Cover page

Title: *Tree Investigators: Using Augmented Reality and Mobile Computers Outdoors*

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Timeline: April 1, 2014 through March 31, 2015
**Abstract**: Tree Investigators is a 12-month research project on how mobile computers can support engagement with the life sciences in people’s communities. Specifically, we compare forms of technologically enhanced facilitation in regard to supporting learners to think scientifically at the Arboretum at Penn State and Shaver’s Creek Environmental Center. The technologically enhanced facilitation supports *observing* to encourage deliberate noticing that will lead to the *development of scientific concepts* as learners coordinate information contained on the mobile computer with the specimens on-site. Tree Investigators relies on mobile computers equipped with web browsers and photo capability to bring digital elements (e.g., text and photographs) to people in a nature center in real time, triggered by Quick Response (QR) codes or other mobile applications. Prior to this application, we conducted two small scale qualitative studies, and now we request funds to support a more rigorous series of qualitative and multi-condition, design-based research studies that will examine various aspects of mobile computing pedagogy. This project will (a) further develop the existing Tree Investigators app, (b) conduct empirical research to develop design principles to advance mobile computing practice that incorporates outdoor learning spaces, and (c) support the development to a future NSF-proposal.
This project builds on our research using mobile computers in nature, where we have investigated how mobile computers can be used to support scientific meaning-making in outdoor learning spaces (Zimmerman, Land, McClain, Mohney, Choi, & Salman, 2013). Our team is advancing technologically enhanced pedagogies that turn people’s everyday communities into learning laboratories through the inclusion of knowledge-generative tasks that rely on photography deployed on mobile computers (Land, Smith, & Zimmerman, 2013). We have completed two IRB-approved pilot iterations with a total of 35 people; we are proposing this new project to rework our existing materials based on initial findings to conduct a series of larger scale qualitative and quasi-experimental studies with at least 2 conditions (n=50-90 people), both to develop design principles suitable for publication and presentation and to inform a National Science Foundation (NSF) grant application.

Description of the online innovation

Tree Investigators users rely on their Internet-enabled cell phone (or a borrowed iPod™ or iPad™) to tour predetermined plants at a nature center. Within the app, visitors are told that they are going to learn to look more scientifically in the garden or trails as “tree investigators”. As they tour the outdoors, they receive information on their mobile device to help them to identify plants and the ecological relationships around pollination based on species’ life cycles. The participants interact with a touch-screen conceptual organizer and then tour four to five flowering plants, using a mobile device to access a QR code. The Tree Investigators materials
include conceptual models, contrastive images of comparative specimens, and photographs of the same specimen at a different time of year, in order to focus observation on key scientifically-relevant elements. Augmentations of a specific species (see Supporting Materials for a sample image) are provided that show aspects of important biological cycles.

Significance of the work

As a case study of technologically-enhanced mobile learning using Penn State outdoor learning spaces, Tree Investigators provides a concrete example of pedagogy that relies on mobile computers to support learners’ investigations outside the classroom—in community and natural settings. Researchers studying human learning, designers of technological resources for mobile computers, and instructors (online or residential) that work with mobile computers and/or life sciences content areas can benefit from this study.

Research questions

Tree Investigators will be tested through design-based research that answers these questions:

RQ1) Can people be supported to scientifically observe and identify species in outdoor spaces by photographic and textual elements delivered by mobile computers?

RQ2) Does a conceptual organizer presented a visual theoretical model support deep understandings of important ecological concepts related to life cycles and pollination?

Our hypothesis is that augmented photographic elements, delivered through mobile computers, will assist in the noticing of scientifically-relevant phenomena allowing for sense-making. Digital photograph will support learners to articulate ideas and annotate their understandings.
Brief description of pertinent research

Augmented reality (AR) and mobile technologies have been used to support science learning in outdoor settings such as forests (Rogers, et al, 2004), aquatic pools (Liu et al., (2009), parks (Tan et al., 2007), and butterfly gardens (Chen, Kao, & Sheu, 2005). These projects utilize handheld computers to provide on-demand science information, and the research is typically conducted in the context of school grounds, field trips (Rogers et al.; Liu et al; Tan et al), or college-level classes on campus (Chen et al.; Rieger & Gay, 1997). Research on these interventions points to gains in factual knowledge (Liu et al), identification skills (Chen et al.; Liu et al.), and conceptual understanding (Liu et al), and suggests that on-demand technological support of observations in a natural environment can lead to improvements in science learning.

AR in education has also been used to augment a real-world location with a layer of virtual data and gaming scenarios (see for example, Dunleavy et al., 2009; Klopfer, 2008; O’Shea, Mitchell, Johnston, & Dede, 2009; Rosenbaum, Klopfer, & Perry, 2006; Squire & Jan, 2007; Squire & Klopfer, 2007). The focus of such AR research is tightly connected to gaming in real, physical contexts—these gaming contexts differ from our proposed work’s focus. In Tree Investigators, we focus on observing deeply in natural surroundings to explore features of a local place. Nonetheless, these prior studies provide important foundational research that point to high levels of engagement from users (O’Shea et al.; Squire & Jan) and result from design elements such as data collection and participation in real locations (Squire & Klopfer), interdependence of and authenticity of roles (Squire & Jan), and personal embodiment within the virtual space (Rosenbaum et al.).
Research design, methodology, and procedures

We propose a design-based research study incorporating mixed methods. The specific iterations will be determined based on analyses of research findings with learners participating in our mobile learning environment. At present, we envision iterations that vary instructional strategies (e.g., conceptual organizers, artifact construction) and/or mobile computing features (e.g., photo taking and sharing) to determine effects on learning, observation, and science practices. Video-based procedures from the learning sciences will be used to ethically examine learning conversations supported by Tree Investigator. Procedures with participants include: recruitment, consent, demographic survey, pre-assessment, 60-75 minute engagement with the Tree Investigators in an outdoor space, photographing of the natural environment, post-assessment, and/or follow-up.

Data collection will include video records of learners engaging with Tree Investigators, demographic variables, a pre-and post-assessment, and a photographs. Data analysis will include t-tests of pre-and post-assessment, qualitative artifact analysis of a phototask, and qualitative and quantitative coding of videorecords with analytical framework used in our prior studies (Zimmerman et al, 2013).

Need for funding

The funding is sought for (a) the refined development of a mobile app and (b) a large enough data collection to be competitive for a research grant through a design-based research study design. All requested funds will be used for graduate student pay and travel support. Faculty will not take funds from the project for summer salary nor travel.
Plan for submission to external funding agencies

- National Science Foundation, Advancing Informal STEM Learning (AISL) - NSF 13-608). The due date is November 14, 2014.

Timeline for the study

Prior to this application, we have submitted an IRB application, collected two sets of data in 2011 and 2013 with 35 people, and analyzed the qualitative discourse from these two pilot studies. In the COIL grant period from April 2014 through March 2015, our primary task would be two-fold: (1) refining the design and development of the technological intervention (mobile app) and (2) conducting a series of qualitative and quasi-experimental studies:

- App development and IRB modification - April and May 2014
- Study preparation, data collection, and data entry - June through mid- July 2014
- Data analysis and write-up - End of July through October 2014
- Development of NSF proposal - September through November 2014
- Final manuscripts prepared and conference presentations -November 2014-March 2015
References


Supporting Material

We have included the following three kinds of supporting materials:

1. Brief summaries of the team members’ capabilities, as relevant to Tree Investigator (1 page).

2. 2-page poster published about Tree Investigators in the 2013 Proceedings of the Computer Supported Collaborative Learning conference (2-pages)

3. Screen Shots from Iteration 1 of Tree Investigators (mobile website) and Iteration 2 of Tree Investigators (mobile app for iOS devices such as iPhones, iPads, and iPod Touches). (1 page)