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Web-based museum trails on PDAs for university-level design students: Design and evaluation

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ABSTRACT

This paper describes the development and evaluation of web-based museum trails for university-level design students to access on handheld devices in the Victoria and Albert Museum (V&A) in London. The trails offered students a range of ways of exploring the museum environment and collections, some encouraging students to interpret objects and museum spaces in lateral and imaginative ways, others more straightforwardly providing context and extra information. In a three-stage qualitative evaluation programme, student feedback showed that overall the trails enhanced students' knowledge of, interest in, and closeness to the objects. However, the trails were only partially successful from a technological standpoint due to device and network problems. Broader findings suggest that technology has a key role to play in helping to maintain the museum as a learning space which complements that of universities as well as schools.

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1. Introduction

This paper describes the development and evaluation of museum trails for university-level design students to access on handheld devices in the Victoria and Albert Museum (V&A) in London. We first give some context about learning in museums, and then more specifically regarding Higher Education (HE) design students and the uses of learning technologies in museums. We then describe the project, the development of the trails, and the results of evaluating them with students. We conclude by commenting on the applicability of such resources for HE students.

2. Learning in museums

Most people today go to museums expecting to learn something (Ellenbogen, 2002; Falk & Dierking, 2000; Falk, Moussouri, & Coulson, 1998; Moussouri, 2002). Learning in the museum is often characterised as informal and free-choice (Falk & Dierking, 2000; Hooper-Greenhill, 1999) or self-directed (Hein, 1998). Visitors are generally free to follow their own paths, and make unexpected and accidental discoveries.

Object-based learning is a central ethos in most museum learning. In the field of Museum Studies, the process of knowledge construction has generally been seen as a one-on-one relationship between individual visitors and individual artefacts, and much of museum education consists of training visitors in how to look closely at objects in particular ways (McClellan, 2003:36). Objects are seen to evoke memories and prior knowledge, and Hooper-Greenhill (1999) sees the active mental construction of knowledge as a dialogue between observation and deduction, whole and part, past and present.

3. Universities and museums

Museums and universities need each other and are working together in productive and original ways, but are not collaborating as much as they could be (Anderson, 1997; Arnold-Forster & Weeks, 2001; Inspectorate of Schools, 1993; van Heyningen, 1999). Museums generally

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provide far fewer resources and services for Higher Education (HE) students than for school-age children, and indeed museum education tends to be perceived as mainly a service for schools (Anderson, 1997), which is overwhelmingly directed at primary school level (Hooper-Greenhill, 2007). Most university-museum partnerships are based on relationships between individual tutors or students and curators, rather than being part of a formally defined service. A 2006 report said partnerships between museums and universities had improved in the previous few years, although it only gave one example of this (Travers, 2006).

Museums and the adult education sector, including universities, consequently lack the expertise which would arise from sharing each others' educational insights and approaches (Anderson, 1995). Museums 'are not geared towards developing skills of getting the most out of objects at HE level' (van Heyningen, 1999:44). Museums are often 'frustrated' by HE students' lack of skills in learning from objects and artworks, partly because HE tutors themselves lack these skills and therefore do not pass them onto students (Anderson, 1997). Yet, partly because of worsening staff-student ratios in HE, it is becoming increasingly important for students to develop independent research skills, and to draw on places for learning beyond the campus and lecture hall.

4. Design students and museums

At HE level, practice-based design education includes disciplines such as Architecture, Product Design, 3D Design and Animation, Illustration and Graphic Design. The main aim of design education is to prepare students for continuing personal development and professional practice (QAA, 2008). Designers are drawn to concrete, sensory experiences, learning in a hands-on way by trial-and-error and by testing concepts in new situations. They are good at seeing situations from divergent points of view, being imaginative and creative, and they tend to act more on feeling than from rational analysis, though the latter is also required for design. It is these skills and qualities that design students develop in their studies (Reynolds & Speight, 2007).

Part of such learning is the study of other practitioners' work in order to gain knowledge of the historical context of practice and develop essential skills (QAA, 2008). Museums are key places for such learning, as well as places where students gain inspiration for their designs. In fact, museum objects are described as the equivalent of the literature of other subjects (Avann & Wood, 1980).

The Victoria and Albert Museum (V&A) is a particularly important custodian and presenter of such 'literature' in the UK and internationally, being the world's largest museum of design and decorative arts. It has thousands of artefacts on display, grouped according to material (for example the Glass Galleries, the Ironwork Gallery); geographical area of origin or use (for example the British Galleries, the South East Asia Gallery); type of object (for example the Fashion Gallery); and historical period (for example the 20th Century Galleries). Its collection and display policy since it was founded in 1852 has been to acquire and display objects of particular merit and use them for educational purposes.

In baseline research carried out at the V&A with design tutors and students, it was found that students use museums in various ways, from 'building a treasury of ideas, objects, images at early stages of courses, to more focused research for particular projects or coursework later on' (Fisher, 2007:11). Many design tutors recommend museum visits, but do not make them compulsory. Some tutors organize visits and accompany their classes to particular museums.

Although museums are important sources of research for design students, the latter's attitudes toward museums may be quite complex. For example, design students aim for originality in their designs and in their ways of seeing objects, and may fear that their personal responses to objects and ways of seeing are pre-empted by the interpretation offered by the museum. They may also need to use museum objects in ways which are contrary to the way they are presented by the museum; for example, displays may emphasise the historical development of a particular style, while a student needs to make more lateral connections between objects which may not be obviously linked, or may wish to browse primarily for aesthetic inspiration for their designs. (Fisher, 2007)

Design students are also trained to challenge authority, including the authority of the museum, while at the same time needing to draw on the museum's expertise (Fisher, 2007). The V&A in particular, according to Fisher (2007), 'also carries with it the concepts of large, elite, expensive.' She contends that 'the V&A will be criticised for trying to have the last word. It would do better to use its authority to create an arena for different perspectives and debate' (Fisher, 2007:21).

Students visit exhibitions that have been recommended to them by their tutors, with some tutors setting questions in advance. This is typically followed by group feedback in the classroom afterwards. According to one design tutor involved in this project:

What's very interesting about it is teaching what we call a kind of learning to look. Because although museums are full of things, the skill at looking hard at stuff — actually really looking — is quite hard to teach....We expect them to know Western art and its relation with the world, which the V&A is part of, but they should develop their own specialism and interests (Purbrick, 2008).

Students want to know about the history and process of creation, since it informs their own developing practical skills. Getting close to objects means not just looking but getting multiple perspectives, and handling; where handling is not possible a mobile digital device holds potential. 'By playing with the object on-screen, the visitor comes close to playing with it in real life, which is the way all of us, at base, like to learn' (Fisher, 2005:32).

5. Mobile technologies and museums

Technological tools can mediate visitors' experience with objects (Thomas, 1998a: viii). While technologies must compete in an already visually rich environment, when used well according to Thomas (1998b:15) they should disappear, letting the narrative come forward or object speak for itself. Mintz (1998) contends that technology can help visitors experience the exhibits more like an expert (Mintz, 1998: 27), and that used well, technology can control the amount of information or expand visitors' options (Mintz, 1998, 32).

If as Mintz (1998) claims, technology in museums gains legitimacy through its proximity to authentic objects, mobile technologies could be considered more 'legitimate' than fixed technologies by virtue of their use directly in the place of encounter between visitor and object.

Initial implementations of mobile technologies in museums have tended to treat them as smaller versions of desktop or laptop computers, their main benefit perceived to be the ability to deliver information to visitors directly at exhibits. Fisher (2005) reports that this can add to the surfeit of information already in the museum environment: 'first time visitors will be trying to reduce the information to

something manageable, rather than looking for more' (2005:8). More generally, Thom-Santelli, Toma, Boehner, and Gay (2005) found that handheld museum guides dictate particular ways of navigating and experiencing a museum, to the exclusion of other ways.

Gammon and Burch (2008) suggest that the design of mobile digital solutions for museums should correspond with technologies visitors are already familiar with. For example, many museum visitors are familiar with browsing the Web, and the use of Web-based conventions such as page-based navigation and hyperlinks has influenced visitors' comfort with handheld guides at Dulwich Picture Gallery (Beazley, 2007) and Tate Modern (Fisher, 2004).

The use of mobile learning technology in museums has been evaluated with particular audiences, including schools (Beazley, 2007; Vavoula, Sharples, Rudman, Meek, & Lonsdale, 2009; Walker, 2008a), but never to our knowledge with HE students.

6. Background to the project

We now describe the development and evaluation of trails for HE design students to access on handheld devices in the V&A. The project was supported by the Centre for Excellence in Teaching and Learning through Design (CETLD), a five-year partnership created in 2005 between the V&A, the University of Brighton, the Royal College of Art (RCA) and the Royal Institute of British Architects. Among the aims of the CETLD are to help design students use and understand museum collections, and explore ways of using mobile learning technologies to enhance design students' learning. The specific aims of this project were to develop resources for HE design students intended to help them explore a range of V&A galleries; to undertake research into design tutors' and students' needs in the museum; and to identify ways in which mobile learning resources can be used in learning and teaching in the museum (Speight, 2007c).

Regarding technology, 97 percent of the students surveyed in preliminary research owned a mobile phone, but few accessed the Internet on it, primarily due to cost (Speight, 2008). Most had not used a Personal Digital Assistant (PDA) before commencing the project. Mobile technologies are often viewed with suspicion by tutors and students alike. 'They are believed to force the agenda and take away from the experience of the real object,' according to Fisher (2007:4). Students' perception of museum technologies is characterised by one student as follows: 'Audio, old people. They move really slowly' (Fisher, 2007:39).

7. Trails development

Paper-based trails have long been developed by museum education departments, as a themed way of navigating through large, diverse collections. These are typically printed on paper in single sheets or booklets, direct visitors to particular places in the museum, identify things for them to look at and for, and usually specify activities to carry out. Aimed mostly at families with early years and primary aged children, these often take the form of themed treasure hunts or 'I Spy' games, though they can also include drawing or writing tasks, or can prompt thinking or talking.

In 2004 StreetAccess, a private company in London, created iGuides software that links a series of museum-created or external Web pages into what are termed trails. Trails can contain audio, text, video and images, and users can also input their own responses and thoughts using photographs, voice recordings, or text and upload these into the trail, making personalised trails which can be accessed on the web after the visit, and used in other activities — for example to create a presentation or to reflect on the museum visit in other ways. Using this system, trails can also be developed and easily modified by a museum itself. The system has been used successfully with secondary students since 2004 at Dulwich Picture Gallery, according to Beazley (2007). The iGuides system was chosen for this project. Twenty trails were developed using the system by one of the authors (Reynolds) who is CETLD Higher Education Officer at the V&A, in a collaborative process with design tutors and students, designers, curators, museum education staff and others.

Trails were hosted on the StreetAccess website. The user accesses this website while in the museum using a handheld device via wireless network. Before the beginning of the project, 23 Jasjar iMate PDAs had been purchased. This model was chosen because it offered constant connectivity together with a range of applications and functions viewed as relevant to teaching, learning and research. It was planned that these would be distributed to users when they arrived at the museum, and trails would be accessed on them. As part of the project, wireless access points were installed in nine V&A galleries and the main museum shop, to enable the online materials to be used.

7.1. Learning objectives

The trails were intended to supplement, not replace, students' other coursework. As well as giving information about the collections, the trails aimed to encourage generic skills. These included reflecting on one's own way of learning in the museum, since considering one's own learning strategies has been shown to improve learning (Harvey & Knight, 1996). The trails encouraged students to reflect on how they learn in a museum, and to offer ways of seeing objects that might be new to them. Some evidence supporting this approach was supplied by a separate study undertaken early in the project, which looked at the use of paper-based trails with ten students. One of the findings was that seven out of the ten students who used the trails said they used the galleries in a different way compared to a 'normal' or 'unaccompanied' visit to the museum. Five of the seven mentioned this (unprompted) as a positive thing (Reynolds, 2007). Trails thus offered a range of ways of using the museum environment and collections. Some trails developed for the project encouraged the students to interpret objects and museum spaces in lateral and imaginative ways, while others more straightforwardly provided context and extra information. There was also a practice trail to help students become familiar with the PDA and its software.

The capabilities of the software and the PDAs also acted as a catalyst for trying out different pedagogical strategies which could be incorporated into materials. For example, the ability of students to input into the devices meant that questions asking them to reflect on the visit were used more often than in traditional gallery interpretation, since students' responses could be recorded and reflected upon later. Most of the trails thus aimed to include both 'knowledge resources' and 'cognitive supports,' to use Hsi's (2004:1) characterisation. Knowledge resources included information about the objects from curators, plus design tutors' and students' responses to the collections and galleries. Cognitive supports included questions which students could consider when exploring the galleries, and prompts to reflect on their own learning processes and on differences between their own and others' responses to galleries.

Learning objectives for particular trails included:

- Tracing the historical development of a particular style. For example, the trail 'From Classical to Medieval' looked at how classical styles became popular and were then superseded by Gothic style.
- Exploring ways in which students and others view objects and collections. For example, the trail 'Stripping the Galleries' included responses to the V&A's Cast Courts and Jameel Gallery of Islamic Art from both a museum architecture education officer and a university architecture tutor, each of whom emphasised different aspects and drew on ways of seeing encouraged by their distinct profession. Students were encouraged to compare these views with their own responses.
- Tracing the processes by which objects are made, in a kind of 'reverse engineering.' For example, the trail 'Victorian Inspiration' used two gallery exhibits: a sketch for a wallpaper design by William Morris, and a piece of the finished wallpaper, inviting students to compare Morris's preparatory sketch to their own sketchbooks.

The more unconventional trails are more specific in directing students' actions. For example, the trail 'Break Into the V&A' suggested lying on the floor, running, or talking loudly. There was also a 'thrill trail', designed by Royal College of Art tutor Brendan Walker. This aimed to encourage extreme states of emotion and different reactions in the museum, such as loss of control, shock and embarrassment. For example, it asked students to stop at a display case in the Jameel Gallery containing plates, play a video on the PDA, set the device on the display case and step back to watch other visitors' reactions. One video showed a woman smashing plates to make a mosaic; another showed the silhouette of a figure throwing plates at a wall. The student was, in effect, augmenting (or undermining) the display in a way which was out of their control. Another part of the trail invited the student to listen to a risqué soundtrack while looking at the Melville bed, built in about 1700 as a possible sleeping space for the monarch.

7.2. Social factors

Most people visit museums with other people. There is considerable evidence that visitors are influenced by people in their own social group, and outside their social group such as explainers, guides, demonstrators, performers — or indeed other visitors. As noted by Fisher (2007):

Students are social. Like everyone else, they are looking for a formula which lets them examine objects independently but also gives them someone to talk to about their experiences.

In other baseline research it was noted:

The opportunity to talk about their experiences as they went around was also considered to be useful by some of the students: vocalisation provided an opportunity to clarify internal thoughts and questions. (Cook, 2006)

Social elements were thus included in the design of the trails, which not only contained some narrative threads but also continually prompted students to articulate their own responses.

Dialogue was a prominent feature of most of the trails. For example, trails such as 'Stripping the Galleries' offered multiple perspectives on objects, an approach described by a tutor as creating a 'kaleidoscope of voices.' Even the single-perspective trails are dialogic: for example, the trail 'A Potter's Eye' counterposed a contemporary potter's monologue about inspirational pieces in the collections with her own work, then at the end prompted students' responses with questions and a feedback box. The trail 'Another Look at the Great Exhibition' augmented the tutor's expertise about particular objects with historical voices, questions, and an invitation to deconstruct the gallery.

There were some more explicitly social prompts:

- 'Break Into the V&A' prompted the student to record a conversation with someone else;
- 'Hanging Out and Watching People' invited the student to laugh out loud with someone else in a quiet space, as a way of reflecting on museum social norms;
- The 'thrill trail' contained several games to play involving other visitors — standing next to them, taking pictures of them, writing secret messages to them — but did not encourage overt interaction; and
- 'Victorian Inspiration' gave the student a choice to either talk with another student, or read or listen to another student voice within the trail; then it prompts them to compare their own ideas.

7.3. Collaborative design

Collaboration on trail development took different forms, ranging from short recorded interviews with contributors which were placed in trails, to tutors and students designing entire trails and being involved in multiple revisions. In trails which required a high level of input from collaborators, the latter were asked to provide insights into aspects of the collections they found interesting and relevant, and to suggest interpretations of galleries and strategies for using them. For example, the trail 'Another Look at the Great Exhibition' was designed by a Design History tutor who chose the objects for students to look at and paths to follow through the galleries, with input from one of us (Reynolds) focusing on the suitability of the content for a mobile learning device and for the trail format — for example, the length of audio clips and extent of direction which could be offered, based on Reynolds' experience of materials design and on research into the optimal design of materials for mobile learning devices (e.g., Fisher, 2005; Proctor & Tellis, 2003).

For other trails, ideas mentioned by design tutors and students were expanded into a trail along with other materials. For example, the trail 'Inside the Cast Courts' was built around a comment from a tutor that the decontextualisation of objects in the gallery helps students to study them as individual objects rather than seeing them as components of particular environments such as churches. This was contrasted with a comment from philosopher John Dewey that decontextualising objects in museums hinders our understanding of them. Photographs of some of the objects in their original contexts were included.

At the beginning of the project, it was hoped that trails would be used as the middle stage in a three-stage series, managed by class tutors. These stages would consist of pre-visit preparation, using the trail in a museum visit, and post-visit follow-up. However, during the project it

became apparent the trails would probably not be used on trips with whole classes, partly because it was difficult to ascertain the commitment of tutors, and partly because it became increasingly apparent that the wireless networking technology had difficulties serving large groups gathered in a small area. Trails were thus deemed more suitable for students on individual or small group visits to the museum, although there could be whole class feedback on the trails afterwards.

8. Evaluation methodology

8.1. Overall evaluation strategy

Evaluation in museums often takes a cyclical approach, with each stage defining the purpose, implementation and outcome of a project (Jackson, 1998). These are often referred to as the front-end, formative and summative stages of a project. It is the match between the purpose (the front-end) and outcomes of a project (the summative) that can help to measure a project's success. This approach was used in the project described here.

A small research team, independent of the trail designer, conducted the evaluation. Each stage was designed to support the delivery of project milestones and the wider goal of exploring how HE Design students learn from museum collections. We wanted to know generally whether the trails actually worked, which ones were most effective, and whether they were suitable for the intended audience.

The evaluation used a multi-method approach, consulting users throughout the duration of the project. Qualitative research methods were used, as detailed below, which enabled the research team to create a detailed and in-depth level of understanding about individual students' experience of conducting trails in the museum, by examining individuals' comments, some of which are quoted here. However, it did not aim to gauge overall popularity of the trails among design students, for which quantitative data would be needed. Evaluation commenced six months after the start of the project, in January 2007, and finished in September 2008. It was conducted at the V&A with design students and tutors from the University of Brighton and the Royal College of Art. Findings from research conducted in autumn 2006 were also used (see Fisher, 2007). The evaluation of the trails in the front end and formative stages focused on the content of the trails rather than the device; since technology quickly becomes quickly outdated, it was important that content was evaluated independently of the type of device used to access it, so it could be used on other devices and platforms. The summative stage then evaluated how the technology mediated students' experience of the trails.

The overall theoretical framework for the evaluation programme drew from socio-constructivist perspectives. Socio-constructivism is an expanded form of constructivism, a perspective to which most museums adhere (Hein, 1998; Hooper-Greenhill, 1999). It takes into account the social and cultural perspectives of individual and groups of learners and how meaning is made within a complex learning environment. It acknowledges that learning is a process in which learners become collaborative meaning makers, among a group defined by a common practice or shared interest. This suited the particular subject group, and guided the selection of research methods that encouraged dialogue between students.

The three stages of evaluation are summarised in Table 1.

8.2. Front-end evaluation

The aims of the front-end evaluation (Speight 2007a) were to explore student and tutor attitudes to the use of mobile learning technology in the museum, to identify their learning objectives for visiting a museum, and to identify key features and ideas for trail development. It was based on one-to-one interviews with ten design tutors. Front-end evaluation findings were used in conjunction with the UK's Qualifications Assurance Authority (QAA) benchmark statements for the Art and Design curriculum as a broad guide to help the trail developer identify tasks that would be most useful to include. For example, the front-end evaluation found that students could use museums to contextualise their own practice; this was also emphasised by the QAA.

8.3. Formative evaluation

The aim of the formative evaluation was to outline the effectiveness of trails, and to identify whether they offered an enhanced learning experience for design students, compared to a normal, unaccompanied visit to the museum. The formative evaluation was divided into two stages.

The first stage invited 16 students to test two prototype trails on paper, then take the same trails on PDAs. A researcher accompanied students as they took the trails, observing what they experienced and prompting them on occasion to describe what they were looking at, as well as their thoughts and ideas. In a post-trail interview, students were asked to consider the content and function of the trails.

A control group was used to compare the experience of students that took PDA trails with those that created their own trails using an MP3 player/recorder. Pairs of students that formed the control group were asked to select six objects and to explain why they had chosen them. The aim of the control group was to identify what type of information students were looking for.

The second stage of the formative evaluation consisted of further user testing with a larger group of students (36). This was conducted later to improve prototype trails. Students chose from a wider selection of trails, and at this stage were not observed taking them. Afterwards they took part in a round-table discussion, which helped to capture students' immediate thoughts and dialogue about the trails.

The data generated by the formative evaluation was analysed using grounded theory (Glaser & Strauss, 1967). The analysis was conducted by two researchers who noted emerging concepts and themes from the first stage of the formative evaluation, which were later analysed and tested in the second stage. Concept identification is a useful technique for identifying initial concepts; it is 'sometimes referred to as "open coding" as the text is opened up and broken apart for intensive scrutiny' (Corbin & Holt, 2005:50). Data from the second stage of the evaluation was reviewed to support or dispel original findings. This was intended to 'discover new relationships between ideas and insights to follow-up' according to Altrichter and Holly (2005:24). Themes emerged through systematic readings that

Table 1
Summary of evaluation stages.

Evaluation stage	Objectives	Evaluation technique	Sample size and description
Front end	<ul style="list-style-type: none"> Identify factors that encourage design students to visit museums Identify factors that inhibit their visit Identify resources the V&A could provide to support design students' use of collections 	One-to-one interview	10 people 30-min interview with 5 tutors from the University of Brighton and 5 tutors from the RCA
Formative stage 1	<ul style="list-style-type: none"> Identify suitable content of trails including level and type of information and optimum trail length Identify navigational problems Control group to compare experience of V&A trails with students' own trails 	<ul style="list-style-type: none"> Accompanied visit: user testing with paper and 'live' trails on PDAS information) Post-trail recorded interview Accompanied visit: student creates own trail using MP3 player Post-trail recorded interview 	12 people 2 practice trails on paper 2 trails on PDAS 4 people 2 control group making their own trails in Fashion and Cast Court galleries
Formative stage 2	<ul style="list-style-type: none"> Test final trails 	<ul style="list-style-type: none"> Live trail testing Self-completion questionnaire Round-table discussion 	36 people
Summative	<ul style="list-style-type: none"> Evaluate the impact and experience of project 	<ul style="list-style-type: none"> Review of research literature and project evaluation findings using Falk and Dierking's learning framework 	

were used to categorise the data. Sources of data included interview and focus group transcripts, observation recordings and students' responses to the trails themselves.

8.4. Summative evaluation

The final stage of the evaluation reflected upon the project as a whole, brought together findings so far, and identified broadly whether trails were a useful way of supporting design students learning in museums. It was carried out independently by one of the authors (Walker). This stage of the evaluation analysed the trail structure and content, the data generated by students, the previous findings, plus additional interviews with key project personnel. These data were all analysed using a hybrid analytical model based on Falk and Dierking's (2000) Contextual Model and a museum-specific application of activity theory (Kaptelinin, 2008; Pierroux, Bannon, Kaptelinin, Hall, & Walker, 2007). The Contextual Model considers three separate but overlapping notions of museum learners' context: their personal, physical, and sociocultural contexts. This has been a predominant approach to museum learning in the past two decades, particularly in the US, and the identification of three different types of context, all specifically relevant to museums, provides a rich picture of the museum learning experience. However, the Contextual Model has been applied mainly to informal family visits, and primarily to science centres. Therefore it is augmented with elements of activity theory, an approach which regards goal-directed activity as a unit of analysis, seen within a rich social matrix of people, artifacts and other resources. Activity theory pays special attention to the mediation of learning processes by tools — in this case the trails as implemented on handheld devices — as interpreted by Kaptelinin (2008) to focus on how tools mediate visitors' experience with museum artefacts. The analytical framework used here is described further in Walker (2008b).

9. Results

Attempting to define 'learning,' much less measure it, is subject to much debate — particularly with regard to museums, in which according to Falk and Dierking (2000), learning is seen to be highly individual, and to take place over long periods of time — long after visitors have left the building. Therefore no attempt was made in this project to measure students' knowledge against concrete learning objectives, or to take a 'snapshot' of learning since it is seen as a constantly evolving process. Instead we look at students' dialogue and activity in context, as measured in observations, interviews and the data they uploaded, for it is in their words and actions that evidence for their meaning making can be found.

9.1. Importance of the physical context

The physical space of the museum featured prominently in many of the trails, and was mentioned repeatedly by students: For example: 'love just wandering around the museum, looking at the architecture and the space, inspiration just comes to me' (Speight, 2007b). Another said the museum 'gives me space to think and contextualise ideas' (Speight, 2007b). Indeed, a few found more inspiration in the museum generally than in the trail specifically: 'The trail was of limited use but the nature of the museum made it very easy to find something pertinent' (Speight, 2007b).

While design students generally liked wandering the museum at random, finding inspiration from unexpected objects which resonated with their personal experience, the trails did point students to objects they would not otherwise have noticed, or to objects the tutor or trail creator felt relevant to the trail theme (Speight, 2008). And in a large museum with diverse collections such as the V&A, it is easy to become

overwhelmed quickly. The trail on the PDA was seen to help in this regard. One student for example said, 'I found the gallery overwhelming but the trail brought me closer to the objects' (Speight, 2007b:8). Indeed, a control group who visited without trails tended to stay in galleries close to the museum's entrance.

9.2. Trails' role in object-based learning

Student feedback shows that overall the trails enhanced students' knowledge of, interest in, and closeness to the objects. They spent much longer looking at objects when following trails, and appreciated the additional information given about objects. The trails effectively slowed the students down and focused them on a few key objects, chosen by subject experts, placed within a thematic context, and viewed from one or more alternative perspectives. Most of all, the trails prompted them to look at objects in different ways.

The trails also heightened students' awareness of objects' original contexts, primarily through careful shaping of content by expert tutors and museum educators. For example, one student said:

It's taught me to learn in a different way. It taught me to learn the context of when things were made and how other people think about it, thought about the objects, the dresses. (Walker, 2008b)

The trails further succeeded in acting as a 'taster' or 'starter' in students' studies because they were left asking more questions:

Why was it drawn in this way...a bit of information like that would be cool...maybe you could have a short overview and then you could have a link to more information...

...historical context...what kind of social structures they had and how this is reflected in the dresses and stuff...

I like to know the designers, fabrics, when it was designed, what collection it comes from and its social context

(Reynolds & Speight, 2008a)

9.3. Trail as structure

During the formative evaluation it was found that generally 'the trails work as both a practical tool for navigating the space and a cognitive tool for making meaning, often within the context of a single visit' (Speight, 2007b). There is ample evidence from the project as a whole that the trails balanced enjoyment and education. Student comments ranged from 'I had a great time because of it' to 'It started ideas,' and learner engagement was mentioned by both tutors and museum staff.

Students appreciated the framing questions, one saying for example, 'Questions force you to think and find things out.' In an unsolicited comment, another said, 'It allowed a personal response' (Reynolds, 2007). Others however disliked the questions, calling them 'very basic,' 'patronising,' too difficult, or too numerous.

The trails were not universally welcomed. As well as being distracted by the PDA, some students simply did not like structure or being led at all, one commenting that the trail created a kind of 'tunnel vision.' Other students offered advice with regard to trail structure:

...a more coherent circuit maybe (logical)

The trail should be room based — type room number and receive list of interests. Also a style referencing system for quotes and links. Also an age preference, targeting different ages written in a different style — more appropriate to the age group.

(Speight, 2007b)

9.4. Technological mediation

In research on mobile technologies in museums there is a tendency to focus on the device alone — on its capabilities or limitations, and as a point of focus or distraction. But this project made clear that the entire technological system must be taken into account. For instance, the factor which most negatively affected learners' experience was the repeated failure of the wireless infrastructure due to inadequate capacity in the PDAs, intermittent technical faults in the wireless network, and the structure and contents of the galleries. There were also issues with regard to protocols and security: the V&A's network required a password before devices could be connected to the system, so visitors' own devices could not be used. Even when the network was available, there were bandwidth problems with streaming audio and video, and the PDAs themselves had trouble playing audio and video files. Because the iGuides system relies on connectivity to the Internet to both retrieve and store content, when the network was not available the trails could not be used at all.

Students and tutors also had problems with the stylus and small keyboard. In addition, the 23 iMate Jasjar PDAs proved too unreliable to use, because they did not allow optimum connectivity, they tended to reset themselves when switched off, and settings such as screen lighting were unpredictable (Reynolds, 2008).

9.4.1. Digital v. paper trails

A direct comparison between paper and digital trails was afforded in the first formative stage (Speight, 2007b). While some students preferred paper, others found the digital trail easier to follow — though it is difficult to make a direct comparison given the state of the network at the time. Paper was seen as a less linear medium — the order could be shuffled, and the learner could easily look ahead or back — a finding echoed by Costabile et al. (2008).

Among the findings was the seemingly obvious one that the PDA holds more than paper. There are deeper issues here with regard to data storage however. For example, since trails are not stored locally on the device, it was only perceived by the students to hold more data when the network was available; otherwise it was virtually useless. The device could indeed hold a great deal of data locally, but this capability was not exploited. When connected, the device affords access to whole libraries of data via the Internet. However, that feature was not exploited either — though there were references in some of the trails to the V&A website for further information. Web links were not used

because of the need expressed by many in the project to constrain the amount of information in a guided visit, and because it might have proved difficult to navigate back to the trail.

9.4.2. Media

A digital device cannot only hold more data (locally or remotely) than paper, it can serve and capture multiple media types including audio, video and images.

The trails in this project — as with other multimedia tours — contained images showing details of objects not easily seen in the display, or images which were used for locating objects in the gallery. Images were seen as useful, particularly for wayfinding, but their resolution was too low to facilitate much study of object details, and they could not be made larger or zoomed into. One student suggested that high-resolution images can bring you closer to an object. It was also noted that images could show the insides or backs of garments on display, and videos or animations could put them in motion or in context; another student said that images of things not inside the gallery could serve to further contextualise objects (Speight, 2007b).

Audio had an important role in the trails. One student for example countered the traditional concern that audio guides isolate visitors by saying that the audio encouraged looking, not passivity. Another said it highlighted details that might not have been otherwise noticed. Reported another, 'I found the gallery very calm so enhanced the trail. I could sit peacefully and listen to the audio files of people's opinions' (Speight, 2008:16) Fisher noted that about 40 percent of design students are dyslexic, and 'therefore, it is easier for them to look at images and to listen to, rather than read, information' (2007:35)

However, there are important points against audio. Some students preferred text over audio because they could scan it to save time (Reynolds & Speight, 2007). Each mode is suited to either browsing or searching, and since audio is a time-based medium there are important arguments therefore for keeping audio clips brief (e.g. Proctor & Burton, 2003; Proctor & Tellis, 2003); and where there is audio, always including transcripts — this serves different learning modes and learning styles. However, text too must be kept brief. One student reported, 'It surprisingly made me look at it [the gallery] less. I spent a lot of time reading from the PDA and looking at the photos on it so when I reached the object I moved on quickly' (Reynolds & Speight, 2008b).

Some students found it difficult to write on the PDA; a tutor also mentioned this. One student also commented that 'it felt like note-taking,' presumably a negative connotation. Audio was thus a more attractive option to some; one mentioned this as an 'easier way of recording thoughts.' Non-native English speakers particularly liked this feature.

9.4.3. Distraction

There is ample evidence from this project that the technology sometimes distracted from the learning experience. For example, one student commented, 'I'm not really enjoying this experience; I'm distracted and not looking at the pieces' (Reynolds & Speight, 2008a). This is partly down to problems with the device and the network; but other research has shown that if the practical process of accessing information is too complex, this can distract from engagement with the content (Laurillard, 2002:111). For example, other students commented:

I think we were impressed because of the technology, but it was compared to the paper trail...a more painful experience. I felt I hadn't actually looked up once because I was constantly looking down to see what was happening on the screen and where it was going. (Reynolds & Speight, 2008a)

I was more engaged with the PDA than with the gallery...I felt very disconnected with things because I didn't look at them much. (Level 3 interview trail analysis)

With use and practice this could possibly happen [the trail adding to the experience of the museum visit], but I found the equipment got in the way of enjoying the gallery. (Speight, 2008)

...it would work much better if you were able to do it on a PDA that you were perhaps more use to. (Speight, 2008)

More important than the device itself — with regard to both visitors' and museum-owned devices — is how the data and the learning experience is structured, and this was the point of the trails. And in fact, for all the students who reported that the PDA was a distraction, a similar number said it helped structure their visit and broaden their knowledge. They sometimes referred directly to the PDA in this regard, but when mentioning structure and information it is clear they were referring to the trail content and structure. The perceived distraction and isolation induced by the device thus seems to have been balanced by the usefulness of the content and structure (Speight, 2007b).

9.4.4. Social factors

The multi-perspective trails were generally found to be popular, and the most popular trails were created by (or in collaboration with) tutors; particularly the 'thrill trail' with its unconventional nature and very specific instructions.

Some students disliked the tone of voice ('poshness' as one termed it) of some of the voiceovers — a distinctive critique from this inherently critical audience, as noted previously. Others felt that audio was more likely to sway one's opinions or ways of looking. Some preferred the voices of other students while others preferred the experts', but what is clear is that someone else's opinion can prompt your own.

Students also talked about being inspired by the passion of other people in the galleries. 'If someone's looking at it,' said one, 'you feel the bond and you wonder why' (Fisher, 2007). This refers to the visitor phenomenon well-known to museum educators called 'shadowing' in which visitors are drawn to objects other people are looking at.

10. Conclusion

The 48 students in this sample responded positively on the whole to the trails' content and structure. However, the trails were only partially successful from a technological standpoint, due to device and network problems. Though these problems distracted students from direct experience with the objects and galleries however, this was balanced by the usefulness of the content and focus.

Students appreciated extra information about objects, and wanted further contextual information about the objects on display beyond what is already provided in the museum. Students appreciated images showing objects from different angles and in different contexts, and

videos showing the creation process. Students spent much longer looking at objects when using trails, feeling closer to them and appreciating them from multiple perspectives. They particularly valued listening to views from different people about the same object, including in some cases those of their peers. Negative feedback mainly concerned the ability of the PDAs to distract from looking at objects, and questions which were felt to be over-directive or patronizing.

Trails effectively made students, especially those in early years of study, less overwhelmed by and in the museum. Trails often left students asking more questions. While tutors believe the level of help and support needed by students in museums diminishes as they progress through the different levels of their course, in fact, help with learning to look was welcomed by students at all levels. Interestingly, students preferred conducting a trail outside their own subject area.

Both tutors and students have a mix of critical and reverent attitudes toward museums; therefore they valued curatorial viewpoints as well as alternatives to these from tutors and other students. Trails cannot take the place of tutors, nor serve as a replacement for guided visits; but they can support students' engagement with the museum by offering questions and prompting articulation and reflection.

Since the technical problems in the project were partly due to an unfamiliar device (88.9 percent of students surveyed had never used a PDA), the problems might be addressed by allowing learners' own devices, thus reducing cognitive load needed to learn the interface. As in this project, Beazley (2007) found that secondary students at Dulwich Picture Gallery initially were engaged primarily by the technology, but it soon became almost second nature to them and served to focus them on learning about specific aspects of art and art history. There is evidence for similar rapid adoption among primary-level students (Walker, 2008a). Due to the brief nature of the visits in this project, it is likely that the more the students used the PDAs, distraction imposed by the device's interface would lessen.

Handheld technology can be a way of serving different audiences in the museum, and of using different pedagogical approaches in museums. This project suggests that approaches to learning more common in formal education have a place in museums, and it may perhaps be more useful to think of the museum as an arena for various types of learning rather than a place which involves a single type of learning. Technology has a key role to play here, helping to maintain the museum as a learning space which complements that of universities as well as schools.

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