

Mobilizing the past for the present and the future: Design-based research of a model for interactive, informal history lessons

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Abstract: Informal history education, including many popular museum learning studies, have shown that mobile media objects, such as apps, quickly could become critical parts of the predominate learning technologies of the future. In the process, this could lessen the overall pedagogical focus for history education on aural transmission, such as lecturing, as well as traditional media delivery systems, such as printed books. Having “an app for that,” though, is just the start of the process of developing effective, efficient, and evocative learning systems. This case study describes a National Endowment for the Humanities-funded mobile app designed in situ and deployed at a National Historic Site with the goal of creating a mobile learning model for the National Park Service. An evaluation of the app module was conducted using a LORI-scale to assess the efforts as they related to informal history learning objectives. This evaluation identified potential best practices for the design of these types of mobile apps, such as interactive activities enabled by the mobile technology, as well as opportunities for improvement in the design of such learning systems.

Keywords: mobile, app, design, design-based research, national historic site.

I. Introduction.

While most of adult learning already happens informally, students of all ages increasingly are becoming disassociated from the teaching and learning of institutional educational contexts (Jones, Scanlon, & Clough, 2013; Lim, Zhao, Tondeur, Chai, & Tsai, 2013). Educators, in turn, have begun reaching out and exploring the potential of mobile technologies as ways to reconnect with learners, through emerging mobile systems that offer powerful pedagogical tools, flexible student scaffolding support, and engaging delivery platforms. Anytime and anyplace, educators suddenly can commune with a learner, without traditional boundaries of time and place, or with the added richness of specific times and places. Mobile technologies have affordances that can expand access to learners in authentic contexts, in which learners continually connect with accessed information, or theoretical knowledge, with the situated knowledge of the environment (Martin & Ertzberger, 2013). Such integration of mobile technologies into varied learning contexts – both traditional and nontraditional -- requires organizational shifts while also demanding innovations that expand openness and responsiveness to new learning environments; these are major changes that many organizational frameworks can be slow to embrace (Cavanaugh, Hargis, Munns, & Kamali, 2012). Despite such potential, though, the combination of mobile technologies and informal learning structures has received relatively miniscule academic attention, especially from researchers approaching the topic with a design-based perspective (Jones, Scanlon, & Clough, 2013). Scholars also have spent a lot of time and effort understanding early formative stages of app design as well as final stages of deployment (Kim,

2005). But an additional gap exists in the literature for refinement of prototypes that are a few iterations into their developments, as a way to establish best practices for sustained improvement of ideas throughout the design process. Of primary concern in this article, then, is the ways in which mobile technologies, and tailored, place-based media, could offer unrealized potential for improving history teaching and learning as well as provide engaging and interactive options that could help to redefine the field. Therefore, in an effort to explore such possibilities through design-based research, a mobile app prototype was designed, built, and launched at a National Historic Site in the Pacific Northwest (Fort Vancouver), and then evaluated using a Learning Object Review Instrument (LORI) scale analysis.

Within the related educational technology literature, a serious and pervasive issue is raised, identified generally as the widening gap between the researcher and the practitioner communities, creating a significant communication chasm between the educational system developers and the educators who eventually adopt (or reject) such systems. This phenomenon is illustrated by the shrinking frequency of system and/or model design research papers being cited in the field (Kinshuk, Huang, Sampson, & Chen, 2013). From a practical viewpoint, researchers who do not develop mobile apps tend to only have access to -- and interest in -- the design process at the beginning and end of projects, when clear stages of development are established and apparent. Yet many of the most significant design decisions actually arise during the in-between moments, and only the most attentive, engaged, and committed members of the project, such as the design team members, are present for those moments.

In response, as a Call to Action to face the “grand challenges” of e-Learning in the 21st century, Psocka (2013) suggested that new leaders and a more modular educational system are needed to expand the classroom into more informal settings and to broaden the attention educators pay to modular design. Psocka added that exploring embedded or augmented realities could be extremely valuable paths of inquiry. Motivated by such sentiments, this article attempts to address the gap between researchers and practitioners by reflectively describing the design, creation, and implementation of a mobile learning object in an informal educational setting (at a national historic site) and then demonstrating how a scholarly instrument can be used as an intermediate step – between the early user-centered development of a learning object and the wide public release of it -- for evaluating such a mobile learning object and guiding its future developments.

Although the label “learning objects” has been defined differently by many researchers and organizations, the most frequently cited definition of a learning object is: “any entity, digital or non-digital, which can be used, re-used, or referenced during technology supported learning” (IEEE, 2005). Traditionally, learning objects included images, simulations, texts, etc. More contemporary digital technologies, including mobile apps, also can be regarded as learning objects. One tool that extensively has been researched and used for evaluation of learning objects is called the *Learning Object Review Instrument* (LORI; see Leacock & Nesbit, 2007; Nesbit & Belfer, 2004; Vargo, Nesbit, Belfer, & Archambault, 2003). A LORI analysis, then, is specifically used to evaluate e-learning resources. The instrument was developed by John Nesbit and colleagues at Simon Fraser University and consists of rubrics and rating scales as well as comment fields to provide qualitative support for the ratings.

LORI has nine items that can be rated and used as metrics for evaluating a learning object. These items include content quality, learning goal alignment, feedback and adaptation, motivation, presentation design, interaction usability, accessibility, reusability and standards compliance. Each item is evaluated on a rating scale of 5 levels ranging from 1 (Low) to 5

(High). Evaluators may opt out of scoring a learning object on a particular item if the item is not relevant to the learning object, or alternatively, if the evaluator does not have sufficient knowledge on that item. In such circumstances, a “non-applicable” (NA) rating could be assigned. For more information on LORI analysis and its use, please refer to Leacock and Nesbit (2007).

As design-based research demands, cyclical stages of analysis of user feedback and redesign are key components of the iterative process integrated into learning object improvement. But scholarly interventions into this process, and as another source of design feedback, are not common, perpetuating the gap between researchers and practitioners.

Hence, the present study investigates these core research questions:

- How does design-based research, through an action-research methodology, affect the creation of a learning object in the form of a mobile application?
- And, as part of that design process, how does applying a scholarly intervention, in the form of a Learning Object Review Instrument (LORI) analysis, affect the development process?

This study, in turn, will describe design-based research as the perspective within which different methodologies, such as action research, can function to shrink gaps between the academy and the industry. User-centered design principles, as part of action research methodologies, are critical to the development of learning objects in many ways, which have been studied in depth (Wallach & Scholz, 2012). This article, instead, focuses on an intermediate step within the design process, in which user-centered design principles have been applied, through a design-based action-research paradigm, and a checkpoint is chosen for an academic evaluation tool – the Learning Object Review Instrument (LORI) -- to intervene. Such formative evaluation tools are intended to provide evidence about the design and value of learning objects, providing expectations of the effects, against which further design iterations could be made and studies could be conducted with actual users to compare results against those expectations (Akpinar, 2008).

II. Developing design-based research through action research.

The design-based research perspective – proposed and developed at first by Brown (1992) and Collins (1992) -- is known by many names, such as design science, design research, design experiments, design studies, development research, developmental research, formative research, and action research. As a broad research label, design-based research typically describes methods that integrate the design of learning environments with the development of theories of learning, in authentic settings, through continuous cycles of design, enactment, analysis, and redesign (Design-Based Research Collective, 2003). Design-based research, in turn, has been proposed as a solution for bridging the gap between research and practice, and it also has been framed as having the flexibility to include a variety of research methods, including action research, in the pursuit of solving a particular kind of research problem: the design problem. In such cases, the researcher acts like a “designer,” to create a blueprint of a solution, based on existing knowledge about the way organizations work. These solution concepts are like designs that consciously and explicitly have been designed before they are used and then are redesigned several times to improve them; these designs also are tested to check their validity, including with action-research type interventions (Wang & Hannafin, 2005; Andrieseen, 2007). While not framed by a single method, design-based research instead uses various methods, such as action-research methods, to

triangulate multiple sources and kinds of data to connect intended and unintended outcomes and to link processes of enactment to outcomes, generating knowledge with direct application to educational practice. In short, the design of innovations enable researchers to create learning conditions that learning theory suggests are productive but that are not commonly practiced, or, are not well understood; methods that document those processes of enactment provide critical evidence to establish warrants as to why particular outcomes occurred (Design-Based Research Collective, 2003).

If the essence of research, in general, is creating new knowledge, action research does that through inquiries conducted within specific and often practical contexts (Koshy, 2005). Traditional predictive research of educational technologies has had limited impact in informing actual use, but recognizing technology as a constructivist process has many potential implications for bringing the technology to the foreground, for deeper understandings of the process and more-focused insider investigations (Amiel & Reeves, 2008). The action-research mantra, established by Fals Borda (1979), is to: “investigate reality in order to transform it” and transform reality in order to investigate it (Kemmis, 2006, p. 470). To follow that mantra, a fundamental binary choice had to be made at the onset of this research process. That was to decide whether the work would be done from an outsider’s or an insider’s perspective, to establish the positionality of the researcher to the research. The interpretive perspective, from which design-based research and action research generates, acknowledges the researcher as an insider, as a part of the fabric of the inquiry, and an indivisible element of the environment, within which people, including the researcher, are interacting (McNiff & Whitehead, 2006).

A model manifestation of this type of situated knowledge is the study of history, which is being continually shaped and contextualized by social and cultural factors. From traditional educational perspectives, history education has been foundering in the United States, with national test scores as well as funding in the field generally remaining stagnant, or declining, for decades (Symcox, 2012; United States Department of Education, 2010; Yarema, 2002). The effectiveness of traditional lecture-based pedagogy, presented in formal contexts, meanwhile has been questioned, and a variety of new methods for learning history have been proposed, including those enabled by technological advances, such as learning with mobile devices (Hung, Hwang, Lin, Wu, & Su, 2013; Kearney, Schuck, Burden, & Aubusson, 2012; Rogers, Connelly, Hazelwood, & Tedesco, 2010; Vavoula & Sharples, 2009; Lee, Doolittle, & Hicks, 2006). While no known studies suggest that history educators simply need to lecture more, or write more books, for the field to thrive once again, a flurry of recent field studies – focused on informal learning environments, such as museums – suggest ideas that new digital media forms could help to change the trajectory of history education in positive directions (Huang, Liu, Lee, & Huang, 2012; Sedano, Sutinen, Vinni, & Laine, 2012; Cho, Yeh, Cheng, & Chang, 2012). Fueled by pedagogical successes established and documented in informal settings, formal classroom environments might expand their boundaries and benefit from such experiences, too, through more educators experimenting with mobile technologies. Mobile apps can embody that potential cross-over platform by bridging informal and formal learning, and they appear particularly poised to benefit history educators, from a variety of different perspectives and in a variety of different ways, as numerous studies have shown (Farman, 2012; Gordon & de Souza e Silva, 2011; Sharples, Taylor, & Vavoula, 2010; de Souza e Silva & Hjorth, 2009; Crow, Longford, Sawchuck, & Zeffiro, 2009; Akkerman, Admiraal, & Huijzena, 2009; Azaryahu & Foote, 2008; Raessens, 2007).

The American Historical Association (2008), when presented with the fundamental question of “Why Study History,” offered two core defenses: 1. History helps us understand people and societies, and 2. History helps us understand change and how the society we live in came to be, by showing what elements of an institution persist despite change. Within that reasoning, then, history also provides people ways in which to understand their own lives as well as offers a moral compass, a source of identity, and paths to better citizenship.

From the mobile-app development perspective, a thorough examination of the myriad of issues facing the U.S. history education system or a fundamental argument for history education as a core component of a liberal arts agenda, is beyond the scope of this article. This piece instead makes the assumptions that history should be vigorously taught throughout formal and informal educational systems and that simply providing more of the same traditional pedagogy will not lead to a resurgence of this field, any more than requiring broccoli to be served in schools will lead to better overall student health and wellness. The intent here, then, is to explore the space between -- and to find common ground among -- the research and practitioner communities through close examination of possibilities afforded by dynamic mobile technologies and interactive, place-based media. The design-based-research approach allows new forms to emerge and to be tested in real-life environments and scenarios, vetted by established criteria. In this case, the new form is a mobile app, created at a national historic site, and analyzed through the perspective of a LORI-scale analysis.

The research site, Fort Vancouver, was the regional trading hub of the Hudson’s Bay Company in the mid-1800s; a massive operation for its time, on the north bank of the Columbia River, a place near present-day Portland, OR. The British contracted Hawaiian laborers and brought them to the Pacific Northwest by the hundreds to work in the booming fur trade. When the furs were gone, and the United States wanted the property, the company moved north to what is now Canada. But many of the Hawaiians remained in the area, helping to form the culture of the region. The mobile app module “Kanaka,” which translates to “Hawaiian,” was created during this research process to tell the Hawaiian story while experimenting with mobile technologies. Congress designated Fort Vancouver as a national historic site in 1961, and substantial reconstruction of the fort and its surroundings, plus active educational programming, have brought hundreds of thousands of schoolchildren, as well as lifelong-learning adults, back to Fort Vancouver in the decades since.

From a design-based and action-research perspective, envisioning this site as an informal classroom of sorts, this case study is intended to demonstrate ways in which a mobile app could improve history pedagogy not only in this particular place, under these specific circumstances, but as a model for use in other contexts, with different content. As such, this research project originated not from a specific interest in regional history, or historical interpretation, or even mobile devices in general. Its inspiration came from a recognition of – as well as a curiosity about -- the emergence of the ability of mobile devices to “see” places in different ways -- as far back in time and with as much detail as one wanted -- characterized as the “dynamic peephole interface” (Rohs, Schoning, Raubal, Essl, & Kruger, 2009, p. 1; Hurst & Bilyalov, 2010, p. 1). Indeed, Hight (2003, p. 6) envisioned such place-based media composition through mobile devices as “narrative archaeology,” in which the author, by composing and embedding narratives and sound in physical locations, is “establishing artifacts culled from layers in time.” Examining that phenomenon within a history education format simply became a logical extension of the idea.

With such a perspective, this study focused on the material, concrete, and particular practices of particular people in particular places, in the “here and now.” Rather than taking a more abstract view that construes -- but does not constitute – practice, this research approach aimed to demonstrate that understanding comes from clear awareness of social and educational practices in situ. That focus meant the emphasis for interpretations are drawn from the product of the specific material, social, and historical circumstances that produced the practices, and by which, they are reproduced regularly through social interaction in the particular setting (Kemmis & McTaggart, 2005).

While supporting creative freedom and innovation in research, such an action-based cultural heritage project with a multimodal emphasis, like this Fort Vancouver Mobile project, also builds skills and experience. Those developments, at least in this particular case, come in various styles of writing, editing, graphic design, photography, videography, collaboration, team coordination, public relations, marketing, and computer and Internet technologies. In addition, the public benefits as well from such an app being created (Henson, 2005). Hundreds of people get involved in the app development, testing, and use, gaining access to historical material in innovative digital forms as well as building a new community of people interested in such mobile historical interpretation, around the process of creating the project.

Core action-research goals are to improve practice and develop individuals as well as to transform practice and participants (Herr & Anderson, 2005). “When we build, we do more than create content,” wrote Thomas and Brown (2011, p. 94). “Thanks to new technologies, we also create context by building within a particular environment, often providing links or creating connections and juxtapositions to give meaning to content.” They added (p. 96), “By participating in the making of meaning, we also learn how to judge and evaluate it, giving special sensitivity to the ways information can be shaped, positively as well as negatively.” During such a process, the creator transcends “from experience to embodiment, where the personal investment in technology and digital media changes the focus from social agency to personal agency. When that happens, technology and digital media begin to be viewed as an extension of oneself” (p. 103). To then assess the app product and its effectiveness as a learning tool, an independent evaluation was conducted using the Learning Object Review Instrument (LORI, Leacock & Nesbit, 2007). Descriptions of the LORI evaluation of the app are presented in the results section.

III. Methods.

Design-based research has been heralded as a practical methodological approach, developed to bridge the research and practice communities in education. This puts an analytical focus on learning environments that are designed and systematically manipulated by a researcher to address a localized issue. By closely examining a single, dynamic, built environment, like the one created with the “Kanaka” module, new theories, artifacts, and practices can be established and transferred to other learning situations (Barab, 2006; Anderson & Shattuck, 2012). Yet design-based research also has been critiqued, primarily because of the positionality of the researcher, and how bias might affect the assertions being made (Barab & Squire, 2004). With awareness of this criticism, and mindfulness about how the positionality creates skew, design-based researchers recognize bias not as a flaw within the system but as a fundamental aspect of the personal way of knowing, as outlined by Polanyi (1962). From this perspective, an important part of the research methodology is determining what gets reported and what is left out. As a

brief elaboration, to begin to describe what the Fort Vancouver Mobile app became during this design-based research process involves also acknowledging what parts of the endeavor will remain otherwise unmentioned, due to space constraints. To call this project an app is to flatten the hundreds of iterations of this app into a single piece of mobile software, frozen in time, despite the fact that with mobile development, the creation and refinement process is fluid and never really ends. Since this app was launched to the public in June 2012, many more versions of it have been uploaded, and the app today maintains mostly familial resemblances to the app described here. In addition, this accounting of the app development process will not describe in depth the dozens of meetings and site visits; the thousands of pages of historic source material examined, including maps, images, and journals, which then laboriously were remediated into digital forms; the countless number of informal conversations, ranging from information gathering exchanges to formal partnership building; or the innumerable dead ends as well as pilot tests and experiments that ensued. Instead of aiming for such a book-length breadth and depth of coverage, this article focuses upon the intermediate step of the LORI analysis, providing relevant context about the decision points during the previous and latter stages of development, as a way to situate the study as part of iterative design cycles, with the first primary decision point being to determine the research place.

A. Choosing a place and a story to remediate.

The Fort Vancouver National Historic Site was chosen as the test site, primarily because of its affiliation with the National Park Service, its 1 million annual visitors, its many supporting amenities, its location near the main north-south highway on the West Coast (Interstate 5), and the eagerness of the staff to participate in the project. The main attraction of this site was the reconstructed Hudson's Bay Company stockade, which presented an atmosphere like a scaled-down version of Colonial Williamsburg, with costumed interpreters, regular demonstrations of period arts and crafts, and other interpretive activities. Within the fort grounds, The Village area (see Figure 1) was designated as the area in which the app would attempt to interpret, and within that area, historically, the tales of the native Hawaiians were considered the richest and with the most potential. In The Village, a wayside sign marked the entrance, and another one had been placed in front of the westernmost of the two small houses (see Figure 1). Otherwise, no traditional media was being offered in the immediate vicinity, and the houses were kept empty and locked, meaning the media richness value was quite low, except during rare special events that included live demonstrations and costumed interpreters. This dynamic offered a relatively controlled – and controllable – setting, akin to other unstaffed National Park Service sites. The Village therefore could be considered a model mobile learning environment, in that it is fully mediated, through curatorial



Figure 1. The Village area of the Fort Vancouver National Historic Site, as seen from the Maya Lin-designed Land Bridge.

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reconstructions, grounds maintenance, and the educational content available, and the juxtaposition of the digital and the physical could be kept in rough balance. Without the mobile app, visitors to this site encountered little in terms of historical context and guided pedagogical scaffolding. During the development process, the staff members expressed assumptions that visitors to this part of the 350-acre campus would enjoy and appreciate technological assistance in learning about the place, through electronic media, but rather than start by testing those base assumptions, we made the decision, per Herr and Anderson (1999), to begin by doing something with mobile technology in The Village to allow observation of how users responded to the progressively higher fidelity versions of the app. Design-based research, at its core, involves numerous decisions like that, large and small, and is aligned with other traditional research principles in terms of being inherently systematic and done in an effort to produce knowledge. The purpose of such an approach, according to Giacomini and Cook (2000, p. 480), is to offer a “window-like” or “mirror-like” view on the specific situation or phenomenon being studied (Koerber & McMichael, 2008). As part of the action-research framework, the techniques for inquiry were practical, cyclical, and problem-solving by nature, meant to generate change and improvement at the local level (Taylor et al., 2006). Also embedded within this type of research is the idea that the builders of a system gain knowledge in ways that an observer cannot.

Through this process, the interactive design for the app module began to develop generally around the idea that Hawaiian coral had been found at the site, and the Fort Vancouver staff would like the visitor to help unravel the mystery of why it was there, and what that information could reveal about the people who lived in this place during the apex of Fort Vancouver. Hight’s work in Los Angeles (2003) and the Dublin Liberties Neighborhood project by Nisi, Oakley, and Haahr (2006) were models for this project, in an effort to keep the characters as real as possible. Of the innumerable decisions made in relation to the design of this project, from text syntax to interface affordances, some of these decisions were more global, and philosophical, in nature, decided in the early stages of this process, and with far-reaching implications. The focus here will be upon those key moments, in an attempt to investigate best practices of mobile design, framed as design philosophies. Such crucial decision points from the design-perspective were:

- The app should establish an immersive point of view: The learner would be positioned as being an integral part of the app-using experience, including being asked to help solve the mystery and to produce and provide media at various steps in the storyline. As an example, in pragmatic terms, the first video that was pushed to learners at the entrance to The Village showed archaeology students finding something interesting on site, although not showing exactly what that was, near where the learners were standing. The learners then were asked, “What do you think they found?” Such an immersive approach was hypothesized to improve learning and engender motivation in learners.
- The app would embrace interaction: The learners were asked, through various forms of prompts, to provide responses in text, still imagery, audio, and video, as part of creating and continuing the experience. The interaction affordances of the app were expected to improve learning and motivation.
- The app would experiment with media forms: Some of those digital creations included puzzles, games, Twitter-like dialogues among historical characters, reenactments, and prompts for the user to do tasks both physical and digital, including walking to particular places and engaging in particular mobile-oriented activities.

Procedurally, the app prototype was built in Java and Objective C at first, but HTML5, CSS 3, JavaScript, jQueryMobile, PhoneGap, and other mobile libraries developed dramatically during the various production cycles and later versions of the app were built through non-native code. Four distinct cycles of action research were conducted with users of prototypes before the app was launched to the public from June 2010 to June 2012, and before the Learning Object Review Instrument (LORI) analysis was conducted. As of this publication, the free Apple and Android apps have been downloaded more than 1,500 times, and the behind-the-scenes blog on this project, www.fortvancouvermobile.net, has recorded more than 35,000 page views. The app meanwhile has expanded significantly, as illustrated in the comparison of the June 2010 schematic to its June 2013 counterpart (Appendix A). From a constructivist perspective, as m-Learning inherently tends to be, learners build their own meanings in such situations, and tests of explicit knowledge transfer generally are insufficient and sometimes inadequate for assessing the overall effectiveness of the learning environment, so various evaluation tools were considered, before a LORI analysis was chosen and applied to the prototype app by an independent, external evaluator. While this evaluator worked within the same university system as the project coordinator of the app design team, he also worked on a campus several hundred miles away from Fort Vancouver and had not been involved in the project in any way until this point of evaluation.

After all of the decision points had been made independently by the design team, and the prototype had been built, including a working “Kanaka” module, about the Hawaiian story at Fort Vancouver, the external evaluator was contacted and brought into the project to help provide formative feedback by applying the LORI-scale analysis. Through this approach, we thought he would not be invested in the project in the same ways as the designers and other collaborators, investigating how such independence might affect potential concerns about positionality. In short, besides brief pragmatic discussions about the project, such as what form it was taking, to help decide on the most appropriate evaluation tool, and when it would be done, the evaluator had little knowledge about what the prototype would be like, and he had no input on the design until his feedback on the LORI analysis was completed. The methodological goal in that case was to keep the evaluation as separate as possible from the design, allowing both processes to happen independently until this research project eventually brought them together.

IV. Results.

A. Evaluation of the App.

As his first exposure to the project, the external evaluator visited the test site in August 2012, shortly after the public launch of the app prototype, and he used a LORI analysis to evaluate the “Kanaka” module and to assess the pedagogical design in a detached manner. In the section below, the results of that evaluation are reported, including suggestions for further development of the “Kanaka” module and the Fort Vancouver Mobile app. The evaluation results do not include an extensive description of the nine dimensions of LORI, as previously published papers adequately describe those and how they are rated (Leacock & Nesbit, 2007; Nesbit & Belfer, 2004; Vargo, Nesbit, Belfer, & Archambault, 2003; Nesbit, Belfer, & Vargo, 2002).

Although there is no general consensus on the definition of learning objects, most researchers agree that they are reusable digital learning resources that are designed based on sound pedagogical practices and aimed at promoting learning (Sampson & Zervas, 2011;

Churchill, 2007; Wiley, 2002). From that perspective, the app, especially the “Kanaka” module, can be considered a learning object. Although there are many instruments for evaluating a learning object, a LORI analysis is commonly used, per the literature already cited. In the following section, the results of the evaluation are reported:

B. Overall Analysis of the App.

The Fort Vancouver Mobile app with the “Kanaka” module has been designed with pedagogical and theoretical considerations in mind. Listed below are some of the pedagogical implications evident in the “Kanaka” module:

- The text describing the pictures or what to do with the pictures are close enough to the picture. This aligns with Mayer’s (2009) spatial contiguity principle of multimedia learning resources.
- Learning objectives are clearly set in the introductory page and are followed through with headings showing clearly defined goals.
- There is a great deal of interactivity with the app. Users especially like the recording feature, and its integration throughout the app design provides beneficial learning opportunities.
- There is consistency in the layout (with font, size, and video). This is a good practice, as users will increasingly become familiar with the interface with repeated exposure.
- Sufficient metadata were included and complied with international standards. Metadata, such as credits for the creative team, and descriptions of the various modules, were included.
- The app, and its modules, conform to WCAG 2.0 accessibility guidelines. The “Kanaka” module is mostly accessible to disabled people. Tests with different mobile devices also show that the module is accessible on most devices. Evaluator noticed, though, that the “sponsored by” logos do not have alternative texts, which would improve accessibility. Given that there is complexity in designing modules that are fully accessible, a more pragmatic approach might be to address simple accessibility issues through the use of “alt” tags.
- Ubiquity: The media player required for the user to see the application on the mobile display is widely available.
- Richness: The module loads quickly on mobile phones and videos play well with rich pixel quality.
- Flexibility: The module is viewable and of comparable quality on a variety of mobile devices.
- Display Reliability: The module displays consistently regardless of the browser, mobile device, and screen size.

C. LORI Analysis of the App.

The Learning Object Review Instrument (LORI) analysis was used to more specifically evaluate the potential effectiveness of the app. The nine items of LORI have typically been used to evaluate learning objects. As described earlier, each of the items of LORI has a scale ranging

from 1 (Low) to 5 (High). In the section below, the results of the independent evaluation are presented.

1. Content Quality: Veracity, accuracy, balanced presentation of ideas, and appropriate level of detail

The contents of this module are accurate and ideas are well presented. More importantly, the choice and design of this content were deemed appropriate for learners of varying abilities in history. Out of a scale of 5, the module was rated a 5 in content quality.

2. Learning Goal Alignment: Alignment among learning goals, activities, assessments, and learner characteristics

Learning goals are declared in the introductory page of the “Kanaka” module and are appropriate for the intended learners – visitors to the historic site. There are some recording features that could be used to assess users’ learning. It is recommended that the module should have more assessments that test whether the learning goal has been achieved or not. Out of a scale of 5, the module was rated a 3 in learning goal alignment.

3. Feedback and Adaptation: Adaptive or interactive content

The module is adaptive and can be used in different learning situations. The recording feature could help relay feedback to designers. It was suggested that feedback for users should be incorporated into more of the design. Out of a scale of 5, the module was rated a 3 in feedback and adaptation.

4. Motivation: Ability to motivate and interest an identified population of learners

The module is very motivating. The contents are really useful for the intended users. However, motivation with the module can be improved by embedding more feedback that compares the performance of learners with the goals of the module and how performance could be improved. Again, incorporating assessments or tests would be a good approach here. Out of a scale of 5, the module was rated a 3 in motivation.

5. Presentation Design: Design of visual and auditory information for enhanced learning and efficient mental processing

Text is legible enough with good font size. The content is well segmented. All features are aesthetically appealing. Also, there is nothing in the app that could potentially constitute cognitive overload to effective learning. Out of a scale of 5, the module was rated a 5 in presentation design.

6. Interaction Usability: Ease of navigation, predictability of the user interface, and quality of the interface help features

The module was evaluated as having a good interface design, easy to navigate and

predictable. The module has clear instructions on how to navigate thereby offering just-in-time help to learners. Out of a scale of 5, the module was rated a 5 in interaction usability.

7. Accessibility: Design of controls and presentation formats to accommodate disabled and mobile learners

The module conforms to W3C guideline at level AA. It was suggested that alternative texts be provided for all images so as to improve the accessibility of the module. Out of a scale of 5, the module was rated a 4 in accessibility.

8. Reusability: Ability to use in varying learning contexts and with learners from differing backgrounds

This module can be readily used in other contexts and by other learners without modifications. Its use is not tied to the course or to any external resource. Out of a scale of 5, the module was rated a 5 in reusability.

9. Standards Compliance: Adherence to international standards and specifications

Sufficient metadata were provided. Out of a scale of 5, the module was rated a 5 in standards compliance.

The evaluator recommended that future iterations of the module should provide more simple quizzes, surveys or teaser information to (a) improve interactivity; and to (b) examine the user's understanding at the end of each video presentation. Such low-stakes formative tests have been found to be extremely effective in contributing to learning rather than only being used to measure learning (Roediger & Karpicke 2006; Rohrer & Pashler, 2010).

V. Conclusion and Future Research Directions.

From the beginning, this research had two primary concerns: 1. Reflecting upon how a design-based research methodology could affect the creation of a learning object, and, 2. As part of that process, determining how applying an independent scholarly intervention, a LORI analysis, would affect the development of a learning object, if applied during an intermediate step, which is seldom done.

Design-based research, in this case, allowed an expansive teaching and learning project to grow, in scale, from an idea into a full-fledged prototype by embracing the messiness of learning-object design but also by approaching such design systematically and with particular checkpoints in mind, including the intermediate evaluation step offered by the LORI analysis. The initial teaching and learning goals of creating an immersive experience, embracing interaction, and experimenting with new mobile media forms led to an innovative mobile app prototype, celebrated nationally by such vetting organizations as the National Park Service, the Society for History in the Federal Government, and the National Endowment for the Humanities. In terms of affecting the creation of the mobile app, a design-based research approach affected the project in some of these significant ways:

- By focusing on giving the learner an immersive point of view, and allowing the learner to participate directly in the recreation and interpretation of history, the mobile app changed the ways in which this National Park Service site, and others who have used the app as a model, view the potential of immersion with new teaching and learning technologies. By giving the learner agency in this process, a sovereign view of history emerged, in which each new perspective enriches understandings but also raises questions about what is not being covered through this viewpoint. In short, when history is experienced in this participatory way, as a personal journey, the paths to knowledge no longer seem as straightforward or as narrow, opening more opportunities for teachers and learners.
- By embracing interaction, this mobile app showed that history pedagogy easily could be expanded beyond the megaphones of one-way transmissions, such as lectures, brochures, and wall texts. Teachers can ask for more complex responses, and learners can express more complicated reactions than many of the traditional means of assessment allow. These responses can be shaped within the most appropriate media form -- including audio, video, and still imagery -- rather than primarily being expressed through text, and these responses can happen instantaneously, in the moment, when the student's mind is the most open and active and engaged in the activity of learning.
- By experimenting with media forms in this project, the many untapped possibilities quickly became apparent, in both mobile apps, and in other emerging forms. For example, as soon as the design team started building geolocated material that provided digital overlays of physical locations, augmented reality extensions of this idea seemed as obvious next steps, followed by explorations of such overlays in glasses-like wearable computing. In short, each new step into a new form seemed to raise ideas about where that step could lead. A relatively well-established technique of learning about history, such as watching a historical reenactment video, for example, begins to seem like only the beginning of the possibilities when that video is geolocated through a mobile app into a particular spot, where the historical activity took place, and anyone who comes along can see it there. With that idea already easily accessible, and new technologies emerging, one quickly wonders what historical teaching and learning would be like if the student could see that same scene from the perspectives of the different characters within it; and if the student could play one of the parts; and, if the student eventually could alter the historical choices of any of those characters to affect the outcomes and then role-play the scene over and over again, like modern video games allow, with the student manipulating the parts, as a way to get a deeper appreciation and understandings of how and why things happened, and, in turn, when returning to a present state of mind, gaining a greater appreciation for how they happen in contemporary society.

With the additional step of the LORI analysis, this research project also offered insights into intermediate evaluation opportunities and how those might guide and refine a learning object after the initial user-centered design principles are applied but before the object reaches the end market. The LORI evaluation of the app indeed enabled us to examine the extent to which the design of the app was guided by relevant theories of learning and assessment. Leacock and Nesbit (2007) claimed that one of the major contributions of LORI is to provide a quality tool “to support evaluation of multimedia learning objects” (p. 44). The use of LORI afforded the

ratings and commentaries on nine dimensions of quality of the Fort Vancouver Mobile app: content quality, learning goal alignment, feedback and adaptation, motivation, presentation design, interaction usability, accessibility, reusability, and standards compliance. Overall, the LORI analysis found the Fort Vancouver Mobile app an effective learning resource. Specifically, LORI evaluation found the app to be easy to use and that it presents accurate historical knowledge that aligns with the intended learning goal. Moreover, the interactive features of the app (e.g., recording elements) enhanced learning. By using the LORI-analysis method, the evaluator was able to acknowledge and appreciate the high-quality content and design aesthetic but also to separate and identify areas in which the app module could be improved, such as with user feedback, accessibility, and learning goal alignment.

Since the design team and the evaluator worked independently in this case, before reuniting for the LORI analysis, the design team did not know what evaluation metrics would be used in the process, which could be considered both positive and negative. In one sense, the design team worked more organically that way, behind the guiding philosophical ideals established at the onset, and generally received high marks on the prototype because those ideals often aligned with the LORI scale. In a different case, with different ideals, or a different scale, the results would change. For example, if the value of the learning object was based more heavily on establishing and achieving specific learning goals, then the experimental design approach of the Fort Vancouver Mobile app might be considered less successful. The app also did not score highly on motivating the student through regular and explicit feedback. These ratings show potential weaknesses in the app design, in relation to learning-object evaluation, but they also raise the importance of the alignment and awareness of evaluation metrics. In addition, these ratings were provided by only one trained evaluator. How would the results and the feedback and the effects on design change if the design team started the project with the specific evaluation metrics in mind, and if more evaluators participated? Those are two potential paths for future inquiries.

Mobile technology alone cannot provide the panacea for improving history education in the United States, either. To present findings that demonstrate learners are attracted to the novelty of a mobile app at the Fort Vancouver National Historic Site -- and might even be willing to give it a try -- would not be surprising. More revealing results in this study, then, come from the deeper observations and analyses formed during the construction and use of the app, or the lack of use of it, based on individual needs. In a free-choice learning environment, without coercive controls in place, the learners always have the opportunity to, as the saying goes, vote with their feet, or to close the app at any point, and to never return to it. They are under no obligation to pay attention, to learn, or even to keep the app, no matter how much work has been invested into its production. There is not even the slight guilt of having paid for it, in the Fort Vancouver Mobile case, since this app can be downloaded for free.

Researchers in environments like Fort Vancouver must also wrangle with diverse varieties of competing stimuli and understand that free-choice learners expect communication to get to the point quickly and to be fun. Several studies have demonstrated that people are unwilling to devote sustained attention to media and messages that are not entertaining, and that traditional interpretive and educational materials typically get less viewing time and attention than designers envision (Novey & Hall, 2006). Researchers, though, also have established the potential of interactive exhibits to attract and hold visitor attention for longer periods of time than non-interactive exhibits, to produce more learner engagement with interpretive media, and

to improve learning conditions in ways that reach an immersive experiential state of intellectual and emotional awakening.

While LORI has been extensively used in evaluating learning objects (Leacock & Nesbit, 2007; Nesbit & Belfer, 2004; Vargo, Nesbit, Belfer, & Archambault, 2003), the sole use of LORI for individual evaluation of the Fort Vancouver Mobile app, or other apps, is potentially limited in some ways. For example, LORI authors have explicitly delineated that “while LORI can serve as a component of a program evaluation process, it is not a sufficient tool for evaluating whole educational programs in which the learning objects may be embedded” (Leacock & Nesbit, 2007, p. 44). It appears that LORI may not provide a full picture of the effectiveness of the entire Fort Vancouver Mobile project but rather might provide a good intermediate evaluation of the app, after initial user-centered experiments and early prototypes have worked out the major kinks.

One prospective way of addressing future research, and building from this effort, then, would be to use LORI analysis as part of a convergent participation model of evaluation, so that different evaluators would examine an app project independently and then come together for a discussion of their ratings, and the divergences, which would allow for a collaborative evaluation of the app/project. This evaluation could happen at different stages of the project, too, to provide comparable moments and examine progress toward LORI-based goals. Additionally, as suggested by many within the Multimedia Educational Resources for Learning and Online Teaching ([MERLOT](#)) community, the process of evaluating the effectiveness of a learning object for teaching and learning would be further enhanced through the actual use of the object by students and faculty. Hence, we recommend that the LORI evaluation process followed in this paper could be used for formative purposes and that full-scale summative evaluation of the Fort Vancouver Mobile app should be conducted with historic site users. Although the Fort Vancouver Mobile app was evaluated as effectively designed, future research should investigate users’ learning and affective outcomes with the app. Specifically, future research may conduct and report interviews with historic site users or collect survey data from them. This data then could be triangulated with design and evaluation data to more comprehensively examine the effectiveness of the app and provide design guidance for similar projects in the future. As valuable as these future research recommendations might be, we also believe that the LORI analysis has provided us with an important evaluation perspective at this stage of the app development as well, and those insights will continue to shape future refinement and deployment of modules for the project.

Appendices

Appendix A.

THE FORT VANCOUVER MOBILE PROJECT SCHEMATIC FOR PHASE 1 (THE KANAKA BILLY STORY)

Module goals:

[] Create a compelling historical interpretation of William Kaulehelehe's story of his time at Fort Vancouver, connecting to the larger narrative of the Hawaiian influx to the Pacific Northwest and the cultural ramifications of that but also to bigger themes that provoke abstract thought in users/learners.

[] Experiment with the abilities of mobile devices to tell stories in all possible ways but also to prompt interaction and to create immersive mixed-reality environments that equally engage the users/learners on physical and virtual levels.

[] Refine and get all of the bugs out of this module, to inform future modules, but also to be able to hold this piece up as a powerful proof of concept for the project overall. A simple module is better than a buggy module.

While I am building the frame (the linear intro and the ending) and providing the glue (holding everything together), these abstract nodes, or petals of the flower, such as "work," could be an ideal opportunity for us to collaborate.

The parameters: Each node will have to involve Kanaka Billy's point of view, so the story will mesh, and it should be envisioned as interactive, intellectually provocative and taking no more than five minutes, including the interaction time (but preferably in the three-minute range).

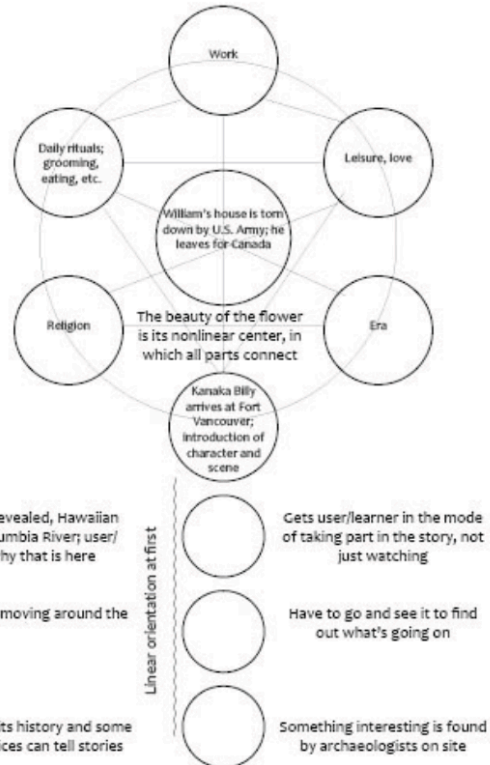


Figure 2. Screen shot of the Kanaka module's June 2010 schematic.

Fort Vancouver Mobile app

Schematic 1 (from launcher icon to module turntable)

FOR: June 2013 Version 2.0

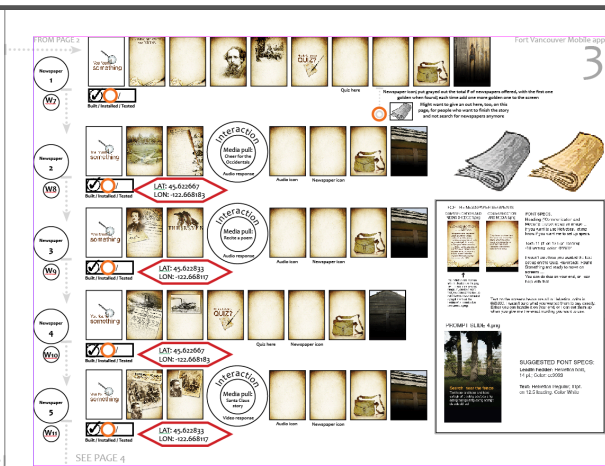
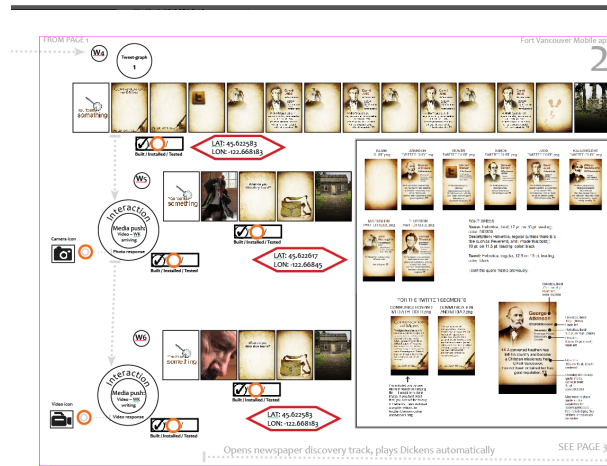
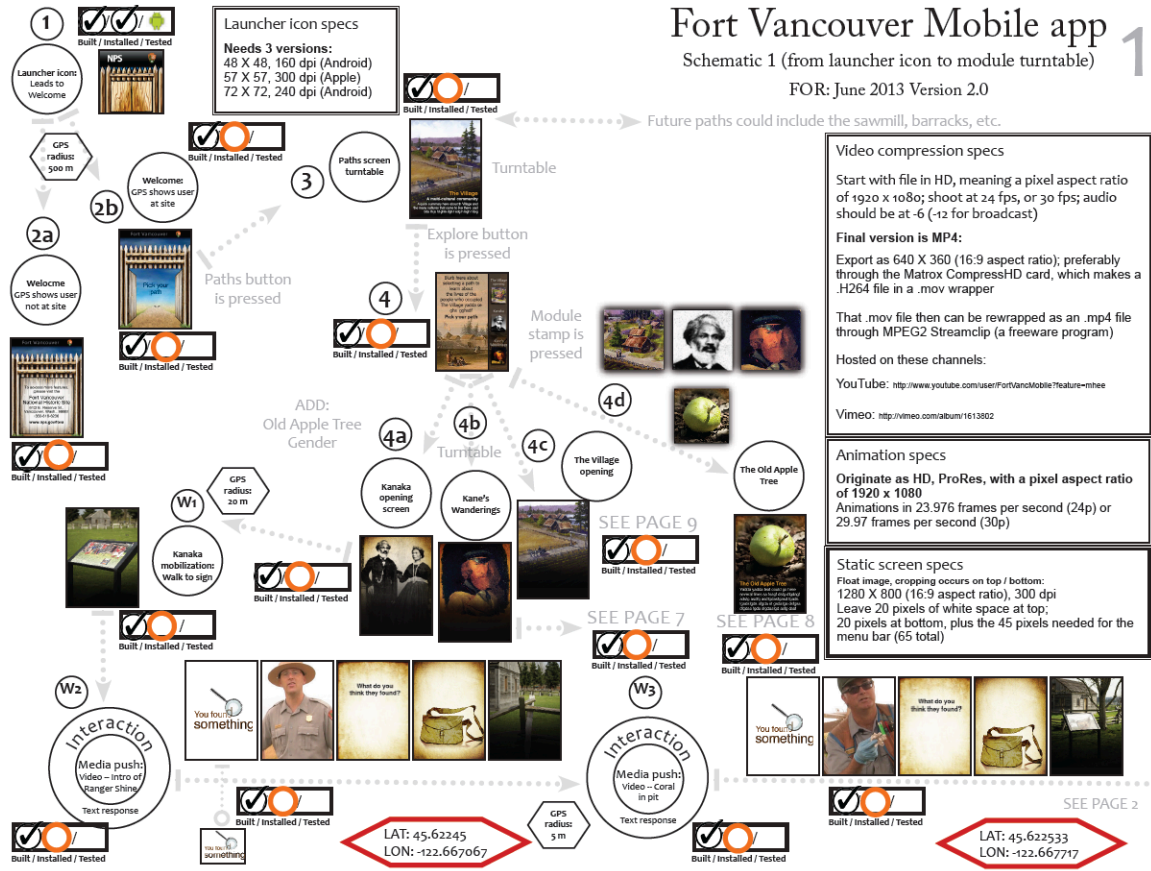




Figure 2. Screen shots of the Kanaka module's June 2013 schematic.

Appendix B.

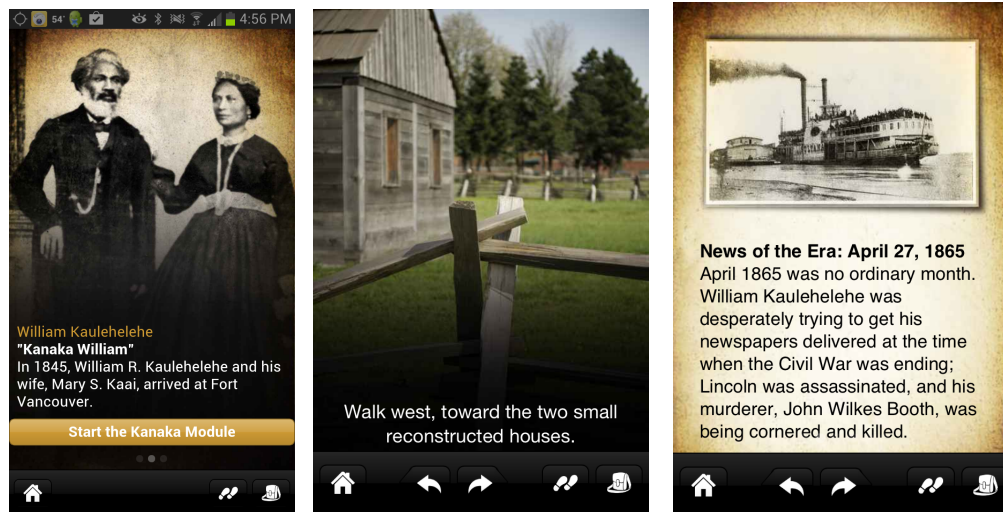


Figure 3. Screen shots of the Kanaka module at its June 2012 debut.

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