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Investigating tangential access for location-based digital cultural heritage applications

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ABSTRACT

As location-based digital cultural heritage applications are beginning to be applied outside 'traditional' cultural heritage sites, there is an increased need to consider their use amongst people who may be interested in the cultural heritage of a site, but have that interest as a tangential, opportunistic, aspect of their visit. We outline why this is important, and present issues in evaluating it. We then introduce Explore: a mobile, location-based, digital cultural heritage application for the Finnish recreational island of Seurasaari. By considering how the common visitor trajectory of a museum visit can be mapped onto a visit to the island, we were able to evaluate Explore with participants who were not primarily there to access cultural heritage. Evaluation with 45 participants over 5 days identified how the low immersion techniques used allowed participants to fit accessing cultural heritage around their visit, how participants managed group tension between those more and those less interested in Explore, as well as issues around considering the use of cultural heritage applications as a tangential purpose of a visit.

1. Introduction

Human-Computer Interaction has a long history investigating the role of mobile digital technology to support *in situ* access to cultural heritage. Approaches most commonly manifest as mobile, location-based applications that help to contextualise or inform users about heritage in their nearby environment. Such applications allow contextual information to be easily integrated with objects, places and artefacts, supporting the notion that *"heritage is not the historic monument, archaeological site, or museum artefact, but rather the activities that occur at them"* (Smith, 2011). Work has evolved from traditional museum environments (Aoki et al., 2002) to outdoor museums (Ciolfi and McLoughlin, 2012), expanding into the everyday built environment, such as city centres (Reid et al., 2005b; Szymczak et al., 2012).

Existing work has largely designed solutions that assume the primary goal of users is to learn about the cultural heritage of the site they visit. Whilst visitors may have multiple reasons to visit (*e.g.* going to a museum on a rainy day Moussouri and Roussos, 2013), common characteristics of the sites imply a clear assumption that accessing information about the heritage of the site is congruent (cultural heritage access can be easily integrated as a secondary or tertiary goal) with the visitor's main goal. Entrance into sites is controlled and monitored (through entry and exit points), often requiring a fee to be paid. Sites are also explicitly defined and delineated (*e.g.* by a fence or wall) as places to learn of cultural heritage.

However, as work moves towards technologically augmenting sites that do not have such defined characteristics, the diversity of reasons why someone may visit increases. Although individuals may be open to learning about the cultural heritage of a site, that may be tangential, and potentially incongruent to the primary reason an individual is at a site. For example, Betsworth et al. (2014) identified dog-walkers, joggers and other passers-by as potential users to engage in the cultural heritage of a disused copper works. This diversity may also put visitors into conflict with each other Hornecker et al. (2014). Existing cultural heritage solutions are still often designed and evaluated from the perspective that they are the user's primary focus, assuming users will follow a defined tour around a city, or where content is designed to be accessed at the physical location it refers to (Audio Trails Limited, 2016; Manchester Metropolitan University, 2012). Whilst it is well known in museum studies (Falk, 2016) that visitors' primary motivation may not be to directly learn about heritage, such activities do take place within the context of a museum. Learning and accessing the heritage of

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the museum is a congruent, although less important, activity. There is a lack of understanding in how location-based digital cultural heritage applications can fit in and around the primary goals an individual may have. Existing work shows that the diverse users at such sites are not always engaged by current approaches Park and Peng (2016).

These issues also extend to evaluation. In evaluating systems deployed in museums, participants are often recruited after they have made the decision to make cultural heritage access a primary part of their activity (*e.g.* after paying to enter the museum or cultural heritage park). In augmentation of sites that are less defined, participants are usually pre-arranged by the experimenter. I.e. they are recruited some time before and attend at an agreed time and place to use the cultural heritage system (Reid et al., 2005b; Szymczak et al., 2012). As such, because the participant has scheduled explicit time to take part, the primary purpose of the visit becomes about accessing cultural heritage, rather than having a walk or some other activity.

In this paper we consider how individuals choose to engage with mobile, location-based, cultural heritage applications where they are interested in accessing heritage, but where its access is tangential and potentially incongruent to their primary goal. Firstly, through designing a location-based digital cultural heritage application, based on existing work, that can be used as a tangential activity. Secondly, through considering how to evaluate such applications with users for whom accessing that heritage is a tangential activity, and carrying out such an evaluation to identifying how participants used our 'app' as a tangential activity during a visit to a Finnish recreational island. We first outline our argument for tangential use in more detail, before discussing the design of our prototype application, Explore.

2. Related work

Whilst the investigation of digital technologies for cultural heritage started, and continues to be developed (Damala et al., 2016), in indoor museums, researchers have been expanding the role and use of digital technologies to much broader sites for many years. Initially this has been to outdoor museums. Ciolfi and McLoughlin (2012) carried out significant work applying digital technologies to a living museum in Ireland. They developed a mobile system where users could scan QR codes to collect audio 'snippets' of historical characters, semantically connected with the location of the QR code. Participants could also collect tangible tokens (*e.g.* a small amount of turf containing an RFID tag). At the end of their visit, participants were able to use their collected tokens with a specially augmented desk to playback recordings other visitors had made. Ciolfi and McLoughlin (2012) noted how such open-air museums were different to traditional museums, particularly that it was important to avoid digital technology dominating the experience of being in the rich historical environment open-air museums seek to generate.

Such experiences using mobile or handheld technologies are often scaffolded onto key elements of the trajectory (Benford and Giannachi, 2009) visitors experience in museum visits, making them an integral part of that experience. Fig. 2 for example, illustrates a high-level trajectory of a typical museum visit, and how digital technologies are scaffolded onto common elements. Visitors must enter via a controlled entry point (often by paying an entrance fee) (B). Before this point (A) visitors have not necessarily made a commitment to visit. They may change their mind, walk away, decide they are uninterested in the content of the museum, or decide the entrance fee is too high. The need to explicitly cross this threshold means that whilst visitors do not always go to a museum with an explicit or specific goal to learn about cultural heritage (Falk, 2016; Walker, 2008), the structured elements of explicit entry (and potential payment to do so) mean that the visitor at least has experiencing the cultural heritage offering of the site as a congruent purpose of a visit. Immediately after point B is often when researchers or museums will introduce a mobile cultural heritage application (*e.g.* an electronic tour guide Waterson and Saunders, 2012) to users, as well as recruit them to a study. Technologies then support or augment the visit (C), providing more (Petrelli et al., 2016b) or less (Ciolfi and McLoughlin, 2012) defined 'tours' around the museum or site. When visitors choose to leave, they again make an explicit decision (D), passing through an explicit, controlled exit point, and reducing the importance of cultural heritage access (E). Immediately before this is often used to support reflection of the experience (*e.g.* Ciolfi and McLoughlin (2012) interactive desk, or (Petrelli et al., 2016b) souvenir postcards from a tangible World War 2 exhibition). Whilst this basic structure affords the use of bespoke hardware, designed to better integrate digital content into the heritage experience (Ballagas et al., 2008; Costabile et al., 2008), applications running on mobile devices still dominate practitioner approaches (Audio Trails Limited, 2016; Dickens Museum, 2012; Manchester Metropolitan University, 2012; Mazel et al., 2012; Tyne & Wear Archives and Museum, 2015; Waterson and Saunders, 2012).

This general trajectory of visits provides a good template to scaffold mobile digital cultural heritage applications onto. It also provides a convenient, as discussed in Section 5, way to support their evaluation, with key points to recruit, introduce interactive technologies and debrief participants. However, as research on digital cultural heritage moves outside such explicit heritage sites, the underlying assumptions to the structure of such visits, and that visitors' primary purpose is to experience cultural heritage (supporting custom hardware and immersive experiences (*e.g.* Marshall et al., 2015)), becomes less clear.

2.1. Integrating cultural heritage into everyday life

These same structured elements of a visit have also been assumed by researchers and practitioners as digital cultural heritage application have begun to be applied in less controlled sites. Marshall et al. (2015) used them when designing and evaluating a situated audio experience for visitors to explore a World War 1 camp in the Italian Alps. On entry, participants were provided with a replica belt that was used to activate loudspeaker beacons placed around the site. Participants walked around the site, with the belt activating audio playback based on a narrative story selected by the visitor via a card placed in the belt. Whilst Marshall et al. (2015) argued that they wanted the experience of participants to be that of a 'normal visit', the site did not have the defined borders, or entry and exit points such as in the work reported by Ciolfi and McLoughlin (2012). Participants were externally recruited and taken to the site. Similarly, McGookin et al. (2012) immersive augmentation of the remains of a rural Roman hill fort made the same assumption, externally recruiting and transporting participants to the site. Whilst in Marshall et al. (2015) case it is reasonable to consider that in future years a development of the heritage site may make it more like that reported by Ciolfi and McLoughlin (2012) and McGookin et al. (2012) explicitly argued against the likelihood of such a development occurring at their site. Practitioner work, often created and deployed in conjunction with a cultural organisation, is also producing mobile, location-based digital cultural heritage applications intended to be used in more everyday places. In use of all of these systems the need for an explicit intent to 'enter' the site (as with a traditional museums) is not required, and the argument that using a cultural heritage application is a primary purpose of a visit is lost. Visitors may be interested in cultural heritage, but do not want to make this the primary goal or objective of their visit to a site, rather leaving it as a tangential goal that must 'fit around' their objectives.

How the nature of a site impacts on the diversity of visitors has been noted by Betsworth et al. (2014), who studied a disused copper works. From their observational studies to understand how the heritage of the site could be presented using location-based digital cultural heritage applications, they noted that visitors visited for a diverse set of reasons, including general leisure activities. They argued it was important to engage such visitors in the cultural heritage of the site. Similar findings, in the diversity of purposes for visits, were identified by

Table 1
Table of identity related motivations for visitors to visit museums as defined by Falk (2016) visitor model.

Identity related role	Description
Explorer	The visitor wants to see 'interesting things', wandering through until they are drawn to something that piques their curiosity.
Facilitator	The visitor is focused on satisfying the needs and maximising the enjoyment of others they are with. They focus on supporting others to identify interesting things in the museum.
Experience seeker	The visitor is focused on the most important and famous part of the museum. They may skim the rest of the museum but with the goal of reaching the key exhibits.
Professional/hobbyist	Visitors have clear goals and objectives on what to see and prioritise these. They are unlikely to be side-tracked and have a sophisticated understanding of the museum and its offers.
Recharger	Largely more focused on the aesthetic and physical space of the museum. Visitors are looking to recharge and rest in a pleasant environment more than looking at the exhibits.

Hornecker et al. (2014) who studied how digital augmentation could be supported sensitively at historical cemeteries. Both Betsworth et al. (2014) and Hornecker et al. (2014) noted how the purposes of visits, and the digital technologies used to augment those visits, could cause conflict and disruption to others in a place. Mazel et al. (2012), who had a more practitioner and design focus in their work to support interpretation of prehistoric rock art in rural Northumbria, found that visits to see rock art were often part of other activities. These other activities often assumed a more primary importance (given that the rock art was often hard to find), with engagement with and walking in the wider landscape, getting lost and 'exploring', as well as making it to a tea shop before it closed, being primarily important. Whilst they clearly identified that visits did not fit neatly into the visit trajectory previously described, and which has been assumed by prior work, this was not explicitly addressed in their studies.

As digital cultural heritage applications continue to be developed for the everyday environment, individuals do not need to explicitly 'visit' the heritage site, they are always within it. This is particularly true in urban environments. Practitioners have long developed and deployed apps to support access to cultural heritage. Most commonly, such 'apps' provide location-relevant content on a map. Content may be available on demand (Manchester Metropolitan University, 2012), or may only be presented when the user is nearby to the location the content refers to (Tyne & Wear Archives and Museum, 2015), whilst in some cases, the order in which content is accessed is prescribed (*e.g.* by having map items numbered) (Audio Trails Limited, 2014). There is however, little data available on how practitioner based work is used by visitors. Whilst many visitors may find value in it, it is likely to not support or engage those at a place for other primary purposes. Park and Peng (2016) developed an 'app' to provide heritage interpretation for visitors to the Sheffield and Tinsley canal through providing an audio tour. Whilst they identified a wide diversity of visitors to the canal, and the value of supporting those visitors, their reported results came from those on explicit walking tours of the canal who had visiting the canal as a primary purpose. Park and Peng (2016) reported little use by the diverse individuals they identified at the canal for other primary reasons, and who they argued might be able to contribute to the history their 'app' sought to present. An explicit tour was not flexible enough to fit around the primary reasons people were at the canal.

Whilst it is clear that work is expanding the sites covered by mobile digital cultural heritage 'apps' to more everyday environments, there is little work that directly addresses the issues of doing so. In particular, how users might incorporate such location-based digital cultural heritage applications as part of other primary and more important activities that draw them to a site. Whilst individuals may not be actively attempting to engage with the cultural heritage of the area, they may be open to finding out about it as a part of everyday life. It is this, we argue, that drives the need to consider the study of location-based digital cultural heritage applications in situations where their use is a tangential goal of users.

2.2. Visitor motivation

In considering how to support visitors who may only be tangentially interested in accessing cultural heritage, it is important to consider existing work on what motivates individuals to visit cultural heritage sites. Museums have long been interested in why an individual will visit. Approaches to understand visitor motivations usually classify visitors based on their intrinsic interest in the museum content, as well as their demographics (including age, educational background and visit frequency) (Falk, 2016). Falk (2016) argues that this provides limited insight into why an individual would choose to visit a museum and what they hope to get out of that visit. More recently, multiple studies have begun to identify diverse reasons why individuals would choose to visit a museum. Whilst learning and discovery of new knowledge often feature strongly, an individual may visit to support self-fulfilment, mental and physical relaxation, and social interaction with friends or others (Hood, 1989; Moussouri, 1997; Packer and Ballantyne, 2002). In visiting a museum, individuals are largely trying to accomplish leisure related needs, with these defining the accomplishment of the visit, rather than becoming educated about the museum content (Beard and Ragheb, 1980).

Falk (2016) developed a model that sought to explain factors in the visitor's experience of a museum. He argued that motivations to visit were largely identity-related to enhance an aspect of self (Goffman, 1969), seeking to match a leisure-time need (*e.g.* mental relaxation, or socialising) with the affordances of a museum. Falk's model identified five identity-related motivations (see Table 1). He found a majority of individuals, though not all, visited a museum based on one of these identity related motivations. Whilst in the majority of cases there was a clearly dominant motivation, visitors could have more than one (Falk et al., 2008). Individuals could also move between different motivations during a visit, and have different primary motivations on subsequent visits (Falk, 2016). Visitor motivation defined their trajectory (Benford and Giannachi, 2008) through the museum visit (between points B and C in Fig. 2). Explorers gravitated towards exhibits that interested them, without a prior plan, and mostly wandered, whilst Facilitators were concerned with making a visit valuable for others, focusing on what they found to be important. This defined where in the museum visitors went. Falk's model also considered that the experience visitors have is an interaction between these motivations, their personal (prior knowledge and experience) context, and the context of the museum (expectations of what it offers, its physical layout, etc.).

Whilst providing a strong starting point to understand the motivation of visitors to museums, Falk's model is not fully comprehensive and not all visitors have been found to fit into an identity related motivation (Falk, 2016). More importantly, the model has been derived from studies within 'traditional' museums, stressing the role that the visitor's perception of a museum and its affordances plays. Whilst it is reasonable to consider that the model would apply to open-air sites, such as that described by Ciolfi and McLoughlin (2012), which share similar site and visit characteristics, it is unclear how it would apply at more

Fig. 1. An overview of Seurasaari Island, with images illustrating the key areas that we augmented with Explore. Map image ©OpenStreetMap contributors.

ambiguous sites (such as described by Hornecker et al., 2014 or Han et al., 2014) where the purpose of a visit may not fall within one of Falk's identity-based purposes. It is not the goal of this paper to apply Falk's model to such sites, though there is value in doing so. However, it does highlight that even in more defined visiting experiences, visitors may not be primarily in a museum to learn about its content. As Falk argues, learning may be a 'leitmotif' to their visit (Falk, 2016), with other priorities dominating. However, accessing and learning about heritage is at least congruent to the primary goal of the user. *E.g.* a visitor primarily meeting with friends will be open to learning about the museum's exhibits given the common ground of being in a museum. In more everyday, ambiguous sites, there may be a wider range of reasons why an individual is there, many of which may be tangential and incongruent with the primary goal a user is engaged in (*e.g.* walking the dog (Betsworth et al., 2014), or going to the shops - a likely scenario where (Han et al., 2014) local history collection 'app' may be used). In considering how mobile digital cultural heritage applications can be used by such individuals, we argue they must fit in and around the primary motivation why someone visits, and be respectful of it.

2.3. Evaluation considerations

Evaluating location-based digital cultural heritage applications with a focus on their use being a tangential purpose presents challenges, most significantly the need to avoid forcing the use of the cultural heritage application to become the main goal of a visit to a site as a side effect of the evaluation. For example, the approach of Petrelli et al. (2016a) and McGookin et al. (2012), and the studies reported by Betsworth et al. (2014), where participants were pre-recruited and taken to a site would not be suitable. By agreeing to take part in a study participants are making dedicated time available, and therefore make interaction with the cultural heritage application the primary goal of their visit. Similarly, existing work that focuses on city-based tours (such as Reid et al., 2005b; Szymczak et al., 2012), although outside a traditional museum context, externally recruit participants and make interaction with the cultural heritage application a primary goal of users. 'App Store' evaluations, where a system is distributed through the Google Play and Apple App stores is an alternative (Morrison et al., 2012; Sahami Shirazi et al., 2014). 'App Store' approaches are understudied for cultural heritage, and although they support evaluation at scale, research data are often restricted to logged device interactions, losing rich interactions and qualitative feedback. Morrison et al. (2012) are considering how richer data may be collected, although such evaluations would need a wide area with cultural heritage (such as a city) to support enough interaction.

As already discussed in Section 2.1, existing work (Park and Peng, 2016) is beginning to highlight the need for these issues to be addressed. Researchers have also begun to consider how individuals may contribute to the intangible heritage of their local areas, breaking down the traditional barriers between curators and visitors (Ciolfi, 2013; Ciolfi et al., 2008). For example, Han et al. (2014) developed and studied a smartphone 'app' to allow people to access and contribute to heritage about their local area. Content (images, comments and text) could be created by users and associated to nearby places (such as buildings). Whilst focusing on local residents of an area, who are less likely to be walking a tour to find out about heritage, Han et al. (2014) evaluated from that perspective. Each participant walked a strict route through the environment to evaluate their 'app'. Although Han et al. (2014) were interested in how individuals contribute to, rather than access, this social history, their work illustrates the importance of beginning to tackle how individuals might access cultural heritage as a tangential, non-primary goal. By pre-recruiting, the study itself changed why individuals were in a location and thus how they would use the app.

In this paper we address how location-based digital cultural heritage applications should be designed to support their use as a tangential, non-primary purpose of a visit. By developing and evaluating a cultural heritage application for the Finnish recreational island of Seurasaari, we identify how evaluations can be carried out without significantly impacting the primary reason individuals visit, as well as key issues in designing apps to support such visitors. In the following section we outline our site, before discussing the design of Explore: a location-based, digital cultural heritage application designed to support its use as a tangential goal.

3. Seurasaari island

Located in central Helsinki, Finland, Seurasaari Island (see Fig. 1)

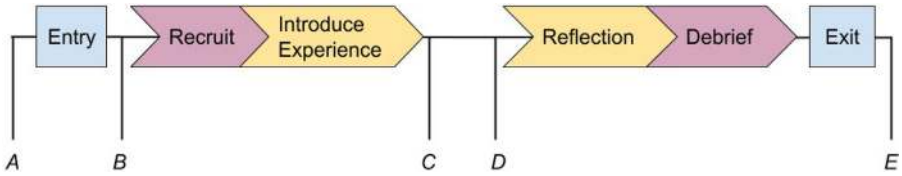

Fig. 2. A common trajectory exploited in both the design and evaluation of digital cultural heritage technologies in museums, illustrating how digital cultural heritage experiences (pink boxes) and their evaluation (yellow boxes) are scaffolded onto the visit. Points A-E illustrate key decision points by visitors that influence the emphasis of accessing cultural heritage during a visit. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Fig. 3. The main walking paths on the island cut through the open-air museum area. Whilst any visitor may walk around the buildings, a ticket is needed to enter them.

was founded as a recreational park in the 1800's. Although visitors with their own boat can enter the island at multiple points, most visitors arrive by foot over a short footbridge linking the mainland to the island. This serves as a common entrance and exit point, but has no barriers, gates or signs that delineate the island from its surroundings. The park contains an open-air museum area, founded in the 1970's, with traditional wooden buildings (such as a farmstead, church and homes) that were relocated from other parts of Finland. The open-air museum area is not separated from the rest of the island, with the buildings integrated into the wider island, next to and along walking paths (see Fig. 3). Whilst any visitor can walk around the exterior of the buildings, a ticket must be purchased (a small badge costing 9€) to enter them. However, not all buildings are open to visitors. Each open building has one or more docents wearing traditional folk costumes. Docents ensure visitors are wearing a badge and answer any questions. Tickets are sold at a kiosk near the bridge that acts as the main access point to the island.

Whilst the open-air museum is a major attraction for visitors, the park has significant natural and cultural heritage itself, with buildings dating from its founding as a park that house a cafe and restaurant, as well as the boathouse used by visitors to reach the island by steamboat before the bridge was built. Ponds that are now home to rich wildlife were originally dug to extract clay for significant buildings in the city. Cultural events, such as folk dancing and music events during the summer, are used to present the intangible cultural heritage of the island. The island also hosts traditional midsummer and Easter celebrations each year.

This mix makes the island popular for both residents and visitors. For visitors, the open-air museum is a key attraction. For residents, the many kilometres of recreational paths in nature afford walking, jogging and general relaxation. However, beyond the open-air museum the rich cultural heritage of the island remains invisible to both.

4. Explore

We worked with Seurasaarisäätiö (www.seurasaarisaatio.fi/homepage/) - who manage the island - to develop a mobile "app" intended to reveal this hidden cultural heritage to those visiting the island. Its goal was to support both residents and visitors to gain new insight into the history of the island. Whilst this included the open-air museum, the focus was on the history of the museum itself rather than the lived experience of people who occupied the buildings (*e.g.* such as with the site described by Ciolfi and McLoughlin, 2012). As previously discussed, it is important to consider that accessing this heritage is a tangential goal of a visit. The "app" should therefore not need to be the primary focus of the visit (such as requiring users to undertake a tour around points of interest (Szymczak et al., 2012)), rather respecting the varied reasons individuals visit the island, and support free exploration.

Our final design, called Explore (see Fig. 4), ran as an application on an Android mobile device. We chose to augment 6 main areas of the island (see Fig. 1), although some content was placed outside these. Historical images and videos from the foundation's archive (both with text descriptions), as well as audio vignettes describing something about the activities of a place, were geo-located at relevant locations in each area. The "app" used the on-board GPS unit to define activation zones (between 10-30m) around real world locations. As a user entered an activation zone he/she was presented with a notification about nearby digital content. The use of activation zones is a common technique, and has been used in existing cultural heritage work (Vazquez-Alvarez et al., 2011). However, existing work often hides this from end users, or uses activation zones as a basic part of a more immersive experience. For example, McGookin et al. (2012) used activation zones to trigger environmental sounds, actors and artefacts that could be "dug up" in their rural Roman site. Marshall et al. (2015) used physical objects and props to hold technology that triggered audio content as individuals came close on their Word War 1 tour. However, as our goal was primarily to fit around existing activities of visitors, we chose to use

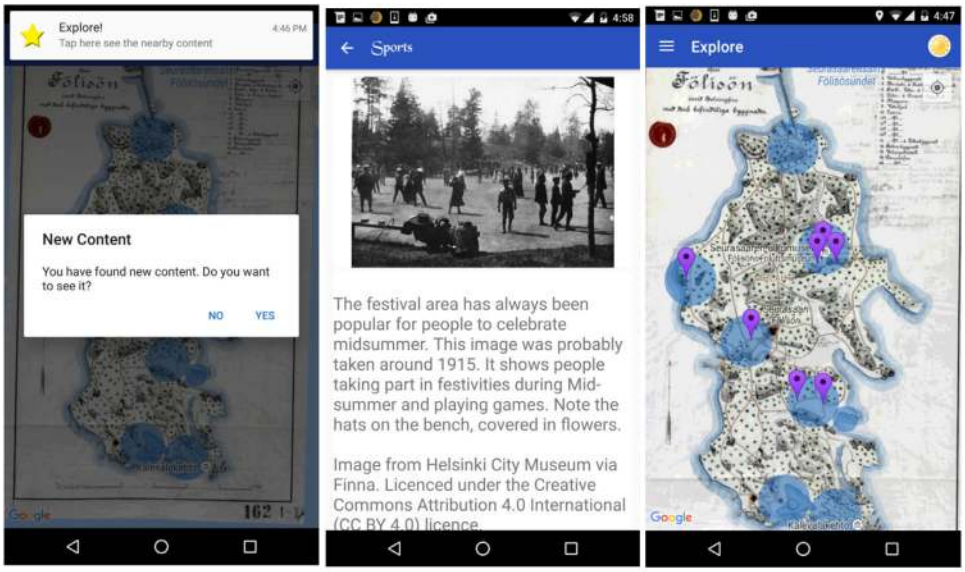

Fig. 4. Screenshots of the Explore interface. A: Notifications used the standard Android notification system, and if the "app" was active, presented this via a dialog on-screen. B: Responding to a notification presented the content (either an image, video or audio recording). C: Previously viewed content was marked on a map and could be viewed at any time.

the standard Android notification pattern. As a user entered an activation zone the "app" presented a standard Android notification (using a custom notification sound and vibration) (See Fig. 4(A)). Notifications are familiar to users, and a standard way that applications create awareness of new content and events (Sahami Shirazi et al., 2014). Note that the screen did not need to be on for the notification to be presented. If the screen was off, the user could activate the notification from the Android notification drawer like any other notification. If Explore was active (Explore was the current "app" and the screen was on), or the user decided to open the application rather than directly access the notification from the drawer, an on-screen dialog was presented (see Fig. 4(A)). Activating this caused a screen to present the digital content (either image, movie or audio) (see Fig. 4(B)). The notification was then cleared (future notifications were not fired for this content) and a marker representing the content was placed on an historical map of the island (see Fig. 4(C)). This allowed the content to be reviewed at any time. The user could also ignore the notification, which was automatically cleared after walking 10m from the activation zone. This ensured that participants would not see content unrelated to their location.

As the use of environmental sound has been effective in other work (McGookin et al., 2012), we incorporated a low-level ambient soundtrack in each of the 6 main augmented areas to highlight the presence of content. For example, a folk music track was played in the festival area. A mute button was provided in the "app" toolbar to silence this if desired.

5. Study outline

Our study ran over 5 days in June 2016. Our goal was to exploit the characteristics of Seurasaari to study the use of Explore in a way that did not force its use as the primary goal of a visitor's visit. Our research team were located in a tent on the island side of the bridge (See Fig. 5). By locating there, all participants had themselves decided to visit the island and we recruited them after that point. As with traditional museums, the bridge acted as a defined entry and exit point, and we exploited it in a similar way to existing work. Unlike museums or other open-air sites however, it was not controlled and did not define a purpose to what the visitor would experience. As visitors visited the island for multiple reasons, crossing the bridge does not imply they are there to access the cultural heritage of the island. As the bridge was also the end point of any visit, the study made no demands that visitors change where they went on the island (*e.g.* to collect or return equipment). Participants were recruited as groups. Research team members were positioned on the bridge and handed out flyers describing the study. This provided visitors with the opportunity to consider as they crossed the bridge, without the presence of researchers, if they wanted to take part in the study. At the island end of the bridge our tent was located in a grassy area in the middle of the roundabout that provided access to all the footpaths around the island. Visitors could approach the tent and ask to take part in the study, but could also walk past and ignore it (see Fig. 5). We did not collect numbers on how many chose not to engage, but the number of participants that did engage were a minority of all those that visited the island.

45 participants (aged 15–79, mean 44.7 years, 24 female) in 26 groups (10 individuals, 11 groups of two, 4 groups of three and 1 group of four) took part. Each participant completed a consent form and demographic questionnaire (including where they were from, currently lived, when they made the decision to visit the island and why they had decided to visit the island). Each group was then given an Android smartphone running Explore and a basic explanation of how it worked. As participants can often focus on the screen of a mobile device if it is carried in the hand (Petrelli et al., 2013), each had a lanyard so it could be worn around the neck, although participants could carry the device as they wished. Each group was told they could use Explore as much or as little as they wanted, and that they could respond to notifications, or not, as they wanted – including not at all. Participants were also told that there were no particular activities that we wanted them to carry out, and they should simply continue with the visit as they were intending to. Further, we informed participants that as the bridge was the only way off the island they should only bother returning the device when ready to leave. Participants were not shadowed during their visit, but interactions with Explore were logged on device. We also ran the lookback screen logging tool (www.lookback.io) on each device to capture interactions. Because lookback.io captured all interactions with the device, not just with Explore, and significantly increased battery drain, we gave participants a test device rather than installing Explore on their own personal device. All groups returned at the end of their visit to the island to return the device. Each member of the group completed a post-visit questionnaire, and we conducted a semi-structured interview with the group that covered how Explore was used and its impact on their visit. Each participant received a movie ticket or Moomin mug (~ 11 Euro) as compensation. Our goal in using this approach was to ensure that participants were aware of Explore and

Fig. 5. Our team were based on the island side of the bridge, at a grassy junction of paths visitors could take around the island after leaving the bridge.

how it worked, but could very quickly get on with their visit. We also wanted to avoid influencing where, or how long, participants visited by carrying Explore. As participants self-selected to take part, we cannot argue that they are fully representative of the groups or individuals that visit the island. However, they do represent those who have some interest in heritage and might be willing to use location-based digital cultural heritage applications tangentially. We return to this point in the discussion.

An additional element of the work we report here was the incorporation of the significant seasonal variations between summer and winter at the site, and how these could be incorporated into Explore. As such we tested two variants of Explore. Whilst both provided access to the same content in the same places, and worked as outlined above, they differed in how the seasonal element of content was presented. Whilst results did reveal significant information about how variations in seasonality should be included in content (as reported in McGookin et al., 2017), there was no difference between how the variants were used or for how long. We therefore combine them in our results and discussion and do not explicitly discuss the seasonal aspects in this paper.

5.1. Data analysis

Post-visit interviews with groups were audio recorded and professionally transcribed. We used a framework approach (Ritchie and Spencer, 1993) to perform initial thematic coding on the interview transcripts. Initial codes were derived from our research goals - why participants visited, what their goals were, how they interacted with Explore and how Explore fitted into their visit. Through iterative coding we refined and developed these codes, using the work of Furniss et al. (2011) to help guide us. This left us with a set of six primary codes, each with a varying number of sub-codes that outlined how participants had used Explore (or not) as part of their visit to the island. Coded interviews were supplemented by the analysis of log files generated on each device. These recorded timestamped events in Explore (*e.g.* a notification being responded to, or the user playing some audio or video content) and provided summary data of Explore use, as well as a geographic trace where each group went on the island. We triangulated logging data with the coded interviews to understand how Explore was used and incorporated by participants.

Based on analysis of the demographic and visiting data we identified two different groups of visitors: Tourists (t) and Locals (l). This distinction was based on the motivation for their visit that day combined with where they lived. We discuss the differences between these groups and justification for them in Section 6.1. Ten groups were composed of locals, 15 were composed of tourists (either Finnish or Foreign), 1 was a mixture (locals visiting with friends).

6. Results

6.1. Visit motivation

As part of the initial questionnaire, all participants were asked what motivated their visit to the island that day. From the results, there was a clear distinction between groups that lived in Helsinki and those that were visiting Helsinki. This is reflected in the initial motivation that caused a group to visit the island, where they went on the island and how long they stayed. Whilst this distinction does not fit into Falk (2016) model, it does provide a useful distinction to consider tangential access to heritage as part of other activities.

For the majority of tourists, the decision to visit the island was opportunistic. PG5(t) for example, made the decision as he left his hostel :*"I guess as I left the hostel. It was about 10.00 or 10.30 and then I came here"*. This decision could be driven by multiple personal factors. *e.g.* PG5(t) expressed a desire for spontaneity and the visit to the island "fitted" with his criteria for the day: *"I guess in the first place I wanted to go somewhere else but spontaneously. I thought about a combination of something like a museum and being in nature and outside would be good."*. Reasons for visiting could also be more mundane, such as the weather PG20(t): *"We looked how the weather will be and the weather was very fine."*, or because the island was close by. PG4(t): *"I was staying in Taka-Töölö, right next to Mailahti hospital, this was so close. That's why I came here today."*. Even though tourists may have intended to visit the island during their trip, the decision on when to visit was still often *ad hoc*. PG22(t): *"This morning. I was a choice, we go here this morning or tomorrow. But we definitely wanted to go here."*.

Unsurprisingly for all of the tourist groups, their goal in visiting was primarily tourism, and in particular to visit the open-air museum. PG23(t): *"We love the Finnish sauna and thought there was gonna be a sauna or two, but we also just wanted to come see all the outdoor buildings."*. There was a clear consideration that tourists were more open to incorporating cultural heritage as part of their visit. Although cultural heritage was discussed only in terms of the open-air museum (excluding the wider heritage that we included in Explore), tourists' primary goal was to experience and learn about the island. Participants did not discuss their goals at a deeper level. This fits with existing work on tourism that shows individuals may have only vague plans, and refine these as they go (Vaittinen and McGookin, 2016).

Interestingly, such opportunistic decisions were also the most common reasons for locals to visit as well. Visits by locals were on average shorter (Locals M = 66 min S.D. = 20 mins, Tourists M = 150 min S.D. = 42 min). Visits were also often not pre-planned, and although the reasons that motivated a visit were often different, they shared the same opportunistic elements. PG26(l):*"I think it was this morning. We just were wondering where would we go and Seurasaari just popped up and then we decided that let's come here."*, and PG21(l):*"She had some accident in her hand yesterday and she couldn't go to her job"*. In addition to such opportunistic visits however, locals also discussed how

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R1:  Usually we are both quite busy -.
R2:  Last week you contacted me.  ...  We visit
Seurasaari approximately once a month.
R1:  Last week I called her.
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Fig. 6. An extract from the interview transcript of PG11(l) illustrating how visiting Seurasaari was a regular occurrence.

the visit to the island was a regular activity, such as providing a regular opportunity to meet with a friend. For example, both participants in PG11(l) (R1 and R2) used a regular visit to the island to make time to see each other and catch-up (see Fig. 6). This reflects that although the island is rich in cultural heritage, it is often not the primary reason why individuals would visit. Six out of the nine local groups stated that their visit was primarily for a walk (without a clear destination), whilst the other three had plans to combine a walk with a favourite place on the island. PG3:*"we also visit just to walk around with the kids, so fresh air. And recreational or whatever it's called."*.

In considering tourists and locals, there is a clear distinction in the emphasis of cultural heritage during a visit. Tourists considered cultural heritage as an important part of their visit, and given the vagueness of their overall plans (Vaittinen and McGookin, 2016), were likely to extend or reduce the time they visited based on sustained interest. Locals, although open to cultural heritage, did not consider it as a primary reason for their visit. In the following sections we use this distinction, between tourists and locals, considering them as two groups where accessing the cultural heritage of the island is a more (locals) and less (tourists) tangential goal of their visit. Whilst this is not the only difference between these groups, as we discuss in following sections, we believe it provides two distinct points on how visitors consider the importance of cultural heritage to consider how this varies.

6.2. Overall use of Explore

No participants returned with Explore before they were ready to leave the island. For two tourist groups the device battery was exhausted (and the device automatically shut down) before the end of the visit. For one tourist group (PG13(t)) the device shutdown significantly (50 min) before they returned to leave the island (total visit length 330 min). Otherwise Explore was active through the whole visit time to the island. Overall locals spent less time on the island (Locals M = 66 min S.D. = 20 mins, Tourists M = 150 min S.D. = 42 min).

6.3. Visited areas

Fig. 7shows representative GPS trace logs of participants. These reflect the areas of the island that participants visited, and our earlier discussion on the purpose of their visit. There was a clear contrast between visitors and locals. The majority of locals reported that they walked a circular route around all or part of the island, largely following the main path around the coast. This path cuts through the open-air museum area, but no participants stopped to dwell at it. As expected from the motivations participants described for visiting the island, most tourists visited the open-air museum, with several spending time inside the buildings; note the large GPS jumps in the trace of Fig. 7 (left) indicating the device is inside. However, only a small minority of tourists visited only the museum. Most tourists combined their visit to the museum with further exploration, such as to more scenic areas (PG25(t)), or to the restaurant for lunch (PG13(t)). Visiting these additional areas was opportunistic, and as described by Vaittinen and McGookin (2016), was driven by seeing the place and balancing competing demands so as to spend more time there. For example, PG4(t) discussed how his visit included getting lost exploring the inner island, but that his time was practically limited (see Fig. 8). To some extent (see Section 6.4), the map of the island in Explore may have increased awareness amongst tourist groups of interesting things nearby and factored into these opportunistic decisions. More practical issues also influenced visit length. For example, a heavy downpour of rain caused PG4(t) to cut his visit short, causing him to decide to do something else.

In relation to existing work on visitor motivation in museums, there were a few differences in how locals and tourists visited. Locals mostly fitted into the social interaction and the recharging identity of Falk (2016), but combined with a professional/hobbyist role (given they spent a shorter time and were more focused in their activity). Tourists, in consideration of Falk (2016), were more Explorer/Experience seekers, with a focus on the open-air museum, but were also open to exploration of other parts of the island. These motivations are not exclusive, but they do indicate that although (Falk, 2016) identity related motivations can be seen in tangential use, they may be more mixed, and further work to more closely study his model in relation to tangential digital cultural heritage access would be valuable.

6.4. Interaction with explore

For all participants, interaction with Explore was driven by notifications. On average, there was less than one interaction per group that was not the result of a very recent notification being presented. PG25(t): *"Every time it buzzed I said yes and I read what it provided me. That was about it."*. Only a minority of participants (all tourists) reported that they accessed Explore independently, without being prompted by a notification. Most often this was to access the map and help understand where they were on the island, or to help find a particular place. Although the island has public maps on boards, these are sparsely distributed. PG4(t):*"Sometimes I looked, mainly because of the map, to see where I'm at. But for the most part, it was just in my hand so that I could look at the map. I did not continuously stare at it, no. Whenever it beeped, I stopped to look what's there."*.

6.5. The impact of notifications

Existing work in the study of notifications has found that they can both disrupt existing activities and apply pressure on users to respond (Sahami Shirazi et al., 2014). Although this is dependent on the 'app' sending the notification (Sahami Shirazi et al., 2014), and most work relates to MMS or Text Messaging, where there is an expectation of a response (Pielot et al., 2014). From the post-study questionnaire, participants were neutral to disagree that the 'app' distracted them from the environment (M = 4.5, S.D. = 1.7, 7-point Likert). Participants reported that they felt able to ignore notifications if they did not wish to respond at that moment (such as being engaged in another activity). PG5(t): *"... it's more up to me if I pass something or if I miss something. So it's okay"*. However, participants ignored a relatively low number of notifications (M = 3.7 S.D. = 2.9 notifications were not responded to per visit out of M = 42, S.D. = 17 notifications fired). Even if it wasn't convenient to look at a notification at the time, it was likely accessed at some point in the near future as notifications were automatically removed if they had not been accessed once the device had moved 10m outside the activation radius (see Section 4). Whilst local groups also reported that they were able to ignore notifications, comments reflected an increased level of disruption from the notification to existing activities. For example, PG11(l) reported how the notifications disrupted their conversations: *"sometimes in our conversations, when we were talking, then [imitates a beep] again."* For local participant groups, where accessing the cultural heritage provided by Explore is more tangential, participants were less open towards being disrupted. Rather than presenting content when most relevant, based on spatial proximity, it may be more appropriate to identify gaps in the primary activity and present content then.

The disruptive impact of the notifications was also in part due to the uneven distribution of content over the site. In particular, as we focused on augmenting six key areas of the island, participants could get very

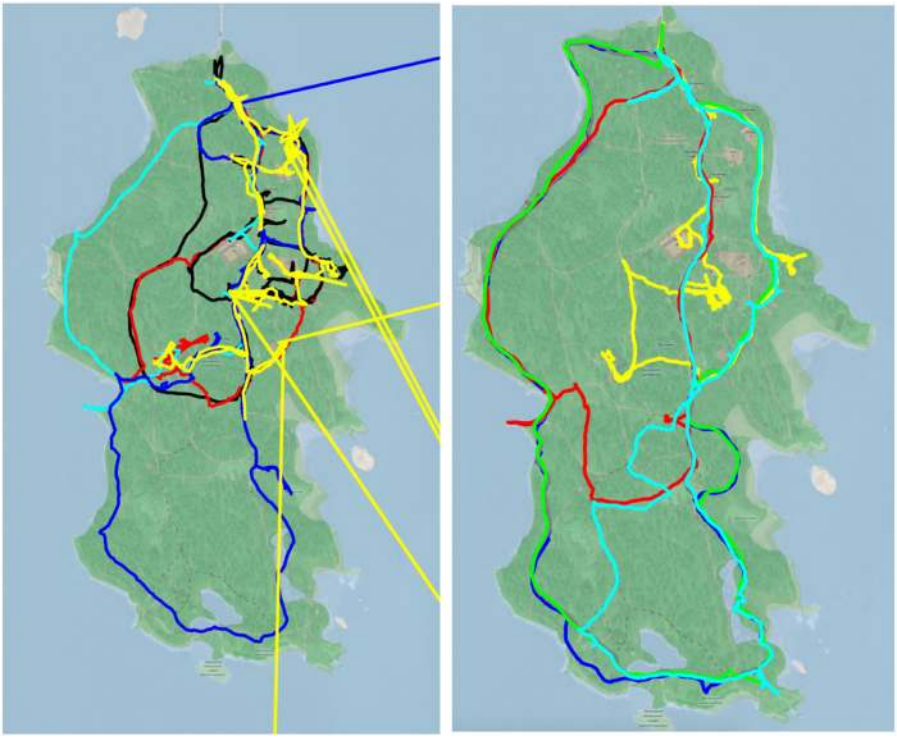

Fig. 7. Representative traces of participant's visits. Left: Tourists combined a visit to the open-air museum with exploration of another area of the island. Note the GPS jumps in the museum area indicating participants are inside the buildings. Right: Locals generally avoided the museum area, often walking around the perimeter of the island. Note colours are used only to help distinguish traces from each other. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

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P: I've lost all my points of the compass [chuckles].
I walked along the left side and then I came back
through the middle of the island and then from the
restaurant I walked along the beach on the right-hand
side, actually in the middle of the forest.
I: Why particularly these areas and not others?
P: Because I don't have enough time.  I would have
walked right to the end of the island if I had more
time I have to catch a flight so that's why a shorter
visit.
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Fig. 8. An example transcript from PG4(t) illustrating how his visit to the island was both exploratory, but limited by practicality.

frequent notifications in some areas and few in others. In parts of these six areas participants found that new notifications would appear as soon as they had dismissed content. As with the previous comments on disruption, it was locals who highlighted this more often. PG3(l):*"Yeah, it was a bit too frequent with the beeps. Every 10meters."*. Uneven coverage of content was also noted in places where there was less content, with some participants checking the phone in short bursts to ensure Explore was still running: PG3(l):*"… when it was silent for a while then I looked at it."*. The contrast with high numbers of notifications from high density areas was reported as a factor for doing this, drawing attention towards the device. Participants discussed how spreading notifications more evenly would be a better approach. However, as content relates to, and is viewed in proximity of, physical locations it is likely that some locations are more important, and thus have more content associated with them than others. For example, such unevenness is a likely characteristic of the community based work of Han et al. (2014) previously discussed, as some buildings are likely to be more culturally important and have more content recorded about them.

6.6. Fitting with the visit

Overall, participants reported that Explore had little impact on where on the island they visited. It did not significantly change or alter the existing plans that participants had. Locals, in particular, were very clear that Explore had no impact on where they visited. PG19(l): *I: "Did the mobile phone application affect your route in any way? P: No."*.

This was also the case for tourists, with two thirds reporting that Explore did not influence where they visited on the island. The remaining third reported that the light blue circles on Explore's map (indicating the six main areas we augmented with content) had some influence on where they went. Although participants did not often view the map independently of a notification (M = 1.1, S.D. = 2.9), it was visible when closing some other content so was regularly seen. PG5(t) described how the awareness of content encouraged him to take a different route back to the bridge, rather than retracing his steps: *"There was one thing, when I had been on the end of the island. I decided to walk the other way around because there was the blue point on the map where it showed that there is something, so I decided to go there instead of going back the same way."*.

In discussing the role that Explore played in their visit, both tourists and locals considered it as a 'companion', able to inform them about interesting things in the current area, rather than as a way to direct or significantly influence where they went. As PG11(l) described, Explore followed them around, rather than them looking for Explore to provide some direction, such as following a trail or path: *P1: "No. We walked the route we had planned". P2: "We do what we usually do". P1: "The phone followed us."*.

Participants found value from Explore in highlighting less obvious things in the environment. PG25(t): *"Walking and reading the 'app' at the same time. I enjoyed that. I didn't think I would enjoy it but I did. Called my attention to things that I wouldn't otherwise have noticed."*. Although notifications could be too frequent, they did support participants to incorporate Explore into their visits. However, this reactive use meant that many of the features, such as reviewing previously seen content (often used as a way to solidify or reflect on the visit (Ciolfi and McLoughlin, 2012; Stanton et al., 2003)), were not used. Using the map to help access previously seen content was also only used by a minority of tourists, all of whom had less familiarity with the island than locals. In targeting users who have cultural heritage access as a tangential purpose of their visit, interaction is likely to be reactive. Proactive interaction with the digital cultural heritage application cannot be considered likely. It is also not likely that individuals will revisit content

later.

The notifications used in Explore allowed visitors to be aware of content and allowed them to largely fit accessing it around their primary activity. However, when those notifications were presented was somewhat simplistic, and in some ways assumed a primacy to cultural heritage access. Like the use of similar techniques in other systems (Reid et al., 2005a; Szymczak et al., 2012), Explore attempts to present digital content at the most relevant time and place to match with the physical environment. However, at times this interfered with the primary goal of users, particularly with locals. Developing techniques to better fit awareness around existing activities, deferring to those activities, even if it means the link between digital content and location is degraded, may be better approach. The tension between these two issues warrants further study.

6.7. Relevance and value of content

In discussing content that was found to be most interesting, participants highlighted looking at the images and reading the text. Participants rarely listened to the audio recordings, preferring to read the text. The public presentation of audio was found to both draw attention towards participants, particularly in busier areas, and potentially interfere with the visits of others. However, such issues were mostly discussed in terms of the environmental sounds (see Section 6.8).

Although there were only a few, videos were found to be valuable, providing access to the intangible heritage of the island (such as folk dancing performances). Although participants found areas that were dense with notifications to be annoying, the majority wanted more content to be provided. PG25(t):*"The content was good, it was very brief. It was interesting. Just not nearly enough."*. Fitting with the use of Explore as a companion, participants highlighted when something interesting to them in the environment was not augmented in Explore. For example, PG24(t) noted how they would have liked more on the natural heritage of the island: *"more information about environment, about animals, especially because there are a lot of birds, for example something about one type of bird, something like that, or about squirrels, there are a lot of squirrels."*.

6.7.1. Perceived role of content amongst tourists

Content also created some conflict where participants interpreted that Explore should be focused on the open-air museum, rather than the island as a whole. Whilst PG6(t) discussed how Explore helped to augment and enhance the interpretation boards placed outside each building in the museum (see Fig. 10), they also discussed how many of the buildings did not have information in Explore (see Fig. 9). In this way the prominence of the open-air museum buildings in the site, and the primary purpose of tourists in part being to visit the museum, led to an expectation that Explore should complement that activity rather than the wider heritage of the island. However, it also highlights that the primacy of a visit may not be between accessing heritage and some other activity, rather it may be between accessing a particular heritage layer (*e.g.* the lived experience of the open-air museum) but being open to understanding, or 'dipping-in' to, the other heritage layers in the same physical space.

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R1:  there were some old bits of information that you
won't get unless you have the 'app'.  The old photos
and -
R2:  Yeah, the historic content.
R1:  - some of the kind of local information, you won't
get by reading the signs here.  So that was good.
But I see a lot of it wasn't related to the cabins
themselves.  Well, maybe we just didn't go to most of
them in the middle, perhaps.
```

Fig. 9. An example transcript from PG6(t) illustrating how Explore both enhanced physical interpretation boards, but also led to an assumption about the role of Explore.

6.7.2. Familiarity and obviousness in content amongst locals

Whilst tourists largely liked the content that Explore provided, locals were more mixed. The impact of content is one of the few areas where we found a clear divide between locals and tourists, whilst in other codes (other than where participants visited) views on Explore were more consistent. Many locals were already familiar with Seurasaari and therefore found much of the content to be familiar. PG11(l):*"I feel the topics were quite familiar; spending the midsummer here, brides - I mean the weddings here and others. Those were quite familiar to me. Seurasaari is, after all, a place I have visited since I was a child."*. Local participants did gain new insight into the island. PG8(l): *"Because the scenery I know, I like it, but to get some, for example one fact was really interesting for me, this kind of comments like; the ponds, that there used to be, they were digging clay from there and that's why this kind of ponds exist and it was used to build so many, this kind of facts that like. I wouldn't have known that, I would have just wondered why they are here."*. It is not unexpected that locals would find some content familiar, and reflects their familiarity with the place rather than why they visited the island. However, visitors would also find content familiar on a second or third visit, particularly if the place is a more everyday environment. Most existing work evaluates only the first visit to a cultural heritage site. Whilst museums and other controlled sites change exhibitions to keep visitors returning, in places that are less defined as heritage sites (Ciolfi et al., 2013; Han et al., 2014), this is less likely to be possible.

Local participants were at least open to the possibility of using the 'app' again on subsequent visits. When asked about this, PG11(l) responded: *"I don't know about that, probably why not? It was an interesting change of pace. It's always good to know about things and to revise."*. Depending on how individuals pass through a place, it is likely that heritage understanding would evolve slowly over multiple visits (*e.g.* if participants are engaged in other activities so are more likely to ignore notifications). This leads to visitors with very different base levels of understanding. Further consideration of supporting this is required, particularly if an approach such as that suggested by Han et al. (2014), where locals contribute to the heritage, is employed. If heritage is at a basic level, widely known to locals, or surprising new knowledge is not contributed, those individuals are likely to stop contributing.

6.8. Environmental sound

In addition to the notification based content we also incorporated environmental audio (such as steamboats near the boathouse, or folk music in the festival area) to support linking content in each of the six main augmented areas together. Although the use of sound in this way is a common feature of existing work, presented both publicly (Marshall et al., 2015) and over headphones (McGookin et al., 2012), it was controversial amongst participants. Most often, participants described that they were neutral towards the environmental sounds, or found them 'ok'. These participants did not expand on this view. However, considering participants who were more positive or negative towards the environmental sound provides some context to consider this. For some participants the environmental sounds helped contextualise the notification based content. PG12(l) described the sound of the steamboat and how this helped contextualise other notification-based content in the area (see Fig. 11).

Such sounds also helped to engage curiosity towards the environment, with participants trying to understand where the sound was coming from. As we used environmental audio sparingly, it was sometimes unclear that the sound initially came from Explore. PG19(l): *"At first, we didn't even realise what it was. Where is this coming from? [laughing]. It was the ship wasn't it."*. However, some participants were against the use of environmental sound. In particular, the open-air museum and festival grounds that we had augmented with traditional Finnish folk music tracks were highlighted. PG7(t) for example,

Fig. 10. Representative interpretation boards that are located outside of each building in the open-air museum.

R: there was a steamboat, some kind of house where the ferry used to pick up people, and the 'app' made a sound, like kind of a boat sound to replicate maybe from the time when the ferry picked up people from the house. And sometimes music too. When we went to the huge festival area it played music
I: What did you think of those sounds? Or the music, for example?
R: I liked them
I: Okay. Did you listen to them or did you turn the music to mute?
R: Yeah I did. I wanted to hear the music. Because it was part of the pictures and it gave an idea what the festival area was used for.

Fig. 11. An example transcript from PG12(l) describing how environmental sounds helped to contextualise other notification based content.

I: I understand. So what about this sound? Did this environmental sound help you or was it rather annoying? Did you switch it off or let it on?
R2: Yes, we let it on, the sound of the folk music.
R1: It's coming very often.
R2: But some people were staring, what these women are When we passed the grill and there was this kind of playground for making the folklore dancing so they were looking at us... why we are making this music.
I: How did you feel about it?
R2: Actually I'm too old care. But I mean I dont know about Saara.
R1: I didn't care very much. It's okay.
R2: We look back and smile and let them grill the sausages.

Fig. 12. An example transcript from PG21(l) describing how the participants were not concerned with the impact of environmental audio on others nearby.

described how he quickly muted the environmental audio when he heard it: *"I listened to it a bit, I think, and then I turned it off. I muted it,"*. Whilst the mute option stopped playing environmental sound in the current area, when leaving this area or entering a new area this was reset. Therefore, participants had to mute environmental sound each time they entered one of the main areas. Some participants did this regularly, others simply turned down the volume of the device using the hardware volume buttons. PG22(t): *"Yeah, but most of the time I put the volume on zero."*. Log files showed that the number of instances where participants activated the mute button for environmental sound (M = 3.4, S.D. = 4.7) was similar to the number of activations of those sounds (M = 3.4, S.D. = 1.4). Given the participants who described turning down the volume, this number is likely to be higher. Participants muted sound largely due to it interfering with other activities. For example, chatting with each other or enjoying the island itself. PG22(t):*"When you're walking in the nature you don't need any more noise."*. We did not give participants headphones as these can isolate individuals from others in a group (Aoki et al., 2002), and given our focus on heritage access as a tangential activity, headphones would likely interfere with participant's goals, so sounds were played over the device speakers. Two groups discussed how this public playing of audio may have impacted on others around them. Whilst one group decided to mute the sound, the other, PG21(l), noted that they enjoyed the environmental sounds and the reaction of others did not bother them (see Fig. 12).

Environmental audio can play an important role in creating immersive experiences, and help to contextualise the site for visitors (Fosh et al., 2013; McGookin et al., 2012; Petrelli et al., 2016a). However, when the user is less focused on cultural heritage as a purpose of the visit, it can be seen as disruptive and annoying. Even though we used environmental audio sparingly, it was not a largely positive experience for participants. Participants were much more sensitive to such sounds than reported in prior work, where the use of a digital cultural heritage 'app' is evaluated as the primary purpose of a visit (McGookin et al., 2012). Participants suggested that rather than being an ambient sound, such audio should play only for a few seconds to avoid becoming disturbing.

6.9. Group interaction

Mobile devices can often isolate visitors from others in their group (Petrelli et al., 2016a). Although researchers have considered how to overcome this issue (Aoki et al., 2002), there is still a lack of work investigating how such mobile apps can be coordinated, particularly when outdoors. Outdoor sensing, such as GPS, can mean two devices in the same physical location may determine they are in different physical locations, causing content on multiple devices to trigger in different places. We therefore provided only one device per participant group. We also did not provide headphones to avoid their isolating effects from others in the group. For the sixteen participant groups containing more than one person, we also asked how the device and its content were shared amongst members in the group.

Relating to how participants largely interacted with Explore in response to notifications, it was common for one person to be 'in charge' of Explore, carrying it, accessing the notifications as they were provided and then sharing this with other members of the group. This could be done be showing the screen to others. PG11(l): *"I had the phone the whole time. But both of us read it and watched it continuously and we discussed the topics of the contents."*. Alternatively, the 'in charge' participant could read the content to others in the group. Often, participants described how they used this as a filter, curating content to better fit it to the others in the group. This illustrates the facilitator role that Falk et al. (2008) identified, where individuals are focused on the needs and interests of others they are with. For example, PG3(l) who were with their daughter, highlighted how they curated content to provide only the most interesting content to her: *"I think I read more quickly than listening to somebody else read it aloud so maybe that was it. And then I could just pick that interesting things and tell (daughter's name) about those."*. This was also identified by the 'in charge' participant of PG10(t) who noted that although she responded to all notifications, she curated what was shared with her partner: *I: "Okay. So did you always decide to*

respond to the notification or... " R: "Yes, I did always. And sometimes I stopped him and tell him to listen now." .

A minority of codes also revealed greater tension within groups, where the degree of interest in Explore's content was more diverse. This was only found with locals, for whom we argue have cultural heritage access as a less congruent part of their visit than tourists. PG21(l), although the only group which clearly revealed a tension between members caused by Explore, did highlight that engagement within groups is an important consideration: *"I was carrying it and she would have liked me to silence it offline. Was annoyed by the sounds but I said that we have to."*. Engagement can also vary over time. PG26(l) noted how his partner (who were visiting with their granddaughter) had become less interested over time: *"I think they just looked at it in the beginning, but after that she was carrying our grandchildren more than this application. I took care of this."*.

In supporting accessing heritage as a tangential aspect of a visit, there is the possibility that a group of individuals may contain those that see it both as a distraction and determent to their activity (*e.g.* as PG21(l) reported), and those that have some interest in accessing the heritage. Considering how these goals can be managed between members of the group is important to consider.

7. Discussion

Our goal was to consider both how a mobile, location-based, digital cultural heritage application could be designed and evaluated where visitors are open to accessing cultural heritage but where it is a tangential purpose of their visit, and to consider how this perspective influences its use. By considering how existing work scaffolds both cultural heritage experiences and their study onto key points in a visitor's trajectory, we have been able to minimise the impact of the evaluation itself on participants, and avoid forcing use of Explore to become their primary goal, such as would be the case if participants were pre-recruited with an arranged time to take part in the study (as is the case with much existing work discussed in Section 2.3). The island itself was a key factor in this. The defined (and single) entry/exit point made it straightforward to recruit and interview participants as a part of their visit, without them needing to significantly alter their visit to accommodate Explore. We cannot argue that our approach had no impact at all (*e.g.* such as PG21(l) who may have felt it necessary to continue using Explore in-spite of disapproval from his partner, or participants who reported they were happy to ignore notifications yet responded to those notifications). However, participants were comfortable putting the device into a pocket or bag, or returning some time after the device battery had been exhausted. Therefore, Explore did not dominate their visit to the island. Unlike in museums, the lack of an entrance fee, and that the island supported multiple diverse activities, meant that accessing heritage, in particular the heritage of the island, was not a main reason why visitors were there. The diversity of cultural heritage on the island was also a significant contributor to tourists visiting the museum not having a strong focus on the cultural heritage of the island. In sites where these elements also exist, the evaluation approach we used is likely to work well. However, in cases where the entry and exit points cannot all be 'staffed' to support recruitment and debriefing this approach may not work as well, such as in a city centre with multiple entry and exit points.

From our data we identified two general categories of users, where accessing and learning of the cultural heritage of the island was a more (locals) and less (tourists) tangential goal of their visit. Tourists and locals had varying reasons to visit the island, and based on their logging data visited in different ways. Although our focus was not on the application of Falk (2016) model of visitor motivation (see Table 1), our results indicate that many of his visitor motivations apply. Considering the island as a whole, tourists were experience seekers, focusing on the open-air museum but still being open to the wider park, whilst locals often appeared more like rechargers, using the island as a social meeting place or environment to relax in. Within both groups we saw examples of other identity related roles, such as a facilitator role where individuals managed and curated content from Explore to others in their group. There is clear value in the future evaluation of (Falk, 2016) model to digital cultural heritage applications in less defined sites to identify the extent to which it can be applied.

Another important aspect of Falk (2016) model is in the assumptions and expectations of a museum's offering. In our context, Explore offered an understanding of the cultural history and heritage of Seurasaari island. However, as the site is less defined than a museum or open-air park (*e.g.* Ciolfi and McLoughlin, 2012), what this should mean in the content and perspective Explore provided was interpreted widely by participants. Some tourists felt Explore should complement the lived experience of the open-air museum more, rather than the wider cultural heritage of the island. Others wanted more focus on birds, wildlife and natural history. Whilst we could have more narrowly defined the scope of Explore, the 'everyday' environment is much richer, layered and more diverse than most 'traditional' heritage sites, where there is a single heritage layer (Ciolfi, 2015) that is exposed to visitors. Particularly as shown with our tourist groups, it may not be that cultural heritage is a tangential aspect of their visit, but the layer and perspective on heritage that is tangential. In urban environments many of these layers may be swamped by much richer and more obvious heritage content, such as with Seurasaari, where the open-air museum dominates over the rest of the island's heritage. Considering access to these layers as a tangential aspect would allow them to be better incorporated into a visit, rather than expecting an "app" or digital tour to be the primary goal of a visit.

Related to assumptions and expectations of museum content is also familiarity with that content. In engaging users that are not at a site primarily to access heritage, such as the dog-walkers, joggers, etc. that Betsworth et al. (2014) and Park and Peng (2016) discuss, who are likely to be similar to our local groups, much of the content will be basic or already known. Whilst these visitors did gain new knowledge, in engaging individuals who are not primarily visiting for heritage access, it is important to consider that their understanding may be more advanced and tailor content towards this. This is particularly the case if, as with Han et al. (2014) work, such individuals might be expected to contribute to that heritage.

However, both groups used Explore in similar ways, viewing it as a companion that should inform them of relevant information but keep out of the way at other times. The relatively basic notification model we used fitted with this use. Where we incorporated more 'immersive' audio elements, such as the use of environmental sounds to contextualise the current area, participants often switched them off. The notification sounds themselves were sometimes also seen as intrusive. More immersive techniques that work well when considering a digital, location-based, cultural heritage application as a primary goal (*e.g.* virtual reality vignettes or games (Ardito et al., 2008)) are likely less suitable, as they require more time, focus and commitment (Ritchie, 2013) than visitors may be willing to provide. However, this is likely also shaped by the degree of congruence and how tangential cultural heritage access is to an individual's current goals. All of our local participants were engaged in a leisure activity, but in a city environment the congruence and how tangential cultural heritage access is may be much more dynamic. For example, an individual walking to a train station may have (or be willing to commit) only a few seconds to access nearby cultural heritage content, but may have several minutes to engage more deeply with the cultural heritage application when walking home from the station after work. Supporting different degrees of engagement and immersion with the cultural heritage application may be a valuable approach to support this dynamic. In any case, content should not automatically be presented without user authorisation. Automatically playing content was found to be most annoying by participants. Based on our work, engagement should initially be lightweight and it should be up to the user to deepen that engagement if

he or she wishes.

There are also implications for approaches that attempt to incorporate a narrative structure where content is designed to be accessed in a specific order. Explore did not contain a narrative that linked the individual content to each other. However other commercial and research approaches have used such as structure (*e.g.* Dickens Museum, 2012; Park and Peng, 2016), or use a linear visiting order, where visiting one location unlocks the next (e.g Rassmus-Gröhn et al., 2013). Ritchie (2013) argues that to follow the narrative in such digital cultural heritage applications requires the user to overcome a narrative value threshold - that the value of the narrative to an individual must overcome the effort needed to move to and find the next location to continue it. He describes this effort as 'really nontrivial', and highlights multiple examples from studies where users have struggled to find and locate the next location to continue a narrative. These used the pre-recruitment approach as discussed in Section 2.3, thus making accessing the narrative the primary goal of a user. In our study, where accessing the narrative would be tangential, the narrative value threshold will be higher, and given participants were not willing to let Explore directly influence where they went, the narrative value threshold may not be surmountable. This may provide context to the canal walking tour of Park and Peng (2016) discussed in Section 2.1, where most use of their tour 'app' came from those on pre-organised walks, rather than those already in the area. Further work in considering if, and how, narrative content might fit into the companionship role that Explore supported would help illuminate these issues further.

Both tourists and locals found benefit in using Explore. For tourists, it gave insight into the cultural heritage of a location many assumed did not contain cultural heritage (beyond the open-air museum). For locals, it enhanced their understanding of environments they knew well providing new insight, highlighting that considering cultural heritage as a tangential aspect of a visit has significant value. Locals were open to using Explore again on future visits. Given the previous discussion on how interactions were short, and how dynamic the degree of engagement with the cultural heritage application may be, it is likely over the longer terms that interactions with Explore will be short, and spread over a prolonged period (such as weeks or months) and multiple visits. Further study of how visitors use mobile digital cultural heritage applications over multiple visits and how to better support integrating understanding of each micro-interaction over time is necessary, particularly given further developments of work such as Han et al. (2014), where digital cultural heritage is pervasive in the city.

8. Design implications

We argue that further study of cultural heritage as a secondary, tangential activity, is important, as what a heritage site is considered to be expands and to provide new opportunities to provide digital cultural heritage access to the diversity of people in these everyday environments. Based on our study, we consider that future designers should consider the following key points when developing mobile digital cultural heritage applications as a tangential goal of a visit to a place.

Evaluations should consider how they affect the primacy of cultural heritage access

In considering access of mobile digital cultural heritage applications as a tangential goal, evaluations should be carefully designed to avoid emphasising interaction with the application and therefore increasing its primacy. For example, recruiting participants in advance and arranging for them to attend a study is likely to make interaction with the cultural heritage application a primary goal of the visit. Seurasaari supported the key stages of a museum visit, and our approach is likely to work well for sites exhibiting similar characteristics. However, in other sites a different approach is required.

Support lightweight micro-interactions

For both tourists and locals interactions were short and focused on the content provided by the notification. Participants did not spend time reviewing or revisiting previously seen content. Whilst some individuals may be open to richer interactions, accessing content should be primarily supported through short micro-interactions.

Respect the primary objectives

Applications should respect that interaction with them is not the user's primary goal. Locals found there were sometimes too many notifications and that environmental audio was distracting. Users will interact in short bursts, and applications should avoid distracting users or requiring interaction outside this (*e.g.* to dismiss notifications or silence audio). It may be beneficial to delay the presentation of available content if the system can detect the user is engaged in another task (*e.g.* discussing with others in a group).

Consider inter-group motivations

Participants in each group had a wide variation in their level of engagement with the cultural heritage context. With local groups particularly, some members were actively hostile towards the use of Explore by others. Participants appropriated different techniques to manage this degree of engagement. For example, one visitor being 'in charge' and filtering content to others. How applications can support this varying degree of engagement should be considered, as should supporting users to manage the tension within groups. As with prior guidelines, highly immersive experiences are not likely to be useful.

Support contextualisation of the current place

As cultural heritage access is not the primary goal of users, applications should not attempt to guide users, or require users to visit content in a specific order. As described by participants, Explore was treated as a contextual companion, illustrating relevant content around them, rather than controlling where they went. Narrative approaches are likely to be problematic as they often require users to move between locations in a particular way.

9. Limitations and future work

Whilst our participants did not have accessing cultural heritage of the island as the primary purpose of their visit, all used Explore during 'leisure' time. In a more urban environment, where participants might be going to the shops or work, and where cultural heritage content is more pervasive (such as argued by Han et al., 2014), would participants still be open to its use? Studying in such environments with users who have accessing such content as a tangential goal is much harder. Similarly, would users, as indicated by our local participants, be willing to use such a system over a longer term, with notifications as new content is uncovered, or would it become annoying? Based on the responses to demographic questionnaires we categorised our visitors into tourists and locals. This provided a useful categorisation of what brought individuals to the island that day, but as noted by Falk et al. (2008), is somewhat crude and provides only a basic level of interpretation as to what motivates individuals. Also, we had only one group of participants who were composed of a mixture of locals and tourists. This group provided little novel insight that was not also identified in local or tourist groups. However, we would have expected that more such groups would visit the island. Given the identity related roles of Falk (2016), particularly the facilitator role where members of a group are more focused on supporting the needs of others - implying a greater and lesser familiarity with the site which might be expected by mixed local and tourist groups - we cannot claim that the groups that

took part in our study are truly representative of all the groups that visit the island. However, our results reflect groups that visit and had some tangential interest in the island's heritage. Whilst our results imply that most visitors adopt behaviour towards Explore of the recharger or explorer roles (Falk, 2016), further study applying Falk's approach is necessary to deepen understanding of this. We are actively investigating these issues through the development of an Explore-like application that works over a city scale, and runs as a background process on an individual's smartphone. This will allow us to consider how cultural heritage access can be integrated into activities where it is not the primary activity individuals are engaged in.

10. Conclusions

As digital cultural heritage systems expand from defined, 'museum like' sites, new issues are raised about who the visitors to these sites are, as well as how and to what extent they would choose to engage with the cultural heritage present there. We have argued that it is important to start investigating interaction with digital cultural heritage as a tangential purpose to such visits, and why existing work does not do this. Our study on Seurasaari illustrated how accessing cultural heritage was a secondary purpose for many visitors. It also illustrated how a cultural heritage application can be used in this role, supporting awareness, whilst being integrated into the primary activity of the user. We hope future study in this area will help expand how we consider cultural heritage interfaces to work in much more diverse places.

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References

Aoki, P.M., Grinter, R.E., Hurst, A., Szymanski, M.H., Thornton, J.D., Woodruff, A., 2002. Sotto voce: exploring the interplay of conversation and mobile audio spaces. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. ACM, New York, NY, USA, pp. 431–438. https://doi.org/10.1145/503376.503454.

Ardito, C., Buono, P., Costabile, M.F., Lanzilotti, R., Pederson, T., Piccinno, A., 2008. Experiencing the past through the senses: an M-Learning game at archaeological parks. Multimedia, IEEE 15 (4), 76–81. https://doi.org/10.1109/MMUL.2008.87.

Audio Trails Limited, 2014. Newcastle Emlyn Heritage Trail.

Audio Trails Limited, 2016. Wild Wales App.

Ballagas, R., Kuntze, A., Walz, S.P., 2008. Gaming tourism: lessons from evaluating REXplorer, a pervasive game for tourists. Pervasive 2008. Springer-Verlag, Berlin, Heidelberg, pp. 244–261. https://doi.org/10.1007/978-3-540-79576-6_15.

Beard, J.G., Ragheb, M.G., 1980. Measuring leisure satisfaction. J. Leis. Res. 12 (1), 20.

Benford, S., Giannachi, G., 2008. Temporal trajectories in shared interactive narratives. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '08) 73–82. https://doi.org/10.1145/1357054.1357067.

Benford, S., Giannachi, G., 2009. From interaction to trajectories: designing coherent journeys through user experiences. CHI '09 Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. ACM Press, Boston, MA, USA, pp. 709–718. https://doi.org/10.1145/1518701.1518812.

Betsworth, L., Bowen, H., Robinson, S., Jones, M., 2014. Performative technologies for heritage site regeneration. Pers. Ubiquitous Comput. 18 (7), 1631–1650.

Ciolfi, L., 2013. The collaborative work of heritage: open challenges for CSCW. ECSCW 2013: Proceedings of the 13th European Conference on Computer Supported Cooperative Work, 21–25 September 2013, Paphos, Cyprus. Springer, pp. 83–101.

Ciolfi, L., 2015. Embodiment and place experience in heritage technology design. The International Handbooks of Museum Studies.

Ciolfi, L., Bannon, L.J., Fernström, M., 2008. Including visitor contributions in cultural heritage installations: designing for participation. Museum Manag. Curator. 23 (4), 353–365. https://doi.org/10.1080/09647770802517399.

Ciolfi, L., McLoughlin, M., 2012. Designing for meaningful visitor engagement at a living history museum. Proceedings of the 7th Nordic Conference on Human-Computer Interaction: Making Sense Through Design. ACM, New York, NY, USA, pp. 69–78.

Ciolfi, L., Petrelli, D., Caparrelli, F., Dulake, N., Goldberg, R., Marshall, M.T., Willox, M., 2013. Exploring historical, social and natural heritage. Proc. of NODEM 2013. pp. 1–8.

Costabile, M.F., De Angeli, A., Lanzilotti, R., Ardito, C., Buono, P., Pederson, T., 2008. Explore! Possibilities and challenges of mobile learning. CHI 2008. ACM Press, Florence, Italy, pp. 145–154.

Damala, A., Hornecker, E., van der Vaart, M., van Dijk, D., Ruthven, I., 2016. The Loupe:: tangible augmented reality for learning to look at Ancient Greek art. Int. J. Mediterr. Archaeol. Archaeom. 16 (5).

Dickens Museum, 2012. Dickens Trail App.

Falk, J.H., 2016. Identity and the Museum Visitor Experience. Routledge.

Falk, J.H., Heimlich, J., Bronnenkant, K., 2008. Using identity-related visit motivations as a tool for understanding adult zoo and aquarium visitors' meaning-making. Curator 51 (1), 55–79.

Fosh, L., Benford, S., Reeves, S., Koleva, B., Brundell, P., 2013. See me, feel me, touch me, hear me: trajectories and interpretation in a sculpture garden. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. ACM, New York, NY, USA, pp. 149–158. https://doi.org/10.1145/2470654.2470675.

Furniss, D., Blandford, A., Curzon, P., Mary, Q., 2011. Confessions from a grounded theory PhD : experiences and lessons learnt. CHI 2011. ACM Press, Vancouver, Canada.

Goffman, E., 1969. The Presentation of Self in Everyday Life. Penguin.

Han, K., Shih, P.C., Rosson, M.B., Carroll, J.M., 2014. Enhancing community awareness of and participation in local heritage with a mobile application. Proceedings of the 17th ACM Conference on Computer Supported Cooperative Work. ACM, New York, NY, USA, pp. 1144–1155. https://doi.org/10.1145/2531602.2531640.

Hood, M.G., 1989. Leisure criteria of family participation and nonparticipation in museums. Marriage Fam. Rev. 13 (3–4), 151–169.

Hornecker, E., Honauer, M., Ciolfi, L., 2014. Exploring historical cemeteries as a site for technological augmentation. iHCI 2014: Proceedings of the 8th Irish Human Computer Interaction Conference. pp. 93–964.

Manchester Metropolitan University, 2012. Manchester Time Machine.

Marshall, M.T., Petrelli, D., Dulake, N., Not, E., Marchesoni, M., Trenti, E., Pisetti, A., 2015. Audio-based narratives for the trenches of World War I: intertwining stories, places and interaction for an evocative experience. Int. J. Hum. Comput. Stud. 1–13.

Mazel, A., Galani, A., Maxwell, D., Sharpe, K., 2012. I want to be provoked': public involvement in the development of the Northumberland Rock Art on Mobile Phones project. World Archaeol. 44 (4), 592–611.

McGookin, D., Tahiroglu, K., Vaittinen, T., Kytö, M., Monastero, B., Vasquez, J.C., 2017. Exploring seasonality in mobile cultural heritage. Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems. ACM, New York, NY, USA, pp. 6101–6105.

McGookin, D., Vazquez-Alvarez, Y., Brewster, S., Bergstrom-Lehtovirta, J., 2012. Shaking the dead: multimodal location based experiences for un-stewarded archaeological sites. Proc. NordiCHI 2012. ACM, New York, NY, USA, pp. 199–208. https://doi.org/10.1145/2399016.2399048.

Morrison, A., McMillan, D., Reeves, S., Sherwood, S., Chalmers, M., 2012. A hybrid mass participation approach to mobile software trials. Proceedings of CHI 2012. ACM, New York, NY, USA, pp. 1311–1320. https://doi.org/10.1145/2208516.2208588.

Moussouri, T., 1997. Family Agendas and Family Learning in Hands-on Museums. Museum Studies Thesis).

Moussouri, T., Roussos, G., 2013. Examining the effect of visitor motivation on observed visit strategies using mobile computer technologies. Visitor Stud. 16 (1), 21–38.

Packer, J., Ballantyne, R., 2002. Motivational factors and the visitor experience: a comparison of three sites. Curator 45 (3), 183–198.

Park, A., Peng, C., 2016. The port of sheffield: co-creation in mobile application development for place-based interaction with large-scale urban heritage sites. Hist. Environ. 28 (2).

Petrelli, D., Ciolfi, L., van Dijk, D., Hornecker, E., Not, E., Schmidt, A., 2013. Integrating material and digital. Interactions 20 (4), 58–63. https://doi.org/10.1145/2486227.2486239.

Petrelli, D., Dulake, N., Marshall, M.T., Pisetti, A., Not, E., 2016. Voices from the war: design as a means of understanding the experience of visiting heritage. Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems. ACM, New York, NY, USA, pp. 1033–1044. https://doi.org/10.1145/2858036.2858287.

Petrelli, D., Marshall, M.T., O'Brien, S., McEntaggart, P., Gwilt, I., 2016. Tangible data souvenirs as a bridge between a physical museum visit and online digital experience. Pers. Ubiquitous Comput. 1–15. https://doi.org/10.1007/s00779-016-0993-x.

Pielot, M., de Oliveira, R., Kwak, H., Oliver, N., 2014. Didn't you see my message? Predicting attentiveness to mobile instant messages. Proceedings of the 32nd Annual ACM Conference on Human Factors in Computing Systems. ACM, Toronto, Ontario, Canada, pp. 3319–3328.

Rassmus-Gröhn, Kirsten, Szymczak, Delphine, Magnusson, Charlotte, 2013. The Time Machine–An Inclusive Tourist Guide Application Supporting Exploration. Oakley, Ian, Brewster, Stephen (Eds.), The Time Machine–An Inclusive Tourist Guide Application Supporting Exploration. Haptic and Audio Interaction Design 127–136. https://doi.org/10.1007/978-3-642-41068-0_14.

Reid, J., Geelhoed, E., Hull, R., Cater, C., Clayton, B., 2005. Parallel worlds: immersion in location-based experiences. CHI 2005. ACM, Portland, USA, pp. 1733–1736.

Reid, J., Geelhoed, E., Hull, R., Cater, K., Clayton, B., 2005. Parallel worlds: immersion in location-based experiences. CHI '05 Extended Abstracts on Human Factors in Computing Systems. ACM, New York, NY, USA, pp. 1733–1736. https://doi.org/10.1145/1056808.1057009.

Ritchie, J., 2013. The affordances and constraints of mobile locative narratives. In: Farman, J. (Ed.), The Mobile Story. Routledge, pp. 65–79.

Ritchie, J., Spencer, L., 1993. Qualitative data analysis for applied policy research. In: Bryman, A., Burgess, R. (Eds.), Analysing Qualitative Data. Routledge, London, pp. 173–194.

Sahami Shirazi, A., Henze, N., Dingler, T., Pielot, M., Weber, D., Schmidt, A., 2014. Large-scale assessment of mobile notifications. Proceedings of the SIGCHI Conference on

Human Factors in Computing Systems. ACM, New York, NY, USA, pp. 3055–3064. https://doi.org/10.1145/2556288.2557189.
Smith, L., 2011. The doing of heritage: heritage as performance. Performing Heritage: Research, Practice and Innovation in Museum Theatre and Live Interpretation. pp. 69–81.
Stanton, D., O'Malley, C., Hui Ng, K., Fraser, M., Benford, S., 2003. Situating historical events through mixed reality: adult-child interactions in the storytent. CSCL 2003. ISLS, Bergen, Norway, pp. 293–302.
Szymczak, D., Rassmus-Gröhn, K., Magnusson, C., Hedvall, P.-O., 2012. A real-world study of an audio-tactile tourist guide. Proceedings of the 14th International Conference on Human-Computer Interaction with Mobile Devices and Services. ACM, New York, NY, USA, pp. 335–344. https://doi.org/10.1145/2371574.2371627.
Tyne & Wear Archives and Museum, 2015. Hidden Newcastle.
Vaittinen, T., McGookin, D., 2016. Phases of urban tourists' exploratory navigation: a field study. Proceedings of the 2016 ACM Conference on Designing Interactive Systems. ACM, New York, NY, USA, pp. 1111–1122. https://doi.org/10.1145/2901790.2901795.
Vazquez-Alvarez, Y., Oakley, I., Brewster, S., 2011. Auditory display design for exploration in mobile audio-augmented reality. Pers. Ubiquitous Comput. 1–13.
Walker, K., 2008. Structuring visitor participation. pp. 109–124.
Waterson, N., Saunders, M., 2012. Delightfully lost: a new kind of wayfinding at kew. Museums and the Web.