ instruction option also selected that they preferred the trial-and-error approach in Question 2.2; although, paradoxically, one user (Q62) did respond to Question 3.1 that they had both used the

ⓘ instruction option *and* that they did not make use of any instructions, without providing further explanation for their remarkable ability to use one instructional form while simultaneously claiming not to have used any instructions.

Impact of Instructional Forms on User Experience and Ability to Interact

The results that I have already presented provide insight into the forms of instructions that visitors use in relation to their interaction experience with *the Gibraltar touch table*, but determining the actual impact of the use of instructions requires further analysis and correlation between different sets of results. Since, according to the development team, interaction with the touch table was designed to be simple, requiring only single-touch input interaction with a limited number of available target spots, I focus this discussion on the use of the swipe left/right function in order to demonstrate the potential influence that different instructional forms have in guiding users to make this particular interaction. It was possible for visitors who interacted with *the Gibraltar touch table* to learn about the swipe left/right function through (a.) the use of the ⓘ instruction option, (b.) through watching other visitors interact, (c.) by engaging in collaborative interaction with another visitor, or (d.) by receiving direct advice from another visitor. I recognise that users may also have discovered the swipe left/right function through the trial-and-error approach to interaction or perhaps expect that this form of interaction may be possible, either through prior knowledge already gained through interaction with *the Gibraltar touch table* or other similar interactive installations, however my focus here remains with the impact of the described instructional forms. Most of these instructional forms rely on interactions made by or with other visitors, and the interactions they make may not necessarily include any indication that the swipe left/right interaction is possible. Only the ⓘ instruction option provided users with clear instructions to swipe the on-screen visual of the van Wieringen painting to the left or right to reveal additional target spots. Neither the “Touch to Start” attractor screen, nor its associated introductory window,

provided any indication that the swipe left/right interaction was possible, and as such, the "Touch to Start" screen is not included in this discussion.

Despite the seemingly straightforward interaction design of the touch table, only 29.3% of observed users made the swipe left/right interaction during their interaction experience (90/307 observed users). The inverse of this result shows that 70.7% of users did *not* make use of the swipe left/right function (217/307 observed users). The swipe left/right interaction is the only interaction that was not clearly evident from the on-screen UI design, therefore the limited use of this interaction may suggest that few users are making use of the available instructional forms that direct users to this interaction. Results show that users tend to prefer taking a trial-and-error approach to their interaction experience, however only 3.6% of observed users made the swipe left/right interaction without using any of the available instructional forms (11/307 observed users), suggesting that some form of instruction is necessary for users to discover the swipe left/right function.

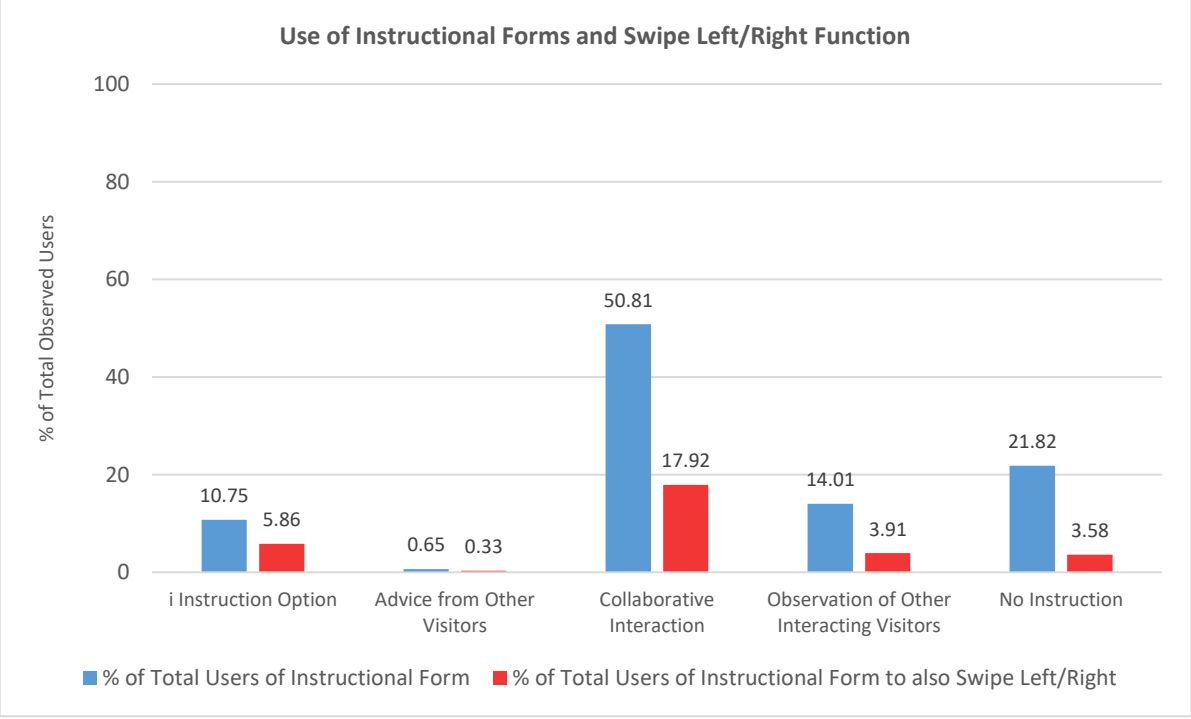


Figure 4.20: Use of instructional forms and swipe left/right function

Figure 4.20 presents the percentage of observed users to use the different instructional forms, together with the percentage of those users to also made use of the swipe left/right function.

The table clearly illustrates the effectiveness of the different instructional forms in guiding users to the swipe left/right function during their interaction experience with *the Gibraltar touch table*. While only 10.8% of observed users selected the ⓘ instruction option, 5.9% also used the swipe left/right function (18/307 observed users), suggesting that the ⓘ instruction may have been an effective form of instruction for 54.6% of the users who used this form of instruction and also made the swipe left/right interaction (18/33 observed users). Results relating to advice from other visitors as an instructional form are extremely narrow, yet may indicate that this *direct-dynamic* form of instruction could be an effective means of instruction; further research into this instructional form with a much larger sample group would provide more accurate results. Of the many visitors who were observed engaging in collaborative interaction with another visitor, totalling 50.8% of those observed, only 17.9% also made the swipe left/right interaction (55/307 observed users), suggesting that only 35.3% of users to engage in collaborative interaction were effectively instructed to the swipe left/right through this *direct-dynamic* instructional form (55/156 observed users). Observation of other interacting visitors has a similar level of effectiveness as an instructional form for guiding users to the swipe left/right function; of the 14.0% of users to use this instructional form, only 3.9% also swiped left/right (12/307 observed users), indicating that observation of other interacting users was only effective in instructing the swipe left/right function for 27.9% of those who used this *indirect-dynamic* instructional form (12/43 observed users). Of the 21.8% who engaged in interaction without any instruction, only 3.58% also made use of the swipe left/right function. If the trial-and-error approach is considered to be a form of self-guided instruction, then these results indicate that this method was only effective at achieving the swipe left/right interaction for 16.4% of its users (11/67 observed users), making it the least effective method for users to learn about the swipe left/right function.

These results merely provide *suggestions* as to the effectiveness of each instructional form for guiding users to the swipe left/right function on *the Gibraltar touch table*. Although the observation results cannot identify exactly which instructional form influences visitor interaction

behaviours, they can clearly show what interactions visitors made with *the Gibraltar touch table* and indicate visitor preferences for using certain instructional forms through analysis of their interaction behaviours. Theoretically, participants in this research had the opportunity to access multiple instructional forms during their interaction experience, therefore it is *possible* that users who managed to achieve the swipe left/right interaction could have been influenced by multiple forms of instruction. Results from observation periods on the number of instructional forms that users made use of suggest that most users relied on a single form of instruction to support their interaction experience. The data shows that 44.6% of observed users relied on a single instructional form, with 30.3% using two instructional forms, and only 3.3% of participants making use of three forms of instruction (133/307; 93/307; and 10/307 observed users, respectively). These results suggest that, for the majority of users who made use of the available instructional forms, only a single form of instruction seems to have been preferred or may have been considered necessary to provide the guidance they felt was needed to support their interaction experience.

Overall, the results relating to use of instructional forms and the swipe left/right function, and the limited use of this function among observed users, indicates a lack of communication about the possible interactions that could have been made with *the Gibraltar touch table*. Given that visitors seem to prefer taking a trial-and-error approach to their interaction experience, offering supplemental sources of text-based instructional forms may not have been the most ideal way to inform users of the potential interactions that can be achieved. Rather, as Oranje suggested, integrating on-screen elements or icons that would have informed users of the possibility to swipe the image to the left or right, such as using on-screen arrows on either side of the screen, for example, may have increased the number of users who made this interaction. She acknowledges that, "[interaction] should feel natural to you. Only by looking at it, you should have the feeling, the understanding. […] Intuition that leads you through." Furthermore, Oranje agreed that adding more textual instruction may not be the most ideal solution for instructing users to the swipe left/right interaction. Molenaar likewise recognises that offering clear visual cues to guide the user to the

appropriate interaction, at the appropriate time, can support the user through intuitive interaction, ideally limiting the need for on-screen instructional texts. Although the ⓘ instruction icon was added as a redundancy, what the development team did not seem to anticipate was the effectiveness of the ⓘ instruction option for guiding users to the swipe left/right function, despite its limited use, and the assumption that most users would have some pre-existing experience or familiarity with touch-based interaction. Even though 89.8% of post-interaction questionnaire participants responded that they owned a touch-based interaction device, such as a smartphone or tablet, any pre-existing knowledge of the interaction possibilities with similar touch-based interaction technologies does not seem to have been sufficient to intuitively guide users to the swipe left/right interaction on *the Gibraltar touch table*.

Instructional Forms Used vs. Instructional Forms Users Want

The results of the museum visitor evaluation offers important evidence on the behaviours and preferences that visitors had during their interaction experience with *the Gibraltar touch table* and their use or non-use of the available forms of instruction available to support their interaction experience. Particularly informative are the results of the visitor observation periods, which provide valuable data on visitor interaction behaviours with the interactive installation, collected without influencing these behaviours. Whereas the observation results offer insight into the actual interaction behaviours of users, the post-interaction questionnaire provides participants with an opportunity to reflect upon their interaction experiences and provide their opinions about their interaction with *the Gibraltar touch table*. Moreover, while the results of both evaluation methodologies yield results relating to the different instructional forms that users did or did not make use of during their interaction experiences, only through the post-interaction questionnaire were participants able to offer insight into the forms of instruction that they would like to have had available during their interaction experience with *the Gibraltar touch table*.

Within the post-interaction questionnaire, I included two questions that ask participants to reflect upon their personal need for instruction, in relation to their interaction experience with *the Gibraltar touch table* and, in a much more general way, in relation to other in-gallery interactive installations found within other museum exhibition spaces. In Question 3.2, I ask participants to provide their opinion on which forms of instructions they would like to have had available with *the Gibraltar touch table* to support their interaction experience with this particular interactive installation. In Question 3.3, I ask more broadly about touch tables in museum exhibitions, asking participants to suggest which kinds of instructions they would personally like to have available when they encounter touch-based interactive technologies in museums. For both questions, I offer the same multiple-choice responses: someone from the museum to show me how it works, pictures showing how the interaction works, video or animation showing how interaction works, clear and easy-to-understand design using familiar icons, a step-by-step guide to interaction, and I include an open space for participants to offer their own written response.

The responses for Question 3.2, which specifically concerns the instructions for *the Gibraltar touch table*, 46.4% of participants selected that they would have liked to have had a clear and easy-to-understand design using familiar icons (45/95 responses; five participants failed to provide a response), suggesting that they would rather rely on visual cues and their own previous experiences with similar interactive technologies than seek out explicit instructions for their interaction experience with *the Gibraltar touch table*. Other participants indicated their preferences for other visual forms of instructions, with 10.5% in favour of pictures that show how interaction works, 8.4% preferring a step-by-step guide to interaction, and 5.3% seeking video or animated instructions (10/95; 8/95; 5/95 responses, respectively). Only 1.1% of participants suggested that they would like to have someone from the museum available to show them how interaction with the touch table works (1/95 responses). The written responses, offered by 44.2% of participants (42/95 responses), suggest that the design of the installation requires no further instruction. In fact, 88.1% of written responses acknowledged that the design of the installation was simple enough not to require

instruction for interaction (37/42 written responses). Only three of the written responses offer suggestions for instruction they would like to have with *the Gibraltar touch table*; Q50 suggested adding a sliding symbol to indicate the slide left/right function, Q66 suggested that the language change option could be clearer and would like additional language options, while Q75 recommended adding a small printed sign to invite visitors to touch the screen. The responses overwhelmingly indicate the preference visitors have for relying on the UI design and their familiarity with other touch-based interaction technologies, rather than seeking out instructions that could guide users through their interaction experience with *the Gibraltar touch table*. Furthermore, the responses align with the results that demonstrate the participants' propensity for taking a trial-and-error approach to interaction, which likely relies on the use of visual cues and previous experience with similar interactive technologies to guide their interaction experiences.

Asking participants to reflect in a more general sense on the kinds of instructions for interaction that they prefer to find with touch-based interactive installations in other museums and exhibition spaces, the results from Question 3.3 are largely consistent with the results of Question 3.2, showing that the majority of participants prefer to find an in-gallery interactive installation that is designed in such a way that it is clear and easy-to-understand, using familiar icons (60/95 responses; five participants failed to provide a response). Participants also favour visual forms of instruction, with 21.1% of participants suggesting they prefer pictures that demonstrate the required interactions, while 10.5% prefer a step-by-step guide to interaction, and 4.2% would like video or animated instructions for interaction (20/95; 10/95; 4/95 responses, respectively). Only 2.1% of participants suggested that they would like to have someone from the museum to demonstrate how interaction works (2/95 responses). A total of 22.1% of participants provided written responses to this question, and once again, the participants used this opportunity to strongly suggest that good design of a touch table interactive installation should require no instruction for how interaction works (21/95 responses). As Q11 advises, "if they don't work without instructions, they are obsolete."

The results from these two questions about visitor preferences for instructions show that what the participants want, or rather what they *expect*, are interactive installations that naturally guide users to the possibilities of interaction through clear, intuitive design. This is likely the primary reason that so many participants attempted to interact with *the Gibraltar touch table* using a trial-and-error approach, rather than seeking out the available instructional forms prior to commencing their interaction experience. The simplicity of the interaction design that *the Gibraltar touch table* employed, requiring single-touch input to access the target spots that provide users with information about the van Wieringen painting, seems to have met the expectations of most users who engaged with the interactive installation. However, as the evaluation data implies, and as members of the development team recognise, additional design measures to indicate the swipe left/right function in a manner that does not require users to access supplemental instructions would be helpful for users, as only a third of observed users actually managed to discover the swipe left/right function during their interaction experience. In fact, the development team acknowledges the importance of clear UI design for supporting the interaction experiences of their users, ultimately agreeing with what Q50 suggests with regards to incorporating some kind of symbol or icon into the UI as a way to instruct users about the swipe left/right interaction. Furthermore, the ⓘ instruction option, which the development team included primarily as a redundancy rather than as a necessary source of instruction, served as an effective form of instruction for those who accessed it, but for users who did not feel the need to seek out additional instructions, it remained concealed behind the ⓘ icon.

Development Team Intentions/Assumptions vs. User Interaction Experience

During my interviews with the members of the development team, different team members identified a number of goals or intentions they had for the user interaction experience with *the Gibraltar touch table*, in some cases indicating their assumptions for how users would engage with the interactive installation. They intended that interaction with the touch table be simple and easy

to achieve for a wide range of potential users, while at the same time, providing an interaction experience that members of their target audience for *The Paintings* gallery would be able to engage in. Presumably the quality of the informative content offered by *the Gibraltar touch table* similarly reflects these goals, providing content suitable for a range of potential users, as well as those within the target *persona* group.

Generally, the decision by HSM and the development team to employ an interactive touch table within *The Paintings* gallery, which had an arguably more traditional object-centric exhibition approach than other parts of the museum, seems to have worked well for the visitors who entered this exhibition space and who participated in this research. In an effort to gauge participant opinion about the usability and enjoyment of their interaction with *the Gibraltar touch table,* participants in the post-interaction questionnaire were asked to respond to two open-questions about their interaction experience. In Question 4.1, participants were asked whether or not they found the touch table "easy-to-use" and Question 4.2 asked participants whether or not they enjoyed their interaction experience. Each question offered participants an opportunity to respond with an affirmative or negative response, as well as an opportunity to provide a more elaborate written response.

The overwhelming majority of post-interaction questionnaire participants found *the Gibraltar touch table* easy to engage with, with 99% of participants responding that the touch table was "easy-to-use", and accompanying written responses offering insight into *why* participants felt this way (99/100 responses). 77.6% of written responses mention the clarity, intuitiveness, or simplicity of the design, with a further 7.9% making specific mention that the design supported a trial-and-error approach (59/76; 6/76 written responses, respectively). Only 4.0% of written responses made any mention of the instructions for interaction with the touch table, while 10.5% made a link between the touch table and other touch-based interaction technologies, such as smartphones or iPhones (3/76; 8/76 written responses, respectively). Two participants did answer "No" to the question; however, one failed to provide a written response (Q9), while the other

suggested the language change option could have been more obvious (Q1).[11] Overall, these results suggest that participants generally acknowledge the simple design of the touch table as the central factor that contributes to the ease-of-use of the touch table, confirming that the intended interaction experience designed by the development team aligns with the actual interaction experiences of users.

The results of the responses to Question 4.2, about whether participants found their interaction experience with *the Gibraltar touch table* to be enjoyable, and why, shows a similarly positive outlook on the behalf of the participants, with 99% of participant responses indicating that participants had enjoyed their interaction experience (98/99 responses). Of the participants who responded positively, 44.9% identify the educational or information elements associated with the touch table as contributing to their enjoyment, with 17.4% re-stating their opinion that the touch table was "easy-to-use", and an additional 4.1% mentioning the design of the interactive installation in their written response (44/98; 17/98; 4/98 written responses, respectively). Only 4.1% of participants explicitly indicate the interactive technology itself as a factor that contributes to their enjoyment of the interaction experience they engaged in with the touch table (4/98 written responses). Only a single user responded that they did not enjoy their interaction experience; Q9, who said, "Nee, want it ben 80 jaar", which translates to, "No, because I am 80 years old." Unfortunately, Q9 failed to provide further detail as to the exact reasons behind this age-related lack of enjoyment, but the response suggests that even members of the "Dick" *persona* target audience that the development team were using during the design process may not find their interaction experience with *the Gibraltar touch table* entirely enjoyable.

The most striking assumption that the development team made about their users relates to the swipe left/right function and their expectation that users would intuitively make the connection between the size of the van Wieringen painting in front of *the Gibraltar touch table* and the limited

[11] Puzzlingly, one participant, Q1, responded both "Yes" and "No" to this question, without providing further explanation for their duplicitous response.

view of the painting visible on-screen. This expectation seems to originate from a combination of the design of the installation context, the potential interactions that can be made with this kind of interactive technology, and the close proximity of the van Wieringen painting to the touch table, which, collectively, was meant to encourage visitors to make the connection between the on-screen visualisation and the possibility to swipe the image to the left or right to reveal more of the painting. Ultimately, this assumption seems to have backfired, as few users of *the Gibraltar touch table* intuitively made the swipe left/right interaction to access the full array of on-screen target spots. Although instructions were available, both *directly* and *indirectly* that could indicate the possibility for the swipe left/right function, results show that few users deliberately made use of the available instructional forms and fewer were receptive to the instruction to swipe left/right to expose more of the on-screen painting. Despite the fact that the members of the development team recognise this oversight of the design, no changes were made to *the Gibraltar touch table* to remedy this design flaw, enduring until the removal of the installation in 2019. I was not offered any justification for why this usability issue had not been corrected by the development team, but I would suspect that making such a relatively minor technical adjustment to *the Gibraltar touch table* was not considered to be a high priority for HSM, since the interactive installation worked reasonably well, even if users did not discover the swipe left/right function, and since HSM continues to prioritise the (re)-development of exhibition spaces and interactive installations throughout the museum, which likely requires substantial resources and budget.

Conclusions

As the evaluation results have shown, the development team behind the creation of *the Gibraltar touch table* at HSM have managed to communicate instruction for visitor interaction with *the Gibraltar touch table* using a combination of *static* and *dynamic* forms of instruction. However, the effectiveness of the strategy used by HSM to communicate instruction for visitor interaction could have benefitted from more rigorous user testing throughout the development process and

once the interactive installation was fixed within its final installation context, and the correction of any user interaction issues identified through testing and visitor evaluation. As I conclude here, there are three main issues that affect the potential impact of the touch table: the influence of the installation context on user interaction, the importance of communication of instructions for interactions, and finally, the effect that the available instructional forms had on the interaction experiences that users had with *the Gibraltar touch table*.

Influence of the Installation Context on User Interaction

The installation context that *the Gibraltar touch table* was presented in does appear to have influenced user interaction with the touch table, just as the presence of *the Gibraltar touch table* influenced visitor flow through *The Paintings* gallery. The physical proximity of *the Gibraltar touch table* to the entry of *The Paintings* gallery could occasionally create a bottleneck, interrupting the flow of visitors through the exhibition space. When there were several visitors who may be interested in interacting with the touch table, or when a tour group entered the gallery, other visitors may have been blocked from viewing the paintings on display or the touch table itself. The physical size of *the Gibraltar touch table* could allow multiple visitors to surround the touch screen and view its available content, but when visitor flow through *The Paintings* gallery was substantial, it may have been difficult for interested visitors to access the paintings or on-screen content they were seeking. The addition of the audio guide trigger, placed directly in front of the van Wieringen painting, could similarly disrupt the flow of visitors through the gallery. In some cases, visitors listening to their audio guides would block access to *the Gibraltar touch table*, preventing other visitors from commencing their own interaction experiences; a problematic feature of the audio guides that has been recognised by HSM and warrants further research.

Although the interaction design of *the Gibraltar touch table* could only accommodate the interactions of a single user at a time, the size of the touch table and its position in the centre of the room was designed to allow multiple visitors to view the on-screen content. Observation results

indicate that this approach was successful, proving that visitors were able to watch each other interact and even interact together in a collaborative fashion, even though users had to take turns interacting with the on-screen content. Collaborative interaction seemed to be a popular interaction approach, especially for visitors who entered the gallery in visitor groups of two or more people, but few visitors appeared willing to interact with other visitors outside of their own visiting group, a result consistent with earlier research on collaborative interaction with interactive technologies in public spaces (Peltonen et al. 2008; Chen et al. 2011). Results also show that visitors rarely exchanged advice on how interaction with the touch table works. However, the installation context could allow visitors the opportunity to watch other visitors interact with the touch table, serving as a functional *indirect-dynamic* instructional form that could support the interaction experiences of visitors who engaged in interaction with the touch table. The differences may be partially explained by the preferences individual users have for engaging in either *social, personal,* or even *parasocial* approaches to their interactions with in-gallery interactive technologies (Peltonen et al. 2008; Sohn 2011). For users who prefer a more *personal* interaction experience, collaborative interaction or engaging in discussion about the usability of the installation may be unlikely to occur, while these kinds of interaction may be preferred for users who like to engage in more *social* interaction experiences, and for visitors who observe the interactions of other users, a more *parasocial* interaction experience may be sufficient.

Compared with other galleries within HSM, *The Paintings* gallery had more of a "look, but do not touch" feel that is consistent with the object-centric approach found in many traditional museum exhibition spaces. Encouraging interaction by its very existence and through the "Touch to Start" attractor screen, the presence of *the Gibraltar touch table* in *The Paintings* gallery did not seem to negatively impact the exhibition atmosphere for visitors who were not interested in engaging with the interactive touch table, unless the gallery was unusually crowded, when physically moving past the interactive touch table could be challenging for some. For those visitors who did choose to interact with *the Gibraltar touch table*, it seemed to effectively serve its purpose as a

source of supplemental information about the van Wieringen painting it depicted. Although the development team recognised that there were certain shortcomings of the design, they generally seem quite satisfied with the interactive installation they offered in *The Paintings* gallery and were aware of the positive feedback that their visitors provided, when asked.

Importance of User Testing

To produce a high-quality product, usability evaluation is a necessity to ensure the needs of the user are being met and that the product functions as intended (Shackel 2009; Stewart 2009; Speicher 2015). When it comes to interactive technologies designed for installation within the context of museum exhibition spaces, usability testing with real museum visitors, within the final installation context, can ensure that visitors are able to interact with the installation and that it functions, as intended, to meet the interaction goals set forth by the development team responsible. According to the members of the development team interviewed about *the Gibraltar touch table*, the course of usability testing that took place prior to the re-opening of HSM and the availability of the touch table to visitors in *The Paintings* gallery was restricted to paper prototype testing and limited user testing, mostly by HSM staff and a few other external participants. User testing was primarily conducted outside of the final installation context, due to the development timeline of the project and the availability of the exhibition space for in-gallery testing, which was difficult to arrange as a result of the work being done to prepare for re-opening of the museum in 2011. Members of the development team also indicated financial concerns as a cause for the limited amount of user testing, namely that the budget allocated for user testing was not sufficient to allow for thorough user testing within the installation context. Given the very large budget for the physical renovation of the museum, it seems HSM did not prioritise user testing of the in-gallery interactive technologies to the extent that they perhaps should have.

Despite the limited amount of user testing conducted during the design and development phases of the project, some evaluation activities, formal and informal, have been conducted since

the re-opening of HSM that have indicated certain flaws in the design of *the Gibraltar touch table*. One such fault, which was ultimately corrected, was the dynamic lighting of the van Wieringen painting to generate a spotlight on the actual maritime painting in front of the interactive installation when a user interacting with the touch table selected a target spot. According to the development team, the intention was that this lighting change would draw the attention of the user interacting with the touch table to view the actual painting, rather than keeping their focus solely on the interactive technology. In principle, this is an interesting approach for encouraging visitors to look closer at the museum object, perhaps creating a greater appreciation for the painting on display, but in reality, the dynamic lighting change on the van Wieringen painting was disruptive for those visitors who were not interacting with *the Gibraltar touch table* or aware of its influence on the lighting presentation associated with the painting. Oranje and van Keulen both acknowledge the visitor feedback that HSM received once the museum was open to visitors and agreed that suspending the dynamic lighting feature was the best solution for ensuring the visitor interaction with *the Gibraltar touch table* would not interfere with the experiences of those visitors who were focused on the painting and not the interactive installation. Although HSM took a bold step to attempt this dynamic interaction approach, and were relatively quick to remove the feature once they found that it was having a negative impact for some visitors, user testing of this feature in the installation context may have provided early insight into the visitor response so that the dynamic lighting system could be suspended or adjusted prior to the re-opening of the museum. Furthermore early user testing of this feature could have potentially saved HSM not only from receiving undesirable feedback about *the Gibraltar touch table* and its negative influence on the visitor experience, but also could have saved HSM financial resources that were spent on the acquisition and installation of specialised lighting required for this feature which has since been suspended.

The other design flaw that could have been identified and possibly prevented through a rigorous course of user testing, of course, relates to the swipe left/right function. With this particular interactive feature, user testing could have identified the error in the assumption made by the

development team that users would critically compare the actual size of the van Wieringen painting with the on-screen visualisation and attempt to move the on-screen image to the left or right. The flaw in the assumption that users would behave in a specific way to discover the swipe left/right function aside, the development team also chose not to incorporate additional on-screen features, like left or right arrows, so as to maintain the simplicity of the on-screen UI and not potentially risk overwhelming users with too many on-screen elements. When selected, the ⓘ instruction option informed users of the swipe left/right interaction, but this does not seem to be a form of instruction that was *direct* enough for guiding the majority of users to make the swipe left/right interaction; it required users to seek out this instruction, to correctly interpret the meaning of the ⓘ icon as a source for instruction, and to follow the instructions that were offered once they selected the ⓘ instruction option. While some users certainly could follow the behaviour patterns that the development team had assumed, discovering the swipe left/right interaction through critical examination of the van Wieringen painting with the on-screen visualisation, user testing in the installation context would have shown that most visitors who interact with the touch table require clear and direct instruction to be properly informed of the availability of this particular interactive feature. Although this fault in the UI design was identified by the development team once *the Gibraltar touch table* became available for visitors, no changes to the installation were made to correct it. The reasons for not correcting this issue were not elucidated during the interviews with the development team members, leaving me to speculate that HSM considered the installation to be functional enough for its visitors and may not have wished to spend further resources, financial or otherwise, correcting what HSM may have deemed to be a relatively minor usability issue. Considering that 70.7% of observed users did not discover the swipe left/interaction, failure to make this relatively minor change to the UI could be interpreted as a somewhat complacent attitude towards the usability of *the Gibraltar touch table* for visitors.

Impact of Instructional Forms on the User Interaction Experience

The results of this research show that, due to the simplicity of the design of *the Gibraltar touch table* and the limited number of interactions available, users did not need to use many, if any, instructions in order to be able to have a satisfying interaction experience with the touch table. Within this chapter, I have presented the range of instructional forms that are available to users who wish to engage with *the Gibraltar touch table*, using the data collected through visitor observation and a post-interaction questionnaire to demonstrate the impact of the different instructional forms on the user interaction experience. The data indicates that some forms of instruction appear to have been more popular among users than others, such as user participation in *direct-dynamic* collaborative interaction with other visitors, or access to the *direct-static* "Touch to Start" attractor screen, but the actual effectiveness of these instructional forms remains unclear as they are subject to unpredictable, highly variable visitor behaviours. For example, access to the "Touch to Start" attractor screen required at least 90 seconds of inactivity with *the Gibraltar touch table* for this instructional form to appear on-screen, while the interactions that may have occurred during collaborative interaction, though instructive, may not have achieved the full range of possible interactions that were offered by the touch table. The same may be said of the *indirect-dynamic* instructional form of watching other visitors interact with the touch table, as this form similarly relied on the variable interaction behaviours that other visitors interacting with the touch table engage in.

The form of instruction that had the strongest evident impact on the interaction experience of users for achieving the range of available interactions is the ⓘ instruction option, although it was also one of the least utilised forms of instruction observed among users who engaged with *the Gibraltar touch table*. The results show that the use of the ⓘ instruction option was the most effective instructional form for instructing users to make the swipe left/right interaction, as Figure 4.20 demonstrates. However, the limited use of this instructional form among all participants in this research suggests that supplemental measures to instruct users of the swipe left/right interaction

would have been advantageous for encouraging a wider set of users to make this interaction, which would expose more of the on-screen visualisation of the van Wieringen painting and associated on-screen target spots, thereby providing access to more of the information layer offered by the touch table.

Overall, the impact of the instructional forms that were available with *the Gibraltar touch table* is influenced by the instructional needs of each user who approaches the touch table and, to some extent, their preference for having a *personal*, *social*, or *parasocial* interaction experience. The results of visitor observation show that 21.8% of users were able to interact with the touch table without seeking out any of the instructional forms, while the results of the post-interaction questionnaire indicate that between 39.4% and 46.9% of participants claim to not have used any of the available instructional forms during their interaction experience. With so many users opting for this trial-and-error approach to interaction, it seems that the development team were successful in designing an installation clear and simple enough that many users were satisfied to interact without needing to seek out additional instructional measures to guide their interaction experience, allowing these users to engage in a primarily *personal* interaction experience. Even for those users who did make use of the available instructional forms, the majority of those observed made use of only a single instructional form, with fewer users seeking out two or more instructional forms to support their interaction experience. Although not definitive, these results suggest that for the users who only elect to use a single form of instruction, whichever form it may be, it was enough to satisfy their instructional needs and allow them to interact with *the Gibraltar touch table* in a gratifying manner.

Chapter 5: Case Study 2: *The Painting Lens*, Gallery One at the Cleveland Museum of Art

Introduction

The host museum of the second case study is the Cleveland Museum of Art (CMA), located in Cleveland, Ohio, USA. Although labelled as an "art museum", the collections held by the CMA also include objects of historical and cultural significance from the past six centuries. To provide visitors with an introduction to the diverse collections on display, the CMA developed an interactive exhibition space, known as Gallery One. Within Gallery One, a range of in-gallery installations employing touch-based or gesture-based interactive technologies were developed to allow visitors the opportunity to engage with a curated sample of the CMA collections. Here, I focus my research on one of the touch-based interactive installations presented within Gallery One: a touch-screen installation referred to as *the Painting Lens*.

I examine this particular interactive installation within its presentation context and describe the available forms of instruction that are meant to support the interaction experiences of visitors. I interviewed members of the development team responsible for the creation of *the Painting Lens* and analysed how they intended to communicate instructions for interaction within the installation to visitors through the design of both the user interface (UI) and the installation context. To evaluate the experiences of the visitors who elected to interact with *the Painting Lens*, I used results from both visitor observation and a post-interaction questionnaire to determine the effectiveness of the available forms of instruction intended to guide users through their interaction experience with the installation and whether or not the aims set forth by the development team relating to user interaction experiences were achieved. My aim throughout is to identify the ways the CMA communicated instruction for interaction with *the Painting Lens* to their visitors. I explore how the CMA invested time and resources to understand their audience, defined clear goals for user

interaction experiences, and conducted user testing to ensure their user interaction experience goals were achieved.

Figure 5.1: The Armor Room in the 1916 Building (Daderot 2012)

The Cleveland Museum of Art: Profile and History

In 2016, the CMA was named as the second-best art museum within the US by Business Insider, outranked only by the Metropolitan Museum of Art (Grebey 2016), but the CMA website describes the museum as "one of the top comprehensive art museums in the nation" (The Cleveland Museum of Art 2015d). It is particularly renowned for the breadth of its collections, specifically those within the Egyptian and Asian departments, but also includes significant offerings in its American and European art departments (Time Out 2015).

The initiative to create a museum for the people of Cleveland was conceived in 1913, but the museum did not officially open its doors to the public until 9 June 1916 (The Cleveland Museum of Art 2015d). Situated on the north side of Wade Lagoon, the CMA was initially housed in a neo-classical, white marble building designed by Hubbell & Benes, now known as the 1916 Building (The

Cleveland Museum of Art 2015d). Over the past century, the exhibition space has grown substantially from the original 1916 Building, including expansions in 1958, 1971, and 1983 (The Cleveland Museum of Art 2015d). More recently, the entire museum has undergone another large-scale renovation and expansion project that increased the exhibition space by 33 percent, including the addition of Gallery One (The Cleveland Museum of Art 2015h).

According to the mission statement of the CMA, the museum aims to "help the broadest possible audience understand and engage with the world's greatest art while honouring the highest aesthetic, intellectual, and professional standards" (The Cleveland Museum of Art 2015d). The collections of the CMA total nearly 45,000 objects, comprising nineteen departments that cover over 6000 years of creative human expression (The Cleveland Museum of Art 2015c), including:

1. African Art
2. American Painting and Sculpture
3. Egyptian and Ancient Near Eastern Art
4. Greek and Roman Art
5. Art of the Americas
6. Chinese Art
7. Contemporary Art
8. Decorative Art and Design
9. Drawings
10. European Painting and Sculpture
11. Modern European Painting and Sculpture
12. Indian and South East Asian Art
13. Islamic Art
14. Japanese Art
15. Korean Art
16. Medieval Art
17. Photography
18. Prints
19. Textiles

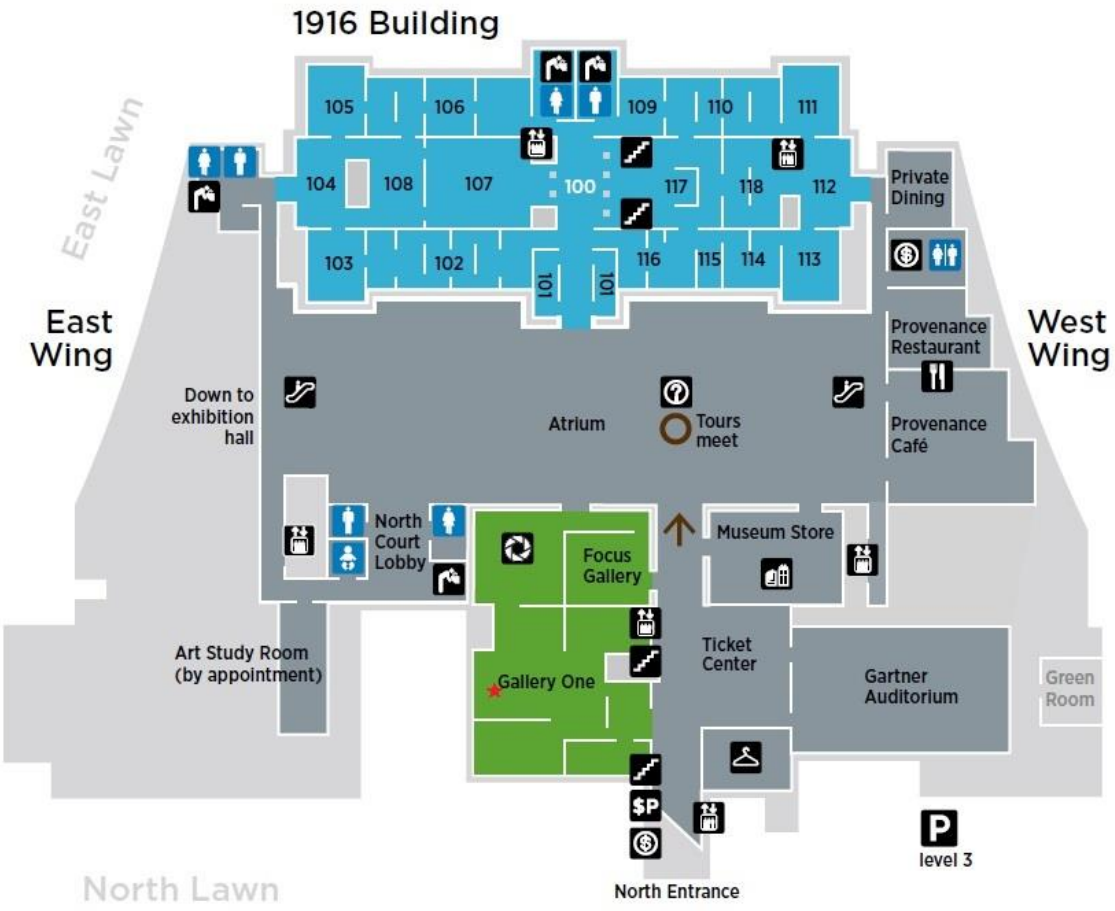


Figure 5.2: CMA, Level 1. The location of *the Paintings Lens* is marked with a small red star within the green area of Gallery One (The Cleveland Museum of Art 2015f)

The CMA is open to the public six days of the week and is able to offer free admission for its visitors to the permanent collection thanks to financial support from individual donors, foundations, and commercial enterprises in Ohio, in addition to community support from the Cuyahoga Arts and Culture program, which funds local cultural activities, and government support via the Ohio Arts Council (The Cleveland Museum of Art 2015c). The display of the collections is done within thematic groupings, exhibited in the permanent galleries throughout the four wings of the CMA: the 1916 Building, the East Wing, the West Wing, and the North Building (see Figure 5.2). The museum also produces multiple temporary exhibitions each year, for which there is often a visitor entry fee, despite the dedicated sponsorship often associated with such temporary exhibitions. In 2016, to celebrate the centennial of the opening of the CMA, a series of special loans were exhibited in the

permanent galleries throughout the year, and the CMA also arranged a program of temporary exhibitions and community engagement events (The Cleveland Museum of Art 2016d).

Figure 5.3: The Reinberger Gallery in the 1916 Building (Rabesphoto 2008)

The CMA offers an array of activities, tours, workshops, and events, both in the museum and in the community, to engage its local audience (The Cleveland Museum of Art 2014). In 2009, the museum formed a Research and Evaluation department to generate a greater understanding of the visitors who come to the museum: who they are, what they enjoy, and how receptive they are to the messages being conveyed (Weaver 2012). Although the Research and Evaluation department is quite active within the museum, their results and reports are primarily internal documents, and therefore, are not available for external use without permission.[12] I was given limited access to a small number of summary reports relating to the Gallery One user experience evaluation results, however, while the results presented within these reports have little relevance to the research I present here, they are an indicator of the volume and variety of evaluation activities conducted by the Research and

[12] Partial results have been published and/or referenced across several articles and reports (e.g.: Alexander, Barton, and Goeser 2013; Alexander 2014a; 2014b; Chun, Gasparotti, and Cairns 2014a; 2014b), which I present when relevant. Reports relating to evaluation activities conducted during the development phases of *the Painting Lens* specifically were not made available, however reports summarizing evaluation results relating to Gallery One, Studio Play, and the ArtLens app were provided.

Evaluation department, including timing and tracking visitor interaction, usability testing, one-on-one interviews, Google Analytics tracking, and long-term participant evaluation, interviewing participants up to two years after their visit to determine any long-term impacts (Bolander and Stockdale 2015; Bolander 2015a, 2015b, 2015c).

Since re-opening its doors in 1969, the CMA has welcomed an impressive total of over 44 million visitors (The Cleveland Museum of Art 2016f; K. N. Schreiber 2019). While numbers for visitor attendance in 2019 are not yet available, visitor numbers for 2018 reportedly increased 31% from the previous year, welcoming 769,435 visitors and surpassing the museum's previous record for annual visitors (K. N. Schreiber 2019). Like so many other museums that aim to provide engaging museum experiences for the widest possible spectrum of potential visitors, the CMA claims it is their goal to offer *something for everyone*, in nearly every space within its walls. Although the CMA considers the demographic make-up of its visitors to be broad, there are certain audience groups that the museum identifies as target audiences for certain events or programming within the museum. For example, the CMA has, in the past, offered a range of tours for visitors with an array of interests; the twice-monthly Stroller Tours were designed for parents and their toddlers to have a shared museum experience that may have included crying infants, while the seasonal Art and Fiction Book Club included discussion about literature and artworks, and was probably better suited for adult visitors without accompanying children (The Cleveland Museum of Art 2014, 2016h, 2016a). More recently, the CMA has published a plan aimed at improving their diversity, equity, and inclusion through better involvement and representation of the cultures presented in the museum and the members of the local community, with associated exhibitions and programming developed to support their goals (The Cleveland Museum of Art 2019).

Figure 5.4: Gallery One, thematic exhibition space – *The Painting Lens* on the right

Gallery One

Between 2002 and 2013, the museum underwent an ambitious expansion and renewal project intended to dramatically increase the available exhibition space, create new public spaces for education and community engagement programs, restore the 1916 Building, and create the exhibition space known as Gallery One (The Cleveland Museum of Art 2013a). On the CMA website, Gallery One is described as a 1,115 square meter exhibition space that serves as an "interactive learning centre" (The Cleveland Museum of Art 2015g, 2015i). The purpose of Gallery One, in its original form, was to offer visitors an introduction to the broad spectrum of ideas, themes, materials, and time periods exhibited in the permanent galleries of the CMA, while simultaneously offering a range of interactive installations to support visitor engagement with the collections (Alexander 2014b). The curated selection of artworks on display were chosen to represent the departments found within the permanent collections, giving visitors an impression of the range of the collections held by the museum, ideally without overwhelming or intimidating them (Alexander, Barton, and Goeser 2013).

The design of the Gallery One exhibition space included three sections:

1. *Studio Play*: To the left, after entering Gallery One, was the interactive space designed for younger museum visitors, known as Studio Play. Here, the target audience was primarily families with children, but the interactives were designed to be usable by visitors of all ages.

The space included several interactive elements that offered visitors a range of engaging games and creative interactive experiences. For example, the “Line and Shape” interactive experience asked visitors to draw lines and shapes on the touch-screen, which would be rapidly analysed and matched to a piece from the permanent collections that would then be shown on-screen, or the “Reveal and Zoom” interactive, which allowed visitors to use an interactive video wall to examine artworks in detail through gestures and motion-tracking technology (Alexander 2014b; The Cleveland Museum of Art 2015j). Studio Play was temporarily closed to the public in the spring of 2016 in order to initiate the renewal of the space and install new interactive technologies, which unfortunately coincided with my own evaluation activities and may have influenced the visitor flow through Gallery One during the evaluation periods.

2. *Thematic Exhibition Space*: The main exhibition space within Gallery One was sub-divided into six curated thematic areas, each associated with an interactive touch-screen, called a Lens: *the Sculpture Lens, the Lions Lens, the Stories Lens, the Globalism Lens, the 1930’s Lens*, and *the Painting Lens*. Each Lens offered visitors the opportunity to engage with curated visual, textual, and video content associated with the thematic collections on display. The interactive appeal for the Lenses was also due to the different interactive experiences they offered, with each Lens offering between one and five interactive experiences. *The Sculpture Lens*, for example, used a Kinect sensor to compare the faces visitors would make with portraits and sculptures from the collection in the “Make a Face” interactive game, while *the Painting Lens* offered visitors a chance to virtually paint in the style of Jackson Pollock or Joan Mitchell in the “Make Your Mark” interactive option. (Alexander 2014b; The Cleveland Museum of Art 2013a, 2015e)
3. *Collection Wall*: Beyond the thematic exhibition space, close to the Ames Family Atrium, lies the Collection Wall: the largest touch-based interaction wall in North America (The Cleveland Museum of Art 2013a; Alexander, Barton, and Goeser 2013; Alexander 2014b).

The 12-meter-long multi-touch MicroTile wall presents images from the permanent collection, changing every 40 seconds, allowing visitors to mark favourites, sort through the collections, and create their own tours. The Collection Wall uses dynamic content from the CMA's digital asset management systems and refreshes every ten minutes, ensuring visitors can have access to the latest content and providing the museum with updated metrics for visitor preferences. Visitors who mark favourites on the Collection Wall can also use the museum's ArtLens app to upload them into their iPad or iPhone on one of eight docking stations. (Alexander 2014b; The Cleveland Museum of Art 2013a, 2015b)

Figure 5.5: Gallery One, the Collection Wall

Although not confined to the exhibition space within Gallery One, the mobile ArtLens application was often associated with it and remains a feature of the re-worked ARTLENS Gallery (The Cleveland Museum of Art 2016b). Here, I separate the ArtLens app from my description of the rest of Gallery One simply because it lacks a singular, dedicated physical space. Unlike the other interactive installations, which were fundamentally associated with the physical exhibition space of Gallery One, the ArtLens app is intended to support the visitor experience throughout the collective exhibition spaces of the CMA, as well as functioning off-site.

As the original epicentre for interactive technologies within the museum, Gallery One was the logical location to provide support for downloading and using the ArtLens app through the presence of a full-time Help Desk where visitors could get information, technical support, and rent iPads pre-loaded with the application. On May 25, 2016, CMA released an update for the app, calling

it ArtLens 2.0, which offers a new interface, a faster download time, and access to content relating to the collections that the museum continues to generate and update regularly (The Cleveland Museum of Art 2016b).

In the autumn of 2016, the version of Gallery One that is described and evaluated here, closed for renovations that involved reconsideration of the thematic groupings, the interactive elements, and the collections on display. In June 2017, Gallery One was provisionally re-opened under the new name, the ARTLENS Gallery, with its internal elements renamed and rebranded: the ArtLens Studio (formerly Studio Play), the ArtLens Wall (formerly the Collection Wall), the ArtLens Exhibition (formerly the central, thematic exhibition space), and, keeping its original name, the ArtLens app (Alexander, Wienke, and Tiongson 2017). Intended as an evolution of the interactive museum experience first tested in Gallery One, the new ARTLENS Gallery employs technologies that focus more on intangible, gesture-based interaction facilitated through sensors and iBeacons, instead of the touch-based interaction offered in the previous iteration (Alexander, Wienke, and Tiongson 2017); however, the ArtLens Wall remains within the updated ARTLENS Gallery as one of its main touch-based interactive installations. While the developments within the ARTLENS Gallery space may provide opportunities for future research, the original iteration of this interactive exhibition space, Gallery One, is the subject of the evaluation and analysis I present here.

The introduction of the first iteration of Gallery One into the CMA was arguably a successful endeavour for the museum, significantly increasing visitor attendance to the museum and bringing recognition to the CMA in the form of museum and design awards (Alexander 2014b, 2014a; Chun, Gasparotti, and Cairns 2014d; Cisco Systems 2014; Alexander, Wienke, and Tiongson 2017). Although the new ARTLENS Gallery exhibition space is a compelling development within the CMA, time and visitor feedback will determine whether this second iteration is as successful as the original Gallery One. Certainly the most significant difference between the two iterations is the move towards gesture-based interaction within the updated ARTLENS Gallery, differing from the use of touch-based interaction that was primarily employed within Gallery One. According to the team of

CMA staff and external developers responsible for the ARTLENS Gallery, the move towards gesture-based interaction is not due to visitor dissatisfaction with the touch-based interaction technologies that were previously employed, but rather as a way to bring a greater degree of interactive intimacy between visitors and the curated selection of artworks presented within the exhibition space, using new, more physically-immersive forms of interactive technology (Alexander, Wienke, and Tiongson 2017; The Cleveland Museum of Art 2017b, 2017a). The continued use of the ArtLens Wall and the ArtLens app, which both rely primarily on touch-based interaction, shows that touch-based interaction technology still prevails within the CMA, despite the new interaction approaches that have been integrated into the renewed ARTLENS Gallery (The Cleveland Museum of Art 2017b).

Substantial changes were made to Gallery One to evolve the entire concept into the new presentation of the ARTLENS Gallery, but the same physical space within the CMA has been used for both iterations. To simplify and focus the following discussion, I refer to the relevant exhibition space as Gallery One, as this is the iteration which I evaluate and examine here. When necessary, I distinguish between the two iterations by their individual titles, using either Gallery One or the ARTLENS Gallery, as the following discussion requires.

Case Study Installation: *The Painting Lens*

As one of six interactive Lenses within Gallery One, *The Painting Lens* offered users the opportunity to explore content relating to four artworks curated around the theme of painting associated with the Lens, and to engage in up to five additional interactive experiences. The goal or purpose of each of the interactive options varied, with some offering informative content and others requiring users to engage in creative expression. Although a great deal of consideration was evidently put into the design of each interactive option, it is not within the scope of this research to comment on the quality of the available educational content or whether each interactive option was successful in achieving its intended pedagogical purpose.

In terms of its technical specifications, *The Painting Lens* was a free-standing touch-screen integrated within the exhibition space of Gallery One, offering a 46" (106.68 cm) interactive 1080p HD display and a 32-point, optically-driven multi-touch overlay, physically installed into a landscape-oriented, ADA approved housing (Alexander, Barton, and Goeser 2013). All of the Lenses within Gallery One ran on Windows PCs, housed in a remote server room accessible through the exhibition space, and used software written with a combination of ActionScript 3/Adobe AIR and C++/openFrameworks (Alexander, Barton, and Goeser 2013).

Figure 5.6: *The Painting Lens* and associated artworks within Gallery One

The location of an interactive installation, its *physical context*, and what visitors experience in the *physical* and *sociocultural contexts* of the museum, has the potential to influence the museum visitor's interaction experience with the technology (Falk and Dierking 1992, 2013; Falk et al. 2004). *The Painting Lens* was found within the thematic exhibition space of Gallery One relating to the exhibition sub-theme of painting, but for the purposes of this analysis, consideration for the installation context of *the Painting Lens* includes not only the immediate physical installation space, but also how *the Painting Lens* figured into the wider visitor experience of the CMA and Gallery One.

Although I do not explicitly evaluate the visitor experience prior to entering Gallery One as part of this research, I acknowledge the possibility that the experiences visitors may have before entering Gallery One could have influenced their interactions within the exhibition space, or at least may have influenced their expectations for interaction. Visitors could access Gallery One either via

the main visitor entry in the North Building, called the “North Entrance” shown at the bottom of Figure 5.2, or by entering through the Ames Family Atrium, called “Atrium” at the centre of Figure 5.2. Both paths had the potential to yield different visitor experiences prior to their entry to Gallery One. The North Entrance path offered visitors an opportunity to immediately immerse themselves in an environment rich in both artworks and engaging interactive technologies, while entry via the Atrium path had the potential to offer a more traditional “look, don’t touch” visitor experience, focusing primarily on the display of the CMA collections.

When entering through the North Entrance, visitors to Gallery One would first encounter a text panel on the window of the doorframe welcoming them into the museum and providing an introduction to Gallery One. The text asked visitors to consider how and why art is made, introducing Gallery One as a space for interactive exploration of artworks, cultures, and technologies. For visitors entering this way, the first *direct-static* form of instruction related to the in-gallery interaction technologies was presented within the brief welcome text: “You are welcome to touch the interactive screens, but please don’t touch the art” (The Cleveland Museum of Art 2013b). Once inside Gallery One, a large presentation screen, known as the Beacon, displayed images from the digital collection and screenshots taken from the different interactive lenses available within the interactive exhibition space, designed as a measure to draw visitors into the exhibition space and conspicuously demonstrate the potential of the interactive elements within the gallery (Alexander, Barton, and Goeser 2013; Alexander 2014b). Opposite from the Beacon, to the left, was Studio Play, while straight ahead lay the thematic exhibition space, offering original artworks and a range of interactive experiences, including *the Painting Lens*.

For visitors who entered via the Atrium, passage through the glass sliding-doors would first bring visitors into the space containing the Collection Wall. As a large interactive installation, the Collection Wall continues to invite and encourage touch-based interaction with the technology and the visual representations of the collections it presents. In addition to the Collection Wall, the room also includes the ArtLens Help Desk and a number of touch-screen tablets that allow visitors to

access the “Ask an Expert” portion of the museum’s website, if they desire (Alexander 2014b; The Cleveland Museum of Art 2015b, 2016c). When entering Gallery One from this direction, the thematic exhibition space was found in the room just beyond the Collection Wall, with *the Painting Lens* being the first interactive to the right.

Challenging the usual “look, but don’t touch” conventions of the museum context, Gallery One integrated touch-based interactive technologies with traditional collections displays, using limited signage to remind visitors where physical interaction within the environment *was* and *was not* appropriate. Signage informing visitors not to touch the artworks on display were especially visible in locations where objects were within close physical reach, in addition to the short instruction incorporated into the introductory signage to Gallery One, noted above (The Cleveland Museum of Art 2013b). For some visitors, this approach of integrating touch-based interactive technologies in the same physical context as the hands-off presentation of museum objects has the potential to send mixed messages about where and when visitors are permitted to interact with their environment, both within Gallery One and potentially the permanent galleries as well.

In the attempt to support the interaction experience of museum visitors, each of the on-screen user interfaces for the interactive Lenses within Gallery One employed a consistent set of icons and elements. They each used the same basic arrangement of interactive options on the “Home” screen; the artworks associated with each of the Lenses were mirrored on-screen, with additional interactive options arranged down the right side of the screen. Interaction with any of the artworks mirrored on the home-screen initiated the “Look Closer” option, intended to allow users the opportunity to explore deeper information and visuals associated with the selected artwork. By employing consistent UI elements across each of the Lenses, visitors, in principle, only have to learn how the interactive parts of the UI work once.

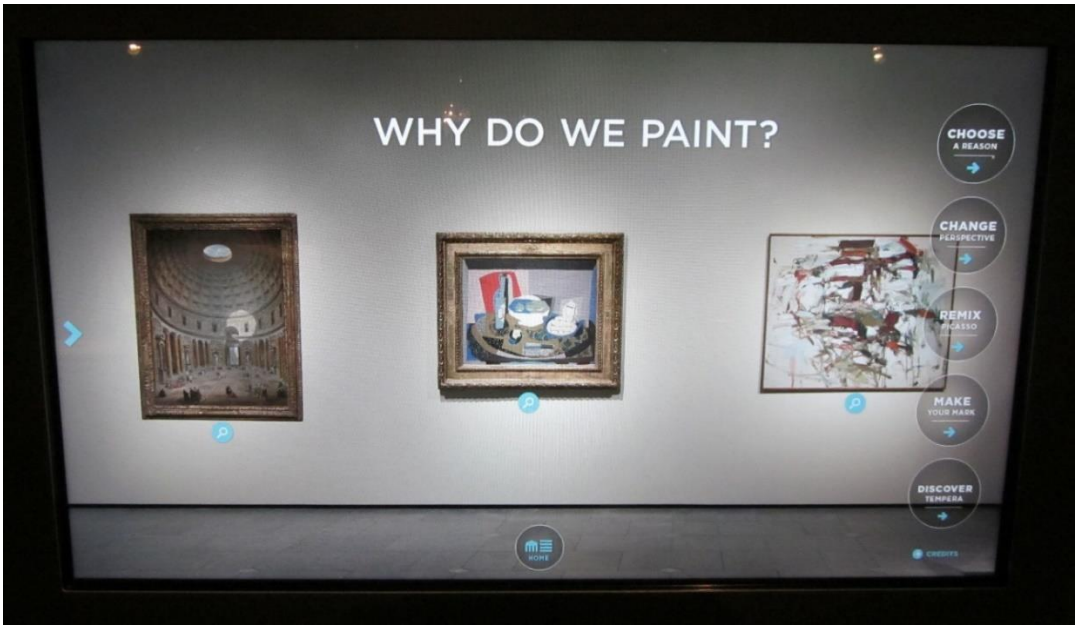


Figure 5.7: The home-screen of *the Painting Lens*

However, no two interactive Lenses within Gallery One shared the exact same UI layout, nor were any of the interactive experience or content options available within each Lens identical, but consistent design elements applied to all of the Lenses seek to create a sense of uniformity and familiarity to support the interaction experience. For example, the "Home" button and accompanying icon was fixed on-screen in the same location, on each Lens, in every possible interactive experience or content screen, creating a sense of continuity across interaction experiences. Additionally, the UI made use of common icons and on-screen elements already ubiquitous within the technologically-inclined Western society within which the CMA resides. For example, the ☒ placed in the top-right corner of text windows indicated that a window could be closed, or the < and > arrows indicated access points to additional content (Archer 2014). This application of familiar symbols and icons is a clear attempt to allow users to guide and influence their own interaction behaviours, relying on their pre-existing knowledge of these icons; indicating how the *personal context* can contribute to a museum visitor experience that includes interactive technologies.

Interaction with *the Painting Lens* was touch-based and the employed technology could facilitate multi-touch gestures, allowing visitors the opportunity to make familiar touch-screen

gestures, such as “pinch to zoom”, as well as accommodating interactions from multiple users at a time. For example, in the “Make Your Mark” interactive option, visitors had the opportunity to try their hand at a form of computer-generated painting. Unlike single-touch or single-input interactive technologies, the multi-touch capability of technology used by *the Painting Lens* could support collaborative interactions among visitors. Interactions with the virtual canvas were not restricted to a single virtual paintbrush; users could paint with two hands at once, or they could collaborate with other users to create a shared artwork.

The size and positioning of the touch-screen sought to further encourage collaborative interaction experiences among visitors engaging with *the Painting Lens*. The centrality of the installation in the exhibition space, rather than being pressed up against a wall, was intended to allow multiple visitors to approach and interact with the touch-screen at a time. The landscape-orientation of the screen also endeavoured to allow more visitors to have physical access to the screen at a single time than portrait-orientation would have allowed.

Interacting with the Painting Lens

Interaction with *the Painting Lens* offered users five different potential experiences, from accessing more information about the paintings associated with the *Painting Lens*, to providing more creative interaction opportunities. By selecting any of the four artworks presented on the home-screen, users could “Look Closer” at each artwork, accessing informative texts, images, and videos about the artwork or its creator. A visual representation of each selected artwork remained on-screen and a menu of any accompanying interactive options would appear on the left side of the screen. Users were able to manipulate the visual representation of the artwork by dragging it, rotating it, or pinching the screen to zoom in and out.

The other interactive experiences available in *the Painting Lens* included opportunities to explore curated educational content or to engage in more creative forms of interaction. For those seeking more information about painting as a medium, *the Painting Lens* offered users an opportunity to “Choose a Reason” why a presented artwork may have been made using a simple

multiple-choice voting system, users could select the “Change Perspective” option to alter or manipulate the number of vanishing points on an on-screen painting, or users could “Discover Tempera” as a painting technique by swiping through interactive layers of information that revealed the complete process used. For visitors seeking a more creative interaction experience, users could “Remix the Picasso”, using the collage technique employed by Picasso to resize and reposition elements of *Still Life with Biscuits* (1924) on a blank virtual canvas. The most creative interaction option allowed users an opportunity to “Make Your Mark” by selecting a virtual painting style and a limited colour palette to experiment with on their own blank virtual canvas. With the “Remix the Picasso” and “Make Your Mark” interactive options, users also had the possibility to e-mail their completed compositions to an address of their choosing.

Interaction was encouraged and supported by a range of instructions available within Gallery One and associated with *the Painting Lens* directly. One of the two entrances into Gallery One displayed a brief written *direct-static* instruction meant to inform visitors that interaction with technologies was possible within the exhibition space. Despite being on public display at the entrance of Gallery One, this text panel did not always receive attention from visitors and, for visitors who entered through the Atrium, it may have been missed altogether. Excluding this *direct*, instructional introduction text, the rest of the installation context offered largely *indirect* instructional cues. For example, there were no signs or texts associated with any of the Lenses to directly indicate the potential for interactivity with the technology, or the ability to access informative content or engaging interactive experiences. The reasonable distance between the artworks and the interactive Lenses within Gallery One helped to define a *physical context* where interaction with the Lenses was appropriate for visitors to engage in, but may have also caused some visitors to miss out on the interactive installations altogether.

The open design of the physical installation space allowed visitors to support each other’s interaction experiences through collaborative interaction and, on occasion, through offering or receiving interaction advice from or for other visitors. This *direct* human communication created

opportunities for visitors to receive personalised, *dynamic* instruction for interaction based on their individual needs. Collaborative interaction with other visitors could similarly serve this purpose.

Among the means that CMA used to more directly facilitate the interactive engagement of its visitors within Gallery One, staff from the museum would often move through the exhibition space to provide personal interaction support for visitors, which I designate as *direct-dynamic* instruction. CMA staff members were available to provide technical support at the ArtLens Help Desk, but members of the security team within Gallery One were also a valuable resource for providing visitors with instructional support for their interaction experiences with the Lenses.

The simple, practically unconscious act of observing other visitors interacting with *the Painting Lens* offered potential users an unobtrusive opportunity to gather *indirect-dynamic* instructional information about how interaction worked with *the Painting Lens*. When visitors observed the interactions of other visitors, they were able to witness a live demonstration of the interactions that did or did not work with the Lens. By watching visitors interacting with *the Painting Lens*, it was possible to learn from their interaction missteps and mirror their interaction successes.

The UI design of *the Painting Lens* relied on many icons and symbols to support user interaction experience. The design of the UI included: left and right arrows to indicate access points to additional content, to skip through introduction videos, or to progress through a sequence; a magnifying glass shown on artworks presented on the home-screen to indicate the option to "Look Closer"; and a counter-clockwise "undo" arrow, to allow users to undo their interactions in the "Make Your Mark" and "Remix Picasso" interactive experiences. I classify instructional elements integrated into the UI design as *indirect* due to the interpretation required on behalf of the user to understand and apply the correct interaction. For example, the small ☒ in the top-right corner of a text window indicated that this was the location where, if touched, the text window would close. For those familiar with this pervasive icon, interpreting that ☒ as a place where the interaction would achieve the closure of the text window was natural, possibly even expected by some users (Archer 2014). For those with little to no experience using computers or touch-based interaction devices,

rare as they may be, this ☒ symbol may have been considered to be abstract or unfamiliar. The ☒ *indirectly* implied its purpose, whereas the phrase "press here to close" would *directly* instruct the user both where interaction was possible and what the outcome of the interaction would be.

The *indirect-static* instructional elements integrated into the UI were complemented by the *direct-static* on-screen instructions and animations. When users would make certain interactions, on-screen instructions would automatically appear as an overlay to the interactive content, occasionally accompanied by a simple animation to demonstrate the possible interaction. These animated instructions typically appeared on-screen offering users an opportunity to perform an interaction that was more complex or required multi-touch interaction, such as the pinch action required to zoom in or out.

Results of Evaluation

In the following section, I compare the expectations of the development team involved in the creation of *the Painting Lens* with the reality of the experiences of the visitors who interacted with *the Painting Lens*, as represented in the results of my evaluation activities. I first introduce the development team members responsible for the creation of *the Painting Lens*, defining their roles in the development process. Drawing on the responses from the interviews with the development team members, I consider their goals and the development process. I follow this by presenting the visitor evaluation results, beginning with an introduction to the demographic data relating to the visitors who participated in the two evaluation methodologies I employ, which I describe at length in Chapter 3: on-site observation periods and a post-interaction questionnaire (Serrell 1997, 2010; Yalowitz and Bronnenkant 2009; Sylaiou et al. 2010; Sheng and Chen 2012; Forrest 2013, 2015; Tzortzi 2014). In the discussion section, I integrate and analyse the responses of the development team members with the visitor evaluation results to determine if the goals of the development team are reflected in the responses of evaluated users.

Development Team Interviews and Analysis

The development team included members from the educational, curatorial and design departments within the CMA, with additional representation from the external IT development company, *Local Projects*.

Jane Alexander*, Chief Information Officer for the CMA*[13] is, according to the CMA website, "responsible for the technology implementation and digital strategies, as well as long-term strategic planning for Information Management Systems, Media Services and Technology Services" at the museum (The Cleveland Museum of Art 2016e). Her role in the development of Gallery One began when she joined the team in 2010, only two years before Gallery One would open and while the ambitious expansion and renewal project was still in progress. With experience in project-based work, Alexander formed the Gallery One development team from museum staff and external development partners, guiding the project from its early conceptual stages through to the opening of the exhibition space.

Seema Rao*, Director of Intergenerational Learning for the CMA*[14] was responsible for leading a team of educators to enrich the museum through "offering engaging studio experiences, developing interpretive content for new media, and team programs" (The Cleveland Museum of Art 2016g). With over a decade of professional museum experience, Rao continued the work in Gallery One that was originally started by her predecessor, Caroline Goeser, who left the CMA in 2014 to take a position at the Museum of Fine Arts in Houston, Texas (Litt 2014). Rao worked closely with Goeser throughout the development of Gallery One and contributed heavily to the educational content found within the exhibition space and the interactive Lenses. In 2017, Rao left the CMA to become the principal behind the Brilliant Idea Studio, a consultancy directed towards museum

[13] My interview with Alexander took place in her office at the CMA, between 12:00 and 13:10 on Wednesday, 13 April, 2016.
[14] My interview with Rao took place in her office at the CMA, between 12:00 and 13:00 on Tuesday, 12 April, 2016.

project planning and development, as well as taking on the role of Senior Experience Officer for the Akron Art Museum (Brilliant Idea Studio 2019; Akron Art Museum 2019).

Jeffrey Strean*, Director of Design and Architecture for the CMA*[15] has worked for the CMA for over twenty years within the Department of Design and Architecture, playing a central role in the recent renewal project and overseeing the redevelopment of the exhibition spaces throughout the museum, including Gallery One (The Cleveland Museum of Art 2015a). As the chief designer, Strean is responsible for the physical exhibition space; in other words, the installation context of both the collections and the interactive Lenses.

Keeli Shaw*, Interactive Project Director for Local Projects*[16] represents the external IT development company, *Local Projects*, and worked together with Jake Barton, principal designer for *Local Projects*, to create the UI and interaction design for the interactive Lenses within Gallery One (The Cleveland Museum of Art 2015a). She has followed Gallery One and its interactive elements from its early conceptual phases, through several iterations of prototypes and user testing, up to the final installation of the Lenses, the Collection Wall, and the ArtLens app, working closely with the CMA team throughout each step.

For the following discussion, I frame the interview responses using five categories that are most complimentary to the responses offered by the interview participants: (1.) user testing and evaluation, (2.) target audiences and target users, (3.) the installation context, (4.) the intended interaction or user experience, and (5.) the design and implementation of instructions for interaction. During my interviews with the members of the development team, my aim was to examine the process of creating *the Painting Lens*, from conception to installation, to explore the design and integration of the different forms of instruction available, and to better understand the

[15] My interview with Strean took place in his office at the CMA, between 13:10 and 14:05 on Wednesday, 13 April, 2016.
[16] My interview with Shaw took place via Skype, between 13:00 and 13:45 EST, or 19:00 and 19:45 CEST, on Monday, 12 September, 2016.

approaches used for communicating instruction for interaction with *the Painting Lens* within Gallery One. A semi-structured interview methodology was applied, wherein each interview was conducted using the same interview template, but the unique responses of each interview participant naturally influenced the flow and line of questioning (Charmaz 2006; Rowley 2012; Kallio et al. 2016). Although it was not always possible, or useful, to follow the interview template in a rigorous manner, it provided a useful guideline for questioning throughout each interview.

User Testing and Evaluation

Throughout each of the interviews with the members of the development team, the role of user testing in the development process came up time and time again. From early stages in the development of Gallery One, up to and beyond the opening of the exhibition space to the public, different levels of user testing and evaluation were regularly conducted to ensure the different interactive installations worked for the visitors who chose to engage with them. Different development team members touched upon the various forms of evaluation relevant to their personal area of expertise. For example, Seema Rao (Director of Intergenerational Learning) spoke about testing different interactive technologies, different orientations of the touch-screens, and various levels of educational content depth, while Keeli Shaw (Interactive Project Director) and Jane Alexander (Chief Information Officer) both spoke about evaluating diverse concepts for different interactive game or puzzle options, and Jeffrey Strean (Director of Design and Architecture) addressed assessing a range of prototype concepts and technologies within the installation context. Although Alexander noted her regret that they were not able to test every single one of the concept prototypes to a high degree, due to limited time available and the considerable number of concept prototypes that were conceived at the start of the development process, the scope of the evaluation activities conducted on the final interactive installations associated with Gallery One is nonetheless remarkable and shows the dedication of the development team and the CMA to the process of undertaking thorough evaluation activities.

Beyond the initial prototype testing stages that took place early in the development of Gallery One, the most significant evaluation activities were conducted within the installation context of Gallery One in the six-week period leading up to its opening. During this time, Elizabeth Bolander, director of the Research and Evaluation department, together with Meghan Stockdale, an audience research associate, led extensive usability and comprehension evaluation of the interactive elements within Gallery One, collecting over three hundred hours of audio and video recordings of nearly one thousand participants to better understand the impact of the interactive technologies on the visitor experience (Alexander, Barton, and Goeser 2013; Alexander 2014b, 359; Bolander and Stockdale 2015; Bolander 2015a, 2015b, 2015c). The analysis of the collected data has provided the CMA with a great deal of insight into the interaction behaviours of their visitors to Gallery One, but the results also identified aspects of the user experience that had the potential to be altered or optimised.

The results of the in-gallery user evaluation activities were especially relevant for Shaw and the IT team within *Local Projects*, who were able to apply the results to better understand how users would interact with the interactive technologies within the context of the exhibition space. Expressing the value gained from in-gallery evaluation, Shaw commented that, "The on-site testing was really helpful to lock down timing and helped us avoid certain design considerations that would have been problematic for usability later on, and also being in front of the artworks is very different […] so that was a major missing component for the [off-site] testing. […] Adding that context made our research testing even better. Ours is much more critical and focused, and once you added the benefit of being in the context with those artworks, people got it a lot faster. Things that might have been an issue in our testing no longer were relevant for those tested on-site." According to the interviewed members of the development team, the results of the in-gallery evaluation activities provided the insight needed to refine different elements of the UI and the available instructional forms that would improve the user interaction experience. The evaluation results afforded the development team the opportunity to base any changes made to the in-gallery interactive installations on *actual* user feedback, rather than on their own assumptions or expectations of how

users *might* interact. Rao specifically noted the ways that evaluation within the installation context, conducted shortly after the opening of Gallery One, identified a need to incorporate a more *direct* form of instruction for users of the interactive Lenses. Using the results and the feedback provided by the evaluation participants, the development team elected to design and implement the on-screen animated instructions that provided users with visual demonstrations of the available interactions.

Target Audiences and Target Users

Keeping with the concepts described in the CMA profile, Gallery One was not designed to necessarily target one *kind* of audience or one *type* of visitor. Each of the interview participants acknowledged the common goal of creating a museum experience within Gallery One that had *something* for everyone, carefully avoiding the trap of trying to offer *everything* for everyone. The development team worked towards creating a range of interactive museum experiences that could support a wide variety of visitor types and behaviours. Alexander asserted that, based on visitor evaluation activities, CMA visitors were found to exhibit three behaviour types, each of which Gallery One was designed to support: the *linear* visitor, who prefers to see or experience content in a particular order, the visitor who wants to *dive deeper* into specific content that is of particular interest to them, and the *wanderer*, whose interests vary and who may wish to sample different content as they move through the exhibition space.

The variety of interactive experiences available within *the Painting Lens* alone were designed to be broad, so as to support a combination of these visitor behaviours. For example, the "Look Closer" option on the home-screen offered deeper levels of content on the associated artworks for visitors who wished to seek it out, like the *dive deeper* visitor behaviour type. The "Make Your Mark" interactive experience provided an opportunity for visitors to get creative through digital painting, and similarly, the "Remix the Picasso" option offered a creative interaction experience that relied heavily on physical interaction with the touch-screen surface to manipulate the fragments of the artwork on-screen; two interactive options more suited for the *wanderer* visitor behaviour type.

Finally, the "Discover Tempera" interactive option, through its design of layered informative content, was more suited for the *linear* visitor behaviour type, as it allowed users to explore the tempera painting process sequentially. In this way, Gallery One mirrors the ArtLens App, which Alexander suggests, "accommodates all types of visitor's behaviour, from the linear path follower, to seeker, to wanderer" (2014b, 352) and with this understanding, the variety of interactive options offered across each of the different Lenses within Gallery One, as well as the variety of interactive experiences offered within each individual Lens, were designed to support the potential for visitors to exhibit a variety of behaviour types.

While the CMA applied rather broad definitions for these three visitor types, each interactive Lens provided a range of interactive options that could offer *something* appealing to each of the three visitor types. Despite this relatively open approach, reducing visitors and their behaviours into only three visitor types could still be criticised as overly reductionist. Considering the variability and unpredictability of human behaviour, it is certainly possible that some visitors may not have fit within the three visitor behaviour types that the CMA considered their visitors to exhibit. Generally, the classification of visitors into narrow demographic groupings or behaviour types may be viewed as too rigid or limiting to be functional (Spock 2006; Dawson and Jensen 2011b; Falk 2011; Lewalter et al. 2015), but I would argue that the CMA managed to avoid this through the provision of the variety of interaction options available to Gallery One visitors, within each individual Lens and across all of the available Lenses collectively. The CMA development team members did not intend that *every* interaction option would be suitable for or appeal to *every* visitor, but rather that every visitor would be able to make a selection from the available interactive options based on their personal preferences.

The UI design of the interactive Lenses was kept clean and clear to facilitate a smooth, user-friendly interaction experience; however, the texts that made up the informative content were formulated using a more clearly defined level of intellectual ability. According to both Rao and Alexander, the informative content within the interactive Lenses was geared towards visitors with a

6th grade or higher reading level. In addition to incorporating a significant amount of graphic content to support visual learners, Rao said, "We wrote [the informative content] at a level that was above USA Today, because our audience is fairly educated. Most people have a college degree."[17] The resulting installations demonstrated a high level of accessibility to a wide range of users, with regards to both textual or visual content and the simplicity of the UI design. Despite the indication by development team members that the language used in the informative content was geared towards visitors with a 6th grade reading level, the CMA staff within the education department responsible for the text claimed that they were conscious not to diminish the quality of the intellectual content, often referred to as "dumbing-down" (Barr 2005, 2007; Waltl 2006; Taheri, Jafari, and O'Gorman 2014), exploring complex ideas about art and history using easily accessible words and grammar.

It was clear from the interview responses that both the museum visitor and their potential interaction experiences with the Lenses were central to the design processes associated with each interactive Lens, rather than focusing on dissemination of content selected by the curatorial staff; every decision made by the development team was meant to take the intended visitor experience into account before a conclusion was reached and implemented into the final design. This was especially evident in the multiple interview responses that discussed the iterative prototyping process and the prototype evaluations, conducted both in- and outside of the museum context, that contributed to a stable UI for the widest range of potential users. While I have already expressed the importance of user testing and evaluation above, it is worth mentioning here that the goal of user testing in the development process was not only to test the usability of the Lenses, but also to ensure that the visitors who would ultimately be interacting with these installations were actively engaged with the content and interactive experiences being offered, and that the available content was understood by the users. As Shaw noted, comprehension user testing "was helpful in determining how deep to go for certain [interactive options] and when things got confusing, even for

[1717] Both the Dale-Chall readability rating and the Flesch Kincaid grade rating for USA Today actually suggest that the newspaper is written, on average, at a 10th grade reading level, based on evaluation of articles sampled from different sections of the newspaper (Jung 2003; DuBay 2005).

the smartest visitors, or the most informed." She specifically acknowledged how this particular kind of testing demonstrated that the informative on-screen content could be understood by a range of users with varying intellectual abilities, thereby validating the efforts of the educational department staff.

Installation Context

For the members of the development team, the process surrounding the design of the installation context for *the Painting Lens* was of critical importance: what it looked like, where it was located, and how decisions relating to the installation context were made. In line with the broader project goal of creating *something for everyone*, the interactive Lenses were each designed to meet the legally mandated Americans with Disabilities Act (ADA) Standards for Accessible Design (Department of Justice 2010). Rao, Alexander, and Strean each acknowledged the influence these ADA Standards had on the physical installation, in particular for determining an appropriate height for the touch-screens and the use of landscape-style orientation. Working within the parameters set forth by the ADA Standards for Accessible Design, the development team members designed an installation context for the Lenses that followed the legal mandates of the ADA requirements, ensuring that visitors of all physical abilities could easily access and interact with the Lenses within Gallery One.

In line with the digital strategy of the CMA, the members of the development team wanted to use the technology as a tool to help visitors gain a greater appreciation for or understanding of the artworks on display, bringing visitors closer to the art on a conceptual level, and the physical proximity between the technology and the artworks was central in achieving this goal. According to Rao, "We wanted to have the art and the technology in the same visual frame." The design of the home-screen on each of the interactive Lenses was meant to display the artworks associated with each Lens in exactly the same way that they were displayed in their respective exhibition areas; the "Look Closer" option serving as a kind of interactive layer in a version of, what could be described as touch-screen augmented reality. Alexander also viewed the proximity between artworks and

technology in Gallery One as a useful stepping-stone for encouraging visitors to enter the permanent exhibition galleries; creating a connection with one piece from the collection that could draw a visitor deeper into everything else that the museum has to offer. But while most visitors acknowledged the nearness of Picasso's *Still Life with Biscuits* to *the Painting Lens* at some point, for example, other visitors still failed to make the connection between the artwork that they were able to manipulate on-screen and the very same artwork hanging on the wall beside them, as early visitor evaluation by the CMA showed (Alexander 2014b, 360).

Overall, the "look and feel" of Gallery One as an interactive exhibition space was meant to be different from the other permanent exhibition spaces found throughout the CMA, primarily through the integration of interactive technology into the physical gallery. The final design of the entire Gallery One project, from the physical installation through to the details of the UI on the Lenses, showed that the efforts of the development team achieved the delicate balance necessary for introducing interactive technologies into the traditionally "hands-off" context of a museum exhibition gallery. According to the members of the Gallery One development team, the process of integrating interactive technologies into the museum context was considered, prototyped, and evaluated to ensure that the concept for the space worked both for the museum and for its visitors. Referring to the wider CMA approach to in-gallery technology, Strean suggested, "It's been pretty consistent that the notion that a cabled thing in the gallery is not what we are after, that the more transparent [the technology] can be, the better; so that the person who really does want to come over and look at their favourite painting isn't bothered by all of this [interactive technology] stuff." With this in mind, the design of the installation context of the interactive Lenses within Gallery One, and the sensitive integration of interactive technologies into the exhibition space in a way that allowed visitors to choose whether or not to engage with the interactive technologies at their own discretion is considered to have been a success, based on multiple reviews of Gallery One (Franklin 2013; Helmreich, Jones, and Stevens 2013; Machado 2013; Rodley 2013a, 2013b; Chun, Gasparotti, and Cairns 2014d; Dawkins 2014; Murphy 2015; Chan 2017; Read 2017).

The approach to Gallery One and the integration of interactive technologies into the exhibition space has since served as a model for inspiring other museums looking to experiment with interactive technologies within their own exhibition spaces (Chun, Gasparotti, and Cairns 2014d). Based on her own professional experience since working on Gallery One, Shaw acknowledged that, the "CMA was a huge watershed for museums across the world, in terms of its adoption of technology. […] After CMA, in the years since then, from my own perspective, I think museums are looking to take more risks with software and technology and their collections." Even within the CMA, the Gallery One exhibition space has since evolved into the new ARTLENS Gallery, employing new forms of immersive interactive technologies intended to push the boundaries of interactive museum experiences within the installation context of a museum exhibition space, according to the team responsible for the redevelopment of the space (Alexander, Wienke, and Tiongson 2017; The Cleveland Museum of Art 2017b).

Intended Interaction or User Experience

Reflecting on the reactions relating to target audience and the accessible design of Gallery One, interview responses relating to the interaction experience that the development team *intended* users to have with *the Painting Lens* were similarly broad. To ensure consistency across the interactive Lenses, the development team worked with a concise set of goals relating to the interactive experiences they wanted users to have with the Lenses within Gallery One. With respect to these goals, Shaw stated, "Number one, it was to inspire visitors to want to learn more, and two, to potentially garner different information and inspiration from the artworks in front of them through making." The idea that the development team was working towards inspiring visitors to interact with the technology was one that echoed through the responses of each of the interviewed development team members, in some form or another.

A non-linear experience was central to the design of Gallery One, as a whole, and this design approach was equally apparent in each of the interactive Lenses. Just as the development team recognised the potential variability across visitor behaviours, they likewise acknowledged the

challenges associated with designing a singular, linear experience for the broad audiences they hoped to engage. As Shaw explained, “The reality is that museum visitors are really transitory throughout the space, so the assumption was made early on in the design process that people are not going to play every single game on every single Lens.” Rather than aim to create a singular, linear interaction experience, the development team divided the more traditionally informative content from the more game-like interactive options, offering two distinct kinds of interaction experiences. In this way, visitors were able to engage in the interaction experiences more suited to their personal preferences, rather than locking each visitor into a linear interaction experience that produced the same, predictable content or outcome.

The variety of interaction experiences and options available within *the Painting Lens* reflected the awareness that the development team had for their potential users, and of the variable and changing behaviours their visitors might exhibit. Each Lens offered multiple interactive options to support the diverse and unpredictable behaviours of the visitors, aiming to offer *something for everyone* throughout the different thematic areas and interactive installations inside of Gallery One. Within *the Painting Lens* alone, visitors were able to “Look Close” into the four associated artworks, in addition to the five separate interactive options available; across all six of the interactive Lenses, the variety was even greater. But throughout the development process, team members aimed to keep the focus on informing and inspiring their visitors about the CMA collections by offering a variety of interactive activities designed to appeal to the different interests visitors may have, and the diverse behaviours they may exhibit. As Alexander suggested, “We offer a wide variety, types of games in different themes to appear to different visitors’ interests. The six Lenses focus on the concepts and artworks in our collection, such as sculpture, epic stories, globalism, [the] Thirties, lion, and painting. While all Lenses shared a similar home screen layout, each possesses its own theme related to the artwork on display. Information was provided in a question and answer format, and hotspots allowed visitors to find out additional information by touching specially designed areas.” The interview responses indicated that the purpose of the interactive Lenses within Gallery One was

more about offering visitors an *opportunity* or an *invitation* to engage with the collections through the medium of touch-based interactive screens, rather than a strict directive to complete a series of prescribed tasks that would collectively create a formulaic experience. Ultimately, the interactive Lenses were meant to provide opportunities for varied, engaging interactive experiences to the visitors of Gallery One, through a variety of potential interactive options, serving as an interactive, yet informative stepping stone that would ideally inspire CMA visitors to enter the permanent galleries with new information or a new appreciation of the museum's collections.

By maintaining reasonably realistic expectations about the variability across visitor interaction behaviours, and by offering a broad set of potential interaction experiences to visitors of Gallery One in their efforts to provide *something for everyone*, the interview responses of the development team showed that they personally considered their open-access interaction experience design a success. Their collective responses identified the use of iterative prototyping and evaluation as crucial contributors to the success of the final interactive installations. Within the renewed ARTLENS Gallery, in their endeavours to fine-tune the museum visitor experience even further, the team at the CMA continues with a rigorous program of testing and evaluation.

Design and Implementation of Instructions for Interaction

Although the development team had broad goals for target audiences and interaction experiences, they agreed that, for visitors who elect to engage with the in-gallery touch-based interactive installations, clear instructions for how to interact with the technology should be provided. Instructions for interaction with *the Painting Lens* were written collaboratively among the members of the development team, with contributions from both the museum and IT sides coming together to support the user interaction experience. When asked about her role in the creation of the instructions for interaction with *the Painting Lens,* Rao noted that, "The instructions were written collaboratively, so I'm not the only voice in them. I'm sort of the visitor side of it and the IT people wrote the instructional side of it, if you could think of it that way. They say, 'you need this' and I say, 'but I need to understand it *this* way,' so we did it collaboratively." This collaboration

ultimately came together to form the integrated instructional texts and animations that appeared throughout the user experience, offering instructional information as it became necessary for interaction.

The use of touch-based interaction technology was a natural choice for the development team; the ubiquitousness of touch-screens provided an opportunity, in that they anticipated that potential users would already know how to interact with this kind of technology. Referring to the ways the development team worked with this pre-existing expectation, Shaw mentioned that, "iPads, iPhones, the pinch-and-zoom is super common. That is just an accepted user paradigm that you operate from. People are immediately going to pinch, zoom, tap, move; so knowing that, how can we cut up this particular artwork and make it feel both intuitive with people's expectations of how people use touch-screens, but also fun?" Once again, interview responses indicated that iterative prototyping and user testing were important elements in identifying and achieving the right balance between *expected* interactions and *possible* interactions. Understanding user expectations associated with the interaction technology, and aiming for clear and concise integrated instructions for interaction were two aspects that the development team recognised as important for contributing to the intuitive interaction experience that they intended users to have with *the Painting Lens*.

In light of their efforts to support the interaction experiences of the visitors to Gallery One, I felt it was important to ask the development team about the reasoning behind intentionally excluding a dedicated instruction or information option from the UI of *the Painting Lens.* Responses showed that the development team wanted the design to be so clear, so easy-to-use that there should be no need for any further *direct-static* instruction in the form of a dedicated panel or text window pop-up. With respect to the design of the UI, the development team claimed that absolute clarity was essential. As Shaw described, "That was a critical mandate for us in the very beginning, and I think in general. If you require a lot of instruction on how to interact with an interface, something is wrong with the design." According to Shaw, user testing conducted during the iterative

prototyping period apparently did not show any ill-effect resulting from the development team's decision to deliberately omit a supplemental instruction panel or text bubble.

The responses of the development team acknowledged that in-person instructional support could be found within the installation context, should circumstances have arisen where a visitor may have felt that they would benefit from personal assistance when using any of the interactive technologies within Gallery One. There was always someone available at the Help Desk next to the Collection Wall to offer one-on-one instructional support, and, from my own observations, security staff within Gallery One could occasionally be seen offering assistance to visitors as well. Alexander in particular remarked upon the importance of the presence of CMA staff within Gallery One and on the positive feedback they had received from CMA visitors who sought their help. Although it may have been rare for visitors to make use of this potential *direct-dynamic* instructional form, its very availability showed the level of awareness that the development team and the CMA had to the potential needs of its visitors and the efforts that were made to accommodate them.

Visitor Evaluation: Observation and Post-Interaction Questionnaire Results

To determine whether or not the development team were successful in achieving their user interaction design goals, visitor evaluation was essential. Moreover, visitor evaluation provides results that record the interactions visitors make and show the effectiveness of the instructional forms available for visitors who elect to interact with *the Painting Lens*. As I explained in Chapter 3, which describes the evaluation methodologies employed, I used visitor observation (Serrell 1997, 2010; Hornecker 2008; Bevan 2009; Yalowitz and Bronnenkant 2009; Zwinkels, Oudegeest, and Laterveer 2009; Kidd 2014a; Tzortzi 2014; Forrest 2015) and a post-interaction questionnaire (Sylaiou et al. 2010; Gonçalves, Campos, and Sousa 2012; Sheng and Chen 2012; Forrest 2013; Zaharias, Michael, and Chrysanthou 2013; Tzortzi 2014) to collect a combination of quantitative and qualitative data about the user interaction experience with *the Painting Lens*, which I introduce and analyse here.

The demographic information collected and presented here relates only to aspects about each participant that could potentially influence their motivations for interacting with *the Painting Lens*. Results provided here relate specifically to the sample of visitors that I evaluated through observation or through participation in the post-interaction questionnaire within Gallery One and, therefore, are not indicative of all visitors to Gallery One, nor to visitors of the rest of the museum, such as the permanent galleries or any temporary exhibitions hosted by the CMA. In fact, as these results intentionally exclude visitors under 18 years of age, due to the methodological practices involved, the data I present here is only representative of adult visitors who entered Gallery One and engaged in interaction behaviours with *the Painting Lens* during the defined evaluation periods.

From 6 to 10 of April, 2016, a total of five observation periods took place within Gallery One. A total of 30.1 hours was spent on-gallery, observing visitors and collecting observation reports on the interactions of 112 individual users. The collection of post-interaction questionnaires occurred between 16 April and 15 May, 2016, over a span of 17 separate collection periods; I personally conducted four collection periods, while the remaining thirteen collection periods were conducted by members of the CMA Research and Evaluation department. It is not possible to indicate a total number of hours used to collect the 53 completed post-interaction questionnaires, as this evaluation activity was shared between myself, as the primary evaluator, and members of the Research and Evaluation department, who kindly continued with post-interaction questionnaire collection upon my departure from the museum after 20 April, 2016. Due to the temporary and unexpected closure of Gallery One during my research trip to the CMA[18], it was not possible for me to reach my evaluation goal of collecting over 50 post-interaction questionnaires during the time period allotted for my personal research visit. Prior to my departure from the museum, however, I provided

[18] Gallery One was temporarily closed on 5 April and from 12 to 15 April, 2016, for technical developments taking place within Studio Play. Due to the nature of the technical work being done in the Studio Play area, the entire Gallery One exhibition space was closed to the public. As such, my evaluation activities were postponed, resuming when the exhibition space re-opened to the public. I am exceedingly grateful that Elizabeth Bolander and her team in the Research and Evaluation department were willing and available to support my research through their efforts to continue with collection of the post-interaction questionnaire in my absence.

instructions for my methodology used to collect post-interaction questionnaires to members of the Research and Evaluation department, who successfully collected the remainder of the post-interaction questionnaires necessary to exceed my quota.

Demographic Results[19]

Total Participants:

Total Observed Users: 112

Total Post-Interaction Questionnaire Participants: 53

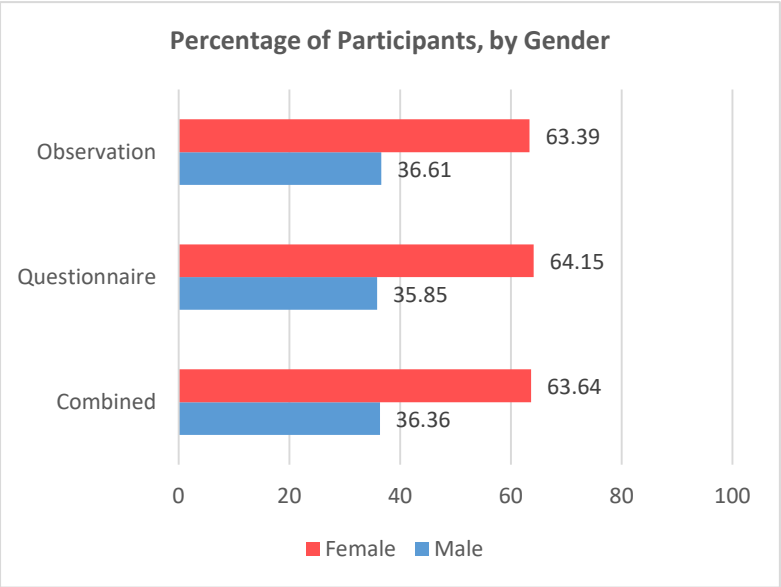
Total Combined Evaluation Participants: 165

	Observation	*Post-Interaction Questionnaire*	*Combined*
Female	71	34	105
Male	41	19	60
TOTAL	**112**	**53**	**165**

Figure 5.8: Total number of participants, by gender

[19] For all in-text percentages, I have rounded up to show only the first decimal figure. For figures and detailed results, I have rounded up to the second decimal figure. As a result of this, some in-text totals may exceed 100%.

Gender:



Observation Results:
Female: 71 (63.39%)
Male: 41 (36.61%)

Post-Interaction Questionnaire Results:
Female: 34 (64.15%)
Male: 19 (35.85%)

Combined Results:
Female: 105 (63.64%)
Male: 60 (36.36%)

Figure 5.9: Percentage of participants, by gender

The separate and combined results consistently show that female museum visitors outnumbered male visitors nearly two to one. The gender results vary by 0.6% between the observation and post-interaction questionnaire results; however, this slight margin may be due to the difference in total participants for each evaluation method. The division between the representations of female and male visitors cannot be discerned from the limited scope of this research and, unfortunately, the CMA has not released detailed evaluation results on the visitor demographics of their visitors that could be used for comparison with these results. It is possible that the representation of the two genders could suggest that female visitors were more likely to interact with *the Painting Lens* than male visitors, or possibly that male visitors preferred to explore the permanent museum galleries rather than enter the interactive exhibition space of Gallery One.

Age:

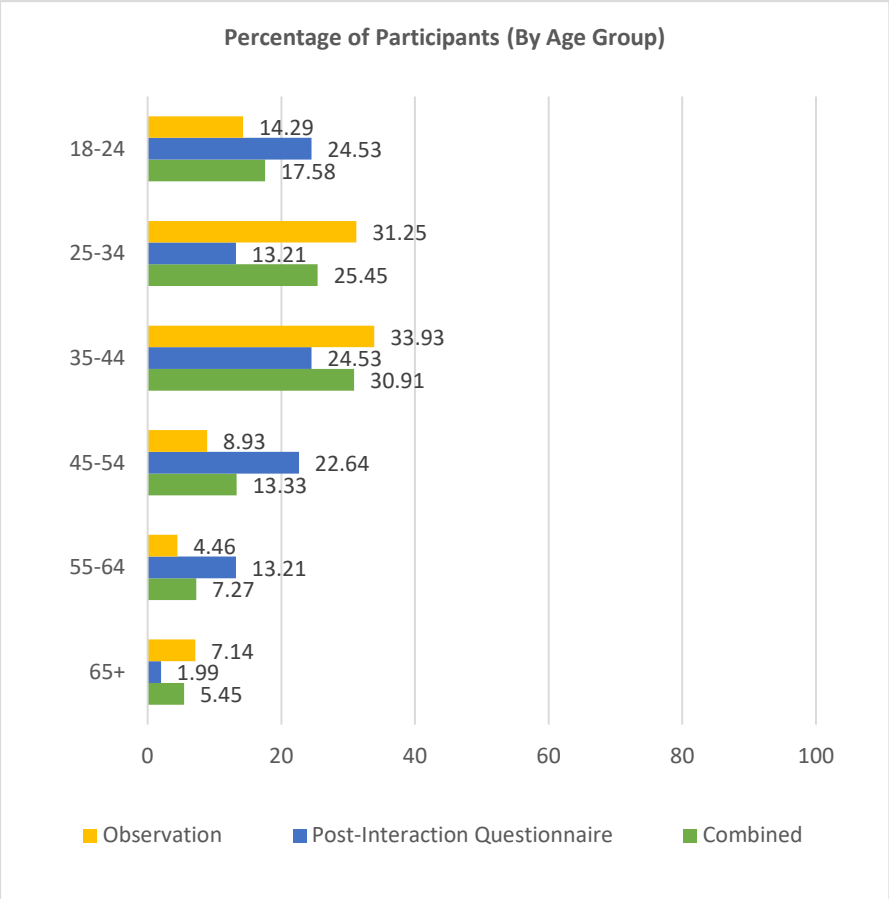


Figure 5.10: Percentage of participants, by age

Observation Results:
18-24: 16 (14.29%)
25-34: 35 (31.25%)
35-44: 38 (33.93%)
45-54: 10 (8.93%)
55-64: 5 (4.46%)
65+: 8 (7.14%)

Post-Interaction Questionnaire Results:
18-24: 13 (24.53%)
25-34: 7 (13.21%)
35-44: 13 (24.53%)
45-54: 12 (22.64%)
55-64: 7 (13.21%)
65+: 1 (1.99%)

Combined Results:
18-24: 29 (17.58%)
25-34: 42 (25.45%)
35-44: 51 (30.91%)
45-54: 22 (13.33%)
55-64: 12 (7.27%)
65+: 9 (5.45%)

Between the observation results and the post-interaction questionnaire results, the representation of age groups shifts marginally. The majority of the observed visitors fall into the 25-34 and 35-44 age ranges, while the majority of the post-interaction questionnaire participants were in the 45-54 and 55-64 age ranges. Since there are more observation results, they have a greater influence over the combined results. The overall distribution of the combined evaluation participants shows a curve similar to the observation results, with over half of participants falling into the 25-34 and 35-44 age ranges, and fewer participants in the 18-24 and 65+ age ranges. Keeping in mind that these results concern only visitors who engaged in interaction with *the Painting Lens*, and are not representative of all CMA visitors to Gallery One, it is perhaps not unexpected that visitors within younger age groups were more likely to interact with the in-gallery interactive technology, while

visitors within the two older demographic ranges were less likely to interact. Although younger visitors appear to have been more likely to engage in interaction, based on observation results, it is especially interesting that visitors within the youngest age range of 18-24 years did not appear to have interacted as often as visitors within the 25-34 and 35-44 age groups. The exact reasons for the distribution of interaction across age groups is not immediately evident and could benefit from further evaluation, however it may be possible that younger visitors are represented more due to their greater familiarity with touch-based interaction technologies.

Visitor Grouping:

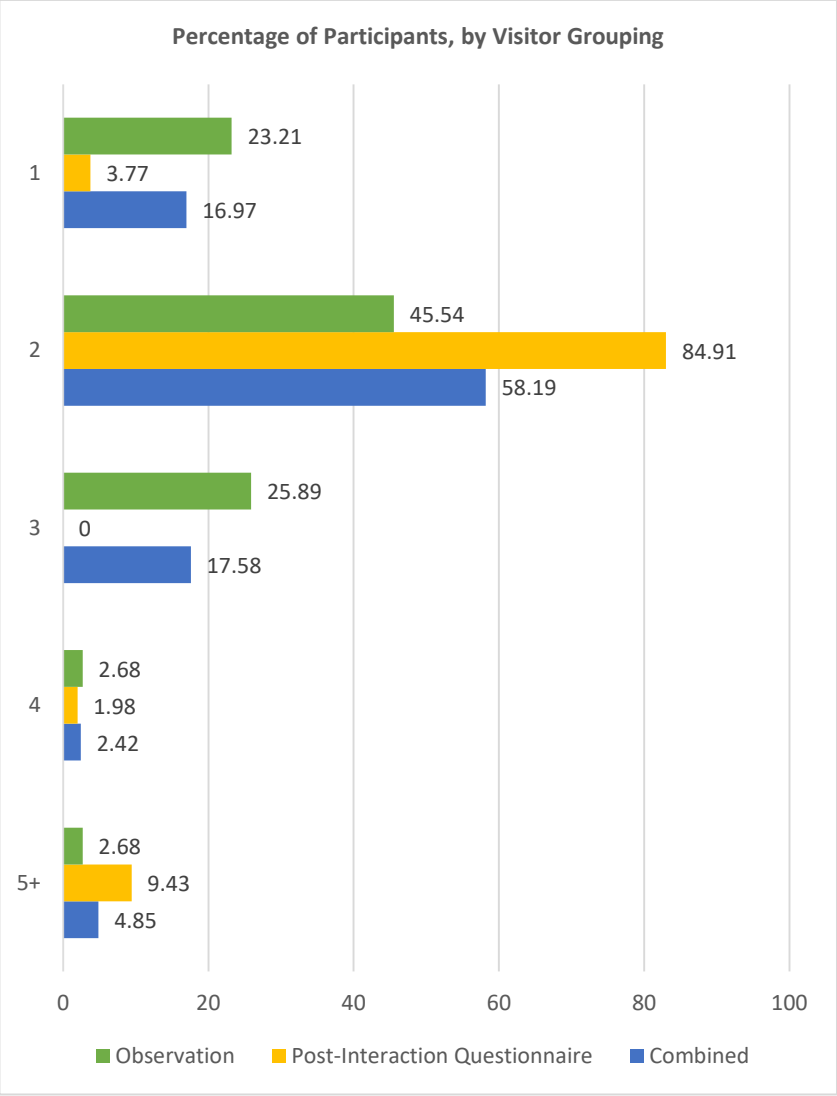


Figure 5.11: Percentage of participants, by visitor grouping

Observation Results:
1: 26 (23.21%)
2: 51 (45.54%)
3: 29 (25.89%)
4: 3 (2.68%)
5+: 3 (2.68%)

Post-Interaction Questionnaire Results:
Alone: 2 (3.77%)
With a Friend or Family Member:
45 (83.02%)
In a Visitor Grouping of:
2: 1 (1.89%)
4: 1 (1.89%)
5: 1 (1.89%)
6: 1 (1.89%)
8: 1 (1.89%)
14: 1 (1.89%)
50: 1 (1.89%)

Combined Results:
1: 28 (16.97%)
2: 96 (58.19%)
3: 29 (17.58%)
4: 4 (2.42%)
5+: 8 (4.85%)

To calculate the combined results, I code the results of the post-interaction questionnaire to match the visitor groupings of the observation results. Each “Alone” result is added to the “1” grouping of the observation results, each “With a Friend or Family Member” is added to the “2” grouping, and so on. The “2” visitor grouping from the post-interaction questionnaire results are counted together with the “2” grouping from the observation results in the combined results; however, the results are listed separately from the “With Friend or Family Member” in the separate post-interaction questionnaire results to stay true to the responses from the participants.

Observations were also made for the number of children grouped with observed users, a demographic result not explicitly collected through the post-interaction questionnaire. It may be possible that post-interaction questionnaire participants included children in their assessments of their own visitor groupings. Although I did not evaluate museum visitors under the age of 18, I acknowledge their presence with observed adult users and recognise their potential to influence the *sociocultural context* of the museum visit experiences for those visitors that they accompany. The observation results for visitors with children are (“0” indicates no accompanying children):

0: 81 (72.32%)

1: 14 (12.50%)

2: 14 (12.50%)

3: 3 (2.68%)

The popularity for visiting the museum in social groupings of two or more visitors is evident in both the visitor observations and the post-interaction questionnaire results. Although I do not evaluate the exact make-up of these social groupings in regard to the relationships grouped visitors have with each other or their social history together, the frequent occurrence of social groupings among visitors is an important part of the *sociocultural context* that contributes to the experience of visiting the museum.

Visitor Motivations:

Results relating to visitor motivations only originate from the post-interaction questionnaire. Participants are fewer and represent a smaller sample of visitors to the museum, calling into question the applicability of these results to broader, more general museum audiences. Participants who responded to this question were able to select as many of the available options as applied to them; I have determined the percentages for each response by dividing total responses by total post-interaction questionnaire participants to respond to the question. One post-interaction questionnaire participant declined to provide a response to the question, therefore the percentages are based on 52 total responses. The visitor motivations available for participants to select are based on Falk's identity-related visitor motivation types (Falk 2009, 2011). Sorted from most to least common responses, participants of the post-interaction questionnaire self-identified as:

- Motivated by curiosity and an interest in exploring the museum collections: 39 (75.00%)
- Motivated to visit the museum for a peaceful, reflective or recharging experience: 19 (36.54%)
- Motivated to facilitate the experiences and learning of others I am visiting the museum with: 16 (30.78%)
- Motivated by the perception that visiting the museum is an important experience (a "been there, done that" destination): 7 (13.46%)
- Motivated by a personal connection or affinity to visit a particular object, exhibition or collection within the museum: 7 (13.46%)
- Motivated by an interest in the museum collections as a professional or hobbyist: 4 (7.69%)
- Motivated to visit the museum to pay respects for those who are honoured and remembered by the museum: 1 (1.92%)

These results show that the majority of participants (75%) self-identified as being motivated by curiosity and their interest in exploring the collections. Interestingly, the two next largest visitor

identity groups indicate the contrast between wanting a more socially-motivated visitor experience, versus wanting an experience with minimal social interactions. Participants motivated to facilitate learning experiences of other museum visitors is 30.8%, and by contrast, those motivated to visit the museum for a peaceful, reflective, or recharging experience is 36.5%.

Familiarity with Touch-Based Interaction Technology:

The post-interaction questionnaire asked participants to state whether or not they own a touch-based interaction device, such as a smartphone or tablet, and given the current ubiquitous nature of touch-based interaction technologies, it is not surprising that 96.2% of participants (51/53 responses) identified as owners of touch-based interaction devices. Owners of touch-based interaction devices have pre-existing experience with touch-based interaction and they brought their experiences with them when they entered Gallery One. Experience with this kind of interaction technology could yield expectations relating to interaction possibilities, or the effect that interacting with familiar icons might have. These aspects of the *personal context* could influence how museum visitors interacted with *the Painting Lens*, and possibly also the forms of instructions that visitors used when they interacted.

Only two participants (3.8%) said they did not own a touch-based interaction device; both participants were female, one 18-24 years old and the other 55-64 years old. Looking at the full interaction results for these two participants, their interaction behaviours appeared consistent with participants who self-identified as touch-based interaction device owners. Furthermore, neither participant mentioned difficulty interacting with *the Painting Lens* in any of their responses or comments. For these two participants, not owning a touch-based interaction device does not appear to have had any negative impact on their interaction experience.

Interactions with the Painting Lens:

Duration of user interactions with *the Painting Lens* varied greatly; 23 users interacted for less than one minute (20.54%, 23/112 observed users), and one user engaged with the Lens for a total of 18 minutes, achieving the longest interaction period observed (U45; 0.89%, 1/112 observed

users). Due to the wide range of interaction durations, I feel it is necessary to examine the average duration of interaction in terms of mean, median, and mode values. Determining the mean duration of interaction is difficult because interactions less than one minute long were not recorded using smaller increments. *If* each interaction less than a minute is counted as being one minute long, *then* the mean interaction duration is 2.67 minutes. This is higher than the median interaction duration, which is 2 minutes, and significantly higher than the most common interaction duration, the mode, which is less than one minute.

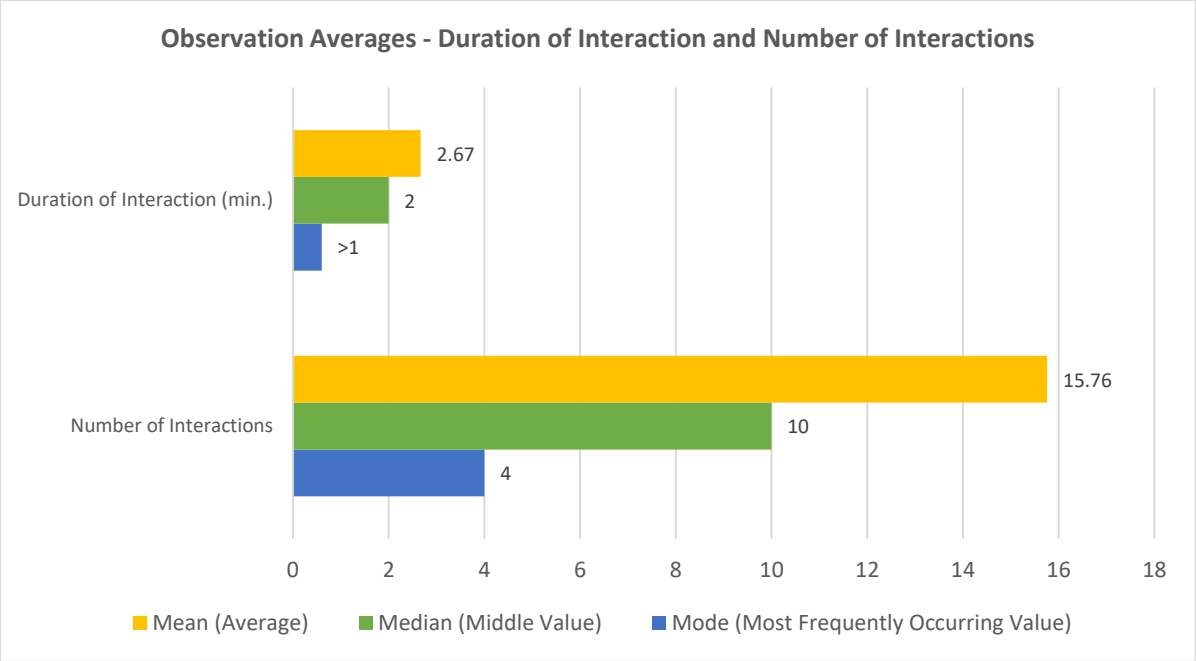


Figure 5.12: Observation averages

The number of interactions observed across all users totals 1765 interactions. Dividing this number with the total observed number of users suggests that the average number of interactions per user can be estimated at 15.8 interactions (1765/112=15.76). This mean value suggests a high level of interaction engagement across all users, however this result is misleading. The data actually shows that the most common number of interactions by observed users is much lower, at 4; this number of interactions was made by 11 observed users (9.82%, 11/112 observed users). The median result is 10 interactions, which fittingly lies somewhat central to the mean and mode results. The mean of 15.8 interactions is skewed by the 95 interactions made by U45; the same user who

achieved the 18 minute interaction period. By contrast, U48 realised the most interactions by a single user in the least amount of time, managing 6 interactions in less than one minute.

The most common interaction observed for all users was the digital painting activity found within the "Make Your Mark" interactive experience. I observed this interaction a total of 372 times over the collective observation periods, accounting for 21.1% of all interactions observed (372/1765=21.08%). It may not be a surprise, therefore, that I recorded 61.6% of observed users select the "Make Your Mark" interactive experience (69/112 observed users). The least popular activity was the "Discover Tempera" function, selected by only 2 observed users (1.79%, 2/112 observed users). It is also worth mentioning that 42.0% of observed users did not engage with any of the interactive experience or game-like activities (47/112 observed users), instead focusing their interactions primarily on the "Look Closer" option available with on-screen artworks.

On the other hand, 58.0% of observed users did not engage with any of the on-screen artworks (65/112 observed users), demonstrating an interesting dichotomy of user preferences. In total, 37.5% of observed users only accessed a single artwork to "Look Closer" at (42/112 observed users). The most popular artwork for observed users to select was *Still Life with Biscuits, Pablo Picasso (1924*), which was selected by 22 individuals (19.64%, 22/112 observed users). The least popular artwork was the *Virgin and Child Adored by Saints Mary Magdalen and Nicolas of Bari; Christ Crucified with the Virgin and Saint John the Evangelist, Sano di Pietro (1400s),* which could only be accessed by selecting an on-screen arrow to reveal the artwork and was not selected by any observed users during any of the periods of visitor observation. The apparent popularity of the "Look Closer" option among users could be due to its on-screen presence on the home-screen, paired with a user's decision to interact with whatever appears on-screen when they approach the interactive installation. Considering that zero observed users accessed the one "Look Closer" option that requires users to touch an on-screen arrow in order to access it, it seems likely that the popularity of interaction with the other artworks in the "Look Closer" option may simply come down to its availability on-screen and a lack of purpose or motivation on behalf of the user to seek out other

interaction experiences offered by *the Painting Lens* (Falk et al. 2004; Wilde and Urhahne 2008; Moussouri and Roussos 2013; Stillwell 2017).

Use of Instructional Forms:

With respect to the use of instructional forms by evaluation participants, I divide the presentation of the results into those derived from the post-interaction questionnaire and those collected from the visitor observation periods.

In the post-interaction questionnaire, I posed two questions that required participants to reflect upon their interaction experience with *the Painting Lens*: Questions 2.2 and 3.1. The phrasing of Question 2.2 is broad, asking "How did you know how to use the touch-screen?" Question 3.1, on the other hand, is more directly associated with the use of instructions, and directly asks, "What kinds of instructions did you use with *the Painting Lens*?" For both questions, I encouraged participants to select all responses that they felt applied to them.

The responses to Question 2.2 show what participants consider to have influenced their use of *The Painting Lens,* indicating a preference for taking a trial-and-error approach to interaction. A total of 50 participants provided responses to Question 2.2; 3 participants (5.7%) declined to respond. The majority of participants (56%, 28/50 responses) identified most with the "I tried a few things until I figured it out" response, while responses acknowledging that they "used the on-screen instructions" were also high (32%, 16/50 responses). Participants who "saw others using it" (12%, 6/50 responses) or who claimed that "someone from the museum helped me use it" (4%, 2/50 responses) were fewer, but still notable within this research. Written comments from a few participants (10%, 5/50 responses) offered either insight into their pre-existing expectations for interaction (Q17: "I made inferences from the experience that I've had with touch-screen technology"; Q29: "Touch-screen technology is common and self-explanatory for the most part"), or remarked on the usability of the Lens (Q46: "It was very intuitive"; Q53: "I touched and saw how it worked and kept touching the screen for more options and info"). While I cannot make the claim that the participants who gave these responses each possessed a high degree of familiarity of touch-

based interaction technologies, given the ubiquitousness of touch-based interaction employed by mobile devices or tablets available today, it is reasonable to assume that these participants may be applying their prior knowledge of touch-based interaction technologies when they approach an interactive installation, even within the museum context (vom Lehn 2006; Moussouri and Roussos 2013; Ciocca, Olivo, and Schettini 2012; Jarrier and Bourgeon-Renault 2012).

Responses to Question 3.1, which asks more specifically which of the available forms of instruction that users relied on for their interaction experience with *the Painting Lens,* shows the influence of the on-screen instructions on the user interaction experience among participants. A total of 52 participants offered responses to Question 3.1. The majority identified with the "I saw the on-screen instructions" response (55.8%, 29/52 responses), while the second most common response was "I didn't use any instructions", selected by 36.5% of participants (19/52 responses). Participants who received help directly from museum staff (1.92%, 1.52 responses) or another visitor (3.8%, 2/52 responses) were few, while participants who reported watching other visitors using the touch-screen were somewhat higher, totalling 15.4% (8/52 responses). Only two participants provided written comment responses (3.8%, 2/52 responses); one mentioned their use of instructional support from a family member, while the other remarked upon their own exploratory, trial-and-error interaction technique. One participant (1.9%) declined to respond to the question.

The differences between the responses to these two questions offers insight into how participants reflected upon their interaction experience and their personal use of instructions. Although 55.8% of participants claimed to have seen the on-screen instructions, only 32% of participants explicitly attributed their use of on-screen instructions with how they "knew what to do" during their interaction experience with *the Painting Lens*. The differences between these results are striking, but I do not believe they show an intentional non-use of the on-screen instructions by 23.8% of participants. Rather, I would propose that the varied interpretation of the question may contribute to the disparity across these results. After all, having *seen* the on-screen instructions may not necessarily be indicative that they were actually *used* by the participant.

Similarly remarkable are the responses that suggest self-sufficiency by participants in figuring out how to interact without relying on instructional support; 56% said they "tried a few things until I figured it out" and 36.5% claimed that they "didn't use any instructions." The trial-and-error approach to interaction and what motivated visitors to make these kinds of interaction attempts were not explained through the responses to these questions, but the results do indicate the popularity of the approach among a high number of participants. For the development team, these results provide insight into the interaction habits for a significant portion of their potential users who seem to prefer to shun the available integrated instructional support in favour of their own, self-reliant approach.

The results derived from the observation periods are more nuanced than those of the post-interaction questionnaire. To bring order to this discussion, I arrange the results according to the defined forms of instructions and their application in *the Painting Lens*. The results I describe here are restricted to those that demonstrate the use of the available forms of instructions by observed users. I offer limited analysis of the results here, however, reserving more in-depth interpretation of these results, and their correlation to the interaction experiences observed, for discussion later in this chapter.

Direct - Static Instructions: *On-screen Instructions and Animations*

Observing the use or non-use of the on-screen instructions and animations by visitors interacting with *the Painting Lens* was a challenging task, precisely because of the integrated and automatic nature of the available instructions. Without a separate "Help" or "Information" button for users to purposefully select, determining exactly when instructions were being used by interacting visitors was difficult to define precisely. That said, analysis of the collective observation results shows that the integrated on-screen instructions and animations did serve to support the interaction experiences of users.

Of the 1765 total interactions observed across 112 users, 698 of those interactions prompted some kind of specific, associated on-screen instruction, potentially indicating that the on-

screen text or animated instructions could have influenced 39.5% of all observed interactions. However, this result may be misleading; it does not definitively prove that users actually acknowledged the on-screen instructions or followed their guidance. While it may be possible that users looked at the on-screen instructions and animations, it could be that they were not fully processing their meaning or direction before initiating their physical interaction with the activities in *the Painting Lens*.

Comparing these results with those responses from the post-interaction questionnaire that relate to the use of on-screen instructions offers little clarity, leading to questions that may call for further research into the use and impact of automatic on-screen text and animated instructions. The ambiguity of results relating to the use of these forms of instruction may also indicate a flaw between the delivery of the instructional form and the method of evaluation. Defining whether or not a user acknowledged and/or utilised an automatic on-screen instruction could be better evaluated with neural activity or eye-tracking software, providing more accurate results than I have been able to collect using observation alone.

Indirect - Static: *UI Design and Icons*

The design of the UI and the icons that visitors used guided observed participants in their interaction experiences and instructed them on potential or appropriate interactions. I observed users for their interactions with specific elements, such as the use of the ☒ icon to indicate the option to close a window, or the left or right arrows; elements lacking explicit definition that were integrated into the UI based on the expectation that users would interpret these icons using their pre-existing experiences with similar UI elements. On behalf of the development team, there was a shared assumption that visitors would innately expect certain outcomes from engaging with these icons and that visitors would be able to use them without requiring explicit instruction.

The observation results provide some evidence to support this assumption, showing that the incorporation of familiar icons into the UI design were effective in instructing visitors through their interaction experience. Across their interaction experiences, the 112 observed users collectively

used ☒ to close a window 62 times (3.51%, 62/1765 total interactions), they used a left arrow 81 times (4.59%, 81/1765 total interactions) and they used a right arrow 179 times (10.14%, 179/1765 total interactions). The values relating to the use of the right arrow are notably higher due to the frequent use of the right arrow function in the "Cast Your Vote" interactive experience.

The ubiquitous nature of personal computing has undoubtedly brought about a high level of familiarity with on-screen icons, something which the development team acknowledged and were able to take advantage of. However, just as with the observation results for the *direct-static* on-screen text and animated instructions, these results cannot definitively prove that users actually looked to the icons and fully processed their meaning before attempting to interact with them.

Direct – Dynamic: *Advice from Other Visitors or Museum Staff, Collaborative Interaction*

Overall, observation results indicate limited instructional support coming from other visitors or members of the CMA staff. Only 2 observed users received assistance from museum staff (1.8%, 2/112 total observed users), while another 2 observed users received assistance from other visitors (1.8%, 2/112 total observed users). Within these narrow results, one participant (U10) made use of instructional support received from both museum staff and from another visitor who had already used *the Painting Lens*. Though these results are restricted to a small number of users, they suggest an overwhelming imbalance between the few users who did receive instructional assistance from CMA staff or other visitors and the majority of users who did not use these *direct-dynamic* instructional forms. Looking at the results of the three participants (U10, U54 and U90) who received assistance from museum staff and/or other visitors, these users made between 11 and 16 interactions, with total durations of interaction between 2 and 8 minutes; above the mean, median, and mode averages for number of interactions and interaction duration. Despite the limited use of these *direct-dynamic* instructional forms, the results suggest that they can have a notable impact on the interaction experiences of the visitors who did use of them.

Unlike other forms of *direct-dynamic* instruction, the majority of observed users participated in some form of collaborative interaction with another visitor during their interaction experience

with *the Painting Lens* (65.2%, 73/112 observed users). The demographic for results associated with these collaborative interactors show that they were mostly female, totalling 67.1% (49/73 total observed users engaging in collaborative interaction); with males comprising 32.9% (24/73 total observed users engaging in collaborative interaction). The age groupings show that the majority of users engaging in collaborative interaction were between the ages of 25-34 (31.5%, 23/73 total observed users engaging in collaborative interaction) and 35-44 (35.6%, 26/73 total observed users engaging in collaborative interaction). The distribution of female to male users and users within different age groups who engaged in collaborative interaction are consistent with the general demographic results presented above in Figures 5.9 and 5.10.

The design of the installation context into which *the Painting Lens* was available facilitated collaborative interaction among users; if it were not for the upright, landscape orientation of the touch-screen, the potential for collaborative interaction among visitors might not be as successful. The pervasiveness of collaborative interaction among observed users is significant and may have contributed towards successful interaction experiences among visitors, but these results do not provide conclusive proof of this correlation. Looking at the mean duration of interactions among users who engaged in collaborative interaction compared to those users who did not engage in collaborative interaction, there is a notable difference across averages. To use the same adjustment that I applied to calculate the mean, whereby each interaction that less than a minute is counted as being one minute long, then the mean interaction duration of users who engaged in collaborative interaction was 3.01 minutes (220 minutes of interaction/73 observed users engaging in collaborative interaction), while the mean interaction for observed users who did *not* engage in collaborative interaction was 2.03 minutes (79 minutes of interaction/39 observed users who did not engage in collaborative interaction). The nearly one minute difference in mean interaction time between those users who did and did not engage in collaborative interaction time is interesting and does, to some extent, validate the design efforts of the development team.

Indirect – Dynamic: *Watching Other Visitors Interacting*

The percentage of observed users to engage in the act of watching other visitors interact with *the Painting Lens* prior to commencing their own personal interaction is 10.7% (12/112 observed users). This result is not far off of the post-interaction questionnaire result from Questions 2.2, whereby 12% of participants claimed they "saw others using it" in reference to how they knew how to interact (6/50 total responses). Demonstrating that between 10.7% and 12% of evaluated museum visitors make an effort to watch other visitors prior to initiating their own interaction experience is notable. These results, however, may be interpreted as an indicator that this form of instruction should not be relied upon as a primary source of instruction for interaction; after all, the inverse to these statistics show that between 88% and 89.3% of evaluated museum visitors were able to conduct their interaction experience without first watching other visitors interact with *the Painting Lens*, possibly relying on other instructional forms to support their interaction experiences.

Recording precise evaluation data for CMA visitors within Gallery One was an arduous task, complicated further by the influence of the social context of the environment. For example, visitors may have entered the exhibition space at times when there were few other visitors around, and so, may not have had the opportunity to observe other interacting visitors. Additional extenuating circumstances may have also contributed to the visitor flow that would have supported visitor-watching-visitor behaviour; such as the closure of Studio Play or the unexpected early-April snowfall, both of which members of the development team acknowledged for likely influencing the reduced visitor numbers within Gallery One during evaluation periods.

Discussion

Throughout this chapter, it has been my aim to examine how the Cleveland Museum of Art communicated instruction for interaction with *the Painting Lens* to its visitors using a combination of instructional forms, and to evaluate the impact of the use or non-use of the variety of available instructional forms by visitors. Prior to this point, the analysis of evaluation results has been presented in relation to the themes evaluated through either the development team interviews or

the in-gallery visitor evaluation. Presenting the combined evaluation results in a single discussion that aligns with the aims of this chapter means comparing the development team interview results, which relate primarily to the design of *the Painting Lens* and its associated goals relating to any intended user interaction experiences, with the visitor evaluation results, which provide insight into the user interaction experience and the use or non-use of instructional forms. To frame the discussion surrounding the analysis of the evaluation results, I use five sub-headings: (1.) a comparison of instructional forms that were *available* and instructional forms *used*, (2.) a comparison of the *observed* use of instructional forms with the *reported* use of instructional forms, (3.) the impact of instructional forms on the user experience and their ability to interact, (4.) an examination of the instructional forms visitors used compared to the instructional forms that visitors would like to have had available, and (5.) an examination of the assumptions and intentions formed by the development team compared with the actual interaction experiences of evaluated users.

Instructional Forms Available vs. Instructional Forms Used

I now take the opportunity to look at the instructional forms available with *the Painting Lens* primarily through their classification within two categories, *static* and *dynamic*. In line with my description of instructional forms provided in Chapter 2, the *static* forms of instruction include the available on-screen text and animated instructions, as well as the UI design and the familiar computing icons employed to help guide users through their interaction experience with *the Painting Lens*. The *dynamic* forms of instruction that I associate with *the Painting Lens* are, on the other hand, subject to interpersonal relations, including advice from other museum visitors or staff, collaborative interaction with other visitors, or the act of watching the interactions of other visitors using *the Painting Lens*. The most significant difference between these two categories of instructional forms is the consistency and reliability of the *static* instructional forms, due to their inextricable integration into the design of *the Painting Lens*, compared with the variable, and occasionally absent, nature of the *dynamic* instructional forms. An alternative way to view the *static* and *dynamic* instructional forms is in terms of their *personal* or *social* engagement; *dynamic*

instructions require multiple visitors or users to be functional as instructional options and, as such, call for interaction experiences to be more *social*, while *static* instructions rely solely on the on-screen content, allowing for more *personal* interaction experiences that do not depend on other visitors or users. As the availability of the *dynamic* forms of instruction rely on *social* person-to-person interaction or behaviours, either active or passive, these instructional forms may not be consistently accessible to visitors who are seeking them, even though the development team were careful to design an installation context for *the Painting Lens* that could engender these kinds of *dynamic,* or *social*, instructional forms.

The availability of the *dynamic* instructional forms depended on the presence of visitors and museum staff within Gallery One; if the exhibition space lacked visitors or staff who might be able to offer instructional advice, collaboratively engage in interaction, or demonstrate interaction with *the Painting Lens* for others, these instructional forms were simply not available. The observation results show that only 1.8% of observed users received advice from another visitor, and 1.8% received advice from museum staff in a manner that served to support their interaction experience (2/112; 2/112 total observed users, respectively). The observation results differ from the results of the post-interaction questionnaire, which show that 3.8% of participants received advice from another visitor and 1.9% were instructed by a CMA staff member (2/52; 1/52 responses, respectively). The observation results relating to visitors who spent time watching other visitors interact with *the Painting Lens* prior to initiating their own interaction experience was somewhat higher, being observed in 10.7% users, but it is unclear if this percentage represents the total number of users who *intended* to use this instructional form, or if it merely indicates its *availability* to potential visitors to watch interacting (12/112 observed users). The results of the post-interaction questionnaire show that 15.4% of participants claimed to have observed other visitors interacting with *the Painting Lens* prior to their own interaction experience (8/52 responses), representing some variability between the results of the two evaluation methodologies. Overall, however, the relatively limited use of these *dynamic* (*social*) instructional forms may suggest the influence of the *social*

context within the exhibition space, affected by the closure of Studio Play, which reduced the projected visitor flow through Gallery One during the observation periods.

These results show that use of these *dynamic* instructional forms was limited, and while it is likely that the restricted use primarily relates to the availability of the instructional forms to users during the evaluation periods, the results cannot indicate whether or not participants would have liked to have made use of these *dynamic* forms. Responses to Question 3.2, which asked post-interaction questionnaire participants to indicate the kinds of instructions they would have preferred to have with *the Painting Lens* show that only one participant would have liked to have had additional instructional support provided by museum staff (1/48 responses), suggesting that even if such *dynamic* instructional forms were more readily available, usage by visitors would likely be extremely limited.

Collaborative interaction was observed in 65.2% of users, which is not especially surprising, given that 77% of observed visitors entered Gallery One in a visiting group of two or more people (73/112; 86/112 observed users). The observation results support the aims that the development team had for creating an installation context for *the Painting Lens* that would create opportunities for visitors to interact collaboratively with the interactive Lenses, but they also illustrate the nature of the *social context* that Gallery One intends to facilitate. Within this interactive gallery space, visitors able to interact with the available interactive technologies in a collaborative fashion thanks to the accessible design of the Lenses, assisted by their landscape-style orientation. Although it is not entirely possible to demonstrate exactly how effective collaborative interaction was as an instructional form using the observation results, the data does provide some indication that users who engaged in collaborative interaction tended to make more interactions with *the Painting Lens* than users who did not engage in collaborative interaction. The mean results of interactions by those who did engage in collaborative interaction show that users made an average of 18.34 interactions, while those who did not engage in collaborative interaction made an average of 10.92 interactions (1339 total interactions made by 73 observed users engaging in collaborative interaction; 426 total

interactions made by 39 observed users who did *not* engage in collaborative interaction, respectively). These results could be interpreted in several ways, but as a measure for the effectiveness of collaborative interaction as a *dynamic* (*social*) instructional form, they suggest that collaboration with another user may have supported the user interaction experience, leading to a greater number of interactions with the interactive installation.

Although observation results suggest that up to 39.5% of all interactions may have been influenced in some way by the availability of the on-screen text or animated instructions, it is difficult to know how many of these interactions were made due to the awareness or at the direction of the on-screen instructions, or if the interactions were made more intuitively, due to user expectation or possibly a pre-existing familiarity with the interactive Lens. Determining the use of the on-screen text and animated instructions is challenging to quantify using the observation results alone, as these elements were integrated into the on-screen UI and, therefore, could not be considered as intentional selections made through deliberate interactions. The post-interaction questionnaire results from Question 3.1, which asked about the forms of instructions participants used during their interaction experience with *the Painting Lens*, show that 55.8% of participants were aware of the on-screen instructions enough to select this option from a list of potential instructions they might have used during their interaction experience, but again, just because participants claimed to have *seen* the on-screen instructions does not necessarily prove that the instructions were *purposefully used* by these participants.

Similarly, I was not able to use visitor observation as a methodology for collecting precise data relating to the use of the on-screen UI elements, such as the ☒ to close icon or the left and right arrows, due to the possibility that users were already familiar with these elements, either as a result of pre-existing experience with *the Painting Lens* or because of the widespread use of the icons in computing domains over the past few decades (Archer 2014). The post-interaction questionnaire results from Question 3.1 indicate that 36.5% of participants claimed they did not use any of the available instructional forms associated with *the Painting Lens*. Unfortunately, the

responses to this question do not provide further indication as to *how* these users knew how to interact with *the Painting Lens*, but it would be reasonable to suggest that, for some users at least, the integration of familiar computing elements into the design of the UI, like ☒ to close, could guide users through their interaction experience without the need for supplemental instructional support.

Observed Use of Instructional Forms vs. Reported Use of Instructional Forms

Within the results that I have presented, there are some inconsistencies between the results that show the *observed use* of the various instructional forms and the *reported use*, depending on whether the results originate from data collected through visitor observation, or post-interaction questionnaire responses. For example, with respect to results relating to the *direct-dynamic* instructional form of advice or assistance provided by a museum staff member, observation results indicate that only 1.8% of users received instructional support from a museum staff member (2/112 observed users), while post-interaction questionnaire responses provide somewhat conflicting results. Responses to Question 2.2, which asks broadly how participants knew how to use the touch-screen, show that 4% of participants claimed to have received this form of instructional support (2/50 responses). Alternatively, responses to Question 3.1, which asks more specifically about the forms of instructions that participants actually used during their interaction with *the Painting Lens*, indicate that 1.9% of participants claim to have been instructed by a museum staff member (1/52 responses). Although these results are quite low and, to some degree, could be interpreted to indicate the high level of usability facilitated by the intuitive design of the UI, requiring few users to pursue instructional support from CMA staff, the variation across these results may be due to the broad phrasing of Question 2.2, compared with the more precise phrasing of Question 3.1, which has a result much closer to that collected through user observation.

As I explained in Chapter 3, I chose to use a *post-interaction* questionnaire so that I might attempt to avoid any possible influence on the interaction behaviours of the participants that I would be evaluating. To achieve this, I only approached potential participants *after* they had completed their interaction experience to invite them to participate in my research. I took this

approach to attempt to avoid the Hawthorne effect, which proposes that evaluation participants may adjust their interactions or behaviours due to prior knowledge of the research subject, altering their responses to provide data that might support the goals of the research (Adair 2000; Sedgwick 2012; Sedgwick and Greenwood 2015). I consider this methodological strategy to have been successful, as the results of the visitor observation are generally consistent with the participant responses to the post-interaction questionnaire; however, there are still some irregularities relating to the use or non-use of instructional forms which call for further examination.

Although it was not possible to collect precise data associated with the use of the on-screen text and animated instructions through visitor observation, the selection of certain on-screen interactive options that would automatically provide integrated instructions by observed participants meant it was possible that up to 39.5% of the witnessed interactions may have been influenced by the integrated on-screen instructions. Referring once again to the post-interaction questionnaire results of Questions 2.2 and 3.1, the responses indicate divergence relating to the use of the on-screen instructions. When asked *how* participants knew how to use the touch-screen, in Question 2.2, 32% of participants claim to have "used the on-screen instructions" (16/50 responses). Yet, when asked about the kinds of instructions that they used with *the Painting Lens*, in Question 3.1, 55.8% of participants responded that they "saw the on-screen instructions" (29/52 responses). This difference of 23.8% between the responses to the two questions is intriguing and could indicate some degree of the Hawthorne effect representing itself in the post-interaction questionnaire data. Although visitors who agreed to participate in the post-interaction questionnaire were not approached prior to their interaction experience with *the Painting Lens*, they were fully informed about the nature and purpose of my research through my invitation to participate in the research. Furthermore, the complete details of the research were provided within the consent form that each participant signed prior to filling in their responses. As such, it may be possible that some participants felt compelled to respond that they had used the on-screen instructions to, in some way, validate my research and their participation in it.

Another way to interpret the difference between the results of Questions 2.2 and 3.1, relating to the use of the on-screen instructions, comes down to the exact phrasing of each question and answer. The wording used in Question 2.2 was rather non-specific, asking "How did you know how to use the touch-screen?" Although I made it clear to each potential participant, when I invited them to participate, that my research relates specifically to their interaction experience with *the Painting Lens*, which was within close proximity when each invitation was made, it is possible that some participants interpreted the question more broadly, perhaps providing responses that reflect their use of any of the touch-screens within Gallery One, rather than solely relating to their use of *the Painting Lens*. The phrasing of Question 3.1, alternatively, was much more case-specific, asking participants directly, "What kinds of instructions did you use with *the Painting Lens*?" Here, the phrasing was less ambiguous and could only be interpreted to relate to *the Painting Lens*, rather than the collective interactive Lenses of Gallery One. It may be that the difference in the wording of these two questions, broad versus specific, influenced the responses provided by the participants, thereby accounting for the fluctuating responses participants provided for the two questions.

Impact of Instructional Forms on User Experience and Ability to Interact

To examine the impact of the instructional forms on the quality of the user experience or a user's ability to interact with *the Painting Lens*, I focus on the qualitative responses that participants of the post-interaction questionnaire provided. I direct this discussion towards evidence that the use of the available instructional forms improved either the user's ability to interact or the quality of their interaction experience. I begin by looking at results relating to the usability of *the Painting Lens*, following this by exploring results that indicate the quality of the user interaction experience.

Within the post-interaction questionnaire, I included three questions designed to provide insight into the user experience with *the Painting Lens*, specifically focusing on ease-of-use, user enjoyment, and rating the interaction experience. In Question 4.1, I asked participants whether they found *the Painting Lens* easy to use, while Question 4.2 asked if participants enjoyed their interaction with *the Painting Lens*. For each of these two questions, participants were able to

indicate an affirmative or negative response, and a blank space was provided so that participants could add more detailed, qualitative written responses. To supplement Question 4.2, I asked participants to provide a rating of their interaction experience with *the Painting Lens* in Question 4.3; a scale out of 10 was provided for visitors to use, with 1 being a poor interaction experience and 10 being an excellent one.

With respect to the ease-of-use of *the Painting Lens*, the responses to Question 4.1 show that 100% of participants found that interaction with *the Painting Lens* was easy to use (50/50 responses; 3 participants declined to respond). In the space that was offered for participants to provide a more detailed response, 72% of participants actually wrote in an explanation for their response to Question 4.1 (36/50 responses). The written responses show a definitive link between the participant's perception of the *ease-of-use* of *the Painting Lens* with either the on-screen UI design, or with the touch-based interactive technology. While many of the written responses acknowledged the clarity and simplicity of the instructions (For example, Q4: "Easy instructions"; Q21: "The instructions were clear and straightforward"; and Q33: "Cues were easy to follow"), others remarked upon the familiarity of the icons, or similarities with other touch-based interactive technologies (For example, Q3: "Similar to apps on my tablet/phone"; Q11: "It is similar to other touch-screens, so very easy to use"; Q47: "It's similar to other touch-screen devices as this – just touch and see what happens"; and Q50: "The remixing and painting activities used common gestures for other phones and tablets").

Concerning user enjoyment, the responses to Question 4.2 similarly show that 100% of participants claim to have enjoyed their interaction experience with *the Painting Lens* (50/50 responses; 3 participants declined to respond). The space left for participants to provide a written response was used by 82% of participants who responded to Question 4.2 (41/50 responses). The written responses to Question 4.2 are significantly more varied than those for Question 4.1, revealing a great deal of insight into how participants perceived their interaction experience with *the Painting Lens*. Some visitors provided very standard and concise responses; for example, references

to “fun” appeared in 18% of responses, while 8% of responses reference how “easy” interaction with *the Painting Lens* was, shedding light on which characteristics of their interaction experience these participants value (9/50; 4/50 responses, respectively). Although responses indicate the characteristics that participants valued in creating their enjoyable interaction experience with *the Painting Lens*, none explicitly mentioned the role of any of the instructional forms in their responses.

Coding the written responses to Question 4.2 for words relating to learning, education, or the artworks on display, results show that 42% of participants related their interaction experience with *the Painting Lens* to something new, informative, or closely associated with the artworks (21/50 responses). According to the members of the development team, one of the primary goals of the interactive Lenses, and of Gallery One, was to connect museum visitors with the artworks; to have them make connections between the art and objects on display within Gallery One, and throughout the rest of the CMA. While not directly relevant to this research, the high percentage of responses implicating the educational content or the artworks on display is incredibly significant, encouraging even, and confirms the success of the development team in achieving this particular, defined user experience goal.

The results of Question 4.3, which asked participants to rate their interaction experience with *the Painting Lens*, show that participants assessed their experience with the in-gallery interactive installation quite highly. None of the participants rated the user experience below a 7, and 46.9% of participants gave a rating of 10/10, indicating a decidedly favourable opinion of the user experience with *the Painting Lens* (23/49 responses; 4 participants declined to respond). Although there does not appear to be an explicit link between participants’ rating of their user experience and the impact of the instructional forms on their perception of the user experience, the results for Question 4.3, together with the positive responses for Questions 4.1 and 4.2, demonstrate that interaction with *the Painting Lens* was considered, by participants of the post-interaction questionnaire, to be enjoyable, easy to achieve, and informative.

Determining the exact impact of each of the different instructional forms or the degree of their influence on the interaction experience warrants further research and evaluation, particularly with respect to the forms of instruction integrated into the interaction experience with the UI. Connecting the use of instruction to the improvement of a user's interaction ability and/or the quality of their interaction experience is not possible here, due to the nature of the results and the limited sample size, but this research can serve as an underpinning for others to build upon to better understand the impact that the use of instruction can have on a museum visitor's interaction experience with an in-gallery interactive installation.

Instructional Forms Used vs. Instructional Forms Users Want

Having presented the results relating to the forms of instructions that participants of this research were observed using, or claimed to have used, during their interaction experience with *the Painting Lens,* I now turn to the results of the post-interaction questionnaire that offer insight into the forms of instruction that museum visitors would like to have available with *the Painting Lens*, and with in-gallery touch-based interactive installations found within museum exhibition spaces more generally. In the third section of the post-interaction questionnaire, concerning instructions associated with *the Painting Lens*, I asked participants to respond to three questions about instructions, both with *the Painting Lens* and more broadly associated with in-gallery touch-based interactive technologies within museums. The results for Question 3.1, which asks about the kinds of instructions participants used during their interaction experience with *the Painting Lens*, have already been presented above. In Question 3.2, I asked participants to provide their opinion about the kinds of instructions they would like to have had available with *the Painting Lens*, and in Question 3.3, I asked participants to reflect on the kinds of instructions they would like to have available with touch-screen installations in museums more generally. For Questions 3.2 and 3.3, the same multiple-choice responses were available: someone from the museum to show me how interaction works, an on-screen option for additional information about how interaction works, an option to replay the on-screen animated instructions, clear and easy-to-understand design using

familiar icons, and an open-ended "other" response with space available for participants to provide their own written suggestions.

Participant responses to Question 3.2, which asked specifically about instructions participants would like to have had available for *the Painting Lens* demonstrate the importance of UI design and the presence of familiar computing icons. Responses show that 50% of participants claimed to prefer "clear, easy-to-understand design using familiar icons", followed by 31.3% for "an onscreen option for additional information about how interaction works", 8.3% of responses for "an option to replay the on-screen animated instructions", and 2.1% seeking "someone from the museum to show me how interaction works" (24/48; 15/48; 4/48; 1/48 responses, respectively). Of the 27.1% of participants who provided more detailed written responses (13/48 responses), most suggested that *the Painting Lens* did not require further instructional measures (e.g. Q1: "Don't really need – this exhibit is interactive, learn as you go"; Q23: "Didn't need any, easy to use"; or Q38: "I didn't need any instructions"). One participant, however, did offer a piece of constructive criticism about a particular aspect of the "Make Your Mark" UI, suggesting that the available colour palette be made larger (Q34), while another participant expressed their hope that instructions could be more technologically advanced (Q44: "voice activated"). A total of 9.4% of participants did not provide a response to the question (5/53 participants).

With respect to instructions available with in-gallery touch-screen installations in museum exhibitions more generally, responses to Question 3.3 echo those provided for Question 3.2, showing participant preference for familiar visual elements of the UI to guide interaction. Results show a predilection for "clear, easy-to-understand design using familiar icons" among 52.9% of participants, followed by 35.3% of participants who would like to have "pictures showing how interaction works" (27/51; 18/51 responses, respectively). Also favouring visual forms of instruction, 21.6% of participants showed partiality towards "video or animations showing how interaction works", with 5.9% of participants suggesting they would prefer personal assistance from museum

staff for instruction (11/51; 3/51 responses, respectively). Two participants failed to provide a response to the question, accounting for 5.9% of the total participants (3/51 participants).

Although the results to these two questions show that participants favour clear, easily comprehensible design first and foremost, there is evidence that some participants may have misinterpreted the two questions or how to respond. This is most apparent in the written response to Question 3.3 by Q44, which says "example in entrance of building w/ voice @ this station only [sic]"; a response that continues to puzzle me. The question asked for general reflection about instructions associated with in-gallery touch-screens in museum exhibitions, yet this incredibly unclear and highly specific response leads me to believe the participant may have had some difficulty interpreting the question as I had intended it be interpreted. I also wonder if misinterpretation of the phrasing for Question 3.2 may have influenced half of the post-questionnaire participants to respond that they would like *the Painting Lens* to have had a "clear, easy-to-understand design with familiar icons" (50%, 24/48 responses), as if it lacked these assets in its final presentation. It could, alternatively, indicate that participants in the post-interaction questionnaire placed a great deal of importance on the clarity of the UI and the familiarity of the icons when they choose to engage with in-gallery touch-based interactive installations.

Despite any misinterpretation related to the phrasing of the questions, responses to Questions 3.2 and 3.3 provide significant insight into the kinds of instructions museum visitors prefer to use and the kinds of instructions that they expect to find associated with in-gallery interactive technologies. For most participants, their preferences for instructions seem to align with the design goals that the development team had for *the Painting Lens*; a clean, easy-to-use UI with familiar icons that could support the user experience without the need to rely on supplemental instructional forms. This alignment shows that the efforts made by the development team, through months of iterative design, prototyping, and user testing, both inside and outside of the museum context, were helpful for meeting the expectations that museum visitors have for the kinds of instructions they associate or prefer to use with in-gallery touch-based interactive technologies.

Post-interaction questionnaire participant responses to Questions 3.2 and 3.3 underline the clear expectation that museum visitors have for the clean, easy-to-use design of the UI's of in-gallery touch-based interactive technologies. Their responses also indicate a preference for visual forms of *static* instruction that can accommodate a much more *personal* interaction experience, such as video, animation, or images; however, it is worth repeating that 31.3% of participants indicated an interest for having an on-screen option for additional instructions to show how interaction worked with *the Painting Lens* (Question 3.2; 15/48 responses). These conclusions are not explicitly evident from the observation results; instead other conclusions about *dynamic* instructional forms emerge, such as the preferences of museum visitors for engaging in collaborative interaction (65.2%; 73/112 observed users), or simply watching other visitors interact (10.7%; 12/112 observed users). The division between the more *social* interaction experiences that could facilitate the availability of *dynamic* forms of instruction and the *personal* interaction experiences that required users to rely on *static* instructional forms is an aspect of this research that I believe warrants further evaluation and could be linked to individual user preferences for engagement with interactive technologies more generally. Although some research exploring user interaction behaviours with touch-screen technology has already been conducted, for example, on providing insight into parallel or cooperative interaction (Peltonen et al. 2008), interactivity among different social groupings (Chen et al. 2011), and user perception about sensory, semantic, or behavioural interaction experiences (Sohn 2011), further research relating to the *personal* and *social* uses of instruction relating to in-gallery interaction technologies could certainly be useful for providing greater insight into user interaction behaviours within museum exhibition contexts.

The collective evaluation results show that museum visitors made use of a range of the forms of instruction available, necessitating a need to include both *static* and *dynamic* forms of instruction to accommodate the instructional needs of the visitors who prefer either more *personal* or *social* interaction experiences within Gallery One. The development team understood this about their audience from the beginning and, through their design and evaluation efforts, they were able

to create and integrate an in-gallery touch-based interactive installation into a museum context that successfully met the instructional needs and expectations of its users.

Development Team Intentions/Assumptions vs. User Interaction Experience

Throughout the conducted interviews, development team members identified a number of goals that they were working towards achieving during the design and development phases they went through to create Gallery One. Additionally, the development team members indicated a number of assumptions that they had about their visitors and the behaviours that they expected visitors to make during their time within Gallery One. Here, I explore a selection of the goals and assumptions that the development team identified in their responses to the interview questions and, when possible, compare these with the results of the visitor evaluation activities to determine the effectiveness of the development team at achieving their goals and how reasonable, or unreasonable, their expectations were in relation to actual visitor behaviours. Though I aim to include discussion relevant to *the Painting Lens* in particular, much of the discussion that follows considers the development team's goals and assumptions relating to Gallery One in a broader sense, while visitor evaluation results relate more specifically to *the Painting Lens*.

One of the primary goals that the development team identified was the aim to create an interactive exhibition space that would offer *something for everyone*. Alexander suggested that, more specifically, "Gallery One blended art, technology, and interpretation to inspire visitors to explore the museum's permanent collection. It offered something for everyone, from first-time to frequent museum visitors." The integration of interactive technologies supports this approach, as during the period when Gallery One was being developed, museums were not typically exploring such extensive use of interactive technologies within their exhibition spaces. The role of technology in achieving the goal of providing *something for everyone* was not meant to just bring in visitors of a certain age or type into Gallery One, it was also intended to influence how visitors perceive the museum. Gallery One and its interactive exhibition space was part of a broader strategy that the CMA used to attract new visitors into the museum, along with their rich program of community

engagement activities and offerings (The Cleveland Museum of Art 2014). Acknowledging this, Strean observed that, "Somehow you hook people that maybe have assumptions about how boring this place was, and that maybe you can break some of this down." In an open comment section of the post-interaction questionnaire, where participants were free to provide any further feedback about their experience with *the Painting Lens*, Gallery One, or the CMA, 55% of participants who provided a written response specifically mentioned "fun" in their reply (11/20 responses). One participant specifically said that Gallery One was a "fantastic way to get 'no-art' people to enjoy the pieces!" and that it was a "fantastic way to enhance the museum experience" (Q36). These written responses, in addition to the high ratings that participants gave *the Painting Lens* when asked to assess their interaction experience with the in-gallery interactive in Question 4.3, show that visitors generally viewed their experience with the in-gallery interactive technology within Gallery One quite positively, and to some extent, validates the "something (fun) for everyone" goal set forth by the development team.

Related to this first goal, the development team members aimed to make use of in-gallery interactive technologies as a means to offer a range of interactive experiences relating to the artworks on display, including layered information and other game- or puzzle-like interactive options. The intention was to offer a number of different interactive experiences that would each, in their own way, encourage visitors to engage and connect with the artworks, both within Gallery One and in the permanent galleries of the CMA. The objectives defined by Rao and her team were, as Alexander said, " The primary goal of Gallery One is to use innovative technology to provide visitors with the toolsets to look closer, dive deeper, and feel comfortable exploring every gallery in the museum. I believe there is something in art for everyone and hope Gallery One helps remove the stigma that museums are boring." An earlier quote from Shaw, which I restate here, saw these objectives broken down into two main aims; to "inspire visitors to want to learn more" and to "potentially garner different information and inspiration from the artworks [through interactivity]." The responses of the visitors who participated in the post-interaction questionnaire echoed these

objectives back in their written comments, offering remarks like those from Q6, who wrote, "I found *the Painting Lens* to be a wonderful tool to learn more about all of the techniques shown. I enjoy being able to 'play' with new knowledge." One participant, Q35, even expressed regret that she did not have more time to engage with *the Painting Lens*, saying, "This was a very engaging display – I would have liked to have interacted with it more, but my kids (aged 9 & 10) took over." Certainly, the comments within the post-interaction questionnaire demonstrate that *the Painting Lens* and Gallery One were effective tools for engaging visitors with the in-gallery interactive technologies and, to some degree, connecting visitors with the artworks on display.

The development team formed certain assumptions or expectations for the way they thought visitors would behave in relation to the in-gallery technologies within Gallery One, and for the pre-existing experiences that their visitors might already have with touch-based interactive technologies. Looking first to the assumption that visitors to Gallery One would already have some pre-existing knowledge of or experience with touch-based interactive technologies, Shaw conveyed her expectation that users would anticipate certain interactions with the touch-screen, such as pinching to zoom, due to the widespread use of this multi-touch interaction paradigm within commercially available touch-based interaction technologies, including iPads and iPhones. Indeed, this pre-existing knowledge of touch-based interactive technologies and the associated interaction paradigms extended into the UI design as well. As Alexander noted, "In designing the space, we used UX [User Experience] and UI that our visitors were already familiar with and intuitive. You will notice on the Collection Wall and the ArtLens App, we use a heart similar to Instagram for our visitors to 'like' artworks. On the Collection Wall, we created a cover-fall similar to iTunes." According to the development team members, the strategy behind these decisions was to rely on elements or technologies that visitors were already familiar with, and as a result, they would be more comfortable initiating interaction and require less instruction, creating a more intuitive interaction experience. As the results of the post-interaction questionnaire show, the participants claimed to have a high level of familiarity with touch-based interactive technologies; 96.2% of participants self-

identified as owners of touch-based interaction devices (51/53 responses). Furthermore, the responses of the post-interaction questionnaire also demonstrate that most users were satisfied with the level of instruction available in *the Painting Lens*, showing that the familiar icons and interaction gestures that the interactive installation employs were sufficient for most users, reducing any need for supplementary instructions to support their interaction experiences.

With respect to visitor behaviour within Gallery One and with the available in-gallery interactive technologies, the development team were not expecting that every visitor to the gallery would interact with every interactive installation. Instead, the development team operated with the aim of offering *something for everyone*, without the expectation that *everyone* would interact with *everything*. Even for those visitors who did elect to engage with the in-gallery interactive technologies, the development team maintained realistic expectations for how much interaction a single visitor might achieve, anticipating that some visitors may be very engaged with the interactive technologies, while others may move through Gallery One without touching a single interactive element. As Alexander said, “The technology is available for those who use tools to engage and learn more. If you don’t need the technology, that’s great too. We design so those can experience the art without using the digital.” Elaborating on this, Rao suggested that “What’s nice is, a portion of the people who look at the art do [interact with] the technology, and a portion of the people doing the technology will look at the art, but it’s not necessarily in any kind of order.” These behaviours were first identified by the development team during the final phases of user testing within the installation context of Gallery One. Shaw noted that user testing demonstrated the variability of user interaction behaviour with the interactive Lenses, saying, “We definitely assumed that people would play maybe one, ideally two of the games, but not more than that. How people picked was definitely up to their own discretion and their own demographic. People will pick so randomly, from what we observed.” Ultimately, the development team aimed to provide the *opportunity* for visitors to create their own engaging, interactive museum experience using the in-gallery interactive installations available within Gallery One, but they were not disappointed when visitors would forego the

interactive technologies to focus on the other aspects of their museum experience. By maintaining this realistic expectation for visitor engagement with the available interactive technologies, and by offering a range of interactive options to their visitors, rather than requiring visitors participate in a strict, linear form of interactivity, the development team were able to achieve their *something for everyone* goal in a way that offered a flexible museum experience for their visitors that included the possibility for a variety of engaging, interactive experiences. Although my own evaluation results do not take into account the number of interactive installations visitors made use of during their time within Gallery One as a whole, evaluation results from the CMA showed that nearly 60% of visitors interacted with at least one of the Lenses (Alexander 2014a, 2014b; Chun, Gasparotti, and Cairns 2014b)[20].

Conclusions

The development team responsible for *the Painting Lens* relied on creating a UI design that was meant to intuitively guide their users through their interaction experiences, supported by a clean and simple (*static*) graphical user interface, and through their design of an installation context that was intended to promote (*dynamic*) interaction with the in-gallery interactive installation in collaboration with other museum visitors. Based on my evaluation results and the outcomes of the interviews, it seems that the members of the development team were successful in their endeavour to communicate instruction largely as a result of their efforts to invest resources, both financial and temporal, into (a.) defining and understanding their potential users, (b.) identifying clear and attainable goals for the interaction experiences they intended their users to have, and (c.) applying a rigorous approach to user testing that ensured their target users could achieve the interaction goals defined by the development team. Here, I present my conclusions relating to the influence of the

[20] According to the partially published results produced by the CMA evaluation activities, 38% of participants interacted with one Lens, 23% interacted with two Lenses, 23% interacted with three Lenses, 12% interacted with four Lenses, and 4% interacted with all five of the Lenses within Gallery One (Alexander 2014a, 2014b; Chun, Gasparotti, and Cairns 2014b).

design of the installation context on the user interaction experience, the importance of user testing for achieving effective communication of instructions for interaction, and finally, the impact of the available instructional forms on the interaction experiences that users had with *the Painting Lens*.

Influence of the Installation Context on User Interaction

Within the CMA, Gallery One was the only exhibition space where in-gallery interactive technologies were presented in place alongside thematically related artworks and collections of the museum. Although museum galleries traditionally follow a "look, but don't touch" paradigm, the physical space within Gallery One offered visitors an opportunity to engage with a number of interactive technological elements, including the Studio Play, the Collection Wall, and six interactive Lenses, of which *the Painting Lens* has been evaluated here. While introductory signage instructed visitors to Gallery One not to physically touch the museum collections on display, they were encouraged to engage and interact with the interactive technologies available throughout the gallery. Research conducted shortly after the opening of Gallery One indicated that nearly 60% of visitors who enter the exhibition space interacted with at least one of the available interactive Lenses, demonstrating Gallery One's effectiveness at encouraging visitor interaction with the in-gallery interactive technologies (Alexander 2014a, 2014b; Chun, Gasparotti, and Cairns 2014b).

As the members of the development team expressed through their interview responses, the presence of the interactive Lenses within Gallery One were intended to offer an engaging way to create a closer connection between visitors and the artworks. Within Gallery One, the relationship between the collections on display within the thematic exhibition space and the interactive Lenses was, for most visitors, relatively clear, supported by close proximity between the artworks and their associated Lenses. The installation context was designed to provide visitors with the *opportunity* to interact with the in-gallery interactive technologies, while at the same time, offering an open exhibition format that would not require visitors to interact in order to understand or appreciate the artworks on display. Indeed, as the development team was aware, visitor behaviours vary and not every visitor to Gallery One may have felt compelled to engage with the available interactive

installations. The juxtaposition of the interactive Lenses to their accompanying displays of thematic collections was designed to be close enough to indicate the association between the artworks and the interactive Lenses, but far enough away that visitors who did not wish to interact with the technology were not obliged to do so and could still enjoy their visit to Gallery One without engaging with the available interactive installations. For those users who chose to interact with the Lenses, the proximity to the artworks on display and the on-screen mirroring of the relevant thematic artworks created a connection between the interactive experience and the exhibition space; however, for some visitors, their interaction experience with the technology could be so consuming that it impeded their awareness of the displayed artworks (Alexander 2014b, 360).

The design of the installation context of *the Painting Lens,* and the other interactive Lenses within Gallery One, was particularly suitable for those visitors who elected to engage in collaborative interaction; the most widely used *direct-dynamic* instructional form evaluated here, practiced by 65.2% of observed users. The landscape-orientation of the touch-screens, in addition to the reasonable height of the housing and the multi-touch capabilities of the interactive technology, facilitated shared interaction experiences with the Lenses among multiple visitors. Designed for full ADA compliance, the Lenses were accessible for visitors with a range of physical aptitudes; ranging from small children to taller adults, as well as for visitors who were physically impaired in ways that may require wheelchairs or other mobility aids (Department of Justice 2010). The design of the interactive Lenses did not only allow several users to interact with a touch-screen at a single time, supported by the multi-touch capabilities of the technology, it also allowed multiple visitors to gather around a screen to view the on-screen content without having to interact; for some, watching other visitors interact may have inspired them to initiate their own interaction experience.

Importance of User Testing

The presence of a permanent Research and Evaluation department within the CMA demonstrates that the museum not only prioritises, but also values, the evaluation activities that provide insight into who their visitors are, their interests, and how they experience the museum.

This was particularly true in relation to Gallery One, which was, according to reviews of the exhibition space, a rather bold and experimental endeavour for the museum to attempt to undertake (Helmreich, Jones, and Stevens 2013; Machado 2013; Rodley 2013a, 2013b; Chun, Gasparotti, and Cairns 2014d; Murphy 2015; Chan 2017). A significant number of research and evaluation activities were conducted throughout the development of Gallery One with the aim of ensuring the final interactive exhibition space would not only appeal to its visitors, but also that the internal elements of the exhibition space, such as the selected thematic artworks, their associated educational content, and the available interactive installations, would collectively be both understood and well-received by CMA visitors.

Testing and evaluation associated with Gallery One was thorough, beginning with concept prototyping and culminating in a six-week period of in-gallery evaluation with visitors to identify any aspects of the visitor experience that would need to be tweaked prior to the official opening (Alexander, Barton, and Goeser 2013; Alexander 2014a, 2014b; Chun, Gasparotti, and Cairns 2014c). Even after Gallery One was open to the public, the CMA continued to prioritise visitor evaluation to identify any further, unforeseen aspects of the visitor experience that were not recognised during the earlier evaluation phases and to validate the functionality of the existing design choices. My own request to conduct the evaluation activates that led to the research presented here was similarly viewed as an opportunity to gain further insight into the visitor experience within Gallery One, demonstrating the prevailing interest the CMA continues to have in understanding the different facets of the experiences their visitors might have had within their interactive exhibition space. The evaluation efforts and their collective results have since contributed to the design and development of the new ARTLENS Gallery, which is currently undergoing its own series of evaluation measures to gain insight into the visitor experience of this newly redesigned and rebranded interactive exhibition space (Alexander, Wienke, and Tiongson 2017; The Cleveland Museum of Art 2017b).

The responses from the development team members showed that the user testing associated with *the Painting Lens* and Gallery One, especially the evaluation that took place within

the exhibition space in the six-week period prior to the opening, helped to identify and resolve issues relating to assumptions of visitor interaction behaviour, and associations between the interactive installations and their related thematic artworks. Most notably, as Rao recalled, the outcomes of some late evaluation activities identified a need to offer visitors a highly visual demonstration of the available interactions, leading to the introduction of the animated instructions, which were integrated into the UI of the interactive Lenses shortly after the opening of Gallery One to the public. According to the development team, these last-minute evaluation efforts provided proof that the animated instructions were a more suitable method for guiding users through their interaction experiences with the interactive Lenses, opposing the assumptions the development team had that the range of interactive possibilities available would be intuitively attempted by all users or by offering lengthy textual instructional options. Additionally, the evaluation conducted within Gallery One exhibition space provided the necessary context for the artworks that simply was not available during off-site evaluation. Although usability testing of the technology and the UI were initially handled off-site by *Local Projects*, the development team came together within the installation context of the CMA to conduct a level of comprehension user testing that led to better understanding of the interaction experiences of the users and their grasp of the available educational content offered by *the Painting Lens*. As Shaw noted, the speed at which users were able to make connections between the on-screen content and the artworks was found to have increased during evaluation activities within the context of Gallery One, especially in relation to the "Look Closer" option and the interaction used to magnify the on-screen image of the selected artworks.

Impact of Instructional Forms on the User Interaction Experience

The evaluation results presented here show specifically the instructional forms that users of *the Painting Lens* preferred to make use of during their interaction experiences, but determining the effectiveness or the influence of each instructional form evaluated is more difficult to precisely define. While the *static* forms of instruction, namely the use of familiar icons integrated into the UI

and the appearance of on-screen text and animated instructions, seem to have been influential in guiding users through an arguably intuitive interaction experience, the specific impact of these instructional forms on the interaction experiences remains unclear, as they relied on the assumption that users had a pre-existing familiarity with these on-screen elements and/or were aware of their on-screen presence throughout their interaction experience. Although 32%-55.8% of participants in the post-interaction questionnaire reported either seeing or using the on-screen text or animated instructions, the influence of the familiar computing icons integrated into the UI, as an instructional form, was not apparent from the post-interaction questionnaire results. That said, however, the results from the 56% of participants who claimed to have "tried a few things until I figured it out", or the 36.5% who claimed not to use any instructions, may be indicative of the impact of the UI design on the user interaction experience and that the design was intuitive enough that users did not feel it was necessary to seek out additional instructional measures. These results may imply that the high level of pre-existing familiarity with touch-based interactive technologies, as evidenced by the 96.2% of participants who claimed to own a touch-based interaction device, may have influenced the success of their trial-and-error approach to interaction. Moreover, the results demonstrate user preferences for engaging a more *personal* approach to interaction, relying on a level of self-sufficiency necessary for attempting a trial-and-error interaction approach or depending on *static* instructional forms that would not require *social* interaction with other visitors.

The impact of the *dynamic* forms of instruction are somewhat more quantifiable, given that the use of these forms of instruction was more easily observable. The design of the installation context supported the availability of *dynamic* instructional forms through the location of *the Painting Lens* within Gallery One and its proximity to the artworks on display, affording users the opportunity to engage in more *social* interaction experiences with other visitors. The accessible nature of *the Painting Lens* within Gallery One allowed visitors to collaboratively interact with one another and with the touch-screen, permitting users to engage in interaction behaviours together, learning from and with each other. The design of the installation context also facilitated

opportunities for visitors to watch one another interacting with *the Painting Lens*, actively or passively demonstrating interaction for each other. Without the need for interpersonal communication, one visitor could observe the interactions of another prior to initiating their own interaction experience with *the Painting Lens*, learning from the successful interactions of other visitors. Advice for successful interaction could also have been shared among visitors, facilitating a transfer of instructional knowledge from one visitor to the next through *social* interaction, however this was rarely observed. Although the results of the visitor evaluation do not indicate that visitors who engaged with *the Painting Lens* frequently sought out members of CMA staff for instructional support with their interaction experience, the permanent availability of museum staff within Gallery One for this purpose was on hand for those visitors who may have preferred this kind of personalised, *social* form of instructional support.

The intuitive design for the UI of *the Painting Lens,* and the limited amount of textual instruction required for visitors to read through and comprehend in order to engage with the touch-screen, seems to have worked exceptionally well for the visitors who participated in this research. Many of the post-interaction questionnaire participants indicated the simplicity of the design of the UI or how easy the on-screen instructions were to follow when asked to provide their opinions about what made *the Painting Lens* easy-to-use. When asked about the kinds of instructions they would have liked to have had available with *the Painting Lens*, 50% of post-interaction questionnaire participants said they prefer a clear, easy-to-understand UI design using familiar icons, while 20.8% provided written responses indicating that they felt the current design to be clear and intuitive enough for their liking, meeting their expectations (11/53 responses). Ultimately, the satisfaction expressed by the post-interaction questionnaire participants about their interaction experiences with *the Painting Lens* and its design can be at least partially attributed to the rigorous evaluation activities conducted by the development team, together with their proclaimed use of the evaluation results, allowing for improvements to their designs and producing this highly functional, user-friendly interactive installation within Gallery One.

Chapter 6: Conclusion

The integration of interaction technologies into museum exhibition spaces has been gradually increasing, but there are still gaps in our understanding of how interactive installations impact the museum visitor experience. Publications on the relationship between museums and the interactive installations they offer are increasing, shedding light upon a range of related themes (e.g. McNamara 1986; Economou 1998; Marty, Rayward, and Twidale 2003; Forrest 2015). However, few focus on the role procedural instructions for interaction can have on a museum visitor's interaction experience. Since I agree with other scholars who are critical of the reliance on case studies within museological publications (Economou 1998; Kidd 2014a; Forrest 2015), I must acknowledge the duplicity of using two case study installations within this thesis. Although the sample size of installations I evaluated is limited to two, the results are useful and contribute nonetheless to our wider understanding of the museum visitor experience and the influence of interactive technologies. More specifically, the results reveal disparity between assumptions made about user preferences and interaction behaviours with the actual interaction behaviours or preferences of museum visitors. In this final chapter, I broaden and generalise the combined case study results so that the conclusions I present here may be applied to a wider range of users, technologies, museums, or contexts.

Throughout this thesis, my objective has been to initiate a discussion about the impact procedural instructions can have on the interaction experiences museum visitors have with in-gallery interactive installations. In Chapter 2, I developed a proposal for a practical framework for defining and identifying four forms of instruction using an approach that combines educational theory with the work of STEM researchers, Carroll and Wiebe: *direct-static*, *indirect-static*, *direct-dynamic*, and *indirect-dynamic* (Carroll and Wiebe 2004; Kirschner, Sweller, and Clark 2006; Kuhn 2007; Böttcher and Meisert 2013). I have found this framework to serve a practical purpose for distinguishing different instructional forms from each other, as well as providing structure to both the discussion and presentation of evaluation results presented in Chapters 4 and 5.

Through the evaluation of two case study installations, I have explored issues relating to the design and development of instruction associated with in-gallery interactive installations, as well as aspects of the visitor experience. As I explained in Chapter 3, semi-structured interviews with members of the development teams responsible for the two case study installations allowed me to investigate aspects of the design and development process associated with the creation and implementation of instructions. In-the-wild evaluation with museum visitors about their interaction experiences, employing both observation and post-interaction questionnaires, provided an opportunity to examine the influence of different instructional forms on the interaction experiences that museum visitors have with in-gallery interactives. With each case study, comparison of the interview results with the visitor evaluation results exposed a number of incongruences, namely between assumptions made by members of the design and development teams and the actual experiences, behaviours, or preferences of museum visitors who engaged in interaction. Here, I identify the common assumptions made by the design and development teams about user interaction and preferences relating to instructional forms, comparing these assumptions with the results that provide the actual experiences and preferences of museum visitors.

While the prevalence of interactive technologies seems to increase with each passing year, it is not yet safe to assume that everyone is familiar with interactive technologies. Members of the design and development teams for both case studies acknowledged their assumption that most of their museum visitors would have some level of familiarity with the touch-based interaction technologies they used, but the visitor evaluation results show that a portion of museum visitors still do not own any kind of touch-based interaction device and, therefore, may lack the assumed familiarity or experience with touch-based interaction (7.95%; 12/151 total post-interaction questionnaire participants). Even if the results showed that 100% of museum visitors were familiar with touch-based interaction, differences in interaction approaches and User Interface (UI) design across applications, devices, and installations mean that providing users with instructions for interaction would still be essential for ensuring usability for the widest possible range of users.

Among the goals expressed in the design and development team member interviews for both case studies was the common aim of creating an intuitive UI design so easy to use that instructions should ideally not be necessary. Research shows that this is a common goal when undertaking UI design (e.g. Martina 2014; Lopatovska et al. 2015; Sillen 2015; Price, Sakr, and Jewitt 2016), but it also reveals the underlying assumption that users will intuitively know how interaction works or that they will be able to use their intuition or knowledge from other interaction experiences to figure it out. Furthermore, such assumptions may stem from the experiences and tacit skills particular to those responsible for design and development, whereas actual users may lack the necessary experience or skills to interact as intended (Pinch, Collins, and Carbone 1996; Forrest 2015; Mason 2015). The results from evaluation of the two case studies highlight the limitations of making assumptions about the intuitive nature of any UI design and make a strong argument for conducting user testing to determine how intuitive the UI design actually works for users. The design and development team responsible for *the Gibraltar touch table* acknowledged that they had assumed users would intuitively swipe left and right to access additional on-screen target spots, however results showed that only 29.3% of observed users actually made the swipe interaction (90/307 observed users), and of those, only 10.8% accessed instruction using the ⓘ symbol (33/307 observed users). The result indicating that only 3.6% of observed users actually made the swipe interaction without relying on any available instruction not only underscores this shortcoming of the UI design, it supports the role of instruction for guiding users to this particular interaction (11/307 observed users). Members of *the Gibraltar touch table* design and development team recognised that user testing could have identified the issue earlier in the development process, but they also acknowledged that the project was subject to constraints that restricted the opportunity to undertake thorough and iterative user testing. The design and development team responsible for *the Painting Lens*, alternatively, relied on iterative user testing to assess the usability of their UI design (Goeser 2013; Alexander, Barton, and Goeser 2013; Chun, Gasparotti, and Cairns 2014b; Alexander 2014a, 2014b, 2015). According to interviewed members of the design and

development team, the animated on-screen instructions were integrated in *the Painting Lens* largely as a result of user testing that revealed a need for additional instructional support among interacting users.

As interaction designer Shailoh Phillips suggests, "museum culture is full of assumptions about who visits and how they want to engage with the artworks in the museum" (Silver 2014), and this research has shown that these assumptions can even extend to more minor aspects of a museum visit, such as the kinds of instructions visitors prefer to use with in-gallery interactive installations. Despite the efforts of the design and development teams to produce a range of instructional forms for each case study installation, which were based on the assumed instructional needs of their target users, evaluation results showed that many users tended to opt for taking a trial-and-error approach to interaction. Post-interaction questionnaire participants also expressed their preference for a UI design that would ideally not require supplemental instructions. Responses also recommended that, in circumstances when instructions are necessary, users would rather be provided with visual forms of instruction, such as a clean UI design that utilises familiar icons or visual aids that illustrate the required interactions, indicating preferences for static instructional forms over dynamic forms (see pages 116-119 for results relating to *the Gibraltar touch table* and pages 189-193 for results relating to *the Painting Lens*). Although both case study design and development teams acknowledged the work they put into designing an installation context that they assumed would support more dynamic forms of instruction, such as collaborative interaction or facilitating observation of other interacting visitors, these efforts seem to contradict the preferences users claimed to have. That said, however, results from visitor observation shows that the installation context facilitates dynamic forms of instruction, particularly collaborative interaction, and were widely used: 50.8% of observed users interacting with *the Gibraltar touch table* engaged in collaborative interaction, (156/307 observed users), as did 65.2% of observed users interacting with *the Painting Lens* (73/112 observed users). Ultimately, the efforts of the design and development teams to provide instructional support do not necessarily match the expressed preferences of users,

but the results show how influential the installation context can be on the interaction experiences of users, on some level validating the assumptions made by the design and development teams about the design of the installation context and museum visitor behaviour.

However, it is important to acknowledge that users also make significant assumptions about how interaction (should) work. The preference for taking a trial-and-error approach to interaction is direct evidence of users making assumptions for how they think interaction should work, relying on existing experiences and expectations to inform their approach to interaction, regardless of forms of instruction that might actually be available. The design and development team members for each case study acknowledged that their use of familiar icons, like ☒ to close, and interaction techniques, such as swiping or tapping, were deliberate design choices meant to take advantage of the assumptions users might make about interaction. By undertaking user testing, especially within the final installation context, it is possible to determine whether the assumptions designers and developers make about user interaction actually align with the assumptions users make about interaction.

The collection of assumptions and actualities I have identified about user interaction experiences demonstrate that there is still room for improving upon the design and development process surrounding the creation and implementation of in-gallery interactive installations and their associated instructions. For museums seeking to design and develop their own in-gallery interactive installations, I would suggest prioritising the following measures to help ensure the usability of the final interactive installation for their visitors. Firstly, consider ways to define the target users for the final in-gallery interactive installation and learn about them, especially with respect to any interaction skills or expectations they may possess. While I agree with other researchers who criticise the segmentation of museum visitors within visitor research as limiting or too categorical (Falk 1997; Christidou 2010; Dawson and Jensen 2011b; Cabrero, Winschiers-Theophilus, and Abdelnour-Nocera 2016), I also recognise that segmenting can be a useful tool for delineating visitor types, when applied correctly. For example, the development team behind *the Gibraltar touch table*

used *personas* to classify their visitors into user groups based on characteristics like age, gender, or subject matter interests (Schokkenbroek 2013; Schoemaker 2017). Interviewed members of the development team acknowledged that their approach required a certain level of flexibility when being applied, accepting that their museum visitors may actually identify better with multiple *personas* or perhaps with none, but found that applying the *persona* system was a useful tool for referring to groups of museum visitors that share common traits (see pages 77-78 in Chapter 4). After identifying target users for a particular in-gallery interactive installation, it is important to learn about them, their interaction skills, and any expectations or preferences that they may have associated with interactive technologies within the museum context. Rather than relying on assumptions, it is this kind of knowledge about the targeted users that should be used to inform the design and development of a project, as well as any strategies employed for communicating interactivity to users (Smith, Vega, and McCrickard 2008; Ingram, Wang, and Ribarsky 2012; Huot 2013).

The second measure I would advise relates to the definition of simple and realistic usability and user experience goals associated with in-gallery interactive installations. According to Interaction Designers and researchers, Jennifer Preece, Yvonne Rogers, and Helen Sharp, "usability goals are concerned with meeting specific usability criteria (e.g., efficiency) and user experience goals are largely concerned with explicating the quality of the user experience (e.g., to be aesthetically pleasing)" (2002, 13–14); definition and achievement of these goals is not only central to the Interaction Design (ID) process, they guide design and development throughout. Following established ID practices, once usability and user experience goals are defined, it is then possible to determine the appropriate interactions needed to achieve these goals and, finally, to design a strategic approach for guiding users through their interaction experiences with a combination of instructional forms (Preece, Rogers, and Sharp 2002; Huot 2013). In an ideal situation, usability and user experience goals should be formed with knowledge of the target users' skills, preferences, and

expectations, and defined usability or user experience goals should be evaluated through user testing.

While this research has identified a collection of assumptions related to interaction with technology within the museum context, I consider the origins of these assumptions to be worthy of future museological research. Examination of how assumptions made about user interaction with technology in the museum context are formed, applied, and justified could demonstrate when assumptions about visitor behaviours may be especially effective as a design and development tool.

I have acknowledged how research continues to grow on subjects relating to museum visitor experiences with interactive technologies in the museum context, but research into themes that examine the user interaction experience have the greatest potential for providing insight that can improve how interactive installations are designed and developed for museum contexts. With respect to future research into instruction associated with in-gallery interactive installations, I contend that there is still significant work to be done in this quickly growing field. The proliferation of interactive technologies and the number of museums actively working to integrate technology into their visitor offerings continues to increase, offering new opportunities to research and evaluate a range of topics where cultural heritage, interaction technologies, and museum visitor experiences intersect. This also may provide new opportunities to revisit existing research, to determine whether results can be replicated or whether new evaluation approaches need to be developed.

Throughout this thesis I have repeatedly argued in support of user testing and how it is necessary for ensuring that the design and development of an in-gallery interactive installation does not rely on unproven assumptions. Once again, I assert that museums must invest resources in conducting user testing, ideally iteratively throughout the design and development process to validate or refute any assumptions about users and their interaction behaviours or preferences (Shackel 2009; Gonçalves, Campos, and Sousa 2012; Kay 2013; Martina 2014; Mason 2015). I recognise the potential implications that prioritising user testing could have on professional museum practice and the development of in-gallery interactive installations. User testing, whether it is

iterative or not, can require significant time in order to collect, analyse, and present the results (Preece, Rogers, and Sharp 2002; Hudec 2004; Huot 2013). Scheduling sufficient time for user testing would need to be incorporated into the development schedule relating to the creation of any in-gallery interactive installation. Similarly, in order to conduct user testing within the intended installation context, scheduling relating to the production of the exhibition or presentation into which it may be integrated would likewise need to be adjusted to accommodate user testing (Wilde and Urhahne 2008; Hauser et al. 2009; Hornecker and Nicol 2012). Along with time, museums interested in developing in-gallery interactive installations should also set aside a portion of the project budget to conduct user testing and for improving their design based on the results, especially if user testing or improvements to the design are handled by external specialists (Feast 2014; Huang 2014; Walker 2015). Finally, in addition to time and money, conducting user testing requires the support of personnel to take responsibility for conducting the research and analysing and presenting the results (Hudec 2004; D. Kelly 2009; Fretchling et al. 2010). As the case studies show, personnel that conduct user testing can include internal museum staff, such as the Department of Research and Evaluation at the Cleveland Museum of Art, or be outsourced to external specialists, as Het Scheepvaartmuseum did when they employed *Motivaction* and *Kiss the Frog* to conduct visitor research and user testing on their behalf.

Museums electing to undertake the design and development of in-gallery interactive installations may have ambitions to conduct iterative user testing throughout development, apply an Interaction Design approach, but in reality, constraints may mean having to compromise on this ideal. I would argue, however, that the costs associated with conducting user testing should be measured against the risks connected to neglecting user testing. For example, failure to conduct user testing may not reveal critical UI design flaws, a need for additional instructional support, or indicate whether the target users actually understand how to properly interact to achieve any designated interaction experience goals. I contend that it is far better to prioritise resource expenditure on user testing to get an interactive installation right the first time, especially if it is intended as a permanent

installation or if it is a central element of an exhibition or display. Neither museums nor museum visitors want to find a piece of expensive, unstable, or unusable interaction technology cluttering up an exhibition space, and user testing can ultimately prevent this by identifying usability issues that could improve the user interaction experience, if corrected.

Bibliography

Achiam, Marianne, Michael May, and Martha Marandino. 2014. “Affordances and Distributed Cognition in Museum Exhibitions.” *Museum Management and Curatorship* 29 (5): 461–81. https://doi.org/10.1080/09647775.2014.957479.

Adair, John G. 2000. “Hawthorne Effect.” *Encyclopedia of Psychology*. American Psychological Association Oxford University Press.

Adams, M., and T. Moussouri. 2002. “The Interactive Experience: Linking Research and Practice.” In *Proceedings of International Conference on Interactive Learning in Museums of Art and Design*, 1–22.

Akron Art Museum. 2019. “Seema Rao to Join Akron Art Museum as Senior Experience Officer.” Press Releases. 2019. https://akronartmuseum.org/newsroom/inews-releasei-seema-rao-to-join-akron-art-museum-as-senior-experience-officer-/13827.

Alexander, Jane. 2014a. “Gallery One, the First Year: Sustainability, Evaluation Process, and a New Smart Phone App.” In *MW2014: Museums and the Web 2014*, 1–44. Baltimore, MD, USA.

———. 2014b. “Gallery One at the Cleveland Museum of Art.” *Curator* 57 (3): 347–362. https://doi.org/10.1111/cura.12073.

———. 2015. “Gallery One: Transforming the Museum Experience.” In *League of American Orchestras*. Cleveland, OH.

Alexander, Jane, Jake Barton, and Caroline Goeser. 2013. “Transforming the Art Museum Experience: Gallery One.” In *MW2013 : Museums and the Web 2013*, 1–13. Portland, OR, USA.

Alexander, Jane, Lori Wienke, and Phillip Tiongson. 2017. “Removing the Barriers of Gallery One: A New Approach to Integrating Art, Interpretation, and Technology.” In *MW17: MW2017*, 1–48.

Amato, Flora, Angelo Chianese, Antonino Mazzeo, Vincenzo Moscato, Antonio Picariello, and Francesco Piccialli. 2013. “The Talking Museum Project.” In *Procedia Computer Science*, 21:114–21. Elsevier. https://doi.org/10.1016/j.procs.2013.09.017.

Anderson, Frances E. 1985. “Electronic Media, Videodisc Technology, and the Visual Arts.” *Studies in*

Art Education 26 (4): 224–31.

Anthony, Lisa, Kathryn A. Stofer, Annie Luc, and Jacob O. Wobbrock. 2016. “Gestures by Children and Adults on Touch Tables and Touch Walls in a Public Science Center.” In *Proceedings of the International Conference on Interaction Design and Children*, 12. Manchester.

Archer, Lauren. 2014. “X to Close.” Re:Form. 2014. https://medium.com/re-form/x-to-close-417936dfc0dc#.vysxf7w29.

Archives & Museum Informatics. 2007. “The ICHIM Conference Series Has Ended.” International Cultural Heritage Informatics Meetings. 2007. http://www.archimuse.com/conferences/ichim.html.

Atkins, Leslie J., Lisanne Velez, David Goudy, and Kevin N. Dunbar. 2008. “The Unintended Effects of Interactive Objects and Labels in the Science Museum.” *Science Education* 93 (1): 161–84. https://doi.org/10.1002/sce.20291.

AVICOM. 2010. “AVICOM: About Us.” ICOM International Committee for Audiovisual and New Technologies of Image and Sound. 2010. http://network.icom.museum/avicom/about-us/avicom/L/10/.

Bakker, Saskia, Elise van den Hoven, and Berry Eggen. 2015. “Evaluating Peripheral Interaction Design.” *Human–Computer Interaction* 30 (6): 473–506. https://doi.org/10.1080/07370024.2014.921531.

Bannon, Liam, Steve Benford, John Bowers, and Christian Heath. 2005. “Hybrid Design Creates Innovative Museum Experiences.” *Communications of the ACM* 48 (3): 62–65. https://doi.org/10.1145/1047671.1047706.

Barbieri, Loris, Fabio Bruno, and Maurizio Muzzupappa. 2017. “Virtual Museum System Evaluation through User Studies.” *Journal of Cultural Heritage* 26: 101–8.

Barr, Jean. 2005. “Dumbing down Intellectual Culture: Frank Furedi, Lifelong Learning and Museums.” *Museum and Society* 3 (2): 98–114.

———. 2007. “Educational Research and Undiscovered Public Knowledge.” *Studies in the Education*

of Adults 39 (1): 22–37.

Berkovich, Marianne, Jenna Date, Rachael Keeler, Marti Louw, and Maureen O' Toole. 2003. "Discovery Point: Enhancing the Museum Experience with Technology." *CHI '2003: New Horizons (CHI'03)*, 994–95. https://doi.org/10.1145/765891.766112.

Bevan, Nigel. 2009. "What Is the Difference between the Purpose of Usability and User Experience Evaluation Methods?" In *Proceedings of the Workshop UXEM*, 1–4.

Bickford, Adam. 2010. "Book Review: Identity and the Museum Visitor (Falk) AND Life Stage of the Museum Visitor: Building Engagement over a Lifetime (Wilkening & Chung)." *Curator* 53 (2): 247–55.

Bitgood, Stephen C. 1996. "The Role of Attention in Designing Effective Interpretive Labels." *Journal of Interpretation Research* 5 (2): 31–45.

Bitgood, Stephen C., and Donald D. Patterson. 1993. "The Effects of Gallery Changes on Visitor Reading and Object Viewing Time." *Environment and Behavior* 25 (6): 761–81. https://doi.org/10.1177/0013916593256006.

Bolander, Elizabeth. 2015a. "ArtLens User Experience Research Summary." Cleveland, OH.

———. 2015b. "Gallery One Main Space User Experience Research Summary." Cleveland, OH.

———. 2015c. "Studio Play User Experience Evaluation Summary." Cleveland, OH.

Bolander, Elizabeth, and Meghan Stockdale. 2015. "Gallery One and ArtLens Evaluation Report." Cleveland, OH.

Böttcher, Florian, and Anke Meisert. 2013. "Effects of Direct and Indirect Instruction on Fostering Decision-Making Competence in Socioscientific Issues." *Research in Science Education* 43: 479–506. https://doi.org/10.1007/s11165-011-9271-0.

Bradburne, James M. 2001. "A New Strategic Approach to the Museum and Its Relationship to Society." *Museum Management and Curatorship* 19 (1): 75–84. https://doi.org/10.1080/09647770100701901.

Briggs, Nigel. 2000. "Reaching a Broader Audience." *The Public Historian* 22 (3): 95–105.

Brilliant Idea Studio. 2019. “About Us.” 2019. https://brilliantideastudio.com/about-us/.

Burmistrov, Ivan. 2015. “Touchscreen Kiosks in Museums.” *InterUX*.

Buxton, Bill. 2009. “Multi-Touch Systems That I Have Known and Loved.” 2009. http://www.billbuxton.com/multitouchOverview.html.

Cabrero, Daniel G., Heike Winschiers-Theophilus, and José Abdelnour-Nocera. 2016. “A Critique of Personas as Representations of "the Other” in Cross-Cultural Technology Design.” In *AfriCHI’16*, 149–54. Nairobi.

Cafaro, Francesco, Leilah Lyons, Joshua Radinsky, and Jessica Roberts. 2010. “RFID Localization for Tangible and Embodied Multi-User Interaction with Museum Exhibits.” In *Proceedings of the 12th ACM International Conference on Ubiquitous Computing (UbiComp’10)*, 397–398. https://doi.org/10.1145/1864431.1864455.

Calcagno, Monica, and Claudio Biscaro. 2012. “Designing the Interactions in the Museum.” *International Studies of Management and Organization* 42 (2): 43–56. https://doi.org/10.2753/IMO0020-8825420203.

Carr, David. 1991. “Review: The New Museology by Peter Vergo.” *The Library Quarterly: Information, Community, Policy* 61 (3): 340–41.

Carreras, Cèsar, and Josep Rius. 2011. “Evaluation of ICT Applications in the New Lleida Museum, Spain.” *Visitor Studies* 14 (2): 219–32. https://doi.org/10.1080/10645578.2011.608025.

Carroll, Lee, and Eric N. Wiebe. 2004. “Static versus Dynamic Presentation of Procedural Instruction: Investigating the Efficacy of Video-Based Delivery.” *Proceedings of the Human Factors and Ergonomics Society 48th Annual Meeting*, 1059–63.

Carrozzino, Marcello, and Massimo Bergamasco. 2010. “Beyond Virtual Museums: Experiencing Immersive Virtual Reality in Real Museums.” *Journal of Cultural Heritage* 11 (4): 452–58. https://doi.org/10.1016/j.culher.2010.04.001.

Ceipidor, U. Biader, C. M. Medaglia, V. Volpi, A. Moroni, S. Sposato, M. Carboni, and A. Caridi. 2013. “NFC Technology Applied to Touristic-Cultural Field: A Case Study on an Italian Museum.” In *5th*

International Workshop on Near Field Communication (NFC'13), 1–6. https://doi.org/10.1109/NFC.2013.6482445.

Chan, Tabitha. 2017. "The Cleveland Museum of Art: Gallery One." Musings. 2017. http://musingsmmst.blogspot.nl/2017/01/the-cleveland-museum-of-art-gallery-one.html.

Chang, EunJung. 2006. "Interactive and Contextual Learning Experiences in Museums." *Studies in Art Education* 47 (2): 170–86. https://doi.org/10.2307/3497107.

Charmaz, Kathy. 2006. *Constructing Grounded Theory: A Practical Guide through Qualitative Analysis*. London: Sage Publications.

Chen, Chien-Hsu, Hsiao-Mei Hung, I-Jui Lee, Yu-Wen Chen, and Fong-Gong Wu. 2011. "Observe the User Interactive Behavior with a Large Multi-Touch Display in Public Space." *Universal Access in HCI, Part III, HCII 2011* LNCS 6767: 141–44. https://doi.org/10.1007/978-3-642-21666-4_16.

Christidou, Dimitra. 2010. "Re-Introducing Visitors: Thoughts and Discussion on John Falk' s Notion of Visitors' Identity-Related Visit Motivations." *Papers from the Institute of Archaeology* 20: 111–22.

Chun, Susan, Valeria Gasparotti, and Suse Cairns, eds. 2014a. "Museums and the Web Showcase: I. Overview." In *Museums and the Web Showcase*, 4.

———. , eds. 2014b. "Museums and the Web Showcase: V. The Lenses." In *Museums and the Web Showcase*, 7.

———. , eds. 2014c. "Museums and the Web Showcase: X. Audience Research and Evaluation." In *Museums and the Web Showcase*, 5.

———. , eds. 2014d. "Museums and the Web Showcase: XII. Reception of Gallery One." In *Museums and the Web Showcase*, 6.

Ciocca, Gianluigi, Paolo Olivo, and Raimondo Schettini. 2012. "Browsing Museum Image Collections on a Multi-Touch Table." *Information Systems* 37 (2): 169–82. https://doi.org/10.1016/j.is.2011.09.009.

Ciolfi, Luigina, and Marc McLoughlin. 2012. "Designing for Meaningful Visitor Engagement at a Living

History Museum." *NordiCHI 2012*, 69–78. https://doi.org/10.1145/2399016.2399028.

Cisco Systems. 2014. "IoE-Driven 'Gallery One' Boosts Attendance and Repeat Business for CMA."

Clough, G., A. C. Jones, P. McAndrew, and E. Scanlon. 2008. "Informal Learning with PDAs and Smartphones." *Journal of Computer Assisted Learning* 24: 359–71. https://doi.org/10.1111/j.1365-2729.2007.00268.x.

Coffee, Kevin. 2007. "Audience Research and the Museum Experience as Social Practice." *Museum Management and Curatorship* 22 (4): 377–89. https://doi.org/10.1080/09647770701757732.

Collin-Lachaud, Isabelle, and Juliette Passebois. 2008. "Do Immersive Technologies Add Value to the Museumgoing Experience? An Exploratory Study Conducted at France's Paléosite." *International Journal of Arts Management* 11 (1): 60–71. https://doi.org/10.2307/41064975.

Cooper Hewitt Smithsonian Design Museum. 2019. "Using the Pen." Current Exhibitions. 2019. https://www.cooperhewitt.org/events/current-exhibitions/using-the-pen/.

Daderot. 2012. "Armor Room, The- Cleveland Museum of Art." Wikimedia Commons. 2012. https://commons.wikimedia.org/wiki/File:Armor_room_-_Cleveland_Museum_of_Art_-_DSC08980.JPG.

Damala, Areti, Pierre Cubaud, Anne Bationo, Pascal Houlier, and Isabelle Marchal. 2008. "Bridging the Gap Between the Digital and the Physical." *3rd International Conference on Digital Interactive Media in Entertainment and Arts (DIMEA'08)*, 120–27. https://doi.org/10.1145/1413634.1413660.

Dawkins, Nicole. 2014. "Gallery One at the Cleveland Museum of Art." Cultural Capital. 2014. http://www.lord.ca/CulturalCapital/Spring2014/article5ND.htm.

Dawson, Emily, and Eric Jensen. 2011a. "Contextual Approaches to Visitor Studies Research: Evaluating Audience Segmentation and Identity-Related Motivations." *Visitor Studies* 14 (2): 127–40.

———. 2011b. "Towards A Contextual Turn in Visitor Studies: Evaluating Visitor Segmentation and Identity-Related Motivations." *Visitor Studies* 14 (2): 127–40.

De Telegraaf. 2013. “Maatregel Tegen Scheepvaartmuseum Na Schieten,” July 19, 2013.

Department of Justice. 2010. “2010 ADA Standards for Accessible Design,” 279.

Dijk, Elisabeth M.A.G. van, Andreas Lingnau, and Hub Kockelkorn. 2012. “Measuring Enjoyment of an Interactive Museum Experience.” In *ICMI’12*, 249–56. https://doi.org/10.1145/2388676.2388728.

DuBay, William. 2005. “Victims of Fog Creep: What’s With the Newspapers?” Plain Language at Work Newsletter. 2005. http://www.impact-information.com/impactinfo/newsletter/plwork15.htm.

Economou, Maria. 1998. “The Evaluation of Museum Multimedia Applications: Lessons from Research.” *Museum Management and Curatorship* 17 (2): 173–87. https://doi.org/10.1080/09647779800501702.

Eiriksdottir, E., and R. Catrambone. 2011. “Procedural Instructions, Principles, and Examples: How to Structure Instructions for Procedural Tasks to Enhance Performance, Learning, and Transfer.” *Human Factors: The Journal of the Human Factors and Ergonomics Society* 53 (6): 749–70. https://doi.org/10.1177/0018720811419154.

Ethics Committee. 2012. “Procedure for the Ethical Review of Research at the University of Amsterdam’s Faculty of Humanities.” Amsterdam.

Falk, John H. 1997. “Testing a Museum Exhibition Design Assumption: Effect of Explicit Labeling of Exhibit Clusters on Visitor Concept Development.” *Science Education* 81 (6): 679–687. https://doi.org/10.1002/(SICI)1098-237X(199711)81:6<679::AID-SCE5>3.3.CO;2-7.

———. 2006. “An Identity-Centered Approach to Understanding Museum Learning.” *Curator: The Museum Journal* 49 (2): 151–66.

———. 2008. “Viewing Art Museum Visitors Through the Lens of Identity.” *Visual Arts Research* 34 (2): 25–34.

———. 2009. *Identity and the Museum Visitor Experience*. Walnut Creek: Left Coast Press. https://doi.org/10.1111/j.1548-1379.2010.01108.

———. 2011. “Contextualizing Falk’s Identity-Related Visitor Motivation Model.” *Visitor Studies* 14

(2): 141–57. https://doi.org/10.1080/10645578.2011.608002.

———. 2013. “Understanding - Museum - Visitors’ - Motivations and Learning.” In *Museums - Social Learning Spaces and Knowledge Producing Processes*, 106–33. Copenhagen: Kulturstyrelsen - Danish Agency for Culture.

Falk, John H., and Lynn D. Dierking. 1992. *The Museum Experience*. Washington, DC: Whalesback Books.

———. 2013. *The Museum Experience: Revisited*. Walnut Creek: Left Coast Press.

Falk, John H., Carol Scott, Lynn D. Dierking, Leonie Rennie, and Mika Cohen Jones. 2004. “Interactives and Visitor Learning.” *Curator* 47 (2): 171–98. https://doi.org/10.1111/j.2151-6952.2004.tb00116.x.

Fanning, Jason, and Edward McAuley. 2014. “A Comparison of Tablet Computer and Paper-Based Questionnaires in Healthy Aging Research.” *Journal of Medical Internet Research* 3 (3): 1–10.

Feast, Terra. 2014. “Integrated, Interactive Learning in Museums.” Boise State University.

Forrest, Regan. 2013. “Museum Atmospherics: The Role of the Exhibition Environment in the Visitor Experience.” *Visitor Studies* 16 (2): 201–16. https://doi.org/10.1080/10645578.2013.827023.

———. 2015. “Design Factors in the Museum Visitor Experience.” The University of Queensland.

Franklin, David. 2013. “Of Pixels and Paintings: Gallery One, ArtLens and the Role of Technology in Museums.” The Huffington Post. 2013. http://www.huffingtonpost.com/david-franklin/cleveland-museum-of-art_b_2870285.html.

Frenkel, Karen A. 1989. “The Next Generation of Interactive Technologies.” *Communications of the ACM* 32 (7): 872–81. https://doi.org/10.1145/65445.65454.

Fretchling, Joy, Melvin M. Mark, Debra J. Rog, and Elmima Johnson. 2010. “The 2010 User-Friendly Handbook for Project Evaluation.”

Garzotto, Franca, and Francesca Rizzo. 2007. “Interaction Paradigms in Technology-Enhanced Social Spaces: A Case Study in Museums.” *Designing Pleasurable Products And Interfaces*, no. August: 343–56. https://doi.org/10.1145/1314161.1314192.

Germak, Claudio, and Sara Khan. 2017. “Interaction Design Applications for Museum Spaces. New Exhibit Paths Driven by a Bluetooth Sensor’s System.” *The Design Journal* 20 (sup1): S3914–24.

Goeser, Caroline. 2013. “Blending Art, Technology, & Interpretation: Cleveland Museum of Art’s Gallery One & ArtLens.” Art Museum Teaching. 2013. https://artmuseumteaching.com/2013/04/15/blending-art-technology-interpretation-cleveland-museum-of-arts-gallery-one-artlens/.

Gogh Museum, Van. 2017. “Van Gogh Reviews Annual Report 2017.”

Gonçalves, Lígia, Pedro Campos, and Margarida Sousa. 2012. “M-Dimensions: A Framework for Evaluating and Comparing Interactive Installations in Museums.” In *NordiCHI 2012*, 59–68. https://doi.org/10.1145/2399016.2399027.

Goulding, Christina. 2000. “The Museum Environment and the Visitor Experience.” *European Journal of Marketing* 34 (3/4): 261–78. https://doi.org/10.1108/03090560010311849.

Grammenos, Dimitris, Xenophon Zabulis, Damien Michel, Thomas Sarmis, Giannis Georgalis, Konstantinos Tzevanidis, Antonis Argyros, and Constantine Stephanidis. 2011. “Design and Development of Four Prototype Interactive Edutainment Exhibits for Museums.” *Universal Access in HCI, Part III, HCII 2011* LNCS 6767: 173–82. https://doi.org/10.1007/978-3-642-21666-4_20.

Grebey, James. 2016. “The 25 Best Museums in America , RANKED.” Business Insider. 2016. http://www.businessinsider.com/the-best-museums-in-america-ranked-2016-8?international=true&r=US&IR=T.

Hall, Sebastian. 2013. “Creating Strong Cross Media Concepts for Museum Exhibitions.” Umea Universitet.

Hanko, Karlene, Sarah Lee, and Nnenna Okeke. 2014. “What Makes a Great Museum Experience and How Can Technology Help?: Visitor Research and Segmentation for The Field Museum’s Grainger Initiatives.” Chicago.

Hart, Jennefer, Alistair G. Sutcliffe, and Antonella De Angeli. 2013. “Love It or Hate It! Interactivity

and User Types." In *CHI 2013: Changing Perspectives*, 2059–68. Paris.

Hauser, Walter, Annette Noschka-Roos, Eva Reussner, and Carmen Zahn. 2009. "Design-Based Research on Digital Media in a Museum Environment." *Visitor Studies* 12 (2): 182–98. https://doi.org/10.1080/10645570903203497.

Heath, Christian, and Dirk vom Lehn. 2008. "Configuring 'Interactivity': Enhancing Engagement in Science Centres and Museum." *Social Studies of Science* 38 (1): 63–91.

———. 2009. "Interactivity and Collaboration: New Forms of Participation in Museums, Galleries and Science Centres." In *Museums in a Digital Age*, edited by Ross Parry, 266–80. Milton Park: Routledge.

Heath, Christian, Dirk vom Lehn, and Jonathan Osborne. 2005. "Interaction and Interactives: Collaboration and Participation with Computer-Based Exhibits." *Public Understanding of Science* 14: 91–101. https://doi.org/10.1177/0963662505047343.

Hein, George E. 1995. "The Constructivist Museum." *Journal of Education in Museums* 16 (4): 21–23.

———. 1998a. *Learning in the Museum*. *Assessment*. Vol. 47. London: Routledge.

———. 1998b. "The Constructivist Museum." In *Learning in the Museum*, 155–79. London: Routledge.

———. 1999. "Is Meaning Making Constructivism? Is Constructivism Meaning Making?" *The Exhibitionist* 18 (2): 15–18.

———. 2005. "Museum Education." In *A Companion to Museum Studies*, edited by Sharon Macdonald, 340–52. Oxford: Blackwell.

Helmreich, Anne, Jessimi Jones, and Jason Jay Stevens. 2013. "Exhibition Critiques: Gallery One, Cleveland Museum of Art." *Exhibitionist* Fall: 91–100.

Het Scheepvaartmuseum. 2014. "Het Scheepvaartmuseum - Press Release: Willem Bijleveld Vertrekt Bij Het Scheepvaartmuseum." 2014. http://www.amports.nl/media/191362/Persbericht vertrek Willem Bijleveld 8 januari 2014.pdf.

———. 2015a. "Het Scheepvaartmuseum - Press Release: Pauline Krikke Steps Down as Director."

2015. https://www.hetscheepvaartmuseum.nl/about-the-museum/press/pressrelease-paulinekrikke-steps-down-as-director.

———. 2015b. “Jaaroverzicht 2015 Het Scheepvaarrtmuseum.” 2015. https://www.hetscheepvaartmuseum.nl/over-het-museum/pers/persbericht-jaaroverzicht-2015-vooruitblik-2016.

———. 2016a. “Het Scheepvaartmuseum - About the Museum: The Building.” 2016. https://www.hetscheepvaartmuseum.nl/about-the-museum/the-building.

———. 2016b. “Het Scheepvaartmuseum - Press Release: Michael Huijser Nieuwe Algemeen Directeur Het Scheepvaartmuseum.” 2016. https://www.hetscheepvaartmuseum.nl/over-ons/pers/409/michael-huijser-nieuwe-algemeen-directeur-het-scheepvaartmuseum.

———. 2016c. “The Building.” About the Museum. 2016. https://www.hetscheepvaartmuseum.nl/about-the-museum/the-building.

———. 2017a. “East Indiaman Amsterdam.” 2017. https://www.hetscheepvaartmuseum.nl/discover/east-indiaman-amsterdam.

———. 2017b. “Het Scheepvaartmuseum - Discover.” 2017. https://www.hetscheepvaartmuseum.nl/discover.

———. 2017c. “Het Scheepvaartmuseum - Floorplan.” Amsterdam.

———. 2017d. “Het Scheepvaartmuseum - Navigational Instruments.” 2017. https://www.hetscheepvaartmuseum.nl/discover/exhibitions/navigational-instruments.

———. 2017e. “Het Scheepvaartmuseum - Press Release: Raad Voor Cultuur Positief over Nieuwe Activiteitenplan.” 2017. https://www.hetscheepvaartmuseum.nl/over-het-museum/pers/raad-voor-cultuur-positief-over-activiteitenplan.

———. 2017f. “Het Scheepvaartmuseum - Steamship Christiaan Brunings.” 2017. https://www.hetscheepvaartmuseum.nl/discover/steamship-christiaan-brunings.

———. 2017g. “Het Scheepvaartmuseum - The Paintings.” 2017. https://www.hetscheepvaartmuseum.nl/discover/exhibitions/the-paintings.

———. 2017h. “Het Scheepvaartmuseum - The Photo Albums.” 2017. https://www.hetscheepvaartmuseum.nl/discover/exhibitions/photo-albums.

———. 2017i. “Het Scheepvaartmuseum - The Royal Barge.” 2017. https://www.hetscheepvaartmuseum.nl/discover/the-royal-barge.

———. 2017j. “Het Scheepvaartmuseum - The Tale of the Whale.” 2017. https://www.hetscheepvaartmuseum.nl/discover/exhibitions/the-tale-of-the-whale.

———. 2017k. “Het Scheepvaartmuseum - The Yacht Models.” 2017. https://www.hetscheepvaartmuseum.nl/discover/exhibitions/yacht-models.

———. 2017l. “Het Scheepvaartmuseum - Voyage at Sea.” 2017. https://www.hetscheepvaartmuseum.nl/discover/exhibitions/voyage-at-sea.

———. 2018. “Jaarverslag 2017.” 2018. https://www.hetscheepvaartmuseum.nl/sites/default/files/2018-05/Jaarverslag Het Scheepvaartmuseum 2017.pdf.

———. 2019. “A New Look for the National Maritime Museum.” Press. 2019. https://www.hetscheepvaartmuseum.com/about-us/press/1576/persbericht-het-scheepvaartmuseum-vernieuwt-eng.

Hirumi, Atsusi, Wilhelmina Savenye, and Brockenbrough Allen. 1994. “Designing Interactive Videodisc-Based Museum Exhibits: A Case Study.” *Educational Technology Research and Development* 42 (1): 47–55.

Hornecker, Eva. 2008. “‘I Don’t Understand It Either, But It Is Cool’ - Visitor Interactions with a Multi-Touch Table in a Museum.” In *Proceedings of the 3rd International Workshop on Horizontal Interactive Human Computer System (TABLETOP’08)*, 21:113–20.

———. 2010. “Interactions Around a Contextually Embedded System.” In *Proceedings of TEI’10*, 169–76.

———. 2011. “The Role of Physicality in Tangible and Embodied Interactions.” *Interactions* 18 (2): 19–23.

Hornecker, Eva, and Emma Nicol. 2012. “What Do Lab-Based User Studies Tell Us About In-the-Wild Behavior? Insights from a Study of Museum Interactives.” *Proceedings of the Designing Interactive Systems Conference (DIS ’12)*, 358–67.

Hornecker, Eva, and Matthias Stifter. 2006. “Learning from Interactive Museum Installations about Interaction Design for Public Settings.” In *Proceedings of the 20th Conference of the Computer Human Interaction Special Interest Group (CHISIG) of Australia on Computer Human Interaction Design Activities Artefacts and Environments (OZCHI ’06)*, 135–42.

Hsi, Sherry, and Holly Fait. 2005. “RFID Enhances Visitors’ Museum Experience at the Exploratorium.” *Communications of the ACM* 48 (9): 60–65.

Hsu, Fu Song, and Wei Yang Lin. 2014. “A Multimedia Presentation System Using a 3D Gesture Interface in Museums.” *Multimedia Tools and Applications* 69: 53–77. https://doi.org/10.1007/s11042-012-1205-y.

Huang, Kuo Hung. 2014. “Outsourcing E-Learning Project in Museums: Case Studies of Public Museums in Taiwan.” *2014 7th International Conference on U- and e- Service, Science and Technology*, 19–21. https://doi.org/10.1109/UNESST.2014.14.

Hudec, Heather. 2004. “Evaluation: A Critical Step in Creating Effective Museum Exhibits.”

Hunt, Julia Kathryn. 2013. “Emerging Trends with Interactives in Art Museums.” University of Washington.

Huot, Stephane. 2013. “Designing Interaction: A Missing Link in the Evolution of Human-Computer Interaction.”

Ieremieieva, Nataliia. 2014. “Het Scheepvaartmuseum, Amsterdam.” Wikimedia Commons. 2014. https://commons.wikimedia.org/wiki/File:Het_Scheepvaartmuseum,_Amsterdam.jpg.

Ingram, Amy, Xiaoyu Wang, and William Ribarsky. 2012. “Towards the Establishment of a Framework for Intuitive Multi-Touch Interaction Design.” *Proceedings of the International Working Conference on Advanced Visual Interfaces (AVI ’12)*, 66–73. https://doi.org/10.1145/2254556.2254571.

ISO/IEC, International Organization for Standardization. 1998. “Standard 9241: Ergonomic Requirements for Office Work with Visual Display Terminals (VDT)s, Part 11. Guidance on Usability.” International Organization for Standardization.

Jafari, Aliakbar, Babak Taheri, and Dirk vom Lehn. 2013. “Cultural Consumption, Interactive Sociality, and the Museum.” *Journal of Marketing Management* 29 (15–16): 1729–52. https://doi.org/10.1080/0267257X.2013.811095.

Jarrier, Elodie, and Dominique Bourgeon-Renault. 2012. “Impact of Mediation Devices on the Museum Visit Experience and on Visitors’ Behavioural Intentions.” *International Journal of Arts Management* 15 (1): 18–29.

Jones, Stephen. 1988. “Hall of Fame PCs at Bat.” *Computerworld*, 1988.

Jung, Jaemin. 2003. “Business News Web Sites Differ From Newspapers in Business Content.” *Newspaper Research Journal* 24 (2): 114–19.

Kaasinen, Eija, Virpi Roto, Jaakko Hakulinen, Tomi Heimonen, Jussi P. P. Jokinen, Hannu Karvonen, Tuuli Keskinen, et al. 2015. “Defining User Experience Goals to Guide the Design of Industrial Systems.” *Behaviour & Information Technology* 34 (10): 976–91. https://doi.org/10.1080/0144929X.2015.1035335.

Kallio, Hanna, Anna-Maija Pietila, Martin Johnson, and Mari Kangasniemi. 2016. “Systematic Methodological Review: Developing a Framework for a Qualitative Semi-Structured Interview Guide.” *Journal of Advanced Nursing* 72 (12): 2954–65.

Kay, Judy. 2013. “Reflections on Brian Shackels Usability - Context, Definition, Design and Evaluation.” *Interacting with Computers*, 1–12.

Kéfi, Hajer, and Jessie Pallud. 2011. “The Role of Technologies in Cultural Mediation in Museums: An Actor-Network Theory View Applied in France.” *Museum Management and Curatorship* 26 (3): 273–89. https://doi.org/10.1080/09647775.2011.585803.

Kelly, Diane. 2009. “Methods for Evaluating Interactive Information Retrieval Systems with Users.” *Foundations and Trends in Information Retrieval* 3 (1–2): 1–224.

https://doi.org/10.1561/1500000012.

Kelly, Lynda. 2014. “Multi-Touch Tables - Overall What Did the Research Say?” Museums & The Digital. 2014. https://musdigi.wordpress.com/category/multi-touch-tables/.

Keulen, Ernst van, Saskia Oranje, and Kiss the Frog. 2017. “E-Mail Correspondence: Technical Specifications of the Gibraltar Touch Table.”

Khalil, Mohammed K., and Ihsan A. Elkhider. 2016. “Applying Learning Theories and Instructional Design Models for Effective Instruction.” *Advances in Physiology Education* 40 (2): 147–56.

Kidd, Jenny. 2014a. “Chapter 5: ‘Interactives’ in the Social Museum.” In *Museums in the New Mediascape: Transmedia, Participation, Ethics*, 87–102. Surrey: Ashgate.

———. 2014b. “Introduction: On Museum Media.” In *Museums in the New Mediascape: Transmedia, Participation, Ethics*, 1–22. Surrey: Ashgate.

Kidd, Jenny, Irida Ntalla, and William Lyons. 2011. “Multi-Touch Interfaces in Museum Spaces : Reporting Preliminary Findings on the Nature of Interaction.” *Rethinking Technology in Museums: Emerging Experiences. University of Limerick*, 11.

Kirschner, Paul A., John Sweller, and Richard E. Clark. 2006. “Why Minimal Guidance During Instruction Does Not Work: An Analysis of the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching.” *Educational Psychologist* 41 (2): 75–86. https://doi.org/10.1207/s15326985ep4102_1.

Knipfer, Kristin, Eva Mayr, Carmen Zahn, Stephan Schwan, and Friedrich W. Hesse. 2009. “Computer Support for Knowledge Communication in Science Exhibitions: Novel Perspectives from Research on Collaborative Learning.” *Educational Research Review* 4: 196–209. https://doi.org/10.1016/j.edurev.2009.06.002.

Koch, Anne, Christian Meyer, Petra Tillessen, Annette Wilke, and Katharina Wilkens. 2011. “Museum in Context.” *Journal of Religion in Europe* 4: 71–101. https://doi.org/10.1163/187489210X553502.

Kollmann, Elizabeth Kunz. 2007. “The Effect of Broken Exhibits on the Experiences of Visitors at a

Science Museum." *Visitor Studies* 10 (2): 178–91. https://doi.org/10.1080/10645570701585251.

Korn, Randi. 1985. "The Computer as a Potential Evaluation Tool." *The Journal of Museum Education* 10 (2): 7–9.

Kortbek, Karen Johanne, and Kaj Grønbæk. 2008a. "Communicating Art through Interactive Technology: New Approaches for Interaction Design in Art Museums." In *Proceedings of the 5th Nordic Conference on Human-Computer Interaction (NordiCHI '08)*, 229–38. https://doi.org/10.1145/1463160.1463185.

———. 2008b. "Interactive Spatial Multimedia for Communication of Art in the Physical Museum Space." *Proceeding of the 16th ACM International Conference on Multimedia (MM '08)*, 609–18. https://doi.org/10.1145/1459359.1459441.

Kröller-Müller Museum. 2015. "Painting Game." Kröller-Müller Museum. 2015. http://krollermuller.nl/en/painting-game.

Kuhn, Deanna. 2007. "Is Direct Instruction an Answer to the Right Question?" *Educational Psychologist* 42 (2): 109–13. https://doi.org/10.1080/00461520701263376.

Kung-Ming, Tiong, and Sim Khoon-Seng. 2009. "Asynchronous vs. Synchronous Interaction." In *Encyclopedia of Distance Learning*, edited by Patricia L. Rogers, Gary A. Berg, Judith V. Boettcher, Caroline Howard, Lorraine Justice, and Karen D. Schenk, 122–31. Hershey: Information Science Reference.

Lallemand, Carine, Guillaume Gronier, and Vincent Koenig. 2015. "User Experience: A Concept without Consensus? Exploring Practitioners' Perspectives through an International Survey." *Computers in Human Behavior* 43: 35–48. https://doi.org/10.1016/j.chb.2014.10.048.

Lankford, E. Louis. 2002. "Aesthetic Experience in Constructivist Museums." *Journal of Aesthetic Education* 36 (2): 140–53. https://doi.org/10.2307/3333763.

Lehn, Dirk vom. 2006. "Embodying Experience: A Video-Based Examination of Visitors' Conduct and Interaction in Museums." *European Journal of Marketing* 40 (11/12): 1340–59.

https://doi.org/10.1108/03090560610702849.

Lewalter, Doris, Siëlle Phelan, Claudia Geyer, Inga Specht, Rahel Grüninger, and Wolfgang Schnotz. 2015. “Investigating Visitor Profiles as a Valuable Addition to Museum Research.” *International Journal of Science Education, Part B* 5 (4): 357–74.

Li, Richard Yu-Chang, and Alan Wee-Chung Liew. 2015. “An Interactive User Interface Prototype Design for Enhancing On-Site Museum and Art Gallery Experience through Digital Technology.” *Museum Management and Curatorship* 30 (3): 208–29. https://doi.org/10.1080/09647775.2015.1042509.

Lindeboom, Gea. 2016. “UvA Ethics Committee Approval.” Amsterdam.

Lindgren-Streicher, Anna, and Christine A. Reich. 2007. “Visitor Usage of Digital and Physical Artifacts in Two Museum Programs.” *Visitor Studies* 10 (2): 152–67. https://doi.org/10.1080/10645570701603666.

Litt, Steven. 2014. “Caroline Goeser Leaves the Cleveland Museum of Art for Top Education Post at the MFA Houston.” Cleveland.Com. 2014. http://www.cleveland.com/arts/index.ssf/2014/03/caroline_goeser_leaves_the_cle.html.

Liu, Kegeng. 2013. “Designing Visitor Experience for Open-Ended Creative Engagement in Art Museums: A Conceptual Multi-Touch Prototype Design.” Iowa State University.

Lopatovska, Irene, Kathleen L. Arthur, Corina Bardoff, Jan Diolola, Tim Furlow, Leah Honor, Rebecca Kluberdanz, et al. 2015. “Engaging Digital Artworks through Emotion : Interface Design Case Study.” In *IConference 2015*, 1–11.

Louvre Museum. 2019. “The Museum Audio Guide.” Activities & Tours. 2019. http://www.louvre.fr/en/museum-audio-guide/audioguide-louvre-nintendo-3ds-™-xl#tabs.

Ma, Joyce, Isaac Liao, Kwan-Liu Ma, and Jennifer Frazier. 2012. “Living Liquid: Design and Evaluation of an Exploratory Visualization Tool for Museum Visitors.” In *IEEE Transactions on Visualization and Computer Graphics*, 18:2799–2808.

Macdonald, S. 1990. “Posting Questions about the Purposes of Museums. Review: The New

Museology, by Peter Vergo." *Current Anthropology* 31 (2): 225–28.

Machado, Carlos. 2013. "Cleveland Museum of Art: Gallery One." Accuware Blog. 2013. https://www.accuware.com/blog/cleveland-museum-of-art-gallery-one/.

Mancini, Federica. 2008. "Usability of Virtual Museums and the Diffusion of Cultural Heritage: Reflections on Virtual and Real Exhibits Design, for Public Education and Entertainment."

Mara, Andrew, and Miriam Mara. 2015. "Capturing Social Value in UX Projects." In *SIGDOC'15 Proceedings of the 33rd Annual International Conference on the Design of Communication*, 6. Limerick.

Maritime Digital. 2016. "Maritime Digital Home." 2016. http://www.maritiemdigitaal.nl/.

Martina, Andrea. 2014. "Virtual Heritage: New Technologies for Edutainment." Politecnico di Torino.

Marty, Paul F., W. Boyd Rayward, and Michael B. Twidale. 2003. "Museum Informatics." *Annual Review of Information Science and Technology*, 258–94.

Mason, Marco. 2015. "Prototyping Practices Supporting Interdisciplinary Collaboration in Digital Media Design for Museums." *International Journal of Museum Management and Curatorship* 30 (5): 394–426.

McCray, Kimberly. 2010. "A Review of 'Identity and the Museum Visitor Experience.'" *Visitor Studies* 13 (1): 121–24. https://doi.org/10.1080/10645571003621885.

McKnight, Lorna, and Daniel Fitton. 2010. "Touch-Screen Technology for Children: Giving the Right Instructions and Getting the Right Responses." *Proceedings of the 9th International Conference on Interaction Design and Children (IDC '10)*, 238–41. https://doi.org/10.1145/1810543.1810580.

McLeroy, Kenneth R., Daniel Bibeau, Allan Steckler, and Karen Glanz. 1988. "An Ecological Perspective on Health Promotion Programs." *Health Education Quarterly* 15 (4): 351–77.

McNamara, Patricia. 1986. "Computers Everywhere - But What Happened to the Research?" *The Journal of Museum Education* 11 (1): 21–24, 6.

Meisner, Robin, Dirk vom Lehn, Christian Heath, Alex Burch, Ben Gammon, and Molly Reisman.

2007. “Exhibiting Performance: Co-Participation in Science Centres and Museums.” *International Journal of Science Education* 29 (12): 1531–55. https://doi.org/10.1080/09500690701494050.

Mitchell, Joan. 1958. “Metro.”

Mody, Ashish, Muneeb Akram, Kamruzzaman Rony, Muhammad Sajjad Aman, and Ridha Kamoua. 2009. “Enhancing User Experience at Museums Using Smart Phones with RFID.” In *IEEE Systems, Applications and TEchnology Conference (LISAT09)*, 1–5.

Mol, Linda. 2013. “Reinventing Het Scheepvaartmuseum / the National Maritime Museum Amsterdam.”

Motivaction International. 2018a. “About Motivaction.” 2018. https://www.motivaction.nl/en/about-motivaction.

———. 2018b. “Concepttest Tentoonstellingen Museum Boerhaave.” 2018. https://www.motivaction.nl/klanten/concepttest-tentoonstellingen-museum-boerhaave.

———. 2018c. “Snacking Based on the Personas of the Van Gogh Museum.” 2018. https://www.motivaction.nl/en/cases/snoepen-volgens-persona-s-van-gogh-museum.

Moussouri, Theano, and George Roussos. 2013. “Examining the Effect of Visitor Motivation on Observed Visit Strategies Using Mobile Computer Technologies.” *Visitor Studies* 16 (1): 21–38. https://doi.org/10.1080/10645578.2013.767732.

Murphy, Sarah. 2015. “Gallery One at the Cleveland Museum of Art: Connecting Audiences to Art Through Technology.”

Nederlands Openluchtmuseum. 2013. “Jaarrekening 2013.”

Newes-Adeyi, G., D. L. Helitzer, L. E. Caulfield, and Y. Bronner. 2000. “Theory and Practice: Applying the Ecological Model to Formative Research for a WIC Training Program in New York State.” *Health Education Research: Theory & Practice* 15 (3): 283–91.

Nielsen, Jane K. 2015. “The Relevant Museum: Defining Relevance in Museological Practices.” *Museum Management and Curatorship* 30 (5): 364–78.

https://doi.org/10.1080/09647775.2015.1043330.

Othman, Mohd Kamal, Helen Petrie, and Christopher Power. 2013. “Measuring the Usability of a Smartphone Delivered Museum Guide.” In *Procedia - Social and Behavioral Sciences*, 97:629–37. Elsevier. https://doi.org/10.1016/j.sbspro.2013.10.282.

Pallud, Jessie, and Emmanuel Monod. 2010. “User Experience of Museum Technologies: The Phenomenological Scales.” *European Journal of Information Systems* 19: 562–80.

Panasuk, Regina M., and Sumudu Lewis. 2012. “Constructivism: Constructing Meaning or Making Sense?” *International Journal of Humanities and Social Science* 2 (20): 1–11.

Panini, Giovanni Paolo. 1747. “Interior of the Pantheon, Rome.”

Pannucci, Christopher J., and Edwin G. Wilkins. 2010. “Identifying and Avoiding Bias in Research.” *Plastic and Reconstructive Surgery* 126 (2): 619–25. https://doi.org/10.1097/PRS.0b013e3181de24bc.

Pattison, Scott A., Scott Ewing, and Angela K. Frey. 2012. “Testing the Impact of a Computer Guide on Visitor Learning Behaviors at an Interactive Exhibit.” *Visitor Studies* 15 (2): 171–85. https://doi.org/10.1080/10645578.2012.715010.

Pekarik, Andrew J., and Gary Shank. 2015. “Book Review: Designing for the Museum Visitor Experience.” *Curator: The Museum Journal* 58 (4): 435–39.

Peltonen, Peter, Esko Kurvinen, Antti Salovaara, Giulio Jacucci, Tommi Ilmonen, John Evans, Antti Oulasvirta, and Petri Saarikko. 2008. “‘It’s Mine, Don’t Touch!’: Interactions at a Large Multi-Touch Display in a City Centre.” *Proceeding of the Twenty-Sixth Annual CHI Conference on Human Factors in Computing Systems (CHI ’08)*, 1285–94.

Pender, Hanna-Liisa, and David Lamas. 2013. “Exploring the Role of the Semiotic Engineering in Interaction Co-Design.” In *ChileCHI ’13*, 18–23. Temuco.

———. 2014. “Identifying Intention and Perception Mismatches in Digitally Augmented Museum Settings.” In *Human-Computer Interaction, Part I, HCII 2014*, edited by M. Kurosu, 565–76. Springer.

Petrelli, Daniela, Luigina Ciolfi, Dick Van Dijk, Eva Hornecker, and Albrecht Schmidt. 2013. "Integrating Material and Digital: A New Way for Cultural Heritage." *Interactions*, 58–63.

Picasso, Pablo. 1924. "Still Life with Biscuits."

Pietroni, Eva, Christie A. Ray, Claudio Rufa, Daniel Pletinckx, and Iefke Van Kampen. 2012. "Natural Interaction in VR Environments for Cultural Heritage and Its Impact inside Museums: The Etruscanning Project." *Proceedings of the 18th International Conference on Virtual Systems and Multimedia (VSMM'12)*, 339–46. https://doi.org/10.1109/VSMM.2012.6365943.

Pinch, Trevor, H. M. Collins, and Larry Carbone. 1996. "Inside Knowledge: Second Order Measures of Skill." *The Sociological Review* 44 (2): 163–86. https://doi.org/10.1111/j.1467-954X.1996.tb00420.x.

Preece, Jennifer, Yvonne Rogers, and Helen Sharp. 2002. *Interaction Design: Beyond Human-Computer Interaction*. 1st ed. Crawfordsville: John Wiley & Sons, Inc.

Price, Sara, Mona Sakr, and Carey Jewitt. 2016. "Exploring Whole-Body Interaction and Design for Museums." *Interacting with Computers* 28 (5): 569–83. https://doi.org/10.1093/iwc/iwv032.

Pujol-Tost, Laia. 2011. "Integrating ICT in Exhibitions." *Museum Management and Curatorship* 26 (1): 63–79. https://doi.org/10.1080/09647775.2011.540127.

Raad voor Cultuur. 2012. "Advies: Het Scheepvaartmuseum, 2013-2016."

Rabesphoto. 2008. "Reinberger Gallery, The Cleveland Museum of Art." Wikimedia Commons. 2008. https://commons.wikimedia.org/wiki/File:Reinberger_Gallery.jpg.

Ravelli, Louise J. 1996. "Making Language Accessible: Successful Text Writing for Museum Visitors." *Linguistics and Education* 8: 367–87. https://doi.org/http://dx.doi.org/10.1016/S0898-5898(96)90017-0.

———. 2006. *Museum Texts: Communication Frameworks*. New York: Routledge. https://doi.org/10.4324/9780203964187.

Read, Charles. 2017. "The World's Most Technologically Advanced Museum? The Cleveland Museum of Art's Gallery One." Blooloop. 2017. https://blooloop.com/features/cleveland-museum-art-

technology/.

Reeves, Stuart. 2011. *Designing Interfaces in Public Settings: Understanding the Role of the Spectator in Human-Computer Interaction*. London: Springer. https://doi.org/10.1007/978-0-85729-265-0.

Rennie, Léonie J., Rosemary S. Evans, Fiona E. Mayne, and Susan J. Rennie. 2010. "Factors Affecting the Use and Outcomes of Interactive Science Exhibits in Community Settings." *Visitor Studies* 13 (2): 222–37. https://doi.org/10.1080/10645578.2010.509699.

Rijksmuseum Boerhaave. 2017. "Ontdek de Wereld van Wetenschap: Jaarverslag 2017."

Roberts, Toni. 2015. "Factors Affecting the Role of Designers in Interpretation Projects." *Museum Management and Curatorship*, 1–15. https://doi.org/10.1080/09647775.2015.1055582.

Robinson, Edward Stevens, Irene Case Sherman, and Louis E. Curry. 1928. "The Behavior of the Museum Visitor." *American Association of Museums, New Series* 5: 70.

Rodley, Ed. 2013a. "Review: Cleveland Museum of Art's Gallery One - Part One." Thinking About Museums. 2013. https://exhibitdev.wordpress.com/2013/09/23/review-cleveland-museum-of-arts-gallery-one-part-one/.

———. 2013b. "Review: Cleveland Museum of Art's Gallery One - Part Two." Thinking About Museums. 2013. https://exhibitdev.wordpress.com/2013/09/29/review-cleveland-museum-of-arts-gallery-one-part-two/.

Roppola, Tiina. 2012. *Designing for the Museum Visitor Experience*. Routledge. New York.

Rossum, Matthias van, Karwan Fatah-Black, Lex Heerma van Voss, Jaap Bruijn, Gerrit Knaap, Leo Balai, and Petra van Dam. 2014. "'De Directie van Het Scheepvaartmuseum Kiest Voor Pretparkkoers.'" *De Volkskrant*, July 30, 2014.

Roussou, Maria. 2004. "Learning by Doing and Learning Through Play: An Exploration of Interactivity in Virtual Environments for Children." *Computers in Entertainment* 2 (1): 1–23.

———. 2006. "Virtual Reality and Education: Evaluating the Learning Experience." *VI Seminar on Archaeology and Education*, 69–84.

Roussou, Maria, Akrivi Katifori, Laia Pujol, Maria Vayanou, and Stefan Rennick-Egglestone. 2013. “A Life of Their Own: Museum Visitor Personas Penetrating the Design Lifecycle of a Mobile Experience.” In *CHI 2013: Changing Perspectives*, 547–52. Paris.

Roussou, Maria, Martin Oliver, and Mel Slater. 2006. “The Virtual Playground: An Educational Virtual Reality Environment for Evaluating Interactivity and Conceptual Learning.” *Virtual Reality* 10: 227–40. https://doi.org/10.1007/s10055-006-0035-5.

Rowley, Jennifer. 2012. “Conducting Research Interviews.” *Management Research Review* 35 (3/4): 260–71. https://doi.org/10.1108/01409171211210154.

Rutkowska, Joanna, David Lamas, Froukje Sleeswijk Visser, Zuzanna Wodyk, and Olga Bańka. 2017. “Shaping Loyalty: Experiences from Design Research Practice.” *Interactions* 24 (3): 60–65.

Ryall, Kathy, Meredith Ringel Morris, Katherine Everitt, Clifton Forlines, and Chia Shen. 2006. “Experiences with and Observations of Direct-Touch Tabletops.” In *First IEEE International Workshop on Horizontal Interactive Human-Computer Systems (TABLETOP ’06)*, 89–96. https://doi.org/10.1109/TABLETOP.2006.12.

Sanford, Camellia W. 2010. “Evaluating Family Interactions to Inform Exhibit Design: Comparing Three Different Learning Behaviors in a Museum Setting.” *Visitor Studies* 13 (1): 67–89. https://doi.org/10.1080/10645571003618782.

Sano di Pietro. n.d. “Virgin and Child Adored by Saints Mary Magdalen and Nicolas of Bari; Christ Crucifies with Virgin and Saint John the Evangelist.”

Sayare, Scott. 2012. “Nintendo Devices To Help at Louvre.” *The New York Times*, April 16, 2012.

Sayre, Scott, and Kris Wetterlund. 2008. “The Social Life of Technology for Museum Visitors.” *Visual Arts Research* 34 (2): 85–94.

Schmitt, Bénédicte, Cedric Bach, Emmanuel Dubois, and Francis Duranthon. 2010. “Designing and Evaluating Advanced Interactive Experiences to Increase Visitor’s Stimulation in a Museum.” In *Proceedings of the 1st Augmented Human International Conference (AH’10)*, 1–8. https://doi.org/10.1145/1785455.1785470.

Schoemaker, Roel. 2017. “Personas: Knowing and Understanding the Customer.” Motivaction. 2017. https://www.motivaction.nl/en/research/target-group-and-segmentation/personas.

Schokkenbroek, Joost C. A. 2013. “Setting Sails on a New Course! Het Scheepvaartmuseum in Amsterdam after Its Renovation.” *Drassana: Revista Del Museu Maritim* 21: 152–63.

Schreiber, James B., Andrew J. Pekarik, Nadine Hanemann, Zahava D. Doering, and Ah-Jin Lee. 2013. “Understanding Visitor Engagement and Behaviors.” *The Journal of Educational Research* 106 (6): 462–68.

Schreiber, Kelley Notaro. 2019. “The Cleveland Museum of Art Announces Record Attendance in 2018.” Press. 2019. https://www.clevelandart.org/about/press/media-kit/cleveland-museum-art-announces-record-attendance-2018.

Screven, C. G. 1992. “Motivating Visitors to Read Labels.” *ILVS Review: A Journal of Visitor Behavior* 2 (2): 183–211.

Sears, Andrew, Catherine Plaisant, and Ben Schneiderman. 1990. “A New Era for Touchscreen Applications: High Precision, Dragging Icons, and Refined Feedback.” *Advances in Human-Computer Interaction* 3: 1–39.

Sedgwick, P. 2012. “The Hawthorne Effect.” *BMJ* 344 (d8262): 1. https://doi.org/10.1136/bmj.d8262.

Sedgwick, P., and N. Greenwood. 2015. “Understanding the Hawthorne Effect.” *BMJ* 351 (h4672): 2.

Sen, Ferhat, Lily Diaz, and Tommi Horttana. 2012. “A Novel Gesture-Based Interface for a VR Simulation: Re-Discovering Vrouw Maria.” In *IEEE Virtual Systems and Multimedia (VSMM’12)*, 323–30.

Serrell, Beverly. 1997. “Paying Attention: The Duration and Allocation of Visitors’ Time in Museum Exhibitions.” *Curator* 40 (2): 108–25. https://doi.org/10.1111/j.2151-6952.1997.tb01292.x.

———. 2010. “Paying More Attention to Paying Attention.” InformalScience.Org. 2010. http://informalscience.org/perspectives/blog/paying-more-attention-to-paying-attention.

Shackel, Brian. 2009. “Usability – Context, Framework, Definition, Design and Evaluation.” *Interacting with Computers* 21: 339–46. https://doi.org/10.1016/j.intcom.2009.04.007.

Sharpe, Elizabeth. 1983. “Touch-Screen Computers: An Experimental Orientation Device at the National Museum of American History.” Office of Public and Academic Programs, National Museum of American History, Smithsonian Institution.

Sheng, Chieh-Wen, and Ming-Chia Chen. 2012. “A Study of Experience Expectations of Museum Visitors.” *Tourism Management* 33: 53–60. https://doi.org/10.1016/j.tourman.2011.01.023.

Sillen, Jenny. 2015. “Touch Interfaces from a Usability Perspective: Effective Information Presentation for User Interaction on a Touch Screen.” KTH Royal Institute of Technology.

Silver, Dana Mitroff. 2014. “Using Design Thinking to Connect the Physical and Digital at the Rijksmuseum: An Interview with Shailoh Philips.” Design Thinking for Museums. 2014. https://designthinkingformuseums.net/2014/09/25/design-thinking-at-rijksmuseum/.

Smith, Gregory, Laurian C. Vega, and D. Scott McCrickard. 2008. “Education and Design: Using Human-Computer Interaction Case Studies to Learn.” *Proceedings of the 46th Annual Southeast Regional Conference (ACM-SE 46)*, 346–51. https://doi.org/10.1145/1593105.1593197.

Sohn, Dongyoung. 2011. “Anatomy of Interaction Experience: Distinguishing Sensory, Semantic, and Behavioral Dimensions of Interactivity.” *New Media & Society* 13 (8): 1320–35.

Soren, B. J., and Canadian Heritage Information Network. 2005. “Best Practices in Creating Quality Online Experiences for Museum Users.” *Museum Management and Curatorship* 20 (2): 131–48. https://doi.org/http://dx.doi.org/10.1016/j.musmancur.2005.03.001.

Speicher, Maximilian. 2015. “What Is Usability? A Characterization Based on ISO 9241-11 and ISO/IEC 25010.”

Spero, Susan B. 2013. “Review: The Museum Experience Revisited.” *Museum Management and Curatorship* 28 (4): 430–32.

Spock, Daniel. 2006. “The Puzzle of Museum Educational Practice: A Comment on Rounds and Falk.” *Curator: The Museum Journal* 49 (2): 167–80.

Stewart, Tom. 2009. “Usability Evaluation.” *Behaviour & Information Technology* 28 (2): 99–100.

Stichting Nederlands Scheepvaartmuseum Amsterdam. 2013. “Jaarrekening 2013: Het

Scheepvaartmuseum." Amsterdam.

———. 2014. "Jaarrekening 2014: Het Scheepvaartmuseum." Amsterdam.

Stillwell, Baylie. 2017. "Putting the 'Play' Back Into Display: Interactive Exhibits in Small Museums." University of Oregon.

Sundar, S. Shyam, Eun Go, Hyang-Sook Kim, and Bo Zhang. 2015. "Communicating Art, Virtually! Psychological Effects of Technological Affordances in a Virtual Museum." *International Journal of Human-Computer Interaction* 31 (6): 385–401. https://doi.org/10.1080/10447318.2015.1033912.

Sylaiou, Stella, Katerina Mania, Athanasis Karoulis, and Martin White. 2010. "Exploring the Relationship between Presence and Enjoyment in a Virtual Museum." *International Journal of Human Computer Studies* 68: 243–53. https://doi.org/10.1016/j.ijhcs.2009.11.002.

Tafler, David. 1988. "The Circular Text: Interactive Video, Reception, and Viewer Participation." *Journal of Film and Video* 40 (3): 27–45.

Taheri, Babak, Aliakbar Jafari, and Kevin O'Gorman. 2014. "Keeping Your Audience: Presenting a Visitor Engagement Scale." *Tourism Management* 42: 321–29. https://doi.org/10.1016/j.tourman.2013.12.011.

Templeton, Cheryl A. 2011. "Museum Visitor Engagement Through Resonant, Rich and Interactive Experiences." Carnegie Mellon University.

The Cleveland Museum of Art. 2013a. "About Gallery One." Gallery One. 2013. http://www.clevelandart.org/gallery-one/about.

———. 2013b. "Gallery One: Visitor Welcome Signage." Cleveland, OH.

———. 2014. "Engaging the Community." Cleveland, OH.

———. 2015a. "Collaborators." Gallery One. 2015. http://www.clevelandart.org/gallery-one/collaborators.

———. 2015b. "Collection Wall." Gallery One. 2015. http://www.clevelandart.org/gallery-one/collection-wall.

———. 2015c. “General Museum Information.” Press. 2015. http://www.clevelandart.org/about/press/general-museum-information.

———. 2015d. “History and Mission.” About the Museum. 2015. http://www.clevelandart.org/about/about-the-museum/history-and-mission.

———. 2015e. “Interactives.” Gallery One. 2015. http://www.clevelandart.org/gallery-one/interactives.

———. 2015f. “Museum Visitor Guide,” no. May: 1–4.

———. 2015g. “Overview: Our Renovation and Expansion Project.” Join and Give. 2015. http://www.clevelandart.org/join-and-give/support-the-transformation/renovation-and-expansion-project/overview.

———. 2015h. “Overview.”

———. 2015i. “Project Milestones.” Join and Give. 2015. http://www.clevelandart.org/join-and-give/support-the-transformation/renovation-and-expansion-project/project-milestones.

———. 2015j. “Studio Play.” Gallery One. 2015. http://www.clevelandart.org/gallery-one/studio-play-2.0.

———. 2016a. “Art and Fiction Book Club.” Learn. 2016. http://www.clevelandart.org/learn/in-the-galleries/art-and-fiction-book-club.

———. 2016b. “ArtLens 2.0.” Gallery One. 2016. http://www.clevelandart.org/gallery-one/artlens.

———. 2016c. “Ask an Expert.” 2016. http://www.clevelandart.org/ask-an-expert/.

———. 2016d. “Centennial Loans.” 2016. http://www.clevelandart.org/centennial/centennial-loans.

———. 2016e. “Jane Alexander.” Contact. 2016. https://www.clevelandart.org/contact/jane-alexander.

———. 2016f. “Our Visitors.” Dashboard. 2016. http://dash.clevelandart.org/cat/our-visitors.

———. 2016g. “Seema Rao.” Contact. 2016. https://www.clevelandart.org/contact/seema-rao.

———. 2016h. “Stroller Tours.” Visit. 2016. http://www.clevelandart.org/learn/in-the-galleries/stroller-tours.

———. 2017a. “ARTLENS Exhibition.” ARTLENS Gallery. 2017. http://www.clevelandart.org/artlens-gallery/artlens-exhibition.

———. 2017b. “ARTLENS Gallery.” ARTLENS Gallery. 2017. http://www.clevelandart.org/artlens-gallery/about.

———. 2019. “For the Benefit of All: The CMA’s Diversity, Equity, and Inclusion Plan.”

Time Out. 2015. “The Cleveland Museum of Art.” Time Out. 2015. https://www.timeout.com/cleveland/art/the-cleveland-museum-of-art.

Ting, Zhen Ling Katharine, Yan Peng Lim, and Elyna Amir Sharji. 2013. “Young Visitors’ Preferences for Touch Screen Design in Museums.” *2013 International Conference on Informatics and Creative Multimedia (ICICM’13)*, 288–91. https://doi.org/10.1109/ICICM.2013.55.

Tinworth, Kathleen. 2011. “Review: Identity and the Museum Visitor Experience.” *Museum Anthropology* 34 (1): 83–85.

Tzortzi, Kali. 2014. “Movement in Museums: Mediating between Museum Intent and Visitor Experience.” *Museum Management and Curatorship* 29 (4): 327–48. https://doi.org/10.1080/09647775.2014.939844.

Underwood, Kaitlin. 2016. “Interacting in the Museum: The Impact of Collaborative Exhibits.” Indiana University.

Vaart, Merel van der, and Christie A. Ray. 2014. “Domus: An On-Gallery Digital Museum Experience in Two Parts.” In *NODEM 2014*, 193–200.

Vergo, Peter, ed. 1989. *New Museology*. London: Reaktion.

Wagner, Ellen D. 1997. “Interactivity: From Agents to Outcomes.” *New Directions for Teaching and Learning* 71: 19–26. https://doi.org/10.1002/tl.7103.

Walker, Dominic. 2015. “Towards the Collaborative Museum? Social Media, Participation, Disciplinary Experts and the Public in the Contemporary Museum.” University of Cambridge.

Waltl, Christian. 2006. “Museums for Visitors: Audience Development - A Crucial Role for Successful Museum Management Strategies.” In *INTERCOM 2006*, 7.

Washburn, D.K. 1991. “Review: The New Museology, Edited by Peter Vergo.” *Museum Anthropology* 16 (2): 58–61.

Weaver, Meredith. 2012. “Behind the Scenes: The Impact of Audience.” The Cleveland Museum of Art Blog. 2012. http://www.clevelandart.org/blog/2012/01/04/behind-scenes-impact-audience-research.

Wecker, Menachem. 2015. “At Some Museums, Blind Visitors Can Touch the Art.” *The Washington Post*, 2015.

Werner, Brian L., Jeff Hayward, and Christine Larouche. 2014. “Measuring and Understanding Diversity Is Not So Simple: How Characteristics of Personal Identity Can Improve Museum Audience Studies.” *Visitor Studies* 17 (2): 191–206.

Whitehead, Christopher. 2016. “How to Analyze Museum Display: Script, Text, Narrative.”

Wiberg, Mikael. 2014. “Interaction Design Research and the Future.” *Interactions*, 22–23.

Widdop, Paul, and David Cutts. 2012. “Impact of Place on Museum Participation.” *Cultural Trends* 21 (1): 47–66. https://doi.org/10.1080/09548963.2012.641775.

Wieringen, Cornelis Claesz. van. 1622. “De Zeeslag Bij Gibraltar 25 April 1607.” *Maritime Digital*.

Wilde, Mathias, and Detlef Urhahne. 2008. “Museum Learning: A Study of Motivation and Learning Achievement.” *Journal of Biological Education* 42 (2): 78–83. https://doi.org/10.1080/00219266.2008.9656115.

Wojciechowski, Rafal, Krzysztof Walczak, Martin White, and Wojciech Cellary. 2004. “Building Virtual and Augmented Reality Museum Exhibitions.” *ACM* 1 (212): 135–45.

Xie, Fei. 2013. “How Interaction Design for Ceramics Exhibition Will Help Audiences to Have a Better Experience in Museums.” University of Cincinnati.

Yalowitz, Steven S., and Kerry Bronnenkant. 2009. “Timing and Tracking: Unlocking Visitor Behavior.” *Visitor Studies* 12 (1): 47–64. https://doi.org/10.1080/10645570902769134.

Zaharias, Panagiotis, Despina Michael, and Yiorgos Chrysanthou. 2013. “Learning through Multi-Touch Interfaces in Museum Exhibits: An Empirical Investigation.” *Educational Technology and*

Society 16 (3): 374–84.

Zwinkels, Juul, Tania Oudegeest, and Michaël Laterveer. 2009. “Using Visitor Observation to Evaluate Exhibits at the Rotterdam Zoo Aquarium.” *Visitor Studies* 12 (1): 65–77.

Appendix 1: Design and Development Team Interview Template[21]

[21] "X" is used here in place of the name of each case study installation

General Project Development:

1. What was your role in the development of X?
2. What were the project goals related to the development of X?
3. What was the development timeline associated with X?
    a. How long did development take from concept to installation?
4. Who participated in the design and development of X?
    a. How big was the development team?
    b. What was the division between museum professionals and interaction design professionals?
    c. What are the occupational titles of members of the design and development team?
    d. Who may be considered stakeholders in the project?
5. What was the project budget associated with X?

Target Audience:

6. What kinds of museum visitors were considered as target users for X?
    a. What criteria were used to define the target users?
7. Why was this particular group of target users selected?
8. What special design criteria were used to cater to the defined target users?

Interaction Design:

9. What were the interaction goals related to X?
    a. What kinds of interactions were you designing?
    b. What outcomes did these interactions achieve (action/reaction)?
    c. How simple or complex did you expect the interactions might be for your target users to achieve?
10. What were the user experience goals related to X?
    a. What kinds of experiences were you designing?
    b. What did you want the target user to experience during their interaction with X?
11. How did the installation context for X, namely its integration into a museum exhibition, influence the design?
    a. What, if any, special measures were taken to accommodate the unique nature of the installation context?
12. How did the type of interaction technology used with X influence the interaction design?

a. Was the technology selected to support interaction, or was it selected for some other purpose?

Instructions and Instruction Design:

13. What was your role in the development of instructions related to X?
14. Reflecting upon the development of the entire project, at what point did development begin related to the user instructions for X?
    a. How soon or how late into the development is instruction considered?
15. What kinds of instructional measures were taken to support the user interaction experiences related to X?
    a. What instructional texts were written and by whom?
    b. What instructional graphics were designed and by whom?
    c. How were these instructional measures presented/displayed?
16. What kinds of instructional measures were taken to support the interaction experiences of the target users?
    a. Were any special design criteria used on the creation of instructions related to X?

Codified Knowledge Applied:

17. What kinds of theories/evidence/experiences guided the development of X?
    a. How did these theories/evidence/experiences impact the development of instructions related to X?
18. Was any evaluation with users conducted during the development of X?
    a. If so, what kinds of evaluation?
        i. What were the results?
        ii. How did the evaluation outcomes alter the design of X?
        iii. Are the results available in some manner (published article, online report, professional blog, etc.)?
    b. If not, was there a reason why no formative evaluation was conducted?

Appendix 2: Interview Quote Approval Form Template

I, [*interview participant*], hereby grant my permission to Christie A. Ray to reproduce the following verbatim quotes, derived from our interview on [*interview date*]:

[*relevant quotes for each interview participant*]

By signing, I provide my consent for the above material to be reproduced in the PhD thesis of Christie A. Ray, entitled "Assumptions and Experiences: How museums communicate interactivity and how visitors engage with instruction in the museum context", and any consequent publications derived from the contents of this thesis.

Signed: _____

Dated: _____

Appendix 3: HSM Observation Template[22]

DATE: _____ / _____ / _____
DAY OF WEEK: _____
OP START TIME: _____:_____
OP END TIME: _____:_____
Observation Period (OP) #:_____

OP NOTES: _____

User #: _____				Gender: F / M				Collaborative interaction with other visitor(s): Yes | No	
Start Time: _____:_____				End Time: _____:_____				Notes:	
Audio Guide Use: Yes | No									
Company: 1 | 2 | 3 | 4 | 5+				Kids: 1 | 2 | 3 | 4 | 5+					
Est. Age: 18-24 | 25-34 | 35-44 | 45-54 | 55-64 | 65+									
Sequence of Attempted Interaction:				Change Language	Sequence of Instructions Used:				UI Icons
				Hot Spot					Watching Visitors
				Close Text Window					"Touch to Start" Screen
				ⓘ Information					ⓘ Information
				Swipe Left/Right					Museum Staff

User #: _____				Gender: F / M				Collaborative interaction with other visitor(s): Yes | No	
Start Time: _____:_____				End Time: _____:_____				Notes:	
Audio Guide Use: Yes | No									
Company: 1 | 2 | 3 | 4 | 5+				Kids: 1 | 2 | 3 | 4 | 5+					
Est. Age: 18-24 | 25-34 | 35-44 | 45-54 | 55-64 | 65+									
Sequence of Attempted Interaction:				Change Language	Sequence of Instructions Used:				UI Icons
				Hot Spot					Watching Visitors
				Close Text Window					"Touch to Start" Screen
				ⓘ Information					ⓘ Information
				Swipe Left/Right					Museum Staff

User #: _____				Gender: F / M				Collaborative interaction with other visitor(s): Yes | No	
Start Time: _____:_____				End Time: _____:_____				Notes:	
Audio Guide Use: Yes | No									
Company: 1 | 2 | 3 | 4 | 5+				Kids: 1 | 2 | 3 | 4 | 5+					
Est. Age: 18-24 | 25-34 | 35-44 | 45-54 | 55-64 | 65+									
Sequence of Attempted Interaction:				Change Language	Sequence of Instructions Used:				UI Icons
				Hot Spot					Watching Visitors
				Close Text Window					"Touch to Start" Screen
				ⓘ Information					ⓘ Information
				Swipe Left/Right					Museum Staff

NOTES:
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

[22] Each HSM template page contains space for observation of three individual users, with space for general notes at the bottom of each template page. Each template page was dated and numbered sequentially for tracking purposes, despite being absent from this sample template.

Appendix 4: HSM Post-Interaction Questionnaire (English Version)

Thank you for agreeing to participate in this research!

This questionnaire is part of a PhD research project that aims to explore usability and the museum visitor experience of the GIBRALTAR TOUCH TABLE. Specifically, this questionnaire will ask you to reflect upon your experience interacting with the GIBRALTAR TOUCH TABLE and any instructions you may have used to support your interaction experience. The results of this questionnaire will contribute to the PhD Thesis of Christie A. Ray at the University of Amsterdam.

Completion of this questionnaire takes less than 5 minutes.

For additional information about the research, you are welcome to contact Christie A. Ray at c.a.ray@uva.nl or +31 (0) 61 774 94 96. The Ethics Committee of the Faculty of the Humanities at the University of Amsterdam may be contacted at commissie-ethiek-fgw@uva.nl.

Please sign the following consent form prior to completing the attached questionnaire.

PARTICIPANT CONSENT

I hereby declare that I have been informed in a clear manner about the nature and method of the research, as described above.

I voluntarily agree to participate in this research study. I retain the right to withdraw my consent, without having to give reason for doing so. I am aware that I may halt my participation at any time.

If results are used in academic publications or are made public in any other way, this will be done in such a way that my anonymity is completely safeguarded.

If I wish to receive more information about the research, either now or in the future, I can contact Christie A. Ray at c.a.ray@uva.nl or +31 (0) 61 774 94 96. The Ethics Committee of the Faculty of the Humanities at the University of Amsterdam may be contacted at commissie-ethiek-fgw@uva.nl.

I understand the text presented above, and I agree to participate in the research study:

Date: _____

Name (printed): _____

Signature: _____

1. Visitor Demographics:

1.1	Gender:	◯	Male
		◯	Female
		◯	_____

1.2	Age:	◯	18 - 24 years
		◯	25 - 34 years
		◯	35 - 44 years
		◯	45 - 54 years
		◯	55 - 64 years
		◯	65 + years

1.3	Today, I am visiting the museum…	◯	Alone
		◯	With a friend or family member
		◯	With a group of _____ (#) people

1.4	Do you own a smartphone, tablet, or touch-screen computer?	◯	Yes
		◯	No

1.5	Which statement best describes you? (Select all that apply)	◯	Motivated by curiosity and an interest in exploring the museum collections.
		◯	Motivated to facilitate the experiences and learning of others I am visiting the museum with.
		◯	Motivated by interest in the museum collections as a professional or hobbyist.
		◯	Motivated by the perception that visiting the museum is an important experience (a "been there, done that" destination).
		◯	Motivated to visit the museum for a peaceful, reflective or recharging experience.
		◯	Motivated to visit the museum to pay respects to those who are honoured and remembered by the museum.
		◯	Motivated by a personal connection or affinity to visit a particular object, exhibition or collection within the museum.

2. Interaction with the GIBRALTAR TOUCH TABLE

2.1	What motivated you to interact with the GIBRALTAR TOUCH TABLE? (Select all that apply)	◯	I wanted to try the touch table.
		◯	I wanted to learn more about the Gibraltar painting.
		◯	I was curious to see what it was.
		◯	It seemed like an interesting way to view and learn more about the painting.
		◯	I wanted to show another visitor.
		◯	Other: _____ _____ _____ _____

2.2	How did you know how to use the touch table? (Select all that apply)	◯	I saw other visitors using it.
		◯	Someone from the museum helped me use it.
		◯	I used the onscreen instructions ⓘ
		◯	I saw the screen that says "Touch to Start".
		◯	I tried a few things until I figured it out.
		◯	Other: _____ _____ _____ _____

2.3	What kinds of interaction did you try? (Select all that apply)	◯	I touched the "hot spots".
		◯	I closed the "hot spot" text windows.
		◯	I swiped left and right to see more of the painting.
		◯	I selected the ⓘ icon.
		◯	I changed the language.
		◯	Other: _____ _____ _____ _____

3. Instructions for using the GIBRALTAR TOUCH TABLE

3.1	What kinds of instructions did you use with the GIBRALTAR TOUCH TABLE? (Select all that apply)	◯	Someone from the museum showed me what to do.
		◯	I used the ⓘ information.
		◯	I saw the "Touch to Start" screen.
		◯	I saw other visitors using the touch table.
		◯	I didn't use any instructions.
		◯	Other: _____ _____ _____ _____

3.2	In your opinion, what kinds of instructions would you like to have had available with the GIBRALTAR TOUCH TABLE? (Select all that apply)	◯	Someone from the museum to show me how interaction works.
		◯	Pictures showing how interaction works.
		◯	Video or animation showing how interaction works.
		◯	Clear, easy-to-understand design using familiar icons.
		◯	Step-by-step guide to interaction.
		◯	Other: _____ _____ _____ _____

3.3	More generally speaking, what kinds of instructions would you personally like to see with touch tables in museum exhibitions? (Select all that apply)	◯	Someone from the museum to show me how interaction works.
		◯	Pictures showing how interaction works.
		◯	Video or animation showing how interaction works.
		◯	Clear, easy-to-understand design using familiar icons.
		◯	Step-by-step guide to interaction.
		◯	Other: _____ _____ _____ _____

4. Usability of the GIBRALTAR TOUCH TABLE

4.1	Did you find the GIBRALTAR TOUCH TABLE easy to use?	◯	Yes, because _____ _____ _____ _____ _____
		◯	No, because _____ _____ _____ _____ _____

4.2	Did you enjoy your interaction with the GIBRALTAR TOUCH TABLE?	◯	Yes, because _____ _____ _____ _____ _____ _____ _____
		◯	No, because _____ _____ _____ _____ _____ _____ _____

4.3	On a scale of 1 (poor) to 10 (excellent), please rate your overall experience using the GIBRALTAR TOUCH TABLE.	____

5. Content of the GIBRALTAR TOUCH TABLE

5.1	What kind of information about the GIBRALTAR painting would you like to see **MORE** or **LESS** of? (Select all that apply)		
	MORE	**LESS**	
	◯	◯	The artist, Cornelis Claesz. Van Wieringen
	◯	◯	The historical moment depicted by the painting
	◯	◯	The kinds of ships and weapons depicted
	◯	◯	The military figures and ranks depicted
	◯	◯	The materials and techniques used to produce the painting
	◯	◯	Other: _____ _____ _____ _____

5.2	On a scale of 1 (poor) to 10 (excellent), please rate the **quality of the information offered** by the GIBRALTAR touch table:	____

6. Comments

6.1	Feel free to comment on your experience with the GIBRALTAR TOUCH TABLE, the Paintings Gallery, or the National Maritime Museum.
_____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____	

Appendix 5: HSM Post-Interaction Questionnaire (Dutch Version)

Hartelijk dank voor uw deelname aan dit onderzoek!

Deze vragenlijst maakt deel uit van een promotieonderzoek naar de bruikbaarheid van de GIBRALTAR-TOUCHTAFEL en de ervaringen van museumbezoekers daarmee. De vragen richten zich specifiek op uw ervaringen met het gebruik van de GIBRALTAR-TOUCHTAFEL en eventuele instructies die u daarbij hebt gekregen. De resultaten van de vragenlijst zullen worden gebruikt voor het proefschrift van Christie A. Ray (Universiteit van Amsterdam).

Het invullen van de vragenlijst neemt minder dan 5 minuten in beslag.

Voor aanvullende informatie over het onderzoek kunt u contact opnemen met Christie A. Ray door een mailtje te sturen aan c.a.ray@uva.nl, of te bellen met +31 (0) 61 774 94 96. De Commissie Ethiek van de Faculteit der Geesteswetenschappen van de Universiteit van Amsterdam is bereikbaar via commissie-ethiek-fgw@uva.nl.

Wij verzoeken u vriendelijk om het volgende toestemmingsformulier in te vullen voordat u met de bijgevoegde vragenlijst begint.

TOESTEMMING DEELNEMER

Ik verklaar dat ik duidelijk ben geïnformeerd over de aard en methode van het hierboven beschreven onderzoek.

Ik doe vrijwillig aan dit onderzoek mee. Ik behoud mij het recht voor mijn toestemming zonder opgave van reden in te trekken. Ik kan mijn medewerking te allen tijde staken.

Als de resultaten in een academische publicatie worden gebruikt of op enige andere wijze openbaar worden gemaakt, zal dat zodanig gebeuren dat mijn anonimiteit is gewaarborgd.

Voor meer informatie over dit onderzoek kan ik nu of in de toekomst contact opnemen met Christie A. Ray via het e-mailadres c.a.ray@uva.nl of het telefoonnummer +31 (0) 61 774 94 96. De Commissie Ethiek van de Faculteit der Geesteswetenschappen van de Universiteit van Amsterdam is bereikbaar via commissie-ethiek-fgw@uva.nl.

Ik verklaar bovenstaande tekst te hebben gelezen en begrepen en zeg toe deel te nemen aan dit onderzoek:

Datum: _____

Naam (in blokletters):_____

Handtekening: _____

1. Demografische gegevens bezoeker:

1.1	Geslacht:	◯	Man
		◯	Vrouw
		◯	_____

1.2	Leeftijd:	◯	18 - 24 jaar
		◯	25 - 34 jaar
		◯	35 - 44 jaar
		◯	45 - 54 jaar
		◯	55 - 64 jaar
		◯	65 + jaar

1.3	Vandaag bezoek ik het museum…	◯	Alleen
		◯	Met een vriend(in) of familielid
		◯	Met een groep van ___ (aantal) mensen

1.4	Hebt u een smartphone, tablet of computer met touchscreen?	◯	Ja
		◯	Nee

1.5	Welke uitspraken zijn op u van toepassing? (Graag alles wat van toepassing is selecteren)	◯	Ik bezoek het museum uit nieuwsgierigheid en interesse in de collecties van het museum.
		◯	Ik bezoek het museum om anderen in staat te stellen het museum te ervaren en iets te leren.
		◯	Ik bezoek het museum omdat ik beroepsmatig of vanuit een hobby geïnteresseerd ben in de collecties van het museum.
		◯	Ik bezoek het museum omdat ik dat een nuttige ervaring vind (een 'verplicht nummer').
		◯	Ik bezoek het museum vanwege de rust, om na te denken of om weer energie te krijgen.
		◯	Ik bezoek het museum uit respect voor diegenen die door het museum worden geëerd en herdacht.
		◯	Ik bezoek het museum vanwege een persoonlijke binding of affiniteit met een object, tentoonstelling of collectie in het museum.

2. Interactie met de GIBRALTAR TOUCHTAFEL

2.1	Wat was voor u de reden om de Gibraltar-touchtafel te gebruiken? (Graag alles wat van toepassing is selecteren)	◯	Ik wilde de touchtafel uitproberen.
		◯	Ik wilde meer over het Gibraltar-schilderij te weten komen.
		◯	Ik was benieuwd wat het was.
		◯	Het leek me een interessante manier om naar het schilderij te kijken en daar meer over te weten te komen.
		◯	Ik wilde hem aan een andere bezoeker laten zien.
		◯	Overig: _____ _____ _____ _____

2.2	Hoe wist u hoe u de touchtafel moest gebruiken? (Graag alles wat van toepassing is selecteren)	◯	Ik heb naar andere bezoekers gekeken.
		◯	Iemand van het museum heeft me geholpen.
		◯	Ik heb de instructies op het scherm gevolgd ⓘ
		◯	Ik zag op het scherm “aanraken om te beginnen” staan.
		◯	Ik heb wat uitgeprobeerd totdat ik het doorhad.
		◯	Overig: _____ _____ _____ _____

2.3	Welke mogelijkheden hebt u uitgeprobeerd? (Graag alles wat van toepassing is selecteren)	◯	Ik heb de ‘hotspots’ aangeraakt.
		◯	Ik heb de tekstvensters van ‘hotspots’ gesloten.
		◯	Ik heb naar links en rechts geveegd om meer van het schilderij te zien
		◯	Ik heb het ⓘ icoon geselecteerd.
		◯	Ik heb de taal veranderd.
		◯	Overig: _____ _____ _____ _____

3. Instructies voor het gebruik van de GIBRALTAR TOUCHTAFEL

3.1	Wat voor instructies voor de Gibraltar-touchtafel hebt u gekregen? (Graag alles wat van toepassing is selecteren)	◯	Iemand van het museum deed het voor.
		◯	Ik heb de ⓘ informatie gebruikt.
		◯	Ik zag op het scherm “aanraken om te beginnen” staan.
		◯	Ik zag andere bezoekers de touchtafel gebruiken.
		◯	Ik heb geen instructies gekregen.
		◯	Overig: _____ _____ _____

3.2	Wat voor soort instructies zouden er volgens u bij de Gibraltar-touchtafel moeten worden gegeven? (Graag alles wat van toepassing is selecteren)	◯	Iemand van het museum die laat zien hoe de tafel moet worden gebruikt.
		◯	Plaatjes die laten zien hoe de tafel moet worden gebruikt.
		◯	Een instructievideo of animatie om het gebruik van de tafel te demonstreren.
		◯	Een duidelijke, begrijpelijke vormgeving met herkenbare pictogrammen.
		◯	Stap-voor-stapinstructies voor het gebruik.
		◯	Overig: _____ _____ _____

3.3	Wat voor soort instructies zou u willen krijgen bij touchtafels bij museumtentoonstellingen in het algemeen? (Graag alles wat van toepassing is selecteren)	◯	Iemand van het museum die laat zien hoe de tafel moet worden gebruikt.
		◯	Plaatjes die laten zien hoe de tafel moet worden gebruikt.
		◯	Een instructievideo of animatie om het gebruik van de tafel te demonstreren.
		◯	Een duidelijke, begrijpelijke vormgeving met herkenbare pictogrammen.
		◯	Stap-voor-stapinstructies voor het gebruik.
		◯	Overig: _____ _____ _____

4. Gebruiksgemak van de GIBRALTAR TOUCHTAFEL

4.1	Vond u de Gibraltar-touchtafel makkelijk om te gebruiken?	◯	Ja, want… _____ _____ _____ _____ _____ _____
		◯	Nee, want… _____ _____ _____ _____ _____ _____

4.2	Vond u het gebruik van de Gibraltar-touchtafel prettig?	◯	Ja, want… _____ _____ _____ _____ _____ _____
		◯	Nee, want… _____ _____ _____ _____ _____ _____

4.3	Welk cijfer, op een schaal van 1 (slecht) tot 10 (uitstekend), geeft u aan uw ervaring als gebruiker van de Gibraltar-touchtafel?	____

5. Inhoud van de GIBRALTAR TOUCHTAFEL

5.1	Over welke aspecten van het Gibraltar-schilderij had u **meer** of juist **minder** willen weten? (Graag alles wat van toepassing is selecteren)		
	MEER	**MINDER**	
	◯	◯	De schilder, Cornelis Claesz. Van Wieringen
	◯	◯	De historische gebeurtenis die op het schilderij is afgebeeld
	◯	◯	De schepen en wapens die zijn afgebeeld
	◯	◯	De militaire personages en rangen die zijn afgebeel
	◯	◯	De materialen en technieken die voor het schilderij zijn gebruikt
	◯	◯	Overig: _____ _____ _____ _____ _____ _____

5.2	Welk cijfer, op een schaal van 1 (slecht) tot 10 (uitstekend), geeft u aan de kwaliteit van de informatie die via de Gibraltar-touchtafel beschikbaar is:	____

6. Opmerkingen

6.1	Hier kunt u eventuele opmerkingen kwijt over uw ervaringen met de Gibraltar-touchtafel, de schilderijencollectie of het Scheepvaartmuseum.
_____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____	

Appendix 6: CMA Observation Template[23]

DATE: _____ D.O.W.: _____ OP#: _____

START TIME: _____:_____ END TIME: _____:_____

User #: ____	**Start time**: ___:___	**End time**: ___:___
Gender: M | F | X	**Est. Age**: 18-24 | 25-34 | 35-44 | 45-54 | 55-64 | 65+	
Company: 1 | 2 | 3 | 4 | 5+	**Kids**: 1 | 2 | 3 | 4 | 5+	

"Home"			
Skip	Right Arrow		
X Close Window	Left Arrow		
Select "Pantheon"	Select info content		
Select "Biscuits"	Switch visual within window		
Select "Metro"	Resize painting		
Select "Virgin&Child"	Drag painting		
Choose a Reason	Number of votes cast:		
Change Perspective	1st	2nd	3rd
	Panini		
	Move Vanishing Point		
Remix Picasso	Resize element		
	Position element on canvas		
	Move element F/B		
	Email to…		
Make Your Mark	"Painting"		
Drip Technique	Select Colour		
Gesture Technique	Undo		
Pour Technique	Email to…		
Discover Tempura	Sequence of layer selection (1-5):		
	Videos played (by layer):		
Credits	Continue viewing: Y | N		
Observation Before Interaction: Y | N	**Assistance from Other Visitor(s)**: Y | N		
Assistance from Museum Staff: Y | N	**Collaborative Interaction**: Y | N		

NOTES: _____

_____

_____

_____

_____

_____

[23] Each CMA template page contained space for observation of two individual users, however only a single observation template is provided here. Each template page was dated and numbered sequentially for tracking purposes, despite being absent from this sample template.

Appendix 7: CMA Post-Interaction Questionnaire

Thank you for agreeing to participate in this research!

This questionnaire is part of a PhD research project that aims to explore usability and the museum visitor experience of the PAINTING LENS in GALLERY ONE. Specifically, this questionnaire will ask you to reflect upon your experience interacting with the PAINTING LENS in GALLERY ONE and any instructions you may have used to support your interaction experience. The results of this questionnaire will contribute to the PhD Thesis of Christie A. Ray at the University of Amsterdam.

Completion of this questionnaire takes less than 5 minutes.

For additional information about the research, you are welcome to contact Christie A. Ray at c.a.ray@uva.nl or +31 (0) 61 774 94 96. The Ethics Committee of the Faculty of the Humanities at the University of Amsterdam may be contacted at commissie-ethiek-fgw@uva.nl.

Please sign the following consent form prior to completing the attached questionnaire.

PARTICIPANT CONSENT

I hereby declare that I have been informed in a clear manner about the nature and method of the research, as described above.

I voluntarily agree to participate in this research study. I retain the right to withdraw my consent, without having to give reason for doing so. I am aware that I may halt my participation at any time.

If results are used in academic publications or are made public in any other way, this will be done in such a way that my anonymity is completely safeguarded.

If I wish to receive more information about the research, either now or in the future, I can contact Christie A. Ray at c.a.ray@uva.nl or +31 (0) 61 774 94 96. The Ethics Committee of the Faculty of the Humanities at the University of Amsterdam may be contacted at commissie-ethiek-fgw@uva.nl.

I understand the text presented above, and I agree to participate in the research study:

Date: _____

Name (printed): _____

Signature: _____

1. Visitor Demographics:

1.1	Gender:	◯	Male
		◯	Female
		◯	_____

1.2	Age:	◯	18 - 24 years
		◯	25 - 34 years
		◯	35 - 44 years
		◯	45 - 54 years
		◯	55 - 64 years
		◯	65 + years

1.3	Today, I am visiting the museum…	◯	Alone
		◯	With a friend or family member
		◯	With a group of _____ (#) people

1.4	Do you own a smartphone, tablet, or touch-screen computer?	◯	Yes
		◯	No

1.5	Which statement best describes you? (Select all that apply)	◯	Motivated by curiosity and an interest in exploring the museum collections.
		◯	Motivated to facilitate the experiences and learning of others I am visiting the museum with.
		◯	Motivated by interest in the museum collections as a professional or hobbyist.
		◯	Motivated by the perception that visiting the museum is an important experience (a "been there, done that" destination).
		◯	Motivated to visit the museum for a peaceful, reflective or recharging experience.
		◯	Motivated to visit the museum to pay respects to those who are honoured and remembered by the museum.
		◯	Motivated by a personal connection or affinity to visit a particular object, exhibition or collection within the museum.

2. Interaction with the PAINTING LENS in GALLERY ONE

2.1	What motivated you to interact with the PAINTING LENS? (Select all that apply)	◯	I wanted to try the touch screen.
		◯	I wanted to learn more about the paintings displayed.
		◯	I was curious to see what it was.
		◯	It seemed like an interesting way to view and learn more about the paintings displayed.
		◯	I wanted to show another visitor.
		◯	I saw others using it and wanted to try it for myself.
		◯	Other: _____ _____ _____

2.2	How did you know how to use the touch screen? (Select all that apply)	◯	I saw other visitors using it.
		◯	Someone from the museum helped me use it.
		◯	I saw the onscreen instructions.
		◯	I tried a few things until I figured it out.
		◯	Other: _____ _____ _____

2.3	What kinds of interaction did you try? (Select all that apply)	◯	I made a selection onscreen to view more information.
		◯	I played a short video.
		◯	I resized and repositioned art onscreen.
		◯	I voted on reasons why different art was made.
		◯	I explored changing perspectives in art.
		◯	I remixed the Picasso painting “Still Life with Biscuits”.
		◯	I “made my mark” and painted a picture.
		◯	I emailed my painting to someone.
		◯	I explored different layers of tempura painting.
		◯	Other: _____ _____ _____

3. Instructions for using the PAINTING LENS in GALLERY ONE

3.1	What kinds of instructions did you use with the PAINTING LENS? (Select all that apply)	◯	Someone from the museum showed me what to do.
		◯	Another visitor showed me what to do.
		◯	I saw the onscreen instructions.
		◯	I saw other visitors using the touch screen.
		◯	I didn't use any instructions.
		◯	Other: _____ _____ _____ _____

3.2	In your opinion, what kinds of instructions would you like to have had available with the PAINTING LENS? (Select all that apply)	◯	Someone from the museum to show me how interaction works.
		◯	An onscreen option for additional information about how interaction works.
		◯	An option to replay the onscreen animated instructions.
		◯	Clear, easy-to-understand design using familiar icons.
		◯	Other: _____ _____ _____ _____

3.3	More generally speaking, what kinds of instructions would you personally like to see with touch screens in museum exhibitions? (Select all that apply)	◯	Someone from the museum to show me how interaction works.
		◯	An onscreen option for additional information about how interaction works.
		◯	An option to replay the onscreen animated instructions.
		◯	Clear, easy-to-understand design using familiar icons.
		◯	Other: _____ _____ _____ _____

4. Usability of the PAINTING LENS in GALLERY ONE

4.1	Did you find the PAINTING LENS easy to use?	◯	Yes, because _____ _____ _____ _____ _____
		◯	No, because _____ _____ _____ _____ _____

4.2	Did you enjoy your interaction with the PAINTING LENS?	◯	Yes, because _____ _____ _____ _____ _____ _____ _____
		◯	No, because _____ _____ _____ _____ _____ _____ _____

4.3	On a scale of 1 (poor) to 10 (excellent), please rate your overall experience using the PAINTING LENS.	____

5. Content of the PAINTING LENS in GALLERY ONE

5.1	What kind of information would you like to see **MORE** or **LESS** of when interacting with the PAINTING LENS? (Select all that apply)		
	MORE	**LESS**	
	◯	◯	The artists responsible for the artworks on display.
	◯	◯	The materials used to produce the artworks.
	◯	◯	The techniques used to produce the artworks.
	◯	◯	The reasons or motivations behind the production of the artworks.
	◯	◯	Other: _____ _____ _____ _____

5.2	On a scale of 1 (poor) to 10 (excellent), please rate the **quality of the information offered** by the PAINTING LENS in GALLERY ONE:	____

6. Comments

6.1	Feel free to comment on your experience with the PAINTING LENS, Gallery One, or the Cleveland Museum of Art.
_____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____	

List of Figures

Figure 2.1: Framework for defining instruction associated with in-gallery interaction technologies..30

Figure 2.2: Presentation of instruction for in-gallery interaction technologies within museums.....33

Figure 3.1: : Summary of research topics and evaluation methodologies 37

Figure 4.1: Exterior of HSM, together with replica of the East Indiaman Amsterdam (Ieremieieva 2014) 54

Figure 4.2: Floor plan of HSM. The location of *The Paintings* gallery in the East wing is indicated with a red arrow (Het Scheepvaartmuseum 2017c).....56

Figure 4.3: Navigational Instruments exhibit.....61

Figure 4.4: Yacht Models exhibit (Het Scheepvaartmuseum 2017k).....61

Figure 4.5: The Voyage at Sea (Het Scheepvaartmuseum 2017l).....61

Figure 4.6: The East Indiaman *Amsterdam* (Het Scheepvaartmuseum 2017a).....62

Figure 4.7: The installation context of *the Gibraltar touch table* within *the Paintings* gallery 65

Figure 4.8: *The Gibraltar touch table*, in front of “The Battle of Gibraltar” by Cornelis Claesz. van Wieringen (1622) 67

Figure 4.9: The "Touch to Start" attractor screen 68

Figure 4.10: Text window of a selected target spot 70

Figure 4.11: Instructions available through selection of the ⓘ 72

Figure 4.12: *The Gibraltar touch table* within *The Paintings* gallery 75

Figure 4.13: Total number of participants, by gender 89

Figure 4.14: Percentage of participants, by gender.....90

Figure 4.15: Percentage of participants, by age group 91

Figure 4.16: Percentage of participants, by visitor grouping.....92

Figure 4.17: Observation averages 98

Figure 4.18: Percentage of observed sample group users to engage in collaborative interaction 104

Figure 4.19: Percentage of observed sample group users to watch other visitors prior to interaction 105

Figure 4.20: Use of instructional forms and swipe left/right function 115

Figure 5.1: The Armor Room in the 1916 Building (Daderot 2012) 133

Figure 5.2: CMA, Level 1. The location of *the Paintings Lens* is marked with a small red star within the green area of Gallery One (The Cleveland Museum of Art 2015f) 135

Figure 5.3: The Reinberger Gallery in the 1916 Building (Rabesphoto 2008) 136

Figure 5.4: Gallery One, thematic exhibition space – *The Painting Lens* on the right 138

Figure 5.5: Gallery One, the Collection Wall 140

Figure 5.6: *The Painting Lens* and associated artworks within Gallery One 143

Figure 5.7: The home-screen of *the Painting Lens* 146

Figure 5.8: Total number of participants, by gender 166

Figure 5.9: Percentage of participants, by gender 167

Figure 5.10: Percentage of participants, by age 168

Figure 5.11: Percentage of participants, by visitor grouping 169

Figure 5.12: Observation averages 173

Summary

Assumptions and Experiences: How museums communicate interactivity and how visitors engage with instruction in the museum context

Museums have been integrating digital interaction technologies into their exhibitions spaces since the early 1980's for a variety of purposes, among them to stimulate, inform, and engage visitors with their collections. These goals continue to persist today, however, the technological toolset available to museums and their visitors has vastly multiplied and diversified over time. While the use of interaction technologies may not be suitable for every museum, its increasing popularity has prompted research and evaluation from several disciplines to explore the impact of interaction technology on the museum visitor experience. For example, there is research dedicated to exploring aspects of usability related to interaction technologies in museums, visitor engagement with in-gallery technologies, learning behaviours associated with the use of in-gallery technologies, and social-interaction among visitors engaged with in-gallery technologies.

Contributing to the growing body of research surrounding the integration of interaction technologies into the museum context, this thesis takes a closer look at a particularly under-researched aspect of usability relating to the use of in-gallery interaction technologies by museum visitors: instruction. I examine how museums communicate instruction for interaction with in-gallery interaction technologies to their visitors and how museum visitors engage with instruction within the museum context, applying Falk and Dierking's Contextual Model of Learning and Falk's Visitor Identity-Related Motivation Model. I create a framework for defining and discussing the various forms of instruction that may be associated with in-gallery interaction technologies, using this framework to explore the development and decision making processes relating to different instructional forms. Focusing on the museum visitor, I consider several facets of the user experience relating to the use of available instructional forms associated with in-gallery interaction technologies, including the impact of the use or non-use of instructions, the instructional forms that

users claim to use compared with actual observed use, and the effectiveness of instructional forms for supporting user interaction.

Despite the many forms of interaction technologies commercially available today, I focus my research on the implementation of touch-screen interactive installations that are physically integrated into the museum context of an exhibition space. Using a combination of methodologies, I evaluate two case study installations: *The Gibraltar Touch Table*, a large touch table within Amsterdam's het Scheepvaartmuseum, and *The Painting Lens*, a touch-screen kiosk from the Gallery One exhibition space within the Cleveland Museum of Art. Both case study installations employ a combination of instructional forms to convey interactivity to potential users within the museum context, providing insight into the effectiveness of different instructional forms. I interview members of the development teams responsible for the design and creation of the two case study installations to better understand their approach to developing and implementing instructions associated with each of the in-gallery interactives. I evaluate the museum visitor experience using two methodological approaches commonly applied in museum visitor studies to provide both quantitative and qualitative results, namely, observation of visitor interaction and voluntary participation in a post-interaction questionnaire.

The cumulative evaluation results from both case studies demonstrate the potential effectiveness of the various available instructional forms for guiding visitors through their interaction experiences. I show how both case study installations rely on user interface design and the design of the physical installation context into which the in-gallery interactive is integrated as the main instructional forms made available to support user interaction experiences. Evaluation results reveal discord between the assumptions that the design and development team members made about user interaction and the actual interaction behaviours that users exhibit, indicating that there are limits to the assumptions that can be made about user interaction behaviours. To avoid relying on unproven assumptions, I contend that museums must invest time, money, and personnel into identifying and understanding their target audience or users, in addition to defining a clear set of

goals relating to their intended user interaction experience in order to ensure instruction for interaction with in-gallery interactive installations is being communicated effectively. Furthermore, I argue on behalf of iterative user testing associated with in-gallery interaction technologies to ensure the defined target audiences or users are able to achieve the defined user interaction experience goals set forth during development phases.

Samenvatting

Aannames en ervaringen: Hoe musea interactiviteit communiceren en hoe bezoekers omgaan met instructies in de museale context

Sinds de vroege jaren ’80 van de twintigste eeuw hebben musea om verschillende redenen digitale interactieve technologieën geïntegreerd in hun tentoonstellingszalen, zoals het stimuleren, informeren en betrekken van bezoekers bij hun collecties. Deze redenen zijn ook vandaag de dag nog relevant, met het belangrijke verschil dat met de jaren het aanbod aan technologische middelen voor musea en bezoekers groter en diverser is geworden. Hoewel het gebruik van interactieve technologie niet voor alle musea geschikt is, heeft de toegenomen populariteit ervan binnen verschillende vakgebieden geleid tot onderzoek en evaluatie met het doel de impact van interactieve technologie op de museumervaring te verkennen. Voorbeelden hiervan zijn onderzoek naar de gebruiksvriendelijkheid van interactieve technologieën in het museum, onderzoek naar de interactie van bezoekers met technologie op zaal, onderzoek naar leergedrag in relatie tot technologie in tentoonstellingen en onderzoek naar sociale interactie tussen bezoekers die technologie gebruiken tijdens hun bezoek.

Dit proefschrift draagt bij aan het groeiende onderzoeksveld gericht op de integratie van interactieve technologieën in de museale context, door zich te richten op een tot nog toe ondervertegenwoordigd aspect van gebruiksvriendelijkheid in relatie tot het gebruik van interactieve technologieën door museumbezoekers: instructie. Ik bestudeer hoe musea instructies voor het gebruik van interactieve technologieën op zaal naar hun bezoekers communiceren en hoe bezoekers met instructies omgaan in de context van het museum. Hierbij maak ik gebruik van het *Contextual Model of Learning* van Falk en Dierking en het *Visitor Identity-Related Motivation Model* van Falk. Ik ontwikkel een raamwerk voor het definiëren en bespreken van de verschillende instructievormen die met interactieve technologieën op zaal geassocieerd kunnen worden. Dit raamwerk gebruik ik vervolgens om de ontwikkeling van verschillende instructievormen en het daarbij behorende

beslissingsproces te omschrijven. Ik richt mij hierbij op de museumbezoeker en verken verschillende facetten van de gebruikservaring met betrekking tot de beschikbare instructievormen gerelateerd aan de interactieve technologieën op zaal. Deze facetten bestaan uit de impact van het gebruiken of niet gebruiken van instructies, een vergelijking van het door bezoekers omschreven gebruik van instructies met het geobserveerde gebruik en de effectiviteit van instructievormen bij het ondersteunen van interactie door de gebruiker.

Er zijn tegenwoordig vele vormen van interactieve technologie op de markt, maar mijn onderzoek richt zich specifiek op de implementatie van interactieve touchscreen installaties die zijn geïntegreerd in de fysieke context van een tentoonstellingsruimte. Ik evalueer twee casestudies, waarbij ik verschillende methodologieën combineer: *De Gibraltar touchtable*, een grote touchtable in het Scheepvaartmuseum in Amsterdam, en *De Schilderlens*, een touchscreen kiosk in de tentoonstelling Gallery One van het Cleveland Museum of Art. Bij beide casestudies zijn meerdere instructievormen gebruikt om de interactiviteit van de installaties aan mogelijke gebruikers te communiceren. Dit biedt inzicht in de effectiviteit van de verschillende instructievormen. Om inzicht te krijgen in de de ontwikkeling en implementatie van instructies voor beide installaties, heb ik leden van de projectteams die verantwoordelijk waren voor het ontwerp en de ontwikkeling van de casestudie installaties geïnterviewd. Om bij de evaluatie van de bezoekersbeleving tot zowel kwalitatieve als kwantitatieve resultaten te komen, heb ik twee methodologische benaderingen toegepast die gebruikelijk zijn bij publieksonderzoek in musea: het observeren van bezoekersinteractie met de installatie en het vrijwillig invullen van een vragenlijst door bezoekers na het gebruik van de installatie.

De gezamenlijke uitkomsten van de evaluaties van beide casestudies geven inzicht in de potentiële effectiviteit van de verschillende beschikbare instructievormen bij het begeleiden van bezoekers tijdens hun interactie met de installatie. Ik toon aan hoe beide installaties het userinterface design en het ontwerp van de fysieke context waarin de installatie is geïntegreerd gebruiken als belangrijkste instructievormen om de interactieve ervaring te begeleiden.

Evaluatieresultaten laten zien dat er een discrepantie bestaat tussen de aannames die het projectteam maakte over het gedrag van bezoekers en het daadwerkelijke bezoekersgedrag. Dit impliceert dat er grenzen zijn aan de aannames die vooraf gemaakt kunnen worden over het interactieve gedrag van gebruikers. Om te voorkomen dat men zich baseert op onbewezen aannames, stel ik dat musea tijd, geld en personeel moeten investeren in het identificeren en begrijpen van hun beoogde publiek en daarnaast heldere doelen moeten stellen met betrekking tot de beoogde gebruikerservaring om effectieve instructies voor interactieve installaties op zaal te garanderen. Daarnaast beargumenteer ik de noodzaak van iteratieve gebruikstests tijdens de ontwikkeling van interactieve technologieën op zaal om zeker te stellen dat de beoogde gebruikers of bezoekers in staat zijn de vastgestelde doelen voor de interactieve ervaring te behalen.

Acknowledgements

I would first like to extend my most sincere gratitude to Prof. Dr. Robin Boast and Dr. Manon Parry for their excellent academic guidance. I am especially appreciative of their unwavering support for my research and for the constructive feedback they readily offered throughout the development of this thesis.

The research presented in this thesis could not have been possible without the participation of the two case study host museums: Het Scheepvaartmuseum and the Cleveland Museum of Art. As an external researcher, I am incredibly grateful to have had the opportunity to conduct my research in each of these institutions and especially for all of the exceptionally kind staff members who supported my evaluation activities. I am particularly thankful for the participation and openness of the interview members, namely: Ernst van Keulen, Saskia Oranje, Remco Molenaar, Jane Alexander, Seema Rao, Jeffrey Strean, and Keeli Shaw. I would also like to acknowledge the efforts of Elizabeth Bolander and her team in the Research and Evaluation department at the Cleveland Museum of Art, for continuing to collect post-interaction questionnaires for me after my research trip concluded.

Finally, I would like to thank my dearest friends and family for their love, encouragement, and support throughout my scholarly pursuits. My parents, Patricia and Karl, have always helped me in every way possible to further my academic interests, for which I am infinitely grateful. I will also be forever thankful for my husband, Jeffrey, whose love and partnership has sustained and inspired me to see this goal reach its end, and for our son, Ethan, whose arrival has enriched our lives with love and new meaning.