

**Assessment of the Practicality and Effectiveness of Self-Guided Digital
Resources for Families at the Museum of London**

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Abstract

The goal of our project was to help the Museum of London capitalize on the growing use of technology in museums by assessing whether self-guided digital resources for families are a practical and effective means to complement visitors' experiences. We interviewed staff and examined digital resources at several museums in London and used their advice to guide our development of an iPad application for the Victorian Walk gallery at the museum. After receiving feedback from 63 families and ten museum staff, we recommended that the museum should 1) implement more digital resources for families in its galleries, 2) further explore digital activities to promote family learning, and 3) consider implementing resources for visitors' personal devices.

Executive Summary

Digital technologies have changed the way we live our lives by providing new opportunities for governments and businesses around the world. Due to this change, the Department for Digital, Culture, Media & Sport in England outlined a strategy that focuses on the impact digital technology has on cultural institutions. “[T]echnology offers unprecedented opportunities for the [United Kingdom] cultural sector . . . We witness technology’s role in engaging new audiences, nationally and internationally, through digital platforms and distribution channels” (Department for Digital, Culture, Media & Sport, 2017).

Museums are capitalizing on this potential by using technology to digitize collections, provide educational online content, and create self-guided digital resources for visitors to use in their galleries (“Digital Culture 2017: Museums,” 2017). In line with this trend, the Museum of London has been using digital technology for its exhibitions, school group activities, and galleries. From 2011 until 2014, the museum implemented a resource on iPads for families, but an evaluation of this resource found mixed results. While families thought that iPads were a good way to learn, they found difficulty with the resource’s story and several of the museum hosts voiced operational concerns about the iPads. Five years later, the museum decided to reevaluate the practicality and effectiveness of digital resources.

Our goal was to assess whether self-guided digital resources for families are a practical and effective means to complement the experience at the Museum of London. To begin this assessment, we met and interviewed stakeholders of three existing resources. From our visits, we discovered how mobile applications can be useful tools for visitors, how other museums implement their digital resources and challenges the museum faced when implementing their digital resources and they addressed them.

We developed our resource based on these findings from other museums, along with a digital resource framework for interaction in a museum and aspects of family learning. The human-computer-context interaction (HCCI) framework outlines that our resource should include content that facilitates interaction between the visitor, the device, the objects of the gallery, the context surrounding these objects, and the visitor’s peers or family members (Sung, Chang, Hou, and Chen, 2010). The aspects of family learning we aimed to promote through our resource’s activities were collaboration through conversation, recognizing context and culture, and joint attention (Tison Povis, 2017). Additionally, we developed our resource for only the Victorian Walk gallery. We chose this gallery because it had a single entrance and exit to allow for easy iPad distribution and collection, and the gallery had no existing exhibit descriptions to compete for visitor’s attention.

We built the application using the Swift programming language inside of the Xcode development environment provided by Apple. During development, two members of the team programmed the application while the other two researched relevant historical information and created activities that were designed to encourage the aspects of family learning and promoted the interactions outlined in the HCCI framework. The existing paper guides at the Museum of London, activities in other museums’ digital resources, the HCCI framework, and the aspects of family learning all inspired these activities. The activities on the application were implemented using only text and included discussion questions, quizzes, and searches for objects in different displays.

We used an iterative process during the development of our application. After initial development, we tested our application with family visitors and made changes based on feedback

before testing further. By the end of our iterative design process, 63 families in total had used our application. Of these 63 families, we surveyed 45 and observed 20.

Data from our observations and surveys also showed that families have a favorable attitude towards digital resources. In general, families expected more digital resources from museums and enjoyed using our application in the gallery. Consistent with our findings, the analysis of the museum's previous digital resource stated that families felt iPads provided an appropriate way to promote family learning. Based on the feedback and favorable attitudes towards digital resources among family visitors, we recommended that the museum incorporate more digital resources for families in its galleries.

Additionally, our data showed that our resource promoted family learning among the surveyed families. Families reported that the activities on our resource were effective in encouraging discussion, the recognition of context and culture, and joint attention. Based on this data, we recommend the museum further explore digital activities to promote family learning.

In addition to testing, we also conducted interviews with the hosts at the Museum of London. Our goal for these interviews was to investigate how practical it would be to include an application like ours in the museum, as well as what factors go into resource maintenance. The museum's previous method of taking a £100 security deposit from visitors to rent out an iPad was impractical for the museum's visitors and staff. The museum's hosts, who do the most of the interaction with the museum's visitors, did not want to worry about the safety of the iPads and the security deposit, while also worrying about the safety of the visitors. To address these issues of practicality, we recommend the museum should consider implementing resources for visitors' personal devices.

Overall, our study showed that currently digital resources for families can be an effective but perhaps not practical means to complement the museum experience. While our resource demonstrated its effectiveness through its activities by showing that families enjoyed using the resource, and that it promoted family learning, we found practicality issues in the distribution model the museum used previously. From our efforts, we hope the Museum of London can add to the research we have done and continue finding new ways to use digital resources to engage audiences in the museum. These recommendations can help the museum address the push for digital seen throughout other cultural institutions in the United Kingdom, and help shape the future use of digital resources to promote family learning and enjoyment in the museum.

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Chapter 1: Introduction

From interactive ordering kiosks at restaurants to the smartphones in our pockets, digital technology has changed the way we live our lives and provided new opportunities for governments and businesses around the world. In response, the government of the United Kingdom (UK) has created a Digital Strategy to improve the country's economic position in a world of growing digital technological influence (Bradley, 2017). Part of this strategy focuses on the impact digital technology has on cultural institutions. The Department for Digital, Culture, Media & Sport (2017) released a plan for increasing the development and usage of digital technologies in cultural institutions across England. It states that "technology offers unprecedented opportunities for the [United Kingdom] cultural sector . . . We witness technology's role in engaging new audiences, nationally and internationally, through digital platforms and distribution channels" (Department for Digital, Culture, Media & Sport, 2017).

The government is not the only one who sees a potential for digital technology in cultural institutions. Almost 70 percent of UK cultural organizations report "a major positive impact from digital technology on their ability to deliver their mission" ("Digital Culture 2017," 2017). Museums are capitalizing on this potential by using technology to digitize collections, provide educational online content, and create experiences like self-guided digital resources for visitors to use in their gallery ("Digital Culture 2017: Museums," 2017). For example, The National Archives "have digitised and published online over 80 million of their historical documents which in 2015-16 received more than 17 million visits" ("Digital Culture 2017: Museums," 2017). The National Trust has also implemented a similar digital guide to help visitors access more information.

In line with this trend, the Museum of London has been using digital technology in its exhibitions, school group activities, and galleries. The museum has a wealth of educational digital resources available online for school groups that help the museum further align with the goal of the push for digital, such as Great Fire 1666: A Minecraft Experience ("Great Fire 1666," n.d.). However, "the [number] of digital resources is currently heavily skewed towards schools" (A. March, personal communication, 6 June 2019).

As families make up 32 percent of the Museum of London's annual visitors, the museum attempted to create a digital resource for families from 2011-2014 (Morris Hargreaves McIntyre, 2018). The resource was an interactive self-guided storybook experience on iPads for families visiting the museum. An internal evaluation by the museum found that the resource had a tendency to distract visitors from learning from the exhibits directly around them, despite iPads having significant potential for facilitating social interaction for museum learning (Rubino, 2011; Webb, 2013).

As governments encourage museums to use mobile technologies, and as those technologies have matured and further embedded themselves in people's lives, the Museum of London wishes to renew their examination of the practicality of a family-oriented self-guided digital resource. Our goal was to assist the Museum of London by assessing whether self-guided digital resources for families are a practical and effective means to complement the experience at the Museum of London. Our objectives were to:

- Examine self-guided digital resources in other museums across London
- Develop a prototype of a self-guided digital resource for the Victorian Walk
- Test the prototype in the Victorian Walk and assess its effectiveness and practicality

- Develop recommendations on the use of self-guided digital resources for the Museum of London.

Following our objectives, we developed a digital resource for families for use on the iPads at the Museum of London. We tested our resource by surveying families after they used it in the Victorian Walk gallery. We found that it was effective and enjoyed among the 65 families that tried it. Using visitor feedback from our resource and information from museum staff across London, we developed recommendations for the future use of digital resources at the Museum of London.

Chapter 2: Background

The purpose of this chapter is to provide background relevant to understanding our project and reasoning for our methods. We begin by explaining how family learning is important in the museum and the best practices for family learning. Next, we explain how digital resources can help museums further their goal of visitor learning. We then continue by explaining the shortcomings of the Museum of London's prior attempt at a family-oriented self-guided digital resource. Finally, we talk about the best practices for digital resources design and the recommendations from an analysis of the previous resource.

2.1 Family learning

In the 2017/2018 season, 32 percent of visitors to the Museum of London were families groups, which the museum divided into two categories, kids first families and learning families (Morris Hargreaves McIntyre, 2018). While kids first families mainly wanted an engaging, fun and entertaining museum experience, learning families also wanted the experience to be educational (Morris Hargreaves McIntyre, 2018). As our project aims to focus on families and their museum experience, our resource needs to address both types of family visitors to be effective. Family visitors are defined as “any multigenerational social group of more than two people, containing at least one child” (Wu, n.d.). The adult in the family serves as the caregiver, and does not necessarily have to be a parent, but can be another relative or a mentor (Tison Povich, 2017).

To address resource effectiveness for learning families, we researched important aspects of family learning to integrate into our resource. Our research shows that families need self-facilitation to interact and engage in a museum together (Dierking, n.d; Falk & Dierking, 2000). Usually, the adult(s) in the family group help facilitate the education and conversations during a visit (Tison Povich, 2017). Through conversations, families can revise and construct explanations about a gallery or display and develop a deeper understanding to enhance their learning (Riedinger, 2013). When museums can promote collaboration through conversation, family members can learn valuable skills (Ellenbogen, Luke, & Dierking, 2004; Tison Povich, 2017).

2.1.1 Best practices of family learning

Just as there are many definitions and theories behind learning in general, many experts have tried their hand at defining family learning. Tison Povich (2017) studied three mechanisms of effective family learning: framing, joint attention, and conversation. Framing is a method that museums use to encourage visitors to think about a gallery within a certain context. Joint attention is a mechanism where at least two people pay attention to the same thing at the same time. Conversation can influence a family's learning during and after an experience. Parents can use conversation to help focus attention, determine a child's understanding, and make connections. Conversation also promotes collaboration within a family (Tison Povich, 2017).

Doherty and Ferguson (2016) suggested five key principles to excellent family learning: “engaging families in learning together; empowering families to take control; recognising context and culture; starting from a positive not a deficit model; and that [*sic*] family learning is planned, funded and delivered at a strategic level, whether local or national” (p. 19). The idea behind engaging families in learning together is that family members learn best when they learn

with the rest of their family. Empowering families to take control involves enabling families to learn how they choose. Recognizing context and culture involves helping families understand why they are learning the information they are learning. Starting from a positive, not a deficit model and planning, funding, and delivering family learning at a strategic level are both mechanisms that governments use to promote family learning (National Institute of Adult Continuing Education, 2013).

2.2 How digital resources can assist museums

Digital resources, as materials and information presented through computers and other electronic devices, have shown potential as a facilitator of social interaction. The definition of a digital resource is broad and refers to online articles, kiosks, applications downloaded onto mobile devices, or other forms of electronically accessed information. For the scope of this project, the term digital resource refers specifically to content or application downloaded onto a mobile device for use inside a museum. Digital resources differ from the Museum of London's current paper resources, which consist of small cards with activity suggestions that visitors can take through the museum.

Digital resources can offer a new way to present information to visitors as museums seek to “communicate and exhibit” their collection. According to the International Council of Museums, a museum “acquires, conserves, researches, communicates and exhibits the tangible and intangible heritage of humanity and its environment for the purposes of education, study and enjoyment” (International Council of Museums, n.d.). Unlike static paper resources, digital resources can react to user input and display information in creative and dynamic ways. Creatively presenting information in a digital form can facilitate greater motivation and cultivate a curiosity among visitors (Carrier, Damerow, & Bailey, 2017). If visitors are motivated and naturally want to learn more, then they are more likely to take in and retain more information (Pluck & Johnson, 2011). The increased likelihood of learning also serves museums' purpose of “education, study and enjoyment.”

In addition, museums encourage their visitors to interact socially as a means to facilitate learning (Falk & Dierking, 1992). In a social group setting like a family, the technology of an iPad has the potential to be an effective digital resource that promotes discussion, interaction, and collaborative exploration of museum galleries (Sala, Vannini, & Rubegni, 2011). Visitors that use these resources tend to be more engaged (Ash, 2003; Sala et al., 2011).

2.2.1 Challenges for designing and implementing digital resources in museums

While resources that promote social interaction in museum are useful and offer the ability to further the purpose of museums, challenges can arise when trying to implement digital components into existing exhibits. Challenges such as providing too much text, a story that is difficult to follow, and a poor operational service were highlighted in the Museum of London's previous iPad resource from 2011 “The Search for the Four Givens.” The goal of this resource was to encourage families with children aged ten and over to engage with the museum's collection and explore sensitive issues and personal experiences (S. Hedblad, personal communication, 9 May 2019). The resource was an interactive storybook that depicted two children as they traversed the museum in search of four givens, or objects that held meaning. The storybook aspect of the application created the first challenge for this resource. According to a report on the application from Alyson Webb of Frankly, Green, and Webb, a digital consultancy

firm, users complained the experience was too “book-like” and presented challenges such as difficulties following the story, navigating the gallery space, and connecting with objects. In addition, visitors were “frequently unsure of where they should be and what they should be looking at” (Webb, 2013, p. 17). The uncertainty was in part due to competition for visitors’ attention between the device’s screen and the gallery’s objects (Sala et al., 2011, Webb, 2013, p. 17).

From an operational perspective, The Four Givens report explains that “a mobile service is only as good as operations that support it” (Webb, 2013, p. 28). These operations include museum hosts, who are the staff that interact the most with visitors. Museum hosts felt uncomfortable handing out iPads for the Four Givens activity due to concerns of theft and the hosts’ inability to explain and troubleshoot the resource for visitors (S. Hedblad, personal communication, 9 May 2019). Another method of distributing resources is to have visitors bring their own device. A challenge of having have visitors bring their own device, derives from the numerous types of personal devices visitors may have, as developing a digital resource that is compatible with several devices can be difficult and time-consuming (Heitkötter, Hanschke, & Majchrzak, 2013).

2.2.2 Best practices for digital resource design

Based on the potential for digital resources to present information in new ways, their ability to facilitate social interaction among visitors, and the challenges that they create, we compiled a collection of relevant best practices for digital resource design. We organized these practices through the human-computer-context interaction (HCCI) framework. Sung, Chang, Hou, and Chen (2010) developed this framework for the National Museum of History in Taiwan. The framework identifies four levels of interaction (see Figure 1).

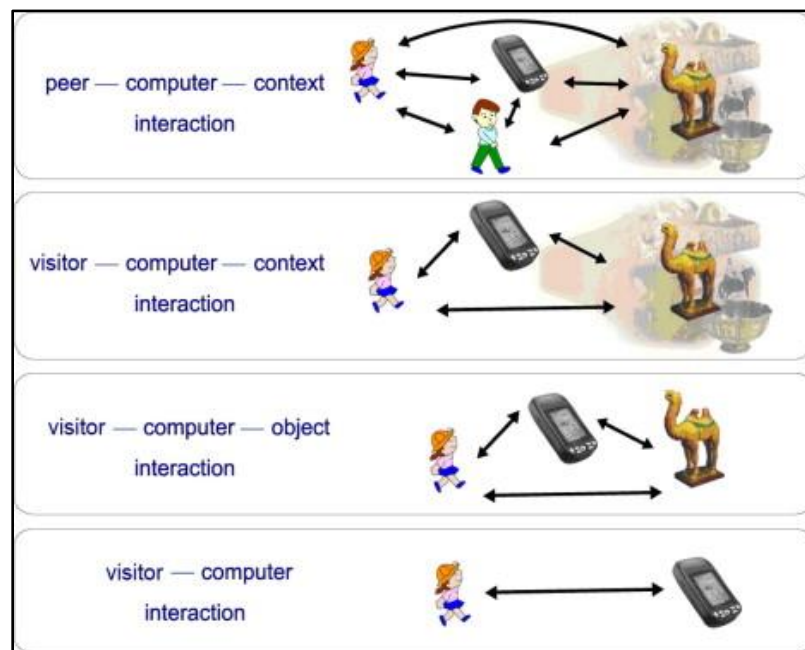


Figure 1: The four levels of interaction as per the HCCI framework (Sung et al., 2010)

At the first level, the visitor only interacts with the device. The second, third, and fourth levels introduce the user's interaction with the objects, the context surrounding the objects, and other visitors, respectively. The ultimate goal for digital resources is at level four of the HCCI framework as this level includes discussion between visitors, share the visitors' attention appropriately, and prevent a feeling of isolation.

To ensure interaction between visitors and the device, the host staff should be able to assist visitors with the resource. The Four Givens report highlights some difficulties with distributing and collecting the old digital resource due to the hosts' inability to help visitors with the resource. To address these difficulties, developers needed to ensure that the host staff received proper instruction on how to facilitate the use of the resource in the galleries, and the museum must make a sustained effort to keep them enthusiastic about the resource (S. Hedblad, personal communication, 9 May 2019). In terms of the device itself, "visitors and staff alike agreed that iPads offer a positive opportunity to enhance family enjoyment and learning at the Museum of London" (Webb, 2013, p. 4). Families also reported that the iPads themselves were "very or somewhat easy to use" (Webb, 2013, p. 6).

In addition, research shows that interaction between human beings and computers should incorporate user interface practices. When designing digital resources, it is important to keep users at the center of all design choices (Rosenfeld, Morville, & Arango, 2015). Users are a key part in testing and decision making, as listening to the users will provide a better user experience (Harrison, 2013).

The User Interface (UI) of a device is the collection of displays and controls that the visitor interacts with when using a digital resource. The UI of a resource is important as it is the first thing that users interact with and see. A good UI is necessary in the reduction of stress and cognitive load (Harrison, 2013; Hsi, 2002). When designing a good general UI, it is important to design to the path that people's eyes tend to follow when viewing a screen with no visual hierarchy (Rosenfeld et al., 2015). Therefore, placing all important information on the left side of the screen increases the likelihood of the user reading it. Additionally, research suggests that text presented to the user should be designed with the user's interpretation in mind (Rosenfeld et al., 2015). Words may be clear to the writer, but the user might interpret them differently.

To ensure interaction between visitors, the objects on display, and the context surrounding those objects, a digital resource's activities should fit "the physical [and] situational context in which they will be experienced" (Webb, 2013, p. 12). They should tie into familiar experiences to help the visitor make connections between their life and the museum's content (Casey, 2015). According to Josh Blair, the Digital Learning Manager at the Science Museum, a digital resource should also aim to foster visitor-made connections between objects in multiple different displays in a gallery to help visitors interact with the historical contexts of the objects (personal communication, 22 May 2019).

Other research continues to stress the importance of context interaction in an effective digital resource. Specifically, the technologies must "build on and optimize [visitors'] prior experiences, visit motivations, and interests" (Falk & Dierking, 2008, p. 26). Methods of achieving context interaction in resources include allowing for visitor-made choices in the resource and allowing visitors to customize their learning experience based on their prior knowledge and experiences (Falk & Dierking, 2008).

To ensure social interaction between visitors, according to Sandra Hedblad, the Senior Learning manager for families at the Museum of London, the content on this resource should be "fun for children but interesting to adults, involving a personal connection, evoking discussion,

and promoting imagination” (personal communication, 9 May 2019). Developers can create such content by having relatable characters, overarching topics, or direct questions to prompt parents. The Four Givens report also indicates a positive effect from the story in the resource. It states that visitors experienced “really powerful moments where the experience delivered on its objectives for shared family learning” due to the story (Webb, 2013, p. 4).

Overall, digital resources provide a new opportunity to present information and promote social interaction among museum visitors. The new digital platform is capable of exciting and engaging audiences in ways paper resources cannot. In summary, the existing literature shows that to complement the museum experience for both learning families and kids first families, a family-oriented digital resource should:

- Be easy and efficient for host staff to hand out
- Promote family learning by encouraging discussion and interaction between family members
- Appropriately share visitor attention between the content on the screen, the objects on display, the context surrounding the objects, and their peers.
- Utilize effective user interface strategies to promote usability
- Tell stories and attempt to encourage the user to make connections

Chapter 3: Methods

The Museum of London wanted to investigate the potential for self-guided digital resources for family visitors. The museum's previous digital resource for families is no longer in use and the museum wanted our team to develop developing and implementing a digital resource and create a set of recommendations and considerations on the use of digital resources. The purpose of this chapter is to explain what our objectives were, how they assisted us in accomplishing our goal, how we achieved them. The goal of our project was to assess whether self-guided digital resources for families are a practical and effective means to complement the experience at the Museum of London. Our objectives are to:

- Examine self-guided digital resources in other museums across London
- Develop a prototype of a self-guided digital resource for the Victorian Walk
- Test the prototype in the Victorian Walk and assess its effectiveness and practicality
- Develop recommendations on the use of self-guided digital resources for the Museum of London

3.1 Examine self-guided digital resources in other museums across London

The purpose of this objective was to examine the usage of the self-guided digital resources at museums in London and the museum's intentions behind their design. Usage includes what digital resources are available, the platform and scale of their implementation, and how the museum presents them. Intentions encompass why the museum developed the digital resource, what gaps did it fill or what did it offer for the visitors.

To determine usage, we considered definable factors, such as which museum the resource was associated with, the activities and content on the resource, what device the museum implemented the resource on, whether it applied to one gallery or the whole museum, and how visitors obtained access to the resource. To organize these factors, we created a digital resource assessment guide on an electronic spreadsheet.

As a team, we spent the first few weeks exploring museums with self-guided digital resources. We found these museums with the help of advertisements on museum websites and recommendations from our project sponsor, Simone Few, the family learning program manager at the Museum of London. We used the information from our visits to determine how museums were already using digital resources. Our observations also provided a starting point for brainstorming our own resource's content.

To examine the museums' intentions behind the design of their resources, we researched the motivation and process behind their creation. We sought out interviews at locations that had digital resources. After visiting and testing out the resources for ourselves, we had conversations with museum employees who had been on development teams or had other insights concerning the resources. We discussed the concept of the apps, who the target audiences were, and the learning motivations, testing procedures, user responses, and best practices. Through our interviews, we collected qualitative data that we used while creating our application and our recommendations.

3.2 Develop a prototype of a self-guided digital resource for the Victorian Walk

Prior to developing the prototype, we chose the Victorian Walk. We found that the Victorian Walk gallery was best suited for the resource for three main reasons. First, there are no descriptions inside the gallery because all of the exhibits are recreated Victorian shop fronts. The lack of display descriptions gave us an opportunity to provide a unique learning experience without visitors being overwhelmed with text. Secondly, the location of the gallery was convenient, since it only had one opening to the rest of the museum which allowed us to distribute and collect the iPads easily. Lastly, the gallery also had a family desk nearby where we stationed ourselves for our testing.

Our decision to choose the Victorian Walk gallery impacted the design of our prototype in two ways. To avoid conflict with the existing immersive nature of the recreated Victorian shop fronts, the Victorian time period influenced the style of the application through its textures, images, and fonts. Additionally the Victorian theme determined the historical information for the resources's activities.

When first designing the application's user interface, we used a quick ideation method known as Five Design Sheets to draft initial designs (Roberts, 2011; Roberts, Headleand & Ritsos, 2016). Our team individually sketched out designs for each screen of the application using our experience with digital resources at other museums and our user interface background research. From this brainstorm, we combined features from designs that would be easy for us to implement in a limited development period, while also allow users to navigate easily and intuitively between screens. We discuss the user interface design of our resource further in Chapter 4.

We developed our resource in the form of an iPad application using the Swift programming language for potential publication in the Apple App Store (see Appendix A). We used iPads because the museum has an abundance of iPads for us to use for this project, and iPads in general are useful tools for learning (Sala et al., 2011). Additionally, Swift is the standard development language that Apple provides for the creation of applications (Manning, Buttfield-Addison, & Nugent, 2018).

The two main aspects of development were the content and implementation of the application, and the historical information that the application presents to family visitors. Due to the two distinct parts of activity and content development, the team divided up to develop both parts of the application simultaneously. Two team members researched the Victorian era at the Museum of London's library while the other two programmed the application.

We designed this application's content by taking inspiration from other resources examined during our first objective, and our background research into family learning aspects and best practices for digital resources. The activities on our resource were text-based as they were easy to develop and incorporated family, context, and object interaction in the gallery. We discuss the creation and implementation of the activities in Chapter 4.

Our application helped us test first-hand if digital resources complement the family museum experience at the Museum of London. Over the course of our testing, we obtained feedback from families, our advisors, the hosts, and members of the learning department, and addressed the feedback in sequential iterations as we developed.

3.3 Test the prototype in the Victorian Walk and assess its effectiveness and practicality

To assess the effectiveness and practicality of our newly developed prototype, we created a criteria of what makes a resource effective and practical for the Museum of London. An effective family digital resource caters to the two types of families that visit the Museum of London. These families are kids first families, and learning families. Kids first families desire an enjoyable museum experience, while learning families want to learn during their museum experience. Therefore an effective digital resource for families is a digital resource that is both enjoyable for visitors to use and helps families learn. A practical digital resource for families is a resource that is easy to both use and distribute among museum visitors.

With this criteria in mind, we used the existing family learning desk near the Victorian Walk gallery as a base to conduct our testing (see Appendix B). We lent out the iPads to families for them to use the resource in the gallery. By opting in and signing a consent form (see Appendix C), participants gave permission for us to observe them. We also guaranteed their anonymity in any data we would collect.

In term of effectiveness, we narrowed down the list of family learning aspects that we had discovered in our background research to just three that we were able: recognizing context and culture, collaboration through conversation, and joint attention. We used one aspect from Tison Povis (2017) and adapted another. The Victorian Walk gallery was unsuitable for framing under the scope of our project, so we were unable to evaluate it. We tested for joint attention within families by asking if everyone in the family felt invested and engaged in the application. We adapted conversation into the broader aspect of collaboration through conversation so that we could include the family learning aspects that related to having everyone in the family work together. We tested for collaboration through conversation by asking if the application promoted conversation.

We also used one aspect from Doherty and Ferguson (2016), who discussed “engaging families in learning together; empowering families to take control; recognising context and culture; starting from a positive not a deficit model; and that [*sic*] family learning is planned, funded and delivered at a strategic level, whether local or national” (p. 19). Engaging families in learning together falls under joint attention and collaboration through conversation. By designing our resource to be self-guided, we empowered families to take control by allowing them to choose their own paths through the gallery. We were not able to design our application to inherently include recognizing context and culture, so we decided to test for that aspect by asking families if our application helped them understand the objects in the Victorian Walk and by asking if they had a desire to learn more about the Victorian era. Because the last two aspects are government-based, they are outside of our scope.

To analyze the effectiveness of our resource, we observed families and how they engaged with the application and with each other. In order to do so, we searched for aspects of family learning that aligned with the HCCI framework from our background. Therefore, we watched for family interaction between the device, the objects, the context surrounding the objects, and other family members. If we saw a family group repeatedly pointing or clearly looking at objects in the gallery, we considered that visitor-object interaction. Likewise, if a family frequently talked amongst themselves while using the iPad and participating in the activities, we considered that visitor-peer interaction. As stated earlier, we needed to survey families to determine if they interacted with the context surrounding the objects. Additionally, we observed points of

frustration and recorded verbal complaints of the application in order to address them in a later iteration. We also kept note of the family members included in the activities and who led most of the conversation. To record these observations, we used notepads and pens inside the gallery and tracked each of the families through the walk. We then adapted these observations onto a digital document for us to use in our analysis of our overall findings.

Once a family finished, they exited the gallery where we asked them to complete an exit survey (see Appendices D, E, F, G). The survey asked questions to determine if the application achieved the learning outcomes in families, such as their attitude towards the application, any skills or information they may have learned, and their overall enjoyment of the application. Each of the questions focused on family learning. The whole family completed the electronic survey and we stored their responses in a digital spreadsheet.

3.4 Develop recommendations on the use of self-guided digital resources for the Museum of London

We analyzed our observational and survey data from families using our digital resource in the Victorian Walk to determine the effectiveness and practicality of our resource. Additionally we interviewed staff at both the Museum of London and other museums in London to acquire greater insight into digital resource practicality. We specifically interviewed the Museum of London hosts because they are important stakeholders in a digital resource as they would be the main staff handling the resource distribution process in the future. We showed them our resource to determine if someone can easily handle, set up, distribute, and describe our application.

Based on an assessment of our own resource, interviews with museum staff and our background research, we developed recommendations that addressed overall future use of digital resources, digital resource practicality, and digital resource effectiveness.

Chapter 4: Building the prototype

The purpose of this chapter is to provide an explanation of the design decisions we made as part of our iterative development process. The chapter begins by describing the user interface design decisions. From there, we discuss the fundamental user interface aspects of our design, and then look into the motivations behind our content creation. Throughout the chapter, we use points from our visits to other museums to justify certain elements of design.

When designing the application, we used Five Design Sheets to draft initial designs. Our team individually sketched out designs for each screen of the application using our experiences from the self-guided digital resources we examined in other museums. From this brainstorm, we collaborated on combining features from designs that would be easy for us to implement in a limited development period, allow users to easily navigate between screens, and fulfill the requirements of a level four HCCI resource. As a result, we decided to incorporate several text-based activities as they were easy to develop and could easily incorporate family, context, and object interaction in the gallery.

4.1 User interface design



Figure 2: Introduction screen

The title screen was the first screen families see and was meant to attract the family and set the theme of the application. The title screen of our app, as shown in Figure 2, depicted a map of Victorian London and a decoration inspired by the late Victorian era that includes the name of the prototype, Victorian Adventure (Morris, 1988). The Victorian influences are consistent throughout the application. The institution logos on the title screen provided the user with the context of who made the application. In addition, the title screen contains a large green-yellow button labeled “BEGIN” indicating to the user how to transition to the next screen. While the theming and coloration of buttons is consistent throughout the application for continuity, the text of the button is altered based on its purpose.



Figure 3: Tutorial screen

From our experiences visiting other museums, we learned that it is important to provide the user with an on-loading process. This process is meant to introduce the user to what they will be doing in the resource rather than starting the resource on the main content (J. Blair, personal communication, 22 May 2019). We added our tutorial screen to implement an on-loading process. It introduces the visitors to the resource, and provides the families with a story and instructions for the application. As the story in the “Four Givens” was confusing and distracted visitors from the gallery, we confined our story to be only a paragraph to prevent distraction, as shown in Figure 3. From our testing, we found families were confused that not every display had an activity. We also noticed that many families went through the gallery in order of the numbers displayed on the map screen, rather than entertaining the self-guided nature of the experience as intended. To aid this, we added the second paragraph which addressed these points of confusion. In addition, similar to the introduction screen, there is a large button that transitions the user to the next screen when pressed. This button is labeled “EXPLORE” to relate to the story and title of the application and takes you to the map screen.



Figure 4: Map screen

The map screen's default state included an area for text on the left side and provided a map of the gallery on the right. We took inspiration from the Victorian Walk's paper guide, as it included descriptions of the displays and a map of the gallery. All of the displays in the gallery had numbered plaques corresponding to the paper guide's descriptions. By incorporating a numbered map, we provided the resource with locational awareness, or the ability to show the user only relevant content for what they are looking at.

We placed the text on the left to allow for easy reading, as people read English from left to right. The map itself is the gallery map from the paper guide for the Victorian Walk with a cloth texture applied over it to elicit the emotion and feeling of the Victorian era (Desmet, 2003). When the user touched a number on the resource, a blue icon appeared over the number to indicate what display was currently selected, as shown in Figure 4. Additionally, the sidebar then provided the corresponding display name and description. If the selected display had an activity, a button labeled "GO" appeared on the bottom left. The button transitioned the user to the display's corresponding activity screen.

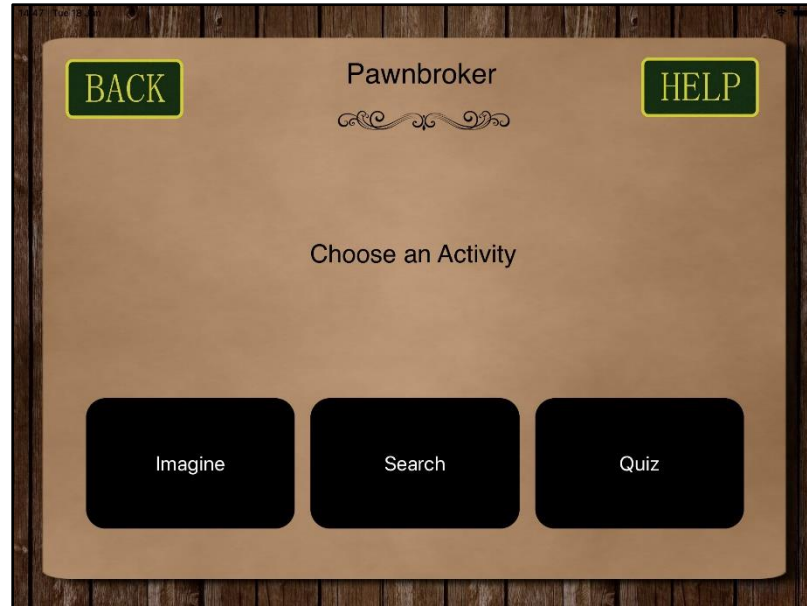


Figure 5: Activity screen

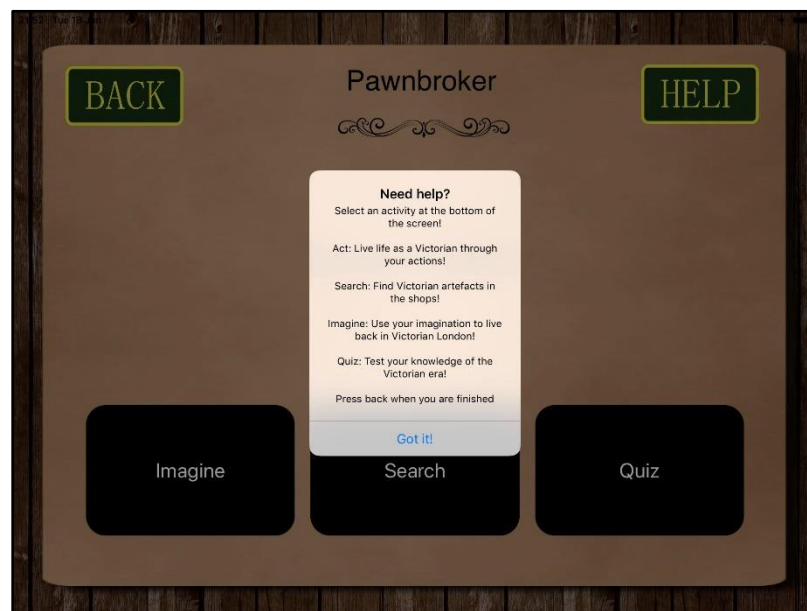


Figure 6: Help screen

The activity screen as shown in Figure 5, presented the family activities as choices in the form of black buttons with the corresponding activity name. The screen also presented “BACK” and “HELP” buttons, and displayed the title of the display at the top. The back button, as the name suggests, transitions the user to the previous screen when pressed. We added the help button to address feedback that some users were confused by the activities. When a user pressed the help button, a small pop-up appeared and described the activities, as shown in Figure 6.

After pressing an activity button, the instructions that said “Choose an Activity” were replaced with the corresponding text based activity. Due to iterative feedback from visitors and hosts, we added more text activities and made the Quiz activity multiple choice to encourage

more thought than just pressing a button to reveal the answer. When a user chose an incorrect answer, the button they selected turned red, and the text changed to “Try Again.” When they selected the correct answer, the application provided more information about the answer. Additionally, we increased the font size of the content across all screens to make the text more readable and shortened the display descriptions and activity text for to make the application more accessible for children who were still learning to read.

4.2 Content design

The content of our application included two main features, the display descriptions and the activities. The display descriptions provided families with context and information about the displays they were viewing. We adapted our descriptions from the museum’s existing paper resource located outside the Victorian Walk. We shortened the previous descriptions so that families would have less text to read, and reworded the descriptions to be better suited for children ages 7 and up (see Appendix H).

The variety of text-based activities allowed for user choice based on their learning preferences. Emilia McKenzie, the digital learning manager at the Science Museum and a former member of the Adventure Cards team at the British Museum, developed similar activities for the Adventure Cards digital resource because “you can’t expect a five-year-old to know facts [about the] Roman Empire, but they can be involved in more expressive ways” (personal communication, 13 June 2019). Offering a variety of activities gave families a choice in how they wanted to interact with the gallery.

We designed the activities in our application to provide opportunities for families to engage with the objects, the culture and context surrounding the objects, and their family members (see Appendix I). These activities we included were Act, Imagine, Quiz and Search.

Act prompted families to act out relevant scenes from the displays. For example, the Act activity in the barber shop prompted families to act out shaving another family member’s face. This activity offered the opportunity for families to make a connection between the Victorian era and modern times. Imagine prompted families to use their imagination to think about the Victorian era. Like Act, this activity also offered the opportunity for families to understand the deeper context of displays, whether they were making personal connections to the gallery or relating different displays in the gallery. For example, one of the Imagine activities asked the family to “Pick an object and make up a story about it” and answer questions like “Who did it belong to? Why did they sell it?” Quiz provided additional information to families and allowed them to test their knowledge through multiple choice questions. Search prompted families to spot certain objects in a given display. Examples of all of these activities are in Appendix I.

Chapter 5: Findings

In total, 63 families used our application. We observed 20 families and collected 45 survey responses during our testing. In addition, we interviewed six Museum of London hosts. These observations, survey responses, and interviews helped us develop the following findings regarding the effectiveness and practicality of a digital resource at the Museum of London. The number of families and hosts that participated in this study is only a small fraction of the number of families that come through the museum and hosts that work at the museum. As such, the results of the data may not accurately represent the attitudes that all families have towards digital resources.

5.1 Families possess favorable attitudes towards digital resources

From our survey responses, we found that families had favorable attitudes towards our resource (see Figure 7). We also found that families preferred a digital resource over a paper resource and expected digital resources in museums (see Figures 8 and 9).

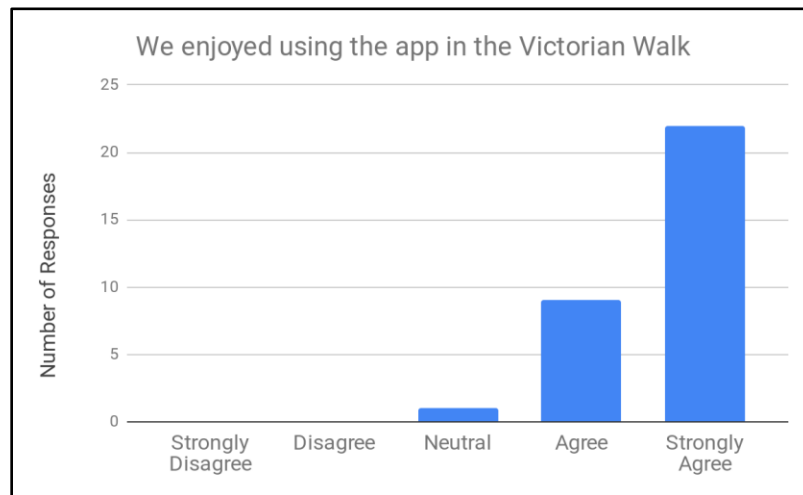


Figure 7: App enjoyment survey responses

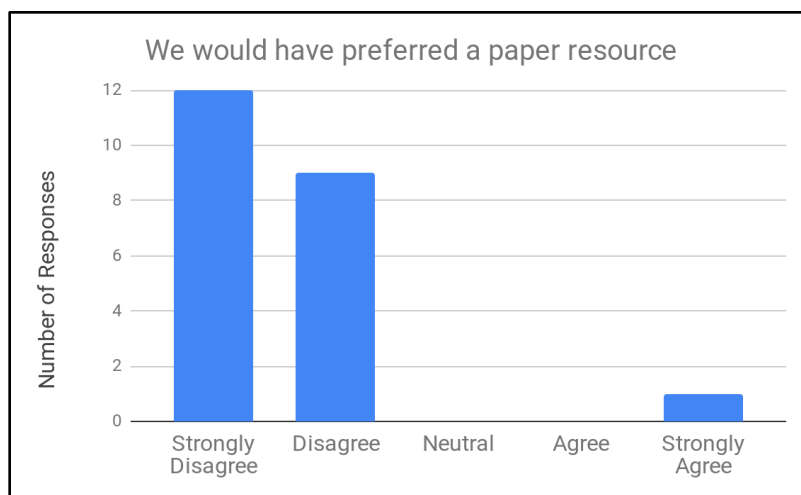


Figure 8: Resource preference survey responses

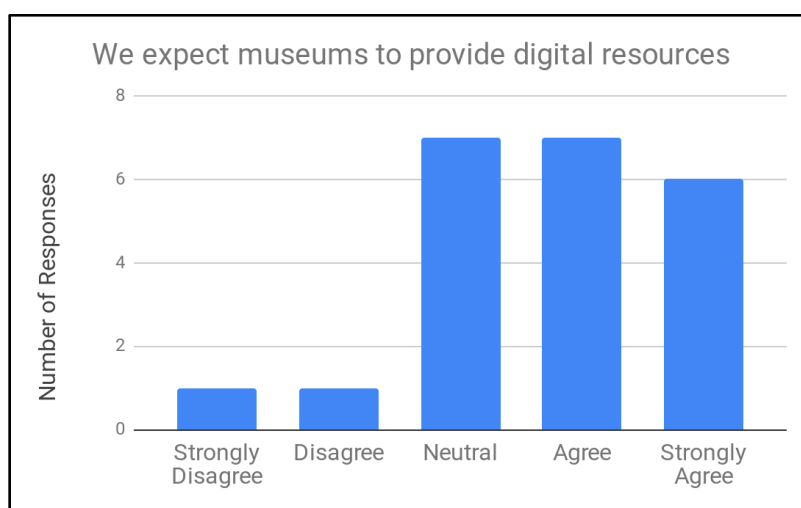


Figure 9: Resource expectation survey responses

We surveyed 32 families on whether families enjoyed the experience using the application (see Appendix D, question 2d). Of those surveyed, only one had a neutral opinion, and the rest agreed or strongly agreed (see Figure 7). It is clear from the data that the majority of families who responded enjoyed using our digital resource in the Victorian Walk. As referenced in our background, enjoyment and positive attitudes are an important measurement of family learning to cater to the museum's fun based families.

We also asked families whether they expected the museum to provide more digital resources, and whether they would have preferred a paper resource instead of our application (see Appendix D, questions 2e and 2g). From these questions, we gained an understanding about how families felt about digital resources in a museum, and how ours compares against traditional paper resources.

Twenty-two families responded to these questions. Figure 8 shows that overwhelmingly families preferred our digital resource over a paper resource. This finding is similar to what the Four Givens report had previously found, which had stated that "visitors and staff alike agreed that iPads offer a positive opportunity to enhance family enjoyment and learning at the Museum

of London” (Webb, 2013, p. 4). As seen in Figure 9, most visitors had either positive or neutral feelings about the idea that museums should provide digital resources, with a few respondents having negative responses.

We also asked families whether or not they would want to see more apps or resources like ours in other galleries (see Appendix D, question 1c). These responses reflect some interesting viewpoints from visitors:

- “[Y]es. Times are moving on digitally and we should keep up with the market.”
- “Yes, because children are obsessed with technology and it might help them get more engaged.”
- “[M]aybe but it would need to be set up for different ages.”

Overall, the survey responses showed that families enjoyed our application, had a positive experience, and had positive attitudes towards digital resources. We also found that families want more galleries to include digital resources, and they offered useful considerations to keep in mind for those resources.

5.2 Our application supports family learning

In our background we defined a set of three aspects that are important to family learning and directly address digital resource effectiveness for learning-first families. These aspects were collaboration through conversation, recognizing context and culture, and joint attention. Through our survey data and observations, we found that our resource was effective in achieving all three of these family learning aspects.

5.2.1 Joint attention

We found that families exhibited joint attention while using our application. We had designed the entire application with the intention that families would work together and share in the experience. From our observations, we found that naturally, some families exhibited more joint attention than others, specifically when parents helped direct the experience but that when parents directed the experience, family members tended to be more focused and involved. On the other hand, when parents just handed the iPad to their children and did not display interest, failed to engage their children, and those children ended up rushing through the children rushed the displays and didn’t failed to take time to complete the activities.

However, we also observed that the majority of families were engaged with the application. We also received feedback that supported this observation. When asked if the whole family was engaged, six out of the seven families responded “yes” (see Appendix G, question 2b). When asked if the application was engaging for the whole family, four out of five families responded positively (see Appendix F, question 3b). When asked if all family members were included and invested in the activities (see Appendix E, question 1f), all 10 families responded with either “Agree” or “Strongly Agree,” with more choosing “Strongly Agree.”

From these findings, we conclude that from the sample of families we had using our application, that families were utilizing good family learning practices. While we did have a small sample size, we cannot say that our resource was objectively effective among everyone. However the support from the surveys and the observations support that family visitors used joint attention when using our application.

5.2.2 Collaboration through conversation

We found that our application promoted conversation among family members. By observing and surveying families in the gallery, we found that the application helped prompt conversation. In our surveys, we asked visitors how much the application encouraged conversation amongst the group (see Appendix F, question 1d; Appendix E, question 1e; Appendix D, question 2c). We asked this question in our survey on 29 May 2019, and we obtained five family responses. Four of the families responded positively to the statement and one family was neutral. We asked a similar question on 30 May 2019, and we obtained 10 responses. We combined these responses to create Figure 10. Everyone responded positively, either agreeing or strongly agreeing with the statement. Across different iterations of the application, we found that respondents were consistent with their response to this question.

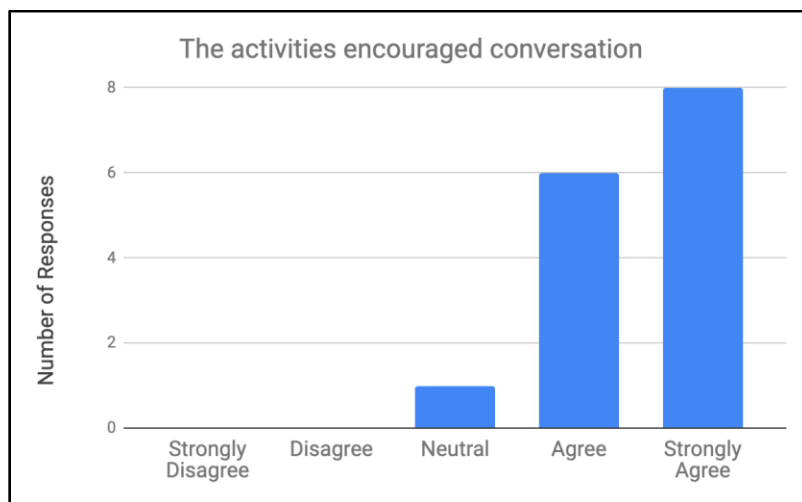


Figure 10: Conversation survey responses

The families also gave positive feedback about the activities. One family on 31 May 2019 claimed that their favorite activity was “discussing what went on in the shops,” referring to all the shops in the gallery. Another family said that the Imagine activity “caused lots of interesting conversation.” Comments like these gave us confidence that our application was promoting conversation among family members. While we were not able to measure the quality of conversations through our observations, we were able to see that conversation was occurring among families. Of the 20 families we observed, we saw 14 participating the Imagine activity, which encouraged conversation. Through the comments and numbers from the survey and in our observations, we can see that families were having active conversations using the application.

5.2.3 Recognizing context and culture

We found through the use of our application, people made cultural and contextual connections as they discovered and learned. Our survey data provided us with significant data points and comments that support this finding.

In our surveys we asked visitors to list their two favorite activities. Out of the 21 families who responded to this question on 31 May and 1 June 2019, 17 noted that Quiz was one of their favorite activities, while 11 said Imagine. Knowing that these were common favorites suggested

that the families were taking the time to learn and think about the context and culture of Victorian London.

We also wanted families to recognize objects and relate them to Victorian culture. We asked a question to see if the application helped them understand the objects around them (see Appendix E, question 1b; Appendix D, question 2a). Thirty-one of the 32 families surveyed reported that the app helped their understanding of the objects (see Figure 11). In addition, we frequently observed families looking between the iPad screen and the displays in front of them. Activities like the Search and Quiz activities helped groups interact with the objects and make deeper connections to their everyday lives. From the results of our observations and survey responses, we found that families were recognizing the context and culture of the gallery.

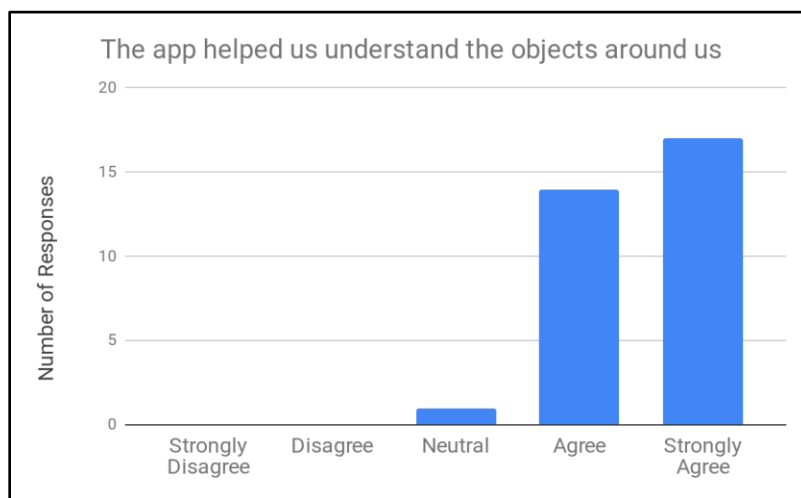


Figure 11: Understanding objects survey responses

We also collected interesting comments that highlight the connection families were making in the gallery. On 31 May 2019, we asked visitors to answer the question, “Do you have a desire to learn more about Victorian London? Why or why not?” (see Appendix D, question 1b) The following are a couple responses to the question:

- “Yes because it is interesting how it is so similar to modern day life.”
- “[Yes because] my children are learning about it in school”

Additionally, we asked the families if there was a point in the activities that excited them (see Appendix D, question 1a). One family said, “We were excited to hear that the first public toilets were at the Great Exhibition in 1851.” Each of the quotes highlights connections they’re making to their lives, whether it be through the children’s curriculum, or even from where they live. These quotes compiled with the results of the other survey questions support our claim that families are recognizing context and culture with the device.

5.3 The distribution method for iPads is not practical for museum staff

Our interviews with the museum hosts showed us that the previous system for distributing iPads out to visitors was not practical. In our interviews with museum hosts, we asked their opinions on renting out digital resources. From our six interviews, the hosts had no

problem collecting IDs as collateral for visitors taking iPads. However, we found from the Four Givens Report, as referenced in the background chapter, that some visitors do not carry an ID and hosts had to take other collateral such as passport, credit card, or £100, which made the process of checking out an iPad more convoluted. Additionally, the General Data Protection Regulation now prevents the museum hosts from taking any kind of identification, such as passports and IDs (Information Commissioner’s Office, 2018). Taking other collateral measures, like credit cards or cash, made the hosts’ uncomfortable and caused complications when handing out the Four Givens resource to families. The hosts who we interviewed unanimously said they would rather spend their time in a more productive manner such as answering visitors’ questions than spend it distributing iPads. Additionally, all but one of the hosts believed that an automated distribution system of digital resources, such as a downloadable application or self-serve kiosk, would improve the visitor experience and prevent wasting the hosts’ time. Overall, we found that collecting collateral as a process for using a digital resource would be impractical with the hosts’ current attitude and the laws regarding privacy in the European Union.

5.4 Visitors did not see the iPad as annoying to carry around during their time in the gallery.

This finding addressed the practicality of digital resources on handheld tablet devices. After families used our application during their time in the Victorian Walk, they mostly disagreed with the statement that “The iPad was annoying to carry around” (See Figure 12).

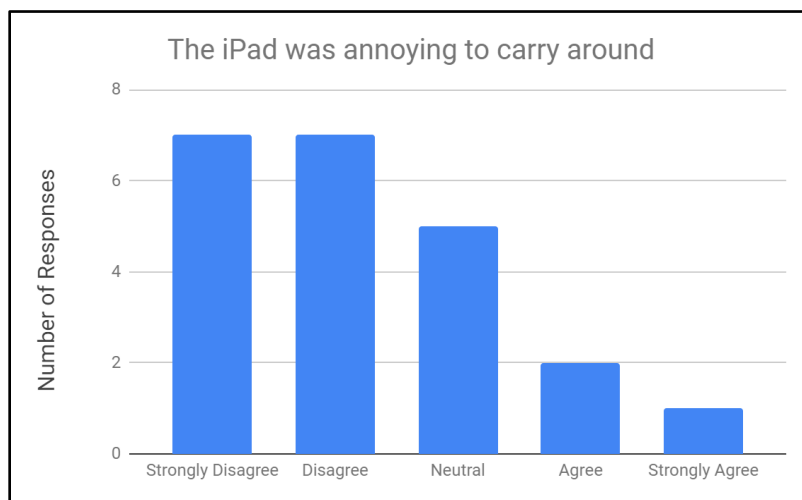


Figure 12: iPad carrying survey responses

It is important to note that families only spent 20 minutes carrying the iPad around the gallery. This is a significantly shorter period of time that they would likely spend holding an iPad should they have to carry it throughout the entire museum like with the Four Givens resource. We also observed one family that put the iPad on the floor at each display to read what was on the screen and several families frequently sat down to read and converse on the benches in the gallery.

Chapter 6: Recommendations

In this chapter, we provided recommendations to the Learning Department at the Museum of London for future development and implementation of resources. Our recommendations address the overall future use of digital resources at the museum, the activities of an effective resource, and a practical distribution model for a resource.

6.1 Implement more digital resources for families in its galleries

The Museum of London currently offers paper resources in its front lobby for families to take through the museum. As the paper resources and our digital resource are both aimed to achieve similar family learning aspects, they contain similar activities. However, we found that families in our test group had a positive attitude towards digital resources. A majority of the surveyed families said that they expect museums to provide digital resources (see Figure 2). The previous application: “The Search for the Four Givens,” also found similar responses from families. Webb found that families saw the device as an appropriate way of supporting family learning and enjoyment, and that the digital resource could help support their child’s learning.

Since we gathered survey results during the testing of our own digital resource, the only digital resource we can fully recommend is one similar to our own in content and design. This does not mean that only resources similar to ours are effective at achieving learning outcomes. As per our criteria, an effective digital resource for families is a digital resource that is both enjoyable for visitors to use and helps families learn. A practical digital resource for families is a resource that is easy to both use and distribute among museum visitors.

6.2 Further explore digital activities to promote family learning

Despite a small sample size, our application and its activities proved to be effective as per our criteria. The application facilitated important aspects of family learning and visitors enjoyed using the application. We believe that the museum should use our work as a starting point in finding new and engaging digital activities. The museum should spend time developing more game activities instead of just text-based activities application in the Victorian Walk after we leave. Creating competition through activities can also help increase engagement among families, therefore we recommend that the museum look into more competitive activities. One example of a non-text-based competitive activity is Shove ha’penny, a British pub game, which we started developing but did not finish in time to test with families.

Additionally, because we developed the app in less than two weeks, many of the graphics and UI elements are a lower quality than they could be. A professional graphic designer could improve many of these elements. We created a foundation for an effective family-oriented application that allows developers to add new activities through the procedures outlined in the provided documentation (see Appendix A).

6.3 Further investigate implementing resources for visitors' personal devices

Due to the prior difficulty in distributing the Four Givens resource and the current hosts' negative attitudes towards distributing iPads, we recommend that the Museum of London examine digital resources that visitors could use on their personal devices as a more practical approach to distribution. Many hosts believe that trying to hand out iPads to visitors in the galleries is an unproductive use of their time. While they can be distributed at the front desk, hosts felt unsafe keeping large amounts of money there. Additionally, the museum has no current distribution method for digital resources beyond collecting £100 in banknotes as a deposit. As it is unlikely that the average museum visitor carries around £100 in banknotes, we recommend the Museum of London explore the possibility of implementing a digital resource that visitors can install on their own devices.

While we found families had minimal issues with carrying around our digital resource in the Victorian Walk gallery during our testing, it could prove to be an issue if families had to carry the iPad for the entirety of the museum. If families were able to install a digital resource onto their own devices, they would likely already be used to carrying it around for long periods of time.

If the museum were to implement a digital resource that visitors could download and install onto their own devices, there would be no need for to collect collateral. Visitors would not need to rent a device from the museum as they would use their own instead. If hosts did not have to worry about handling security deposits, they would have more time to interact with visitors. If the museum chose to continue using our application, they could publish it application in the Apple App Store for public distribution. We recommend that the museum pursue this route if it ever wants to use a bring-your-own-device approach with our resource. Due to the cross-device compatibility of Apple applications, a developer could easily modify the resource to run on iPhones as well as iPads.

Chapter 7: Conclusions

Overall, our study showed that currently digital resources for families can be an effective but perhaps not practical means to complement the experience at the Museum of London. While we demonstrated our resource's effectiveness for both kids first and learning first families by showing that families enjoyed using it and family learning aspects were facilitated, we found practicality issues in the distribution model the museum used previously. Based on this assessment, our recommendations aim to address the overall use of digital resources for families at the Museum of London, their effectiveness for family visitors, and how to make them more practical for the museum's visitors and staff. From our efforts, we hope the Museum of London can add to the research we have done and continue finding new ways to use digital resources to engage audiences in the museum. These recommendations can help the museum address the push for digital seen throughout other cultural institutions in the United Kingdom, and help shape the future use of digital resources to promote family learning and enjoyment in the museum.

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Appendix A: Victorian Adventure source code

The source code for our prototype digital resource is hosted on GitHub. The application was made using the Xcode development environment and written in the Swift programming language. The code has documentation in the form of text comments.

Source Link: https://github.com/Mcdonoughd/London_E2019_MoL

Appendix B: Digital resource distribution guide

This guide bullets how a host may distribute a digital resource at the family desk in front of the Victorian Walk.

Setting up:

- Touch Points of Awareness / Power of Suggestion
 - Web Ad (pre-museum)
 - Flier Ad (at the door)
 - Intercom ad
 - Signage though the museum
 - The handout desk
- Get extension cord from A/V department
- Tape down extension cord outside gallery to prevent tripping
- Load trolley with charging station of iPads, sign-out slips (if needed), and pens and pencils (if needed)
- Roll trolley down to gallery
- Move items to family learning cart
- Stow trolley out of the way
- Plug in charging station to extension cord
- Move advertisement stand into walkway
- Open app on two iPads
- Set up one iPad so that it is visible to visitors
- Hold the other iPad, with the screen to visitors

iPads:

- The handout desk may have stickers or other goodies to attract smaller children
- iPads should have the application already running from the home screen
- Application should be on Guided Access to prevent users from leaving the application
- iPads should have a physical ID (we used tape and a sharpie on the back of the iPad case)
- iPads should be charged with 30% or higher before lending them out
- When needed, iPads should be cleaned with sanitizing wipes

Interacting with visitors:

- Greet visitors with a smile
- Ask if they would like to try a self-guided app for families
- If they say yes, show them the iPad
- Explain that they have to sign out the iPad and why (if needed)
 - Security reasons
 - We write the iPad number on the sign-out sheet
 - Remind visitors that we shred the iPad sign out form

- Hand the iPad to the child if any

Returning the iPad:

- Cross out info of people on sign-out sheet (if needed)
- Thank them for trying our app
- Offer a sticker or goodie to the child

Take down:

- Put the iPads, the charging station and sign out slips (if needed) onto the trolley to wheel back up.
- Shred the sign out slips upstairs so the information is lost (if needed)

Appendix C: Consent form

Informed Consent Agreement for Participation in a Research Study
Investigators: Mario Castro, Ethan Martin, Daniel McDonough, Kevin Stern

Based on: https://web.wpi.edu/Images/CMS/IRB/WPI_Informed_Consent_template.doc

Contact Information: gr-LonE19-MusLon@wpi.edu

Title of Research Study: **Digital Resource for Families**

Sponsor: **Museum of London**

Introduction: You are invited to participate in the alpha testing for a new digital resource for the Victorian Walk gallery at the Museum of London. Before you agree, however, you must be fully informed about the purpose of the study, the procedures to be followed, and any benefits, risks or discomfort that you may experience as a result of your participation. This form presents information about the study so that you may make a fully informed decision regarding your participation.

Purpose of the research studies: We are looking at how effective the resource is for families, and if it promotes relevant discussion and learning. This experiment is designed to increase our knowledge of learning theory and processes and to provide us with an understanding of the research methods used by social scientists.

Procedures to be followed: Once all participating family members agree to the contents of this form, participating family members will take the iPad through the gallery and use the iPad as they see fit. Visitors may not take the iPad to a different gallery. The iPad must be returned after use.

Risks to study participants: Participants may feel uncomfortable being observed or recorded in the Victorian Walk.

Benefits to research participants and others: The results of this study will provide recommendations to the Museum of London for the practicality of a digital resource. This study is also part of the requirement to graduate for the study investigators.

Alternative procedures or treatments available to potential research participants: Participants may opt out at any time by contacting the investigators.

Record keeping and confidentiality: All records will be on pen and paper or a Google form electronic survey. No names, faces, race, religion, or other sensitive information brought to the attention to the investigators will be taken into account. Only the investigators mentioned above will have access to the raw data obtained from this study. Participants will remain anonymous and all raw data will be shredded after 24 June 2019. Records of your participation in this study will be held confidential so far as permitted by law. However, the study investigators, the

sponsor or its designee and, under certain circumstances, the Worcester Polytechnic Institute Institutional Review Board (WPI IRB) will be able to inspect and have access to confidential data that identify you by name. Any publication or presentation of the data will not identify you.

Compensation or treatment in the event of injury: This study does not pose any immediate or non-immediate threat or risk of injury. You do not give up any of your legal rights by signing this statement. As such, normal rules apply for any injuries occurring in the Museum of London.

For more information about this research or about the rights of research participants, or in case of research-related injury, contact: The investigators contact information as mentioned above. In addition, the contact information for the IRB Chair (Professor Kent Rissmiller, Tel. +1 (508) 831-5019, Email: kjr@wpi.edu) and the University Compliance Officer (Michael J. Curley, Tel. +1 (508) 831-6919, Email: mjcurley@wpi.edu)

Your participation in this research is voluntary. Your refusal to participate will not result in any penalty to you or any loss of benefits to which you may otherwise be entitled. You may decide to stop participating in the research at any time without penalty or loss of other benefits. The project investigators retain the right to cancel or postpone the experimental procedures at any time they see fit.

By signing below, you acknowledge that you have been informed about and consent to be a participant in the study described above. Make sure that your questions are answered to your satisfaction before signing. You are entitled to retain a copy of this consent agreement.

Please only have the adults sign this form (over 18 years old)

Appendix D: Final exit survey (31 May and 1 June 2019)

Thank you for trying out our iPad app! We'd like to hear any feedback you might have, so if you and your family could fill out this survey we'd be more than grateful.

1. Short Answer:
 - a. Was there a point in the activities that excited you? (provided a “wow” moment)
If so, what was it? If not, why?
 - b. Do you have a desire to learn more about Victorian London? Why or why not?
 - c. Should more galleries have a similar app or resource? Why or why not?
 - d. Which activities made the whole group feel the most engaged and why?
2. Rate the following statements by how much you agree or disagree with them (strongly disagree, disagree, neutral, agree, strongly agree):
 - a. The app helped us understand the objects around us
 - b. The activities encouraged us to use our imagination
 - c. The activities encouraged us to talk to each other
 - d. We enjoyed using the app in the Victorian Walk
 - e. We expect museums to provide digital resources
 - f. The iPad is annoying to carry around
 - g. We would have preferred a paper resource
 - h. The app was visually appealing
3. Select your two favourite activities (Search, Quiz, Imagine, Act).
4. Verbal:
 - a. Do you have any feedback for us regarding the app or your overall experience?

Appendix E: Prototype exit survey (30 May 2019)

1. Rate the following statements by how much you agree or disagree with them:
 - a. The app was easy to navigate
 - b. The app helped our understanding of the objects in the gallery
 - c. The activities promoted the use of our imagination
 - d. We enjoyed our time using the app in the Victorian Walk
 - e. The activities promoted conversation among the group
 - f. All family members were included and invested in the activities.
 - g. The app changed our appreciation for Victorian London
2. Multiple Choice:
 - a. Select your two favourite activities
 - i. Quiz
 - ii. Act
 - iii. Imagine
 - iv. Search
3. Short Answer:
 - a. Were there any points of frustration during your experience using the app?
 - b. Which activities made the whole group feel the most engaged and why?
 - c. What is something you learned about the Victorian era?
 - d. Do you have any other comments?

Appendix F: Prototype exit survey (29 May 2019)

This is a form to determine the results and outcomes of the family learning app, Victorian Adventure.

1. Respond to the following statements, and rate how much you agree or disagree:
 - a. The app was easy to navigate
 - b. The map was useful for getting around the gallery
 - c. The app promoted the use of imagination
 - d. The app promoted conversation amongst the group
 - e. The app helped me evaluate the information that I learned
 - f. The app promoted making connections between Victorian London and today
 - g. The app gave me an appreciation for Victorian London
 - h. The app helped me learn about the objects around the gallery
 - i. I enjoyed my time with the app
 - j. The app inspired me to learn more about Victorian London
2. Multiple Choice:
 - a. Which activity was your favourite?
 - i. Quiz
 - ii. Act
 - iii. Imagine
 - iv. Search
3. Short Answer:
 - a. Were there any points of frustration with the app? If so, what were they?
 - b. Was the app engaging for the family? If so, how? If not, why?
 - c. What is something you learned about the Victorian era?
 - d. Do you have any other comments?

Appendix G: Prototype exit survey (28 May 2019)

This is a form to determine the results and outcomes of the family learning app, Victorian Adventure.

1. On a scale of 1-5:
 - a. How easy was it to navigate the app?
 - b. How much did you enjoy the app?
 - c. How essential was the app to the gallery experience?
 - d. How useful was the map for getting around the gallery?
 - e. How much did the app inspire imagination?
2. Yes, No, Other:
 - a. Were the display descriptions easy to understand?
 - b. Did the app engage the whole family?
 - c. Did the app help you learn more about the objects around you?
3. Short Answer:
 - a. What is something you learned about the Victorian Era?
 - b. Do you have any other comments?

Appendix H: Victorian Adventure display descriptions

This appendix shows a list of all display descriptions in the Victorian Adventure application. The number in parentheses indicates the number of the display in the gallery.

Toy Shop (1): Victorian children saved their money to buy "penny toys" from street sellers and dazzling toy arcades such as Lowther's on the Strand. Lowther's was an "Aladdin fairy palace" of expensive train sets, dolls, and lead soldiers.

Tobacconist (2): Tobacconists sold blends of loose tobacco. During Victorian times, habits were changing. Rolled cigarettes were available, and wooden smoking pipes replaced clay ones.

Barber Shop (3): Victorian men would go to the barber's for haircuts, shaves, shampooing, and "singeing," which meant burning hairs to seal them off and strengthen them. Barbers often stored customers' personal shaving mugs at the back of their shop.

Public House (4): Working men would relax in the pub, meet with friends, play darts, or attend political meetings. Children often sat outside, waiting for their parents, or were sent in to buy beer for drinking at home.

Glass Showroom (5): James Powell & Sons' showroom was attached to their glasshouse off Fleet Street in Whitefriars. Their table and decorative glass were famous for their high quality, subtle colours, and delicate decoration. The "Eve" mosaic on the wall, is a copy of one Powell's made for St. Paul's Cathedral.

Barrel Organ (6): Introduced by Italian immigrants, barrel organs could play up to 12 popular tunes. By 1900 there were nearly 500 in London's noisy streets, competing with bagpipe players, singers, clowns, performing monkeys, and knife swallowers.

Tea & Coffee Warehouse (7): Tea from China, India, and Ceylon (now called Sri Lanka) arriving in London was taken from the docks to the city's many warehouses. After being weighed, tea was blended and coffee was roasted and ground to send to grocers, tea rooms, and hotels.

Engraver (8): Engravers made visiting cards, business cards, invitations, and bookplates. They usually worked alone in small workshops that smelt strongly of the inks, acids, and polishes they used.

Watchmaker (9): London's watchmakers produced expensive watches for sale around the world. Their intricate work required strong light, so they often placed their workbenches near a window. Specialist skills included hinge-making, dial-painting, and watch case-making.

Public Urinal (10): Introduced for the millions of visitors to the Great Exhibition in 1851, public toilets were available in most towns and railway stations by the 1890s. You had to spend a penny to use one. This is where the euphemism for going to the loo, 'I'm off to spend a penny,' comes from!

Baker's Cart (11): The cries of bakers and dairymen were a familiar sound on London's streets. They pushed handcarts, sold bread and milk, and delivered their goods to private homes.

Grocer (12): Grocers sold the essentials of daily life. Tea, flour, sugar, and rice were drawn from larger containers, then weighed and wrapped for customers. Grocers often lived above their shops.

Pharmacy (13): The pharmacist was where you could go to get medicines. Poisonous liquids were kept in dark green or blue glass bottles with fluted sides to distinguish them from harmless fluids.

Milliner (14): Wealthy women in Victorian London always covered their heads outdoors. At the milliner's they bought hats, bonnets, and caps, as well as various decorations. Milliners would redesign hats, when fashions changed in Paris.

Tailor (15): Tailors catered to "upper class" office workers. Clients first selected a length of material. The tailor measured them, prepared a paper pattern, and cut the cloth. He gave the pieces to an "outworker" or assistant to stitch together on a sewing machine.

Fancy Stationer (16): Many stationers manufactured popular "fancy stationery" - handmade Christmas and greeting cards, as well as Valentine's cards. Their shops were like newsagents today. Daily papers were widely read in London, especially the Daily Telegraph and the Daily Mail.

Pawnbroker (17): Pawnbrokers, referred to as "uncle," were the poor person's bank. Clothing and jewellery were handed over in exchange for a loan. If the loan was not repaid within a year, "uncle" could sell the goods. By 1900 there were 700 pawnbrokers in London.

Bank Clerks' Office (18): London's financial services employed thousands of clerks who did bookkeeping, correspondence, and cashier work behind grilles or screens. In the 1890s the Bank of England for the first time hired women who had passed an exam to count and register banknotes.

Bank Manager's Office (19): Bank accounts were primarily for businesses and the rich. The poor were paid weekly in cash that barely lasted seven days. Small savings for Christmas or weddings

could be placed in a Post Office Savings or National Penny bank. They accepted deposits from a penny upwards.

Victorian Lamppost (unnumbered): Look outside the window and see the London Wall. The wall appears to have been built in the late 2nd or early 3rd century, and finished around the end of the 4th century. This makes it one of the last major building projects undertaken by the Romans before their departure from Britain in 410.

Appendix I: Victorian Adventure activities

This appendix shows a list of the activities in the Victorian Adventure application.

- Toy Shop
 - Search: Can you find the following objects? Skittles, Two lobsters, Balancing scale
- Barber Shop
 - Act: Play out a scene like you're inside the barbershop. Act like you're shaving a family member's face.
- Glass Showroom
 - Search: Can you spot 12 different coloured glasses?
 - Imagine: Can you spot any types of glasses you might find at home?
- Tea & Coffee Warehouse
 - Imagine: Look at different shops. Where else might tea be sold around town?
 - Quiz: How much tea did the average Londoner drink in Victorian times?
 - Londoners would drink ~300-500 cups/year in Victorian times. In comparison, modern Londoners will drink about 550 cups of tea a year [Spencer, 2002].
- Engraver
 - Quiz: Engravers commonly used wood and copper. Is one material better than the other for engraving? Discuss with your family what the differences might be between wood and copper.
 - Engravers used copper to make master prints for copying small cards. They used wood to create newspapers and almanacs. [Price 1968]
- Grocer
 - Imagine: How is the grocer similar to a shop you'd go to today? How is it different? Find and discuss the differences.
 - Quiz: When do you think the busiest day was for the Grocer?
 - Saturdays tended to be the busiest because that was when workers were paid their weekly wages. [Price 1968; Spencer, 2002]
- Pawnbroker
 - Imagine: Pick an object and make up a story about it. Who did it belong to? Why did they sell it?
 - Search: Can you spot the following items? Three pocket watches, Silver cutlery, Drinking glasses
 - Quiz: How much money do you think the pawnbroking industry made annually?
 - 8 million pounds; which today would be equivalent to well over 900 million pounds. With that much business, the pawnbrokers played an important role in the working class economy [Hall, 2011].
- Bank Manager's Office

- Imagine: Say you received a loan from the bank, and you could start any business of your choice. Of the shops you've already seen which one would you want to run and why?