GreenHat: Exploring the Natural Environment Through Experts' Perspectives

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ABSTRACT

We present GreenHat, an interactive mobile learning application that helps students learn about biodiversity and sustainability issues in their surroundings from experts' points of view, before participating in unfamiliar debates about their familiar surroundings. Using the interactive location-sensitive map and video on a smart phone, GreenHat simulates how experts go about making observations in the field and encourages students to actively observe their environment. We present our design process, our initial prototype, report the results from our preliminary evaluation, and discuss ongoing work.

Author Keywords

Mobile learning, sustainability, biodiversity, location-based information, expert perspectives

ACM Classification Keywords

H5.1. Information interfaces and presentation: Multimedia Information Systems-Artificial, Augmented, and Virtual Realities.

General Terms

Design

INTRODUCTION

One of the primary challenges in scaffolding novices to become experts is helping them first develop a "professional vision" – being able to see the world from an expert's perspective [5]. Goodwin identifies the practices of *coding*, *highlighting*, and *producing and articulating material representation* as ways that participants build and contest professional vision. However, in situated contexts where experts are not present to identify the appropriate coding, highlighting, and articulation of material representations, mobile learning systems have the potential to assist students in adopting these expert points of view.

We present GreenHat, a mobile learning system that aims to help students engage with the natural environment with multiple expert perspectives (landscape architecture and conservation biology). By connecting these experts' analyses with the students' everyday landscapes, students can look at their environment from a new perspective, and develop their opinion on location-sensitive controversial conservation issues. Mobile technologies can support the development of expert perspectives by prompting novices with context-relevant information, interactively engaging the student with multiple forms of information and inquiry, and connecting their mobile experiences with the greater community discussion.

BACKGROUND AND RELATED WORK

Sustainability and increasing ecological awareness is of increasing interest to the interaction design community [2]. Previous work on sustainability in interaction design has focused on leveraging social networks to promote ecologically friendly action [7], or enabling citizen science by using cellphones as a mobile sensing platform [9]. While these projects promoted ecological awareness and engaging citizen scientists data, they were not necessarily used to foster debate around sustainability issues.

The NatureTalk aimed to enhance creativity by helping children capture, geo-tag, and explore sound [8]. Researchers have also developed paper-based mobile tools for field biologists [11]. However, these interfaces are much more explorative in nature, and do not necessarily assist a novice in adopting an expert point of view.
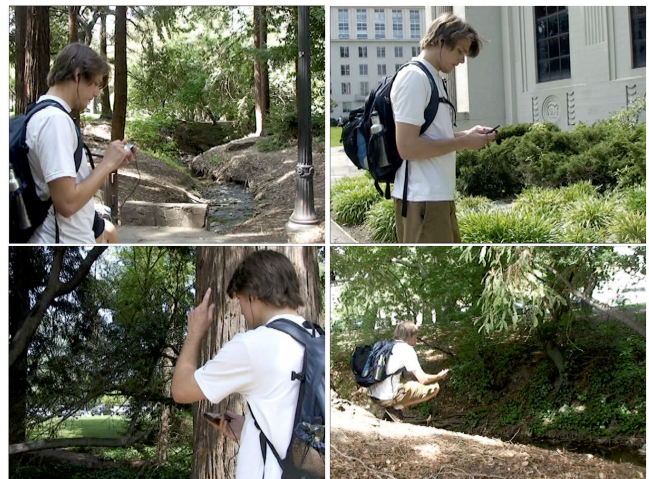

Figure 1: In preliminary tests, students learned about contextually relevant sustainability issues using GreenHat.

Situated cognition theory argues that knowledge cannot be separated from the context in which it is situated – abstract knowledge is not fully understood until it is applied in context [3].

THE GREENHAT

The GreenHat system consists of GreenHat Mobile, an application that runs on a GPS-enabled Smartphone (e.g. Android, iPhone), and GreenHat Web View, a website that aggregates data from multiple users. Previous user needs research on Mobile Learning applications [6] has identified three core needs: *Capture*, *Access*, *Connect*. The features of the GreenHat system address the three main need categories.

- *Capture*: Using GreenHat Mobile, students document observations in the field through text, photos, and audio capture. In addition to automatically-generated time and location metadata, students can add tags to group information. Users' past tagging activity can also be used by GreenHat Mobile to suggest additional content.
- *Access*: At any point, the student can query GreenHat Mobile for more information and request GreenHat Mobile to alert them when they are near interesting opportunities to learn about biodiversity. As the student continues to use the system, GreenHat Mobile prompts further mobile exploration by highlighting locations tagged with commonly used terms.
- *Connect*: Using GreenHat Web View, collaborating students can view a common map that marks where each student has been, their observations at those locations, and frequently used tagging terms. This view enables collaborators to start conversations centered around each others' field work.

GREENHAT DESIGN PROCESS

In order to understand the specific issues of sustainability and biodiversity on campus, the design team first gathered and studied material available through the campus' existing online resources (e.g., an interactive campus map describing the history and biodiversity of the creek that runs through the campus). The design team then took a tour of the campus with experts, including a conservationist biologist and a landscape architect, and conducted interviews and discussions with these experts. Based on insights we gained from the tour and interviews and from mobile learning literature, we developed the following design features for GreenHat.

Simulating the Way an Expert Sees the World: Observe the Environment from Experts' Perspectives
While the design team was in the field with the experts, we noticed that the experts looked at the familiar environment differently from us and noticed things that we usually would not about the familiar places [5]. The expert's physical demeanor and engagement with the environment were different from ours while we walked on the forest paths on campus together. For example, the expert carefully looked around the ground as we walked together (e.g., identifying native oak seedling sprouting where they could be damaged from human traffic), looked up on the trees (e.g., identifying non-native ivy overtaking the light that the oak tree should get), looked around the shrubs (e.g., identifying non-native squirrel species). While being in the

same environment, the experts' eyes and bodies were everywhere, noticing things and asking critical questions about the environment. What, then, is it like to experience this familiar environment from an expert's perspective? What exactly are the experts noticing? What kinds of questions are they asking? What kinds of observations are they making? It is this kind of perspective shift in actively observing one's environment we wanted to simulate in our mobile learning application. While experts' availability is limited, mobile devices have the potential to provide information "on demand" for learners even in the absence of experts [10]. Based on literature on expert vs. novice learning [3], our goal is to simulate an experience for the learner as if s/he is taking a walk with experts on the field.

Our design solution was to use a location-sensitive smart phone and have the device point at points of interest in situ as experts may. We curated the content of the experts' tour and delivered their teachable moments on students' mobile phones in a combination of video, images, and an interactive map. The information resolution moved from a macro view to a micro view. The campus map first indicated their current location and guided students to a specific area (Figure 2, left). Once the student reached their destination, the phone initiated a video of the expert discussing an issue specific to the area (Figure 2, right). This not only showed the expert pointing at specific trees and area, but also demonstrated how the experts go about making observations in the field.
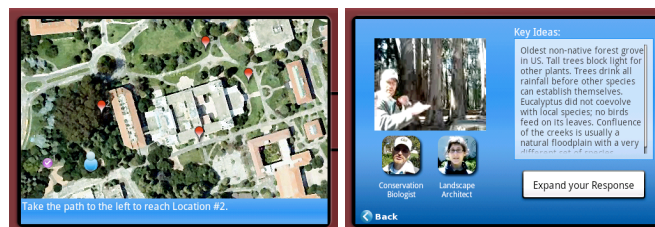

Figure 2: Screenshots from GreenHat prototype. The left shows the interactive location-sensitive map, and the right shows experts' demonstrative videos with key concepts in text.

Utilize the Local Resource: Discover Unfamiliar Debates about Familiar Places
In contrast to in-class or desktop learning environments, mobile learning is a multi-sensory experience (e.g., the movements, noises, air, temperature, shadows, and even the smell of the outside environment, etc.). Learning about nature in nature is powerful, but as our conservation biology expert commented, "one does not need to hop on a bus to Yosemite to learn about biodiversity." Students spend a significant amount of time traveling through various places on campus where there is nature (e.g., commuter trails, paths in between classes, outdoor meeting places, etc.). We agree with the expert that there are plenty of opportunities to provide situated learning on biodiversity right in students' back yard. And, in fact, learning in familiar places make conservation issues even more personal to the student. For example, the students may

learn that the beautiful forest they usually enjoy sitting in is filled with non-native species that are actually a fire hazard to the nearby buildings. Presenting evidence and facts in the familiar physical environment to the learner provides a unique learning experience.

Our design solution is to provide video of experts' presenting evidence by pointing at specific physical locations, at the same location. This actively engages the students in making observations in the field (e.g., with reference to images of native/exotic species on mobile phone). Discussions at the physical familiar location allow students to build on their personal knowledge and experience. As the students visit various familiar locations on campus, they are introduced to additional unfamiliar complex issues and debates. Our mobile learning tool engages the students with these topics by challenging them in situ with debate questions, and asking them to providing both their opinion and evidence.

Present Multiple Perspectives
We wanted to avoid having biased or polarized views by supporting pluralism in perspectives. For example, a nature conservationist may have a mission to restore the landscape with native plants, but what constraints might the landscape architect have? Are there solutions that satisfy both perspectives? To help the students explore variety of possible solutions by considering multiple perspectives, we designed the following four-step inquiry to engage the students in the topic. At each stop, 1) GreenHat asks the student to respond to a multiple-choice question about a controversial sustainability issue in their immediate surroundings (e.g., should we cut the eucalyptus trees?) 2) The student then watches videos of "experts", one conservation biologist and one landscape architect, each presenting their insights on that area. As the videos play, a list of "key ideas" is displayed next to the video. 3) The student is again asked to respond to the controversial question, this time adding the thought process behind their response. 4) The students can also view what other students have said.

Mobile and Beyond / Reflect
We connect the mobile learning experience with the students' existing desktop learning experience. Learning "on the go" provides unique opportunities for the students to make observations in situ and discover relevant facts. However, certain behaviors such as typing long notes or browsing large collections of digital library resources are not ideal on a mobile device with a small screen and keyboard. Our goal is to support uniquely "mobile" learning experiences, but at the same time not limit the experience to mobile devices only. After the trip, the students may reflect and expand on their activities by visiting their personalized online map on a web interface. This web interface also allows them to explore relevant keywords, edit their entries, browse and comment on others' entries, and visit relevant online resources.

Based on literature on mobile learning as well as our previous NSDL mobile learning research [6], interaction

design on mobile device must be engaging but relatively short. Once at the desktop, we provide a web forum for the students to expand on their mobile learning experience. In the web interface, students can view the history of their activities made with their mobile device (i.e., map of explored areas, images, comments, etc.) as well as entries made by others in the community.

IMPLEMENTATION
The GreenHat Mobile prototype was implemented using the Android G1 Dev Phone [1], which features an 8cm (3.17in) 480x320 pixel touch screen, a slide-out QWERTY keyboard, a built-in GPS receiver, and Wi-Fi capabilities. The prototype software was written in Java using the Android Software Development Kit. Participant responses where saved directly to an SQLite database on each device.

EVALUATION
In order to investigate the mobile learning situation offered by GreenHat, we compared two groups, 1) a group using GreenHat Mobile outside, and 2) a group using GreenHat's four-step inquiry running on a desktop. A total of 19 undergraduate and graduate students participated in our study. Twelve students have participated in the GreenHat Mobile group. Each participant spent approximately one hour and a half exploring the campus with GreenHat Mobile. To record their experience, experimenters "shadowed" the participants with video cameras and field notes. After the tour, the experimenters asked a set of open-ended questions such as "How was the experience of learning about Strawberry Creek?"

Seven students participated in the GreenHat Desktop condition, where they had access to all the same digital material as the GreenHat Mobile condition (e.g., expert videos, campus map, key concepts in text) but received these materials on the desktop computer in a room. In both conditions, the students have explored 5 different locations on the campus, following the 4-step inquiry.

RESULTS
We have looked at both the students' answers to the controversial questions (multiple choice) and the reasoning behind their answers (their written responses to the "Why?" question). The two groups were equally diverse in their answers and reasoning behind their answers. For example, both groups equally agreed on the answer to some questions (e.g., for the question, "Which landscaped space, North vs. South Lawn, is more sustainable?" 84% "North Lawn" 16% "South Lawn" for the Mobile condition 77% "North Lawn" 33% "South Lawn" for the Desktop condition), and similarly disagreed to some questions (e.g., for the question "Transplant or pullout the seedling out of place?" 41% "Transplant" and 59% "Pullout" in the Mobile condition and 50% "Transplant" and 50% "Pullout" in the Desktop group). Despite the disadvantage of typing on the small keyboard, the Mobile group wrote as much as the Desktop group with a standard-sized keyboard (the average length of written responses was 24.14 words for the Mobile and 26.6 words for the Desktop).

More Contextual Evidence

While the students' responses to the questions were equally diverse in both Mobile Learning group and Desktop Learning group, the Mobile Learning group seemed to give more contextual evidence in their responses. For example, a student in Mobile condition wrote, *"The lawn seems more functional on this side and **further removed from the bustle of students walking to and from class**."* (providing his observation in the environment). Another student in Mobile condition wrote, *"I actually like hearing the sound of the creek and being able to sit on the grass and see the creek at the same time."* (taking her personal experience into account). These types of comments from personal observation were not seen in the desktop condition. In describing their answers, the desktop group tended to quote the video, e.g., "[…] because the video said […]"

Seeing the World through the Expert's Perspective.

Some of the connections the students made with their environment happened outside of the prompts made by GreenHat in the Mobile group. As they walked between locations on campus with GreenHat, some students voluntarily pointed out the specifics of the environment they just learned to observe (e.g., "Oh, that's the ivy I just learned about!" pointing at the non-native ivy species found outside of the previous area). The Mobile students during the post-study interview described that they would now look at their campus differently. Some students described that they have "learned to be more skeptical" and questioning what they see.

Personal and Multiple Perspectives

The students in the Mobile Learning group reported that the experience of going through their campus and learning about debates on sustainability and biodiversity was "personal." They described that it would not be the same experience if they had learned about the same issue at a desktop, as they would not be as "immersed in the environment" as they were. For example, the students learned that the design of a particular creek side garden with lawn is highly un-sustainable (due to pesticides and energy to run lawn mowers). However, at the same time, they were there on a nice sunny day to observe their fellow students enjoying the green lawn during breaks. They were pushed to consider multiple aspects of the design challenge.

Technical Issues and Future Work

The GPS reception at some locations was not as good as we had originally anticipated due to "urban canyons." Some prompts by GPS were not precise, occurring earlier or later than we designed. In such cases, the combination of the map, images, and videos of experts pointing at specific objects in the location were helpful in guiding the students.

Students reported that some of the videos seemed too long for mobile learning. We plan to edit the videos so that they can be viewed in smaller chunks and also allow the students to save the point where they paused their video and continue watching it later.

We are currently expanding the application to include the mobile location-sensitive search, as well as an interface to digital libraries [4]. This will allow the student to engage with a broader community of experts, experiencing their surroundings from an even greater set of experts and curated resources.

CONCLUSIONS

GreenHat invited students to explore complex issues of sustainability and biodiversity presented at various physical locations in their familiar environment. Our preliminary evaluation of GreenHat prototype showed that having access to multiple experts' perspectives in the physical environment, i.e., how the experts would look at and interrogate the very environment the students stand, encouraged the students to actively observe the physical environment and provide more contextual evidence in forming their responses. Mobile technologies can support the development of expert perspectives by prompting novices with context-relevant information, interactively engaging the student with multiple forms of information and inquiry, and connecting their mobile experiences with the greater community discussion. We contribute the design of mobile learning experience that takes advantage of access to multiple experts and context-sensitive information in the learner's immediate physical environment.

ACKNOWLEDGEMENTS

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