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Abstract

We report a study in which 30 university geography students compared five techniques to enhance the experience of visiting outdoor locations. The techniques were: a pre-prepared acetate overlay of the visual scene; a custom-designed visitor guide running on a PDA; the mScape location-based software running on a GPS-enabled mobile phone; Google Earth on a tablet PC; and a head-mounted virtual reality display. The students were given the assignment as part of their assessed coursework for a field trip to the UK Lake District, where they had to evaluate the techniques and propose improvements or future designs to enable tourists or students on field trips to gain an enhanced understanding of their surroundings. The paper describes these techniques, reports the process and results of the student assignment, and concludes with a discussion of some broader issues emerging from the project.

Author Keywords

Mobile technologies; visitor experience; field trip; geography; student comparison; evaluation.

INTRODUCTION

Previous projects have demonstrated the educational potential of using digital technologies to augment real-world environments (e.g. Ambient Wood (Rogers et al., 2004)) and the value of incorporating geospatial awareness into mobile learning systems (e.g. the Savannah project, (Facer et al., 2004)). There are many different techniques for augmenting the learning experience in outdoor settings, with their own characteristics, capabilities and restrictions. The learning objectives may be subject specific, e.g. to help geography students to develop an understanding of geology and surface landscape characteristics, or they may be more general, e.g. to enable a tourist to gain an appreciation of the landscape and its heritage. Specific mobile technology platforms may be used as a means to address these learning objectives.

We present a student assignment in which the students reflected on the effectiveness of the techniques themselves, compared a range of technologies side-by-side in the field, assessed their value for augmenting the visitor experience and suggested potential improvements. The exercise formed part of a Geographical Information Science (GIS) module available to undergraduates and taught postgraduates at the University of Nottingham. The learning objectives related to the design of robust, useful and usable technology and to the effectiveness of various forms of data representation in engaging the user with the real world landscape. The exercise was framed around the requirements of tourists to the area and students on field trips wishing to know more about the landscape.

BACKGROUND TO THE WORK

The field trip is a very effective mode of teaching and for generations of students these field trips provided popular and memorable experiences, often crucial in understanding aspects of biology or the natural sciences (Rieger and Gay, 1997). However, field trips have gradually fallen out of vogue because they do not easily scale to large numbers. An important element of a field trip is to identify features in a landscape, e.g. evidence for glaciations or mine workings. Often the educator or a knowledgeable guide would lead groups of students around in the field and point out features of interest to the group. With large group sizes, this one-to-many model becomes less effective and difficult for students to engage with appropriate features in the landscape. Many of these functions would be best served on a one-to-one basis between the field guide and the student, given the often inclement environmental conditions and the need to hear clearly what the field guide is saying and see exactly where they are pointing. Inevitably these functions are provided in a one-to-many fashion, with many students failing to gain any benefit when on the periphery of a large group.

In a similar manner to students on a field trip, tourists who visit a location often wish to know more about the surrounding landscape. There is a long tradition of publishing guidebooks that offer "descriptions of scenery...written with good literary taste" (quotation from *The Daily Telegraph* July, 1901, in frontmatter to Baddeley, 1906). More recently, mobile technology has been designed to enhance the tourist experience by providing location-specific information in the form of text, images, sounds and video (e.g. Pocket London, www.pocketlondonguide.co.uk). Handheld devices combined with GPS (Global Positioning System) sensing capabilities, have enabled a user's current position to be used to query any spatially referenced data held on the device or accessible over a network.

Early examples of computer-supported field work include "Wireless Coyote", where children used modified tablet PCs to record and share information relating to the environment (Grant, 1993) and "Cornucopia", where undergraduates used mobile devices to record data for different varieties of corn (Rieger and Gay, 1997). The "Plantations Pathfinder" application provided electronic information for visitors to a garden attraction, meaning it could be updated more quickly than printed matter and could record a visitor's interests as they toured the garden with the device. It also enabled interaction between visitors (past and present) via online discussion forum (Rieger and Gay, 1997).

These projects were indeed location-based, but were not yet "location-aware", in that the mobile devices under consideration did not yet possess any location-sensing technology such as a GPS receiver. This has changed over the last decade, due to improvements in computing and wireless networking, in particular the growing availability of GPS sensors in consumer devices and also the incorporation of GIS technology and data into mapping applications (Stenton et al., 2007).

An example of location-aware field work has been published by Pascoe et al., where a PalmPilot running the "stick-e note" system was used by ecologists in Africa to record contextual data relating to the behaviour of giraffes (Pascoe et al., 1998). "GUIDE" is an example of a location-aware electronic tourist guide for use by visitors to Lancaster, providing personalisation based upon a visitor's own interests and also various environmental parameters (Cheverst et al., 2000). Finally, a well-known location-aware application is the "mscape" platform, developed by HP Labs as part of its Mediascape project (Stenton et al., 2007). These "mediascapes" provide multimedia-rich, context-sensitive location-based experiences, where logic and pre-defined rules related to a user's location determine the behaviour of the triggered media.

Current technologies have evolved the potential for location-aware mobile devices to become powerful aids for fieldwork, where we can measure, record and share a rich variety of information and experiences with other users, both in real time and asynchronously (Tinker et al., 2002). There is clearly much research interest in developing tourist guides based on mobile technologies, but from a teaching and learning point of view there is a great opportunity to develop methodologies that allow students to evaluate the effectiveness of various techniques. Where we have access to geospatial data and technology, the usability of the device and the effectiveness of data representation can become foci for the learning objectives, rather than using the mobile device as a means to an end in addressing subject specific learning objectives.

This paper reports on one such methodology designed to allow students to compare a range of mobile technologies in terms of their ability to complement, or augment, a person's experience in the field. The exercise developed, entitled 'Augmenting the Visitor Experience' formed one day out of a four-day residential fieldtrip in the English Lake District. The development of techniques used in this day project was partly funded through the SPLINT (SPatial Literacy IN Teaching) project, a collaboration between the University of Nottingham, University College London and Leicester University (lead partner). It is a Centre for Excellence in Teaching and Learning (CETL) and funded by the Higher Education Funding Council for England (HEFCE). At Nottingham, the primary concern has been the development of tools, techniques and strategies for enhancing the use of spatial data in geography curricula, and beyond, using GPS-enabled mobile devices and semi-immersive virtual reality displays.

METHODOLOGY

The study site for the development of the 'Augmenting the Visitor Experience' project was the area around Keswick in the English Lake District, Cumbria, UK, an attractive upland environment popular with tourists and walkers. The project occupied part of a residential fieldtrip involving around 30 students working in small groups (most of whom had taken pre-requisite modules concerning basic GIS) and had a good understanding of digital geospatial data to support in-field tourist guides. The learning objectives of the project focused on developing a critical awareness of the issues that arise when designing and implementing robust and effective mobile tourist guides. A number of different techniques and technologies were made available to the students, who were asked to design a programme of testing in the field to expose those capabilities of the various systems that showed most promise. It was also important for each group to gather evidence of the system features that proved problematic (e.g. usability issues; difficulties associating various media with the landscape features), using photographs and video recordings.

Five techniques were made available, and no prior knowledge in their use was required. The techniques are described below, and pictured in figure 1:

- **Computer-generated acetate** A 3D landscape model of the area was available on a desktop package (Bryce 5) which contained a terrain model draped with aerial photography, as well as alternative geology drapes and a scenario for a retreating valley glacier. The students could generate 3D views from any known location in the model, print the views onto acetates, then visit the real locations in the field. Holding the acetate up in front of them allowed features on the acetate to augment the real scene, for example the size and extent of the retreating glacier could be seen in the context of the present day valley.
- **Bespoke PDA application**. A PDA application was developed to utilise the images created for the acetates, but to upload them onto a GPS-enabled PDA. They then formed waypoints and were automatically displayed as the used

reached the appropriate location in the field. The user could switch between the alternate views, sketch over the display, or listen to audio recordings describing certain landscape features visible from that point.

- **Mediascape on a mobile phone**. A range of media elements, (images, videos and audio recordings), were made available to the students who could then create their own mediascape and test it on a GPS-enabled mobile phone. The students defined the size, shape and position of trigger regions on a map, and assigned media elements of their choice to those regions. Once their mediascape was uploaded to the phone, they could test the effectiveness of various media as they were automatically displayed or played, as the user reached the pre-determined locations.
- **Google Earth on a tablet PC**. The virtual globe Google Earth was made available on GPS-enabled tablet PCs, with data for the area cached on the device. An external GPS connected to the tablet PC enabled the user's current location to be shown on Google Earth and they could then adjust the 3D view to match the view in the field. Image drapes representing topographic information and geology could be switched on and off.
- **Head-Mounted Display.** An experimental system (described in more detail in Jarvis et al., 2008) comprising a Head-Mounted Display (HMD) linked to GPS and an inertial device, allowed a 3D virtual model of the retreating glacier to be rendered to the user in real-time, synchronised to their position and to the orientation of their head. The user is aware of the real scene via their peripheral vision, and can flip the visor up at any time.

Figure 1. Techniques for augmenting the visitor experience (left to right): pre-generated acetate; bespoke PDA application, mediascape on a mobile phone; Google Earth on a tablet PC; and Head-Mounted VR Display.

The information offered by each technique was not exactly the same in each instance, and the choice of information content was not intended to form a complete tourist guide experience. Instead, it represented a sample of the sort of information that can be used to augment the user's experience of the landscape scene. However there was great diversity in terms of the technological sophistication, the size and nature of display device, the mode of interaction, the use of audio, and the way in which information was represented. After the exercise was complete, the students presented their findings in a 20-minute talk, which included evidence in the form of video footage they collected during the day.

CONTRIBUTION

The value of this approach is seen in offering students a wide range of techniques, with different modes of interaction and varying capabilities, in the context of the development of mobile 'augmented' tourist guides. Rather than use a single technique as a means to an end, the project focused the learning objectives on the design of robust and effective technologies, using in-field video to gather evidence of usability issues. Initial findings have confirmed the project as a useful platform for students, and indeed the authors, to engage with issues relating to the challenges of making expert knowledge about various landscape themes work effectively through different mobile platforms.

EVALUATION

The students found the exercise interesting, and even fun. They identified many issues relating to both the usability of the technology and the design of the media and information used with such technologies. Over ten issues were mentioned, the most important being: the simplicity of design and ease of user interaction; how rugged and weatherproof the technique was; the size and visibility of the screen; and the ease of associating information with the landscape such that it became relevant. Almost without exception the student groups developed clear schema by which they chose to evaluate the techniques and also clear recommendations for the design of a system for the future. Whilst differing terms were used to describe their schema, the three broad areas for evaluation related to the device itself, the nature of interaction, and the usefulness of information provided. Interestingly there was great variety within each of these broad categories in terms of the performance of the various techniques. The format and simplicity of the acetates proved surprisingly popular, leading two groups to offer 'electronic acetates' as their visions for the future. The PDA device proved popular in function and screen size but performed badly in terms of stability, including issues with GPS connectivity. Mediascape proved very popular in terms of the ability to control media placement and ultimately affects the usefulness of the system, however the small screen size and modes of interaction let it down. The tablet PC suffered from similar stability issues as the PDA although the combination of large screen and an extensible data exploration environment in Google Earth were attractions. Finally the Head-Mounted Display showed merit, and was fun and engaging, but it was thought that the technical complexity and lack of robustness would prohibit any use in a public context in the near future.

In terms of evaluating the success of the exercise from the viewpoint of the authors, it succeeded in engaging students in a group-based evaluation exercise and led to a critical awareness of the capabilities and limitations of certain mobile technologies. Evidence from the 'Student Evaluation of Module' forms suggests that students appreciated the use of a hands-on field exercise to engage them with what they considered relevant both academically but also in a commercial sense. The student video diaries themselves form an interesting resource which will help the authors explore certain usability issues that the students themselves did not pick up on. For example, several videos revealed that students were looking at one landscape feature whilst listening to an audio commentary which related to another feature. This relates to a broader issue of how people connect media with landscape when accessed through a mobile device in the field, but also how we can evaluate technologies for facilitating such a process. A significant finding of this work may be that the student-led video diary may indeed form a rich source of material for further exploration of how situated media works in mobile learning.

REFLECTION

In addition to the successful technical comparison and the clear ability of students to develop schema for describing the attributes of various systems and techniques, some broader issues of interest to the mobile learning community are emerging. Evidence, in part from student video diaries, suggests that significant challenges exist in the development of robust and effective techniques for allowing users to relate a piece of information on the device with the real world feature or area to which it relates. Of particular interest is ability to automate the function of the human field guide in pointing out landscape features whilst being able to affirm user engagement first. For example a guide could say "You see that forest over there?" and only on seeing that the other person had identified that feature would continue with "OK, well that was the first purchase made by the National Trust". So not only do we have issues relating to the relevance of a piece of information to a particular user's context, but the ability to directly associate that information with a feature in the landscape is of interest, in terms of both the system design and the techniques used to observe and evaluate this process in the field.

One feature of the exercise which could be developed further is to more explicitly evaluate the effect of various techniques for augmentation on the process of knowledge construction. An example could focus on the understanding of the landscape history of the study area, and to develop a post-exercise task which involved the users describing, even mapping out, the important influences on the landscape they had experienced that day. In a field work context, this relates to attempts to replace the one-to-many model often used to disseminate information to groups of students in the field by some kind of mobile field guide. The broader context of this work also relates to how heritage information and other material relating to landscape themes (from glaciation to mining) can engage and enlighten visitors.

Experiences from the first run of this exercise have suggested further developments for the next field season. The authors have begun working with specialists in the development of handheld applications which make use of the internal compasses on devices such as the Google phone and the iPhone, offering handheld augmented reality through the phone's camera and screen (as with applications such as Wikitude). The emphasis on visual augmentation will be supplemented by a more detailed study of the effectiveness of situated audio, focussed initially on one particular expert domain, for example the history of mining in the area. The user requirements for such a system should be relatively easy to define, and organised field tours by an expert already occur within the study area, on which to base the mobile guide.

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