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Scientific inquiry, digital literacy, and mobile computing in informal learning environments

Paul F. Marty[a]*, Nicole D. Alemanne[a], Anne Mendenhall[b], Manisha Maurya[b], Sherry A. Southerland[b], Victor Sampson[b], Ian Douglas[c], Michelle M. Kazmer[a], Amanda Clark[b] and Jennifer Schellinger[b]

[a]*College of Communication and Information, Florida State University, Tallahassee, FL, USA;* [b]*College of Education, Florida State University, Tallahassee, FL, USA;* [c]*Albany College of Pharmacy and Health Sciences, Albany, NY, USA*

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Understanding the connections between scientific inquiry and digital literacy in informal learning environments is essential to furthering students' critical thinking and technology skills. The Habitat Tracker project combines a standards-based curriculum focused on the nature of science with an integrated system of online and mobile computing technologies designed to help students learn about and participate in scientific inquiry in formal classroom settings and informal learning environments such as science museums or wildlife centers. This research documents the digital literacy skills elementary students used while participating in the Habitat Tracker project, exploring the connections between the scientific inquiry practices they developed and the digital literacy skills they employed as they engaged with the Habitat Tracker curriculum. The results of this research have implications for researchers and practitioners interested in fostering both the scientific inquiry practices and digital literacy skills of elementary students in formal and informal learning environments.

Keywords: scientific inquiry; digital literacy; informal learning; collaboration; mobile computing

Introduction

National efforts intended to enhance science teaching and learning call for engaging students in scientific inquiries at all grade levels as a critical component of supporting their understanding of the practices and nature of science (Duschl, Schweingruber, and Shouse 2007). Similarly, digital literacy skills, which include technical, cognitive, media, and social skills, encompass competencies that all students will need to become productive twenty-first century citizens (Hobbs 2011). In light of the limited instructional time and curricular pressures teachers experience, it is essential to design opportunities that authentically engage students with twenty-first century digital literacy skills during their

*Corresponding author. Email: marty@fsu.edu

scientific inquiries (Parr, Jones, and Songer 2004). Given the sometimes reticent nature of teachers to employ digital literacy practices in their instruction, these opportunities must include inquiries that are both intrinsically attractive to teachers and students, and difficult to conduct without the affordances digital literacy provides. Situating inquiries and their associated literacy practices in informal learning environments such as natural science museums and wildlife centers, therefore, holds particular promise in terms of engaging teachers and students with scientific inquiry and digital literacy skills.

Scientific inquiry

Science reform documents promote inquiry as an effective way of helping students learn about scientific content, the practices of science, the nature of science, and the nature of scientific inquiry (American Association for the Advancement of Science 1993, 2000; Collins 1998). The *National Science Education Standards* describes inquiry as a 'set of interrelated processes by which scientists and students pose questions about the natural world and investigate phenomena; in doing so, students acquire knowledge and develop a rich understanding of concepts, principles, models, and theories' (National Research Council 1996, 214).

As opposed to a more traditional conception of a scientific method, inquiry-based instruction is generally understood to involve students in authentic, real-world scientific experiences – i.e., '"doing" science to learn about the world' (Abrams, Southerland, and Evans 2008, xvi). The goal of inquiry-based instruction is to encourage students to engage with scientific questions, understand the importance of evidence in developing responses to questions, connect explanations to scientific knowledge, and communicate explanations using evidence. The National Research Council (1996, 214) highlights the important role that inquiry should play in science education when it states,

> Inquiry is a critical component of a science program at all grade levels and in every domain of science, and designers of curricula and programs must be sure that the approach to content, as well as the teaching and assessment strategies, reflect the acquisition of scientific understanding through inquiry. Students then will learn science in a way that reflects how science actually works.

Despite the prominence of engaging students in scientific inquiry found in all of the national reform efforts, classroom inquiry remains a rare event particularly at the elementary level (Abrams, Southerland, and Evans 2008). The paucity of the use of inquiry has been attributed to a number of factors, but teachers' unfamiliarity with these practices is understood to be a central factor in limiting their use. In order to design a curriculum or program that reflects the construction of scientific understanding through inquiry, educators must give students opportunities to engage with practices inherent to scientific inquiry, which according to the National Research Council (2000), include:

- Making observations – using the five senses to observe phenomena in the natural world.
- Posing scientific questions – developing questions that are based on current knowledge and can be tested by collecting and analyzing evidence.
- Conducting background research – using previously collected information on the phenomena for context and to gain a better understanding.
- Designing investigations – creating an investigation plan that takes into consideration available resources such as materials, background information, available locations, and time constraints.
- Using tools to conduct investigations – using tools to observe and measure phenomena, to analyze data, and to create models.
- Proposing hypotheses, explanations, and predictions – using data to form and test tentative hypotheses and identifying evidence to support findings.
- Communicating results – distributing findings to colleagues and others as part of the collaborative process of science.

Digital literacy

There is some lack of clarity and agreement on a strict definition of 'digital literacy', especially when compared to other concepts such as information literacy, computer literacy, and media literacy (Bawden 2008), but digital literacy is generally presented as a set of skills needed to prosper as a citizen in the twenty-first century, rather than a set of tools or technologies. Eshet-Alkalai (2004), for instance, proposed a framework for digital literacy that envelops cognitive, media, and social literacy skills – including photo-visual literacy, reproduction literacy, information literacy, branching literacy, and socio-emotional literacy – that allow students to think critically, solve problems, and perform difficult tasks in the digital age. Hobbs (2010) proposed a toolkit of digital and media literacy skills that focus on the social context in which these skills are used (e.g., the ability to access and understand information, determine the quality of messages, create content using a variety of forms and tools, and act in a socially responsible way). Bawden (2008) suggested that elements of digital literacy should include items such as computer literacy and general background knowledge, attitudes such as independent learning and social literacy, and competencies such as the ability to comprehend digital and non-digital formats, create and communicate digital knowledge, evaluate information, create knowledge, and possess information and media literacy.

Hobbs (2011) created an integrated cycle of digital literacy competencies that embody critical literacies supported by professional associations such as the National Council for Accreditation of Teacher Education. Teacher, learner, and pedagogical strategies such as scientific inquiry are central constituents in acquiring these digital literacy competencies, which support the goal of the Common Core State Standards Initiative (2010) to prepare students for a technological society (i.e., students need to practice their inquiry skills in concert with consuming and producing media). According to Hobbs (2011), the features of digital literacy competencies encompass:

- Access – the use of technologies to access information.
- Analyze and Evaluate – higher-order skills such as evaluation, analysis, and synthesis.
- Create – the ability to compose and create artifacts.
- Reflect – the engagement in reflective thinking.
- Act – the activity of sharing knowledge individually and collaboratively publicly.

Mobile computing in informal learning environments

Informal learning environments for science education, which often include museums and wildlife centers (Holmes 2011; Rivera, Maulucci, and Brotman 2010), provide learners with direct access to the natural world and scientific phenomena, and can play a significant role in helping students develop scientific inquiry practices and digital literacy skills (*Education Week*, September 19, 2001). Informal learning has been described as unplanned and implicit (Kyndt, Dochy, and Nijs 2009), with a paucity of mediation (Eshach 2007), where learning occurs causally and autonomously (Scanlon, Jones, and Waycott 2005). Informal learning in science settings is often described as being open-ended, learner-centered, unevaluated (Hofstein and Rosenfeld 1996), intrinsic (Csikszentmihalyi and Hermanson 1995), and free choice (Falk and Dierking 1992, 2000; Tran 2006).

Dierking et al. (2003) emphasize that science learning takes place in multiple settings, both in-school and out-of-school, and seldom does the development of scientific knowledge occur during a single experience or environment; exposing students to multiple learning opportunities inside and outside the classroom can be integral to education (Eshach 2007; Hofstein and Rosenfeld 1996). As the National Research Council (2000, 14) notes, scientific inquiry requires 'the identification of assumption, use of critical and logical thinking, and consideration of alternative explanations'. Mobile devices such as tablet computers are particularly well suited for science education activities that involve field-based experiences, such as visits to wildlife centers. The portability and connectivity of mobile technologies allow students to carry mobile devices out of the classroom, collect scientific data, and submit records to databases for analysis in real time (Spain et al. 2001).

Mobile learning applications can encourage elementary students to engage in scientific learning and data collection (Kuhn et al. 2012; Parr, Jones, and Songer 2004), including 'making observations; posing [research] questions

. . . and using tools to gather, analyze, and interpret data . . . ' (Centre for Science, Mathematics, & Engineering Education 2000). The use of mobile learning applications to support field-based scientific inquiry can have positive effects on student engagement and learning (Hung et al. 2013; Vahey and Crawford 2002), which in turn can influence their digital literacy skills. Research documenting the connections between scientific inquiry and digital literacy skills as part of curricula where students are using mobile computing devices and well-designed mobile learning applications in informal learning environments such as wildlife centers, therefore, is essential to furthering our understanding of the critical thinking and technology skills students will need in the twenty-first century.

Background and purpose of study

The Habitat Tracker project (http://tracker.cci.fsu.edu/) provides elementary students with an opportunity to engage in scientific inquiry within formal and informal learning environments through online and mobile computing. Participating students use a specially designed mobile learning (*iPad*) application that guides them through the process of collecting scientific data during a field trip at the Tallahassee Museum (http://tallahasseemuseum.org/), a 52-acre, outdoor natural science museum in Tallahassee, FL. The museum exhibits a variety of animals native to North Florida, including white-tailed deer, wild turkeys, river otters, red wolves, bobcats, panthers, alligators, black bears, grey foxes, and skunks, and is a regular field-trip destination for more than 35,000 students each year.

The Habitat Tracker project features a three-week-long curriculum that emphasizes the nature and practice of science. The curriculum begins in a formal (classroom) environment where students participate in activities that demonstrate components of scientific inquiry such as making observations, using observations to make inferences, and understanding the roles of creativity and subjectivity in science. Students learn how to conduct scientific investigations, develop hypotheses, explanations, predictions, and research questions, and collect observational data. They access the Habitat Tracker website (Figure 1) to explore multimedia content about the wildlife and habitats they will visit during their field trip, browse observational data collected by other students during previous museum field trips, and develop and record research questions in their online journals.

Following this preparation, students implement their scientific inquiry practices, collecting observational data to help them answer their research questions in an informal learning environment, the Tallahassee Museum. The Habitat Tracker *iPad* application helps the students record three types of data – animal, habitat, and weather observations – scaffolding the students' use of the system by walking them through the data entry process step by step. When recording animal observations, for instance, students first record the

Figure 1. Bobcat habitat on Habitat Tracker website.

animal's location on a map of the habitat (Figure 2(a)) and then record the animal's behaviors, such as eating, resting, vocalizing, or walking (Figure 2(b)). When observing the habitats, students are prompted to document the total number of animals in the habitat, along with other relevant observations (e.g., scratch marks, enrichment objects, and other animals observed). Weather observations are recorded using data gathered from one of four different weather stations located around the museum, where students can collect information on temperature, barometric pressure, humidity, and wind speed. Students complete their field trip by using the *iPad* application to write in their online journals, noting details of their experiences and observations, and posing new research questions. Students may also read journal entries as they are being posted, and comment on other students' posts.

After the field trip, teachers facilitate a debriefing session of the museum visit and the scientific inquiry process back in the classroom. It is during this debriefing process that students discuss their research questions, observations, and journal entries. Students analyze data using the Habitat Tracker website analysis tool, which guides them through the process of creating tables, charts, and graphs based on the observational data collected by participating students across multiple schools (Figure 3). The analysis tool is designed to scaffold student knowledge, systematically guiding them to understand the process of science through such tasks as uncovering relationships between

(a)

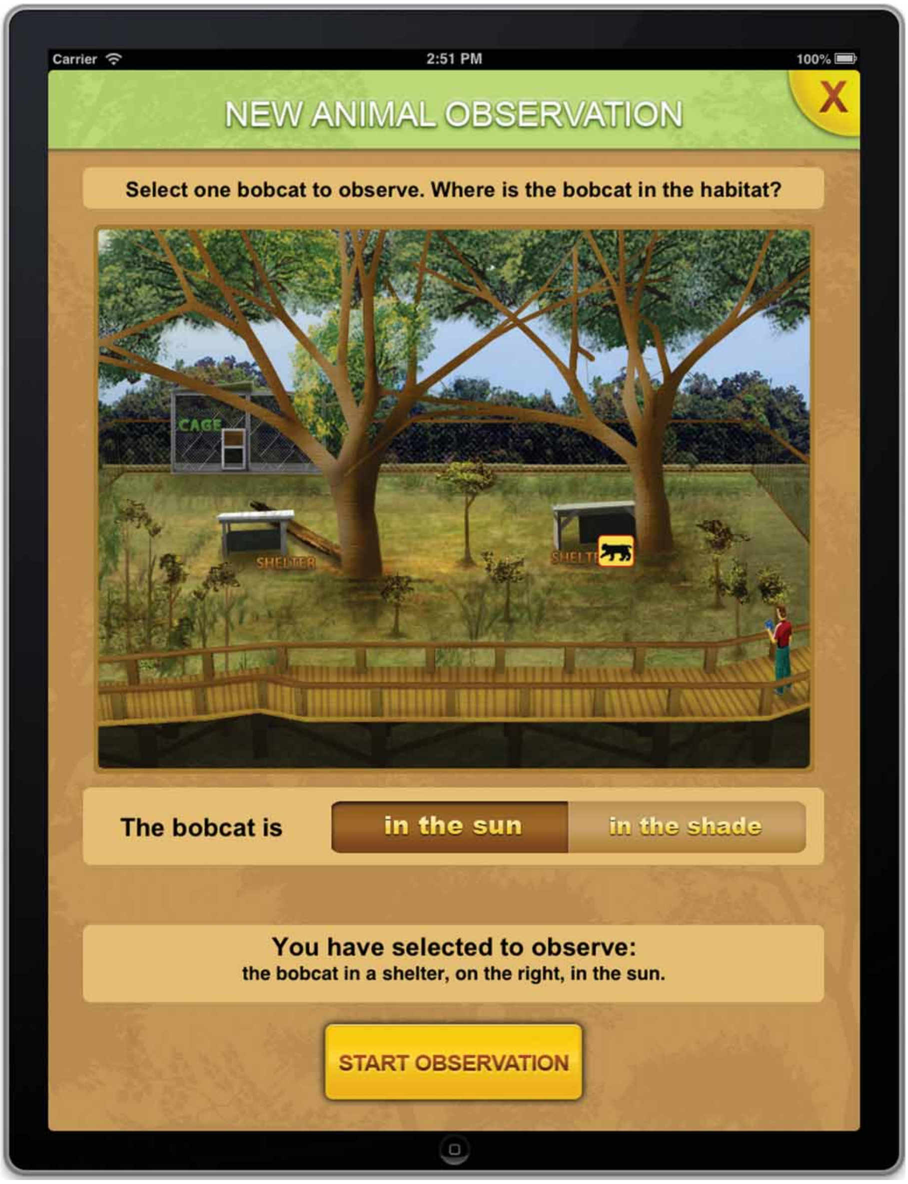

Figure 2. (a) and (b) Animal observation worksheets on *iPad* application.

(b)

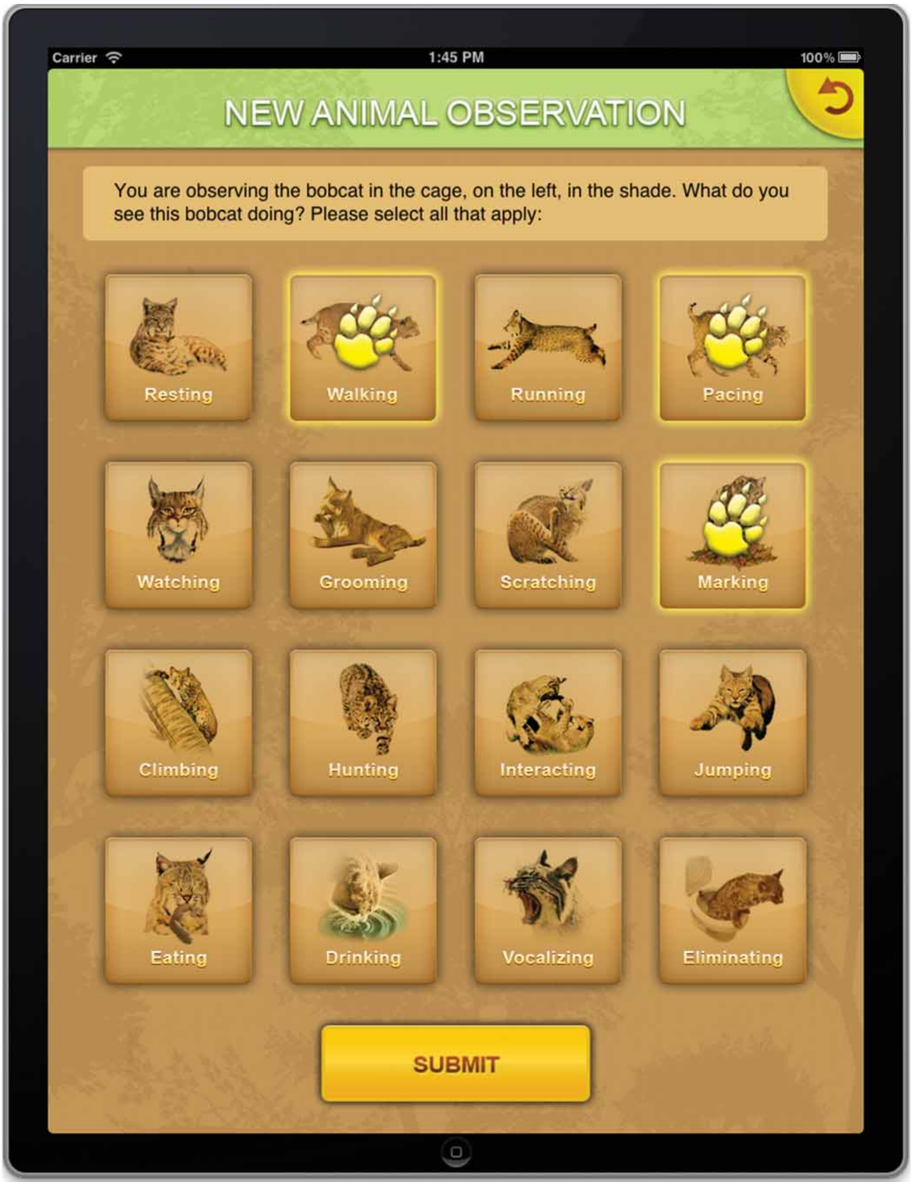

Figure 2. Continued.

different variables (e.g., How often are red wolves resting compared to the panthers? How frequently are bobcats found in trees?), crafting additional scientific questions, and evaluating data to provide evidence to support of results. The curriculum concludes with students creating reports and presenting their findings to the class. Additionally, students engage in follow-up lessons that reinforce the nature of science and scientific inquiry concepts presented

Figure 3. Data analysis tool on Habitat Tracker website.

throughout the program such as differences between experiments and investigations.

In this way, Habitat Tracker scaffolds scientific inquiry practices throughout the curriculum as students progress from developing initial scientific questions using information from the shared observation databases, to making their own observations at the museum, to refining and answering their questions based on evidence provided from their data, and communicating their findings in the classroom (Figure 4). Preliminary results from testing the Habitat Tracker curriculum with nearly 2000 fourth- and fifth-grade students over the past two years indicate that involving students as active participants in their own science education can help students develop scientific inquiry practices and promote a better understanding of the nature of science (Marty et al. 2012). To assess the relationship between scientific inquiry and digital literacy across formal and informal learning environments, this study explores how projects like Habitat Tracker can encourage the students' use of digital literacy skills while engaging in scientific inquiry activities.

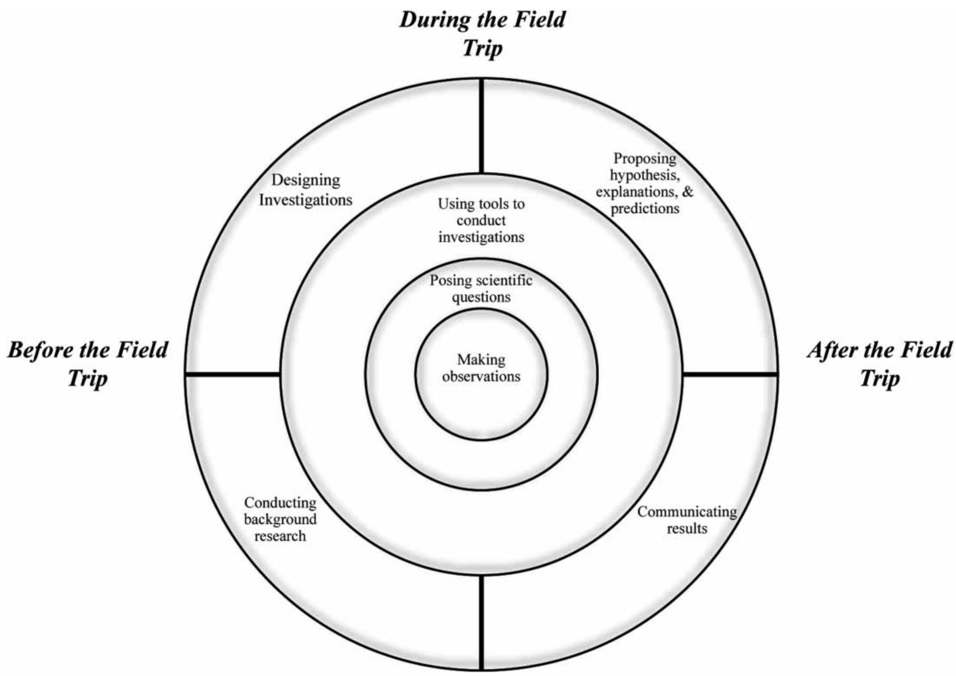

Figure 4. Implementation of scientific inquiry practices in Habitat Tracker.

Methods

To improve understanding of the types of digital literacy skills students employ while participating in projects such as Habitat Tracker in science museums and wildlife centers, the researchers conducted an exploratory study to document the connections between the scientific inquiry practices and the digital literacy skills elementary students employed as they engaged with the Habitat Tracker curriculum. The research was guided by the following questions:

(1) What digital literacy skills do students employ as they engage in scientific inquiry activities in informal learning environments such as wildlife centers?
(2) How does involving students as active participants in their own science education help encourage the use of digital literacy skills?

The research was organized around three rounds of evaluation of the Habitat Tracker project: alpha testing, conducted in Spring 2011, during which prototype versions of the systems and curriculum were tested on a small group of students; beta testing, conducted in Fall 2011, during which revised and updated materials were tested with a much larger group of students; and pilot testing of the final design of the project, conducted in Fall 2012, which included a much more fine-grained set of observations of all facets of the project.

Participants

From 2011 to 2012, 1818 fourth- and fifth-grade students from 12 different public elementary schools in three north Florida school districts participated in three rounds of evaluation and testing of the Habitat Tracker curriculum: alpha testing with 263 students from 4 schools, beta testing with 1170 students from 12 schools, and pilot testing with 385 students from 4 schools. The students were drawn from a diverse group of school districts, including urban, rural, and laboratory schools, serving many different socioeconomic groups. The participating schools included institutions with varied scores on the state's standardized accountability measures, and a wide range of access to technology in the classroom. A team of seven researchers observed student participants over the course of the curriculum (in the classroom and at the museum, as described above), and recorded detailed notes and made observation reports during each evaluation session.

Data collection

Researchers gathered data about the project from three different sources: observations of students conducted during the iterative design and development of the Habitat Tracker curriculum; the observational data and journal entries recorded by students; and the classroom materials and interactive technologies developed for the project.

Observations of students were made by members of the research team as students participated in the Habitat Tracker curriculum. In alpha testing, students were observed using the system to collect data at the museum. In beta testing, students were periodically observed in their classrooms and in the field while using the Habitat Tracker system (typically five observations were conducted in each classroom during their use of the curriculum). In the pilot testing, a researcher was present for each day of the project, in school and in the museum, for an average of 15 days of observations for each school; a total of 90 classroom observations and 6 field trips took place during the pilot testing.

Observational data and journal entries recorded by the students provided data about the students' use of the Habitat Tracker systems in the museum and in school. During the first and second rounds of evaluation, for which testing purposes focused exclusively on just one habitat, students working in pairs made 2083 total observations: 844 observations about the habitat, 751 observations about the animals, and 488 observations about the weather. Participating students also wrote 646 journal entries at the museum, recording notes about aspects of the animal's activities they found interesting, or posing potential research questions based on their observations, such as 'How do bobcats sleep and stay on thin branches?' During the third round of evaluation, where students could use the application with any of the museum's 10 habitats, 2469 total observations were made, including 1145 habitat observations, 1093 animal observations, and 231 weather observations; participating students also wrote 460 journal entries.

The curriculum materials and interactive technologies (online and mobile computing systems) developed for Habitat Tracker provided details about the activities the students engaged in during the project. The classroom materials (http://tracker.cci.fsu.edu/teacher/) included three weeks of lesson plans and associated activities connected with the State of Florida's Next Generation Sunshine State Standards, which directly align with the Next Generation Science Standards at the national level. The interactive technologies included the Habitat Tracker *iPad* application (which students used to write in their journals and record habitat, animal, and weather observations) and the Habitat Tracker websites, which included readings, observations, discussion boards, journals, photos, videos, and analysis tools for each of 10 wildlife habitats.

Data analysis

To shed light on how informal science education projects such as Habitat Tracker, designed to help students understand the nature of science and scientific inquiry, can influence student use of digital literacy skills, in and out of the classroom, a content analysis of the Habitat Tracker curriculum materials and interactive technologies was conducted using the seven practices inherent to scientific inquiry and the five digital literacy competencies (described above) as a framework. The goal of this analysis was to map the connections between the scientific inquiry practices students developed and the digital literacy skills they employed as they engaged with the Habitat Tracker curriculum (Table 1). Each feature of the Habitat Tracker systems (i.e., each *iPad* screen and website page) and each component of the Habitat Tracker curriculum (i.e., each lesson plan and activity) was coded using a digital literacy skills matrix that combined the tasks students performed, the scientific inquiry practices students learned, and the digital literacy skills students employed while participating in the project. The researchers' observations of the students throughout the project, supported by the students' own observations and journal entries, were triangulated using this matrix to determine how Habitat Tracker motivated students to employ digital literacy skills in the classroom and the museum.

Findings

The research findings indicate that Habitat Tracker provides a context where students can learn about the nature of science and scientific inquiry, while simultaneously encouraging the use of digital literacy skills. Students were observed employing digital literacy skills as they engaged in scientific inquiry practices throughout the curriculum, and the results of the analysis demonstrate that each aspect of the Habitat Tracker curriculum and interactive technologies provides links between digital literacy skills and scientific inquiry

Table 1. Scientific inquiry practices and digital literacy skills in Habitat Tracker.

Scientific inquiry practices	Habitat Tracker implementation	Digital literacy skills
Making observations	Using the observation worksheets and journal on the *iPad* application to record quantitative and qualitative data while visiting the wildlife center	Access, Create, Reflect, and Act
Posing scientific questions	Using the website readings pages, photos and videos, observation databases, analysis tool, journal, and discussion board in the classroom before and after the field trip and the *iPad* application observation browse facility and journal while visiting the wildlife center to conduct background research; using the journal to record learning and develop research questions in the classroom before and after the field trip	Analyze and Evaluate
Conducting background research	Using the website readings, photos, videos, and observation databases to learn about the museum's wildlife and natural habitats in the classroom before and after the field trip	Access, Analyze and Evaluate
Designing investigations	Using the digital habitat map, observation databases, and analysis tool to develop research questions, and sharing them with other students through the online journal and discussion boards before, during, and after the field trip	Access, Analyze and Evaluate, Create, Reflect, and Act

(Continued)

Table 1. Continued.

Scientific inquiry practices	Habitat Tracker implementation	Digital literacy skills
Using tools to conduct investigations	Using the website observation databases, and analysis tool to conduct background research before the field trip and follow-up research after the trip; using the, journal, and discussion board to write about research and observational data and discuss investigations with other students; using the *iPad* application habitat map, observation worksheets, and observation browse facility to collect observational data and use the journal and discussion board to write about findings and discuss them with other students while visiting the wildlife center	Access, Analyze and Evaluate, Create, Reflect, and Act
Proposing hypotheses, explanations, and predictions	Using the website observation databases, analysis tool, journal, and discussion board before, during, and after the field trip to analyze observational data; using the presentation template to create presentations and communicate with other students about findings after the field trip	Access, Analyze and Evaluate, Create, Reflect, and Act
Communicating results	Using the website photos and videos, journal, discussion board for presentation materials; using the journal and discussion board to communicate with other students about findings; using the presentation template to communicate results in a presentation	Access, Create, Reflect, and Act

practices (Table 1). The following sections offer a detailed examination of this relationship in the context of informal learning in wildlife centers, documenting the digital literacy skills used by participating students at each stage in the scientific inquiry process.

Making observations

During the field trip to the wildlife center, the Habitat Tracker *iPad* application functions as an interactive scientific notebook, leading students through a data-collection process where they use digital worksheets to record their observations of items in the habitats, the animals' locations and activities, and current weather conditions (reading data from weather stations installed along the habitat trail). Students use a digital map of the museum to locate the habitats that they want to observe, and student observations are stored in shared databases that can be browsed using the *iPad* application (as well as the Habitat Tracker website) so that students can see each other's data. Students are also able to write about their observations and what they are learning in their digital journals, and they can comment on other students' journal entries.

Students observed during the three rounds of evaluation used a number of digital literacy skills to record their observations. The students' ability to learn and practice the *Access* skill was demonstrated through their use of the *iPad* application's navigation tools to select a habitat, find the correct observation worksheets, and read their online journals. Students were also observed practicing the *Create* skill when writing their journal entries and using the interactive worksheets on the *iPad* application to make animal, habitat, and weather observations at the museum. *Reflect* and *Act* skills were also practiced as students learned to work together during the observation and journaling activities, which students completed in pairs or small groups at the museum and in the classroom. Students would often discuss and negotiate their observations with one another while completing the observation worksheets on the *iPad*. These findings indicate that the act of making observations as part of the Habitat Tracker curriculum required the use of key digital literacy skills as students worked with the *iPad* application to record habitat, animal, and weather observations at the museum.

Posing scientific questions

Students participating in the Habitat Tracker project pose scientific questions before, during, and after their field trip to the museum. By studying online information about the native Florida animals that live in the habitats at the museum, and using the online analysis tool to explore the types of questions they might investigate, students are encouraged to develop (and record in their online journals) possible research questions they can answer while conducting their own investigations. At the museum, students are able to access their questions to guide their actions while making their wildlife and natural habitat observations. In the classroom, the students have the opportunity to refine their questions based on their experiences at the museum, and to think about new questions that might emerge from their observations and analyses. Throughout the curriculum, the question development process is encouraged by the online readings and databases, and supported by the online journaling system, which allows students to record their thoughts in the classroom or at the museum and obtain feedback from their peers.

Observations of students as they worked through the process of posing scientific questions revealed active student use of the *Analyze and Evaluate* skill. Students were observed analyzing written and pictorial evidence (including the online readings, photographs, and videos) and learning to develop research questions that could be answered through observations. To determine whether their questions were answerable at the museum, or whether their answers made sense, they had to evaluate their research questions in light of observations already collected by previous students and use the website's analysis tool to look for patterns and connections among research data. These findings indicate that the process of posing scientific questions as part of the Habitat Tracker curriculum encouraged the use of digital literacy skills as students employed the website to develop, analyze, and evaluate potential research questions.

Conducting background research

Before visiting the museum, students use the readings sections of the Habitat Tracker website to gather background information about the animals. Separate readings sections for each animal cover who the animal is, what their place in nature is, how they live, and where they live. There are also links to websites where the students can find further information. Additionally, browsing and analyzing the existing data in the observation databases can help students learn more about the animals and the types of observations that can be made at the museum.

During the evaluation sessions, students were observed using the *Access* skill to navigate to the pages on the Habitat Tracker website that contained the readings, photographs, and videos they needed for their background information. Researchers also observed students using the analysis tool to improve their overall understanding about what they might observe at the museum, and to gain an insight into recent data trends in the habitat, animal, and weather observations. Students also used the *Analyze and Evaluate* skill to assess the background information they obtained, develop their understanding of current knowledge about the animals and their natural habitats, and determine how they can apply that knowledge in advance of their own visits to the museum. These findings indicate that the online readings and databases provided as part of the Habitat Tracker curriculum prompted students to conduct their own background research about the museum's wildlife and natural habitats, and required them to employ digital literacy skills in order to access, interpret, and synthesize these background materials.

Designing investigations

The Habitat Tracker curriculum is designed to scaffold students through the process of planning scientific investigations, including conducting background research, posing scientific questions, using tools to collect and analyze data, and communicating results to their peers. Students gather background information from the readings, browse online photographs of the animals, watch videos to learn about the animals in their habitats, and employ the analysis tool to explore data in the shared observation databases. They are also able to write about their developing research questions in their online journals, and to discuss what they were learning and thinking in the threaded discussion boards.

As students planned their investigations, they were observed using the *Access* skill to locate and open the appropriate website pages and tools. They used the *Analyze and Evaluate* skill to identify, assess, and interpret the information they needed to plan their investigations. They displayed the *Create* skill as they designed their investigations in their online journals, and the *Reflect* skill as they talked about research ethics in the classroom. Finally, students were observed using the *Act* skill as they collaborated to develop joint investigations with their research partners and commented on each other's journal entries. These findings indicate that the Habitat Tracker curriculum encouraged the use of multiple digital literacy competencies as students used different components of the website to design their investigations.

Using tools to conduct investigations

Habitat Tracker provides students with the opportunity to use multiple tools as part of their scientific inquiry activities, and to learn about the multiple ways the tools can be employed in scientific investigations. Students access the project website to gather background information and browse previously collected observational data; interact with observation worksheets and journal entry screens on the *iPad* application to record data at the museum; and use the online analysis tool to develop, refine, and evaluate research questions. The online journals and threaded discussion boards support interpretation and collaboration, while the weather stations mounted at intervals along the museum's habitat trail require students to read and interpret weather data, and enter those data on worksheets using the *iPad* application.

Researchers observed students using a number of digital literacy skills as they interacted with the Habitat Tracker tools. Students used the *Access* skill to navigate the website's analysis tool, selecting the variables they wished to include in their analyses and creating appropriate data visualizations. Students were also observed using the *Access* skill at the museum as they navigated the application, were guided to make observations using the worksheets, recorded observations, composed and submitted new journal entries, and browsed prior observations and journal posts. Over the course of the project, students displayed growing comfort with the *Analyze and Evaluate*, *Create*, and *Reflect* skills as they posted and commented on journal entries before, during, and after the field trip. Collaborating in small groups to complete the curriculum required students to practice the *Act* skill in order to determine the best use of the tools and to help each other use the tools effectively. These findings indicate that the wide variety of tools provided as part of the Habitat Tracker curriculum required students to engage with different digital literacy skills if they were to use those tools and complete the curriculum.

Proposing hypotheses, explanations, and predictions

Before the field trip, the students use the analysis tool on the Habitat Tracker website to develop hypotheses, explanations, and predictions about the natural habitats and wildlife at the museum by analyzing the shared observation databases in preparation for their visit. These hypotheses form the basis for the students' research questions, which they record in their online journals and use to guide their data-gathering behaviors at the museum. After the field trip, students use the analysis tool to interpret the data they collected, combined with data collected by other classes, in light of their hypotheses and research questions, thereby helping them develop explanations for what they observed at the museum.

Researchers observed students strengthening their *Access* skills by using the analysis tool before and after the field trip, and displaying the *Analyze and Evaluate*, *Create*, and *Reflect* skills as they wrote journal entries proposing scientific questions based on their hypotheses, discussed the background information they collected to develop predictions about what they might observe, reflected on their observations and experiences during the field trip, and used the evidence they gathered to develop explanations and answer their research questions. Working together in pairs and small groups, students practiced the *Act* skill as they negotiated the analysis tool and developed their hypotheses and research questions. These results indicate that proposing hypotheses, explanations, and predictions as part of the Habitat Tracker curriculum required students to employ digital literacy skills as they navigated the online tools provided to develop and test their ideas.

Communicating results

The final stage of the post-field trip activities in the Habitat Tracker curriculum requires students to develop presentations through which they can share their hypotheses, research questions, findings, and future questions that they would like to explore. Students are provided with a template they can use for creating a *PowerPoint* presentation, and work in groups to plan, develop, and present their research results. The online analysis tool helped scaffold students' data analyses as they generated tables, graphs, and charts that they used in their presentations to provide evidence in support of their findings to other students.

Researchers observed students using the *Access* skill as they worked with the tools they needed to create their presentations. Students browsed their journal entries to access their research questions, used photos from the website as illustrations, copied tables, graphs, and charts from the analysis tool, and used the provided *PowerPoint* template to create their presentation slides. Students also used the *Create* and *Reflect* skills to design presentations that presented the best evidence to support their findings, and continued to practice the *Act* skill as they collaborated throughout the communication process, working in small groups to create their slides and present their results. These results suggest that by requiring students to communicate the results of their research after their museum visit, the Habitat Tracker curriculum prompted students to use digital literacy skills as they created presentation slides, accessed tables, graphs, and charts, and determine what data and materials were appropriate to support their scientific claims in their presentations.

Conclusions

The Habitat Tracker project is structured so that digital literacy skills serve as scaffolds for elementary students' participation in various practices involved in scientific inquiry. The standards-based curriculum and integrated technologies developed as part of the Habitat Tracker project require students to employ a wide range of digital literacy skills as they participate in the Habitat Tracker project and learn how to engage in inquiry as well as learn about inquiry. Projects such as Habitat Tracker, which combine activities in the classroom and in the field, can help shed light on relationships that can be fostered between scientific inquiry and digital literacy for elementary science education in formal and informal learning environments.

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Notes on contributors

Paul F. Marty is an associate professor in the School of Library and Information Studies within the College of Communication and Information at Florida State University. His research focuses on the evolution of sociotechnical systems, digital convergence and

the evolving roles of information professionals, and involving users in the co-construction of distributed, digital knowledge.

Nicole D. Alemanne is a PhD candidate at the Florida State University's School of Library and Information Studies. Her research interests include interdisciplinary collaboration and knowledge creation in cultural heritage institutions.

Anne Mendenhall obtained her PhD in Instructional Systems from the Florida State University. Her research interests include technology integration in STEM education and the use and validation of instructional systems design models and theories. Her other interests include the creation of distance learning environments in developing countries and coaching faculty in these countries in online and face-to-face collaborative and active learning strategies.

Manisha Maurya received an MS in Sociocultural and International Development Education Studies with an emphasis in science education from the Florida State University. She intends to employ inquiry-based science lessons in her future classroom.

Sherry A. Southerland is a professor in the School of Teacher Education in the College of Education and Co-Director of the FSU-Teach Program at Florida State University. Her research focuses on barriers and affordances to student-centered science teaching and learning.

Victor Sampson is an Associate Professor in the School of Teacher Education and within the College of Education and in the FSU-Teach Program at Florida State University. His research focuses on the teaching and learning of science.

Ian Douglas is Vice Provost of Innovative Learning and Academic Support Services at Albany College of Pharmacy and Health Sciences. Prior to June 2012, he was Associate Program Director at the Learning Systems Institute and Associate Professor in the College of Communication and Information at Florida State University (FSU). His research interests are in usability in technology design, knowledge management and learning organizations.

Michelle M. Kazmer is an associate professor at the Florida State University School of Library and Information Studies, where she teaches in the areas of information organization, information needs, and theory development. Her research focuses on distributed knowledge processes in e-learning, health, and experimental science settings.

Amanda Clark is a PhD candidate at the Florida State University's College of Education. Her research interests include science education and the teaching of the nature and practice of science in elementary education.

Jennifer Schellinger is a PhD student in the College of Education at Florida State University where she is pursuing a degree in Curriculum and Instruction with an emphasis in Science Education. Her research interests focus on developing educational programs that enhance state and national science standards in informal science settings.

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