Supporting science practices outdoors with mobile devices: Findings from the Tree Investigators augmented reality project

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Abstract: This research examines how *Tree Investigators* supported families' science learning with mobile devices. Researchers coded videorecords of families at an Arboretum to understand how augmented reality elements influenced science talk related to observation and explanations about tree biodiversity. Findings suggested that augmented images that provided contrastive cases allowed for families to engage in observations and explanations as demonstrated by high levels of perceptual talk (such as describing and identifying).

Theoretical framework

Our research and design intention is to support families to be competent scientific observers and explainers of natural phenomena through employing mobile technologies. Mobile technologies have been used to support engagement in outdoor settings (e.g., Liu et al., 2009; Rogers, et al, 2004; Tan et al., 2007), as well as to augment real-world locations with virtual data and gaming scenarios (e.g., Klopfer, 2008; Squire & Jan, 2007). Researchers have reported design elements for mobile devices that encourage data collection (Squire & Klopfer, 2007) and engagement in discourse (Rogers, et al, 2004; Tan et al., 2011) that support science learning. Building on this prior work with mobile technologies, our research framework brings together theory about technological supports (Quintana, Reiser, et al., 2004) with theory about using talk to encourage observation and explanation practices (Bell, et al., 2009; Berland & Reiser, 2009; Eberbach & Crowley, 2009). We designed Tree Investigators as a mobile website (see Figure 1) that uses augmented reality (images and text layered onto the physical space) to support families to develop observations and explanations related to tree biodiversity. Our research investigates the following question: How do youth and families talk together about trees and biodiversity while using the Tree Investigators augmented reality program on mobile computers?

Methodology

We conducted a video-based collective case study at an Arboretum (5 hours of video) to understand how mobile devices using augmented reality could support scientific talk. The participants were 25 people from 11 families. Families were videorecorded during a 1-hour guided tour using augmented photographic and textual elements on tablets, smart phones and mp3-players. Given our interest to support science learning in informal spaces, the study's analytical framework considers spoken conversation elaboration (Leinhardt & Crowley, 1998) as a product and process of learning. We used a theoretical-driven approach to code transcripts for evidence of observation and explanation during the Tree Investigators experience. The coding scheme was derived from Allen (2002) as shown in Table 1; in addition, we included a sixth code: reading aloud.

Table 1: Analytical framework applied to family talk while using Tree Investigators.

Code	Description	Exemplar from our data set
Perceptual talk	Identification, naming, describing.	• . . . all the branches are all on the top.
Conceptual talk	Inference, interpretation, prediction.	• This one drops its leaves.
Connecting talk	Life, knowledge, inter-species connections	• They do have those – we were at the Pittsburgh zoo…
Affect talk	Expressions of feeling	• That one's interesting.
Device use	Clarification for device functions	• . . . you had to hit something to take a picture.

Findings

Based on a detailed line-by-line analysis of the families' talk using the Allen (2002) coding scheme and thematic analysis procedures, we found individuals used the Tree Investigator augmented reality images and text to support their observations and understandings of trees, as shown in right-hand column of Table 1 and in Figure 2. Families used the mobile devices in the outdoor setting to coordinate observations with scientific knowledge to support the development of explanations. Images and prompts (see Figure 1) that were part of an AR mobile website were used to support family observational practice and to develop explanations about the differences in trees and their characteristics related to biodiversity. The Tree Investigators' program supported the families so that they: (a) noticed relevant aspects of the trees in the seasonally dynamic environment; (b)

articulated understandings of scientifically-relevant aspects of the trees; and (c) understood differences between evergreen and deciduous trees. Our findings suggest the importance of augmented photographic elements (such as flowers, nuts, and leaves that were not seasonally available) as contrastive cases to the onsite specimens to support deep observational and explanation practices.

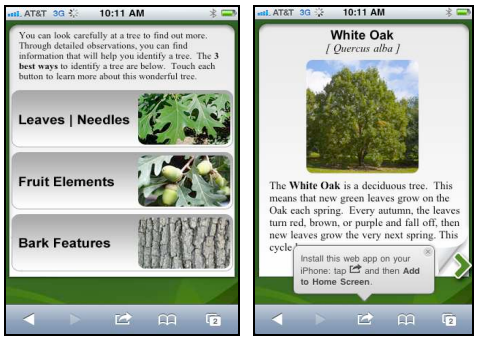

Figure 1. The Tree Investigators interface.

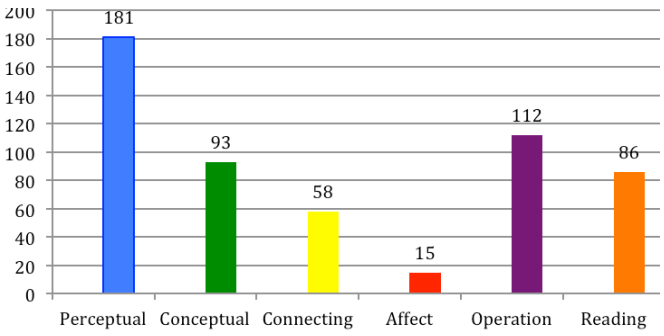

Figure 2. Talk across all the family members.

Discussion and Implications

The significance of this line of work lies in its contribution to the growing literature on technologically-enhanced lifelong informal learning, as shown through the Tree Investigators program supporting scientific talk through AR textual information and visualizations on the mobile website. Given our findings on the way that contrastive images supported elaborated family talk, this study supports efforts to utilize augmented reality approaches on mobile devices to support informal science education. This study suggests the need for additional research on how mobile technologies can be used by families and other learners in out-of-school venues.

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