

The Electronic Guidebook: A Study of User Experiences using Mobile Web Content in a Museum Setting

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Abstract

A study of fifteen is reported as part of a larger research project, The Electronic Guidebook, whose aims are to understand how the introduction of wireless technologies changes and augments user experiences at the Exploratorium, an interactive science museum. The main questions being addressed in this study are: How do users respond to a mobile web resource designed to improve and transform user experiences in a hands-on museum? This paper shares results from interviews with three categories of users: teachers, staff ‘explainers’, and visitors. Several recurring issues and themes emerged from our analyses such as users’ sense of isolation and user attempts to make a seamless experience between real-place and virtual contexts. Teachers, in particular, felt the mobile web content would be more useful as learning activities before and after museum visits. While majority of users expressed a concern that the handheld would interfere with exhibit play, these users also reported positive feedback about the mobile web content and demonstrated new ways in which this resource motivated new ways to think and play with exhibits. Additional insights are provided regarding the role of mobile web content in mediating user interactions including a framework under development for organizing interactions with handhelds.

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1. Introduction

The Electronic Guidebook research project began in 1998 at The Exploratorium, in partnership with researchers at Hewlett-Packard Labs and The Concord Consortium. (<http://www.exploratorium.edu/guidebook>). The Exploratorium is an interactive science museum housed in San Francisco's Palace of Fine Arts, a cavernous, semi-circular open space of over 110,000 square feet, with 50-foot ceilings. There are several hundred exhibits about science, art, and perception on display at a time, out of more than 650 designed on-site, and are frequently moved around as part of a continual prototyping process. Many of the exhibits are noisy and involve sand, electricity, magnetism, heat, water, and other potential hazards to wireless networks and mobile devices.

Because visitors spend about 30 seconds per exhibit in museums [1,2], a key notion was to support sustained inquiry in a "seamless visit" to the Exploratorium in which visitors could explore an idea before coming to the museum, experience a phenomena and/or test out ideas at the museum, and continue a personal investigation after leaving the museum setting. We wanted to avoid simply thinking of the handheld as a miniaturization of workstation desktop applications, but consider designing technologies that can fundamentally change user interactions in a productive way for learning, collaborating, and teaching in informal settings. To realize this vision, a test-bed and wireless infrastructure was created at the Exploratorium to conduct research about 1) information technology infrastructure (networked components delivering the information), 2) human computer interaction issues around form factors, content design, and handheld uses, and 3) the potential impact of wireless infrastructure and mobile web resources on teaching and learning science.

This paper focuses on a descriptive study conducted in the context of the Electronic Guidebook Project in which mobile web content was specifically created to explore and better understand user experiences with wireless handhelds while at the museum. Using an Electronic Guidebook, visitors might 1) access additional information about exhibits, 2) extend their interaction with exhibits by using the networked handheld devices to engage in measurement, data collection, and other experimentation to better understand the phenomena demonstrated by the exhibits, 3) use it as a support tool for explaining phenomena to others and mediating conversations, and 4) capture their museum experience through online records for later reflection or preparation for future visits.

First, we briefly describe the wireless infrastructure and mobile web content designed to support the research, present an evolving framework for organizing user interactions, and present findings and insights into user experiences with the Electronic Guidebook.

2. Wireless infrastructure and research test-bed

Early phases of the project tested different form factors of mobile devices and deployed a wireless network using a variety of handheld computers and radio-frequency identification (RFID) tags to link visitors with exhibit-related content delivered by a Web-based server [3,4]. To enable the handheld to be context-aware, a point-of-information station or ‘pi-station’ was designed to hold a HP Cooltown infrared beacon which sends the URL to a handheld that is in close proximity to an exhibit [5]. The web page corresponding to this URL is then automatically downloaded from the content server and displayed by the PDA's browser. This work demonstrated the feasibility of delivering text, images, digital audio and video over a wireless infrastructure to a handheld. In addition, users were able to construct a record of their visit by bookmarking exhibit content, taking digital pictures from a camera near the exhibit, and accessing this information later on a personal “MyExploratorium” Web page in the museum or following their visit (Figure 1).

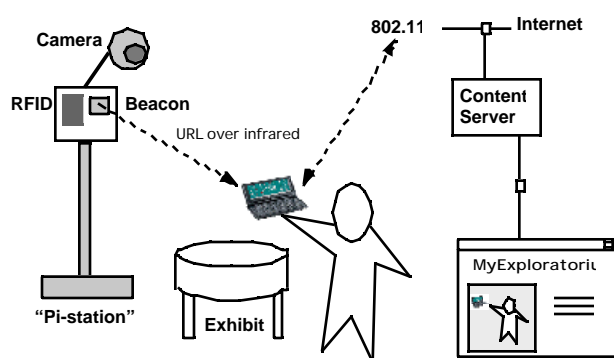


Figure 1: Wireless set-up for the Electronic Guidebook Project at the Exploratorium

3. Framework for organizing user interactions

With a wireless infrastructure in place and proof-of-concept studies completed, we began to conduct more in-depth studies into user experiences as pre-cursors to formal learning studies.

The concept of wireless web access is not new. Wireless handhelds have been explored in situations as diverse as science centers, convention centers, transit stations, sports arenas, community centers, public parks, libraries, and museums as nomadic information guides [6-14]. Several innovative technology research projects have demonstrated the use of PDAs for mobile inquiry learning

and education in informal settings. Handheld computers have been used to augment classroom learning and project-based science activities in outdoor settings [15-16]. Using probeware (e.g. portable computer and sensors) learners can carry out personal investigations, collect real-time data from streams or local ponds, and interpret the graphical results while still in the field [17,18].

Our approach to supporting mobile inquiry opportunities was driven by a theoretical interest in understanding how users negotiate and bridge virtual and physical contexts, and the specific role that ubiquitous technologies can be used to dynamically support learners in mobile inquiry.

Inquiry is an approach to science teaching and learning in which learners readily engage in the process of exploration, observation, critique, and investigation [19]. Learners sort out information, conduct investigations to satisfy their own questions, and are willing to revise explanations as they gain new knowledge. Mobile inquiry presents many opportunities to select ‘driving questions’ and to answer them using resources drawn from different contexts because the participant is able to move between physical contexts such as a classroom/office, a museum, the outdoors, a car, or home. The support of mobile inquiry poses several interesting challenges in designing or orchestrating a user experience that supports smooth transitions between these physical contexts as well as between virtual and social contexts. The handheld presents the virtual context that contains its own set of representations, identities, and pathways into other virtual interactions and web resources. Are users able to support and engage in mobile inquiry, attend to competing physical and virtual resources, and reconcile these multiple contexts into a “seamless visit” to the Exploratorium?

In this study, we were specifically interested in understanding ways in which wireless handheld resources could be useful for different users in a context like the Exploratorium before studying before-museum and after-museum contexts. Unlike prior work done with Electronic Guidebooks in museums [20], our museum environment was noisy and the exhibits involved hands-on manipulation. We hypothesize that not only visitors could benefit from such a resource, but other audiences as well in their role as teachers, museum staff, and Explainers¹. Moreover, while our future goal is to study

¹ Explainers are student volunteers and staff between the ages of 15 and 20 who serve as the primary point of contact with the general public. Explainers stand around exhibits and explain how the exhibits work, perform demonstrations, and help maintain exhibits.

'learning conversations' among groups of users [21], we wanted to first clarify phenomena of interest and identify which interactions were valuable to explore further, thus focusing on the individual as a unit of analysis.

We began by identifying and categorizing typical user interactions in museum settings into a working framework, drawing upon earlier studies and concurrent research with the Electronic Guidebook (Figure 2) [4,5]. Our framework helped to distinguish the types and ranges of interactions possible. Recognizing that a mobile device could be designed to support many different kinds of functions and interactions, and that researching all interactions simultaneously would not be a fruitful approach, we focused initially upon the design of the mobile web content for exploring, requesting information, explaining, and recommending.

- | | |
|------------------------------|---|
| 1. Exploring | * Hands-free: the device is tracking in background |
| 2. Requesting information | * Looking up exhibit background information
Searching in a digital library |
| 3. Documenting / Remembering | * Taking a picture/videos
* Bookmarking
Taking field notes
Recording a noise/voice |
| 5. Recommending / Guiding | * Suggesting ways to play with exhibit
Seeking expert-generated advice
Posing a question for immediate answer |
| 6. Explaining | * Providing scientific explanations
Getting cognitive guidance as hints or prompts |
| 7. Investigating | Collecting real-time data
Making conjectures or predictions
Graphing data
Drawing conclusions |
| 8. Model-making | Manipulating models and data
Making representations |
| 9. Communicating | Instant messaging, Polling, Paging |
| 10. Assessing | Self-assessment
Peer assessment
Learner assessment by teacher |

Figure 2: Framework for organizing user interactions with wireless handheld in Informal Learning Contexts. Resources were designed for the asterisked items.

4. Mobile web content resources

A collection of handheld resources were developed by the Exploratorium staff for the HP Jornada 690/720 model. This device was selected because it provided a larger screen size (16.7 cm, 640 x 240 pixels), wireless capabilities, and a longer battery life than other Palm-sized models, yet also reasonable in weight compared to devices like the Hitachi ePlate.

The exhibits (Spinning Blackboard, String Squirter, Echo Tube, Humming Plates, Aeolean Landscape) ranged from being highly interactive and playful involving the use of two hands (e.g. Humming Plates) to contemplative exhibits involving just observation and reflection (e.g. Aeolean Landscape). These exhibits were also selected in part because there was a rich set of supplemental materials already available that could be turned into handheld multimedia resources. With limited screen real estate, resources were deliberately designed to have navigation via tapping on screen pictures and short text using a stylus. Applying the design principles provided by Woodruff et al. proved useful for shaping the content design for our Electronic Guidebook [20].

The mobile web content contained different types of information that could be mapped to the framework: background information such as the history and evolution of the exhibit, "try this" activities, user contributed responses (i.e. users can enter in their observations, theories, read ideas of others), digital videos of possible ways to play with the exhibit, explanations both text, audio, and digital video links to other related exhibits on the floor, and links to real-world phenomena found outside the museum. In addition, the user could bookmark pages on the handheld to support the function of remembering.

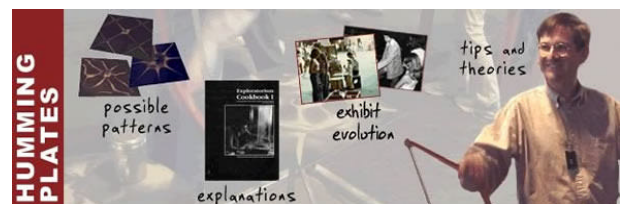


Figure 3: Sample screen of mobile web content. Users tap on images and text to see more information about the Humming Plates exhibit.

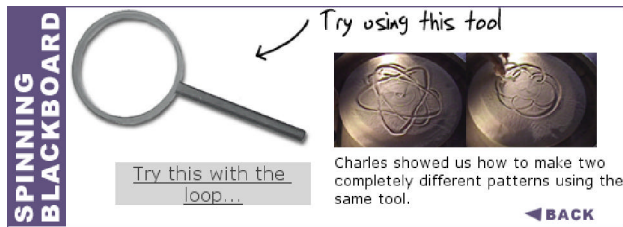


Figure 4: Mobile web content suggesting ways to play with the Spinning Blackboard exhibit. Tapping on the right pictures open a digital video.

5. Methods

Three categories of users were selected to participate in the study: Explainers (early college students and high school student volunteers), science teachers, and museum member visitors. After giving the participant 5 minutes of training on the handheld, researchers then shadowed an individual user for about 45 minutes while s/he visited the exhibits. A participant could navigate the handheld to find particular online resources for any of the five exhibits, or see a page automatically when the participant came in close proximity to the exhibit.

While on the floor, user utterances were captured using a wireless microphone and recorded onto audiotape. Researchers took field observations and noted when the attention of the users were in the virtual space (i.e. the handheld) and when they were playing with the exhibit, transitions, how long they spent at each exhibit, as well as other signifiers that marked the beginning and end of episodes. After visiting the exhibits, a participant was then interviewed using a semi-structured approach for about 45 minutes. Users were both asked about their background, opinions about the mobile web content, explanations of their actions, functionalities they liked/disliked, and speculations about potential uses for this technology in their particular role as a teacher, visitor or Explainer.

The interviews were transcribed, then reviewed by two researchers who mark user comments that were of interest with regard to the framework (Figure 2) as well as other comments that stood out on their own. From this review, several emergent themes were first identified. The interview data was analyzed a second time for the presence or absence of particular themes for each category of user to determine the final 'identified' themes' (Table 1).

6. Themes and Findings

Although three sources of data were collected (field observations, interviews, and log files), the interview data from teachers, explainers and visitors are reported at this

time. See Table 1 for an overview of the interview results.

IDENTIFIED THEME	T (%)	V (%)	E (%)
ANTHROPOMORPHIC	0	25	33
CUSTOMIZABLE	40	50	50
DIRECTIVE	20	25	0
DISCOVERY	0	25	50
EXPLANATIONS	40	0	83
EXHIBIT HISTORY	0	25	5
FAQS	20	25	33
USER INPUT	20	0	50
EXHIBIT LINKING	20	0	50
RECORD EXPERIENCE- photo, bookmark	20	25	50
EXTEND EXPERIENCE – pre-museum, post museum	80	50	33
ISOLATION - less hands-on	100	50	50
ISOLATION - less social	40	25	33
MOTIVATES DOING	80	75	67
MOTIVATES THINKING	60	25	67
NOVELTY	40	0	33
SOCIAL IDENTITY	40	0	50
V/R-PROBE/INSTRUMENT	0	0	50
V/R - SEAMLESS REPRESENTATION	100	75	50

(T = teachers, V = visitor members, E = explainers)

Table 1: The percentage of users (teachers, visitors, and explainers) who articulated in the interview an identified theme.

A sense of isolation (Isolation theme)

While on the exhibit floor, users were observed to move smoothly between looking at handheld resources and playing with the exhibit. Typically, a user would hold the handheld in one hand to watch a video, listen to an audio track, or read text, then manipulate the exhibit with the other hand (e.g. turning a knob, drawing a sand pattern, rosing a bow). On occasion, a user would interact with another person to show the handheld resource to someone else on the exhibit floor. When the exhibit involved two hands to operate, the user would either put the handheld down on a table or put it into a pouch held by a shoulder strap. Users appeared to switch their attention back and forth easily between the handheld and the exhibit. Nonetheless, users found that the handheld contributed to

a sense of isolation, both from less social interaction with others in the museum as well as interference from playing with exhibits.

"It was more like you were interacting more with the handheld than the exhibit. That (the handheld) becomes almost the primary exhibit."

"I didn't really notice other people; I wasn't paying to anybody except for reading the screen."

"I found it distracting from the hands because the reason to come to a hands-on museum is to interact with exhibits"

"I was actually surprised by how much I didn't realize I was in a museum, because I suddenly became so focused on the screen, which sort of takes away from the experience because part of what I like about being here is that it's such an open place. It's a nice place to talk around and just watch other people playing with things."

Because users were wearing one-eared headphones that were plugged into the handheld hear audio, we suspect that might have also contributed to a sense of isolation. Given the high level of ambient noise at the Exploratorium, users had to wear an earphone or watch videos with no audio. Two users used these analogies to describe their experience with the handheld:

"It's like a car window that separates you from reality"

"It's kind of like going to a party and reading a book."

In our context in which users were not given a particular problem to solve or group task to accomplish, users, especially teachers, felt the handheld limited exhibit play. Teachers, however, were encouraged by the idea of using a handheld for instructional activities before and after a museum visit, and using the handheld for students in a structured activity while at the museum (i.e. Extending Experience theme).

Integrating real-place and virtual contexts (V/R theme)

There were two related themes in the area of bridging virtual (handheld) and real (exhibit) contexts. Some Explainers wanted to bridge real (exhibit) and virtual (handheld) by engaging the handheld as an integral part of

an exhibit, such as using the handheld as an audio recorder, data collection, or probing device.

"It would be really cool if it had a microphone hooked-up to it (handheld) and I said something in and it went right into the computer and showed me what it looked like, that would be cool."

Other users made attempts to create a shared attention space to integrate virtual and real world contexts, especially the more contemplative exhibits only required one hand to operate. Users could watch a video and compare the video to the real exhibit on the floor. Users could also listen to audio while playing with an exhibit without the need to switch their focus. However, reconciling the virtual context and the physical context was difficult when anchors such as physical artifacts or pictorial representations were missing. For example, the online pages for the Echo Tube exhibit suggests using time to measure the length of the Echo Tube using a stopwatch. And, in the online pages for the Spinning Blackboard exhibit, the digital videos showed special tools used to create patterns in the sand (Figure 4). Users were actively switching attention between the exhibit and the handheld, looking for these tools to try out suggested activities ("try this" content) and often disappointed when there was not a seamless mapping between the handheld, the content represented in the handheld, and the real exhibit.

(Interviewer: What there something in this experience that was enjoyable/ lacking?)

"There's no stop watch there so you can actually do it there."

"All the tools. One thing about having this video, you have to make sure that all the tools (artifacts) are out there. Everything in the exhibit (online) is out there that's being explained. Then, you feel kinda left out."

"Spinning Blackboard (exhibit), I could see how it would work if the proper tools at the exhibit, which we didn't"

Some users also expected the same text from the exhibit signage to exist in the handheld to see if there was a coherent mapping between the exhibit and the content in the device, while others did not want to see any duplication with information found in the real world and the handheld resource. This suggests a need to improve ways to orchestrate activity between the handheld and the exhibit, align museum floor artifacts and virtual

information, and understand what kinds of ‘content bridges’ might be helpful to build a seamless experience such as the suggestive “try this” type videos and audio.

Mobile web content - explanations, exhibit history, and social identity theme

Users were asked which kind of mobile content resource they enjoyed the most. Some users, especially Explainers, reported they were drawn to explanations, videos, and histories of the exhibit and other explanations provided by other museum staff. Because users recognized particular people (i.e. social identity), they also chose to spend their time looking at those resources.

“The videos I found fun because I knew the people in the videos, not because I was interested in what they were doing.”

“Being able to see Paul. It’s fun, his stuff is always good, its way beyond.”

“It was fun to see all the people I knew, seeing them explaining things.”

Some visitors and explainers also mentioned that they liked the videos that were anthropomorphic:

“I like the video clips, not just the kind of showing or demonstrations, but just the actual person talking in detail about something. I think it’s a nice, personable touch, ironically delivered on a completely impersonal device, but it adds a nice human touch and warms up the experience...I liked the human piece of it.”

Being told versus figuring it out on your own (Directive vs. Discovery Theme)

Users has different preferences for how they used and wanted to use handheld in their Exploratorium experience. Some users felt the handheld should only be used after playing first, while others felt it was necessary because you might ‘do it wrong.’ Both kinds of users were observed in this pattern of behavior.

“You always want to know why it works, why it does what it does. When you figure that out, then you understanding it more, THEN, you can finally start to sink your hands in it and play with it.”

“You have this handheld that is trying to tell you information, which is great to know the

information, but I would rather play with the exhibit and later, when I came again or in the future, I would want to know further explanations.”

“It would take away from my experience if I was told other secret things about how to figure it out or how to play with it.’

Enjoyable experience using mobile web content – (Motivates thinking and Motivates thinking theme)

A majority of users reported (and demonstrated via field observations) that the handheld resources motivated and prompted new ways to play with the exhibit as well as prompted them to think further about many ideas inspired by the mobile web content.

7. Summary & Next Steps

The Electronic Guidebook project continues to advance and refine a wireless test-bed and infrastructure for research about wireless technologies to support user experiences at the Exploratorium, a rich and dynamic, yet challenging context of study. We plan further data analysis of user activity including groups to help inform the design of mobile web content to support a ‘seamless visit’ and to refine our framework. With triangulation of our other data sources, we can better understand which mobile content is useful for mediating interaction and conversation in informal settings.

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