Using Citizen Science to Engage Preservice Elementary Educators in Scientific Fieldwork

By Catherine M. Scott

Preservice elementary teachers' lack of confidence in teaching science is an ongoing concern. Only 29% of elementary teachers in the field felt "very well prepared to teach life science," according to the National Survey of Science and Mathematics Education. Research has suggested that bridging informal and formal science education can improve preservice educators' attitudes toward science and science teaching and expose them to innovative teaching methods. For this study, a citizen science-based research project was implemented in an elementary science methods course. Students in the course collected data on turtles in the campus pond, then uploaded their data to a citizen science database focusing on reptiles. It was found that participation in the project not only increased participants' content knowledge regarding citizen science and reptiles, but it also provided participants with (a) a sense of social responsibility, (b) ownership of the project, and (c) a desire to teach children about the importance of the local environment. Implications for instruction are discussed.

Preservice elementary teachers' lack of confidence in teaching science is an ongoing concern (Fidler, 2012; Martin-Dunlop & Fraser, 2007). According to the National Survey of Science and Mathematics Education, only 29% of elementary teachers in the field felt "very well prepared to teach life science" (Banilower et al., 2013). Those involved in teaching often have limited experiences with inquiry (including fieldwork) and investigations, instead being taught college science courses in traditional, didactic methods that provide them few opportunities to witness models of hands-on, minds-on teaching encouraged in science education (Fidler, 2012; Haefner & Zembaul-Saul, 2004; Stuart & Thurlow, 2000; Varman, Volkmann, & Hanuscin, 2009; Weld & Funk, 2005; Zembaul-Saul, Blumenfeld, & Krajcik, 2000).

Riedinger, Marbach-Ad, McGinnis, Hestness, and Pease (2011) suggested that bridging informal and formal science education can improve preservice educators' attitudes toward science and science teaching and expose them to innovative teaching methods. Informal science education, or science outside of the classroom, offers participants resources that can inspire curiosity, motivate students, and foster positive attitudes (Falk & Dierking, 2000).

One aspect of informal science education that is less often studied is the use of citizen science projects,

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Preservice teachers with turtles caught during the study.

or scientific research conducted by amateurs (i.e., the general public) and shared with researchers interested in the field of study. Over 200 citizen science projects exist internationally; well-known citizen science projects include The Great Backyard Bird Count (Cornell University, n.d.) and Project Squirrel (University of Illinois at Chicago, 2013). Brossard, Lewenstein, and Bonney (2005) noted that citizen science can be used to improve participants' content knowledge. Additionally, Jenkins (2011) noted that citizen science has the potential to provide participants the opportunity to see citizen science in context, specifically relating to their lives, and that this opportunity can be a changing point for those uninterested in or uncomfortable with teaching science.

The Turtle Project at Coastal Carolina University was developed as a means to expose elementary education majors to fieldwork and use of scientific tools, with hopes of improving their content knowledge regarding reptiles and citizen science and impacting their pedagogical practices to include more field-based studies. As a result, this study addressed the following questions: In what ways does engagement in an informal, citizen science project impact preservice teachers' scientific content knowledge and perceptions of citizen science in the classroom? What meanings do participants make of their experiences in citizen science and how it applies to the classroom?

Research methods

The Turtle Project occurred at Coastal Carolina University in the southeastern United States, starting in the spring 2013 semester. The campus where the project took place has a large pond that is home to red-eared and yellow-bellied sliders, two commonly found species of turtles. The red-eared sliders are not native to our state, and many are turtles that our students deposited into the pond once they realized how long their pets would live and how much maintenance was required for their care. Although our university has one of the largest marine science programs on the East coast, none of the faculty had completed any research on the turtle species in the pond, leaving an easy entrance for the education students to get involved and not disturb anyone else's research.

Participants in The Turtle Project learned how to set traps to catch the turtles. Once caught, participants measured the turtle's carapace (top shell) and plastron (bottom shell), along with the weight of the turtle. Participants also developed "names" for the turtles, or three-letter codes that were filed into the scutes (plates on the shell) of the turtle. Each participant, in addition to recording these data, was also responsible for recording weather data, water data, and GPS coordinates for where the turtle was caught. Turtles were photographed and released on collection. Finally, participants uploaded their data to the Carolina Herp Atlas, an online citizen science database used by herpetologists to keep track of species found throughout the states.

The elementary education students collected data on the turtles for 4 weeks as part of their elementary math and science methods courses and then actually taught elementary school students how to collect citizen science data when the children visited campus for an event called "A Day in the Life of a College Student." The students discussed concerns about incorporating similar projects into the classroom, as well as benefits of incorporating similar projects into the classroom.

Data collection

Qualitative data included interviews, field notes and observations, social media postings, and audio recordings as participants engaged in the citizen science project. Four students were interviewed at the end of the academic year, and interviews were audio-recorded and lasted approximately 20 minutes (see Figure 1 for interview questions). Recordings were transcribed and analyzed for the emergent themes.

The author took field notes and audio-recorded every collection day,

FIGURE 1

Questions for participant interviews.

1. Tell me about your role in The Turtle Project.
2. Why did you choose to participate in this project?
3. What were some of the challenges of participating in the project?
4. How do you see yourself making connections between this project and your future classroom?
5. What might be some of the challenges/benefits to completing this project or another citizen science project with students?
6. What did you learn through participating in The Turtle Project?
   - Can you tell me what makes an animal a reptile?
   - What were some of the tools you used to collect data on the turtles, and how did you use them?
   - How can you tell a red-eared slider from a yellow-bellied slider? Which one is native?
7. Was there anything that surprised you during the study?
8. Is there anything else you would like to add to our conversation?

with 16 sessions in all. Data were also collected during the preservice educators' interactions with children during the campus event. This event targets elementary, middle, and high school students in the local school system, each of whom has worked with a college student mentor during the academic year. For the day, these students come to campus with their mentee to learn more about college life and opportunities that await them if they come to college. For the event, the participants in The Turtle Project led stations around the main campus pond for elementary-age visitors. These stations focused on water quality testing (via macroinvertebrate collection) and demonstrating how to catch turtles from the pond for data collection. The interactions with children took place in 45-minute increments, with three interactions total. In addition, photographs were taken of participants interacting with the turtles, the field equipment, and the children.

Finally, Twitter served as a data source for the project. All tweets related to The Turtle Project were downloaded and saved. Students involved in the project, as well as the university, tweeted about the study. A student with a Twitter account under the disguise of the turtles also tweeted from the turtle's point of view; this student was unknown to faculty and students involved in the project.

Data were analyzed in a continuous comparative method. Qualitative data from interviews, field notes, observations, social media postings, and audio recordings were analyzed by segmentation into coding categories. These categories were developed using common themes found across each data source (Yin, 2003).

Participants

The participants in this study were 13 undergraduate education majors at Carolina Coastal University. Ten students were female and three were male. These students were in their first semester of their senior year, preparing to enter student teaching in the subsequent semester.

Analyses and findings

Research Question 1: In what ways does engagement in an informal, citizen science project impact preservice teachers' scientific content knowledge and perceptions of citizen science in the classroom?

Participants in the study demonstrated more robust knowledge regarding citizen science and life science content. Prior to participation, only one preservice educator could fully describe how a citizen science project worked and name an example of a citizen science project occurring worldwide. Additionally, prior to the study, only four preservice educators correctly identified a turtle as a reptile; afterward, all correctly identified turtles as reptiles and could explain the characteristics of a reptile. For example, Anna shared, "I learned that a reptile has scaly skin and usually lays eggs. I didn't know that some reptiles could have live birth, though. And I always thought a frog was a reptile!" (A. Smith, personal communication, July 11, 2013). These findings align with those of Brossard et al. (2005), who noted that engagement in a citizen science project can positively impact participant content knowledge.

As a result of engagement in The Turtle Project, participants developed an interest in trying a similar project with their students. They also showed a shift in thinking toward student capabilities and ease of incorporation into the project, initially thinking that students would be unable to handle a project and that it would be difficult to implement. Following is a discussion between the researcher and several participants.

Researcher: Can you see doing this with students?
D.R.: Totally.
A.S.: Yeah!
Researcher: What would be the challenges?
A.S.: Making sure that all of the kids have a turn . . . the typical classroom has what, 20 students? I think they would all want to be in the water and doing this. I think you'd have to make a list and make sure everyone had a turn . . . you do it on this day, your turn is this day . . .
D.R.: And, seeing a snake, knowing what to do when you saw one.
Researcher: Making sure that kids can identify it and know how to react is definitely important.
A.S.: You could spread this project out over 8–9 weeks, though, like a whole quarter. And you'd need time to analyze the data after.
D.R.: That would work.
Researcher: Can you think of curriculum connections for doing this?
A.S.: Definitely with sixth-grade biology. They would use it there. And in math too. You could do both.
D.R.: I think you could do a lot with North Carolina and things in the state.

While participating in The Turtle Project, participants were witnessed making use of their knowledge of citizen science and reptiles, explaining the purpose of the project as well as the goals behind researching the turtles on campus to other university students that passed by. Participants could answer questions about the parts of the turtles' shells, the rationale for marking the turtles by filing their shells, and how to collect the data that they recorded on each turtle, thus showing an increase in their content knowledge.

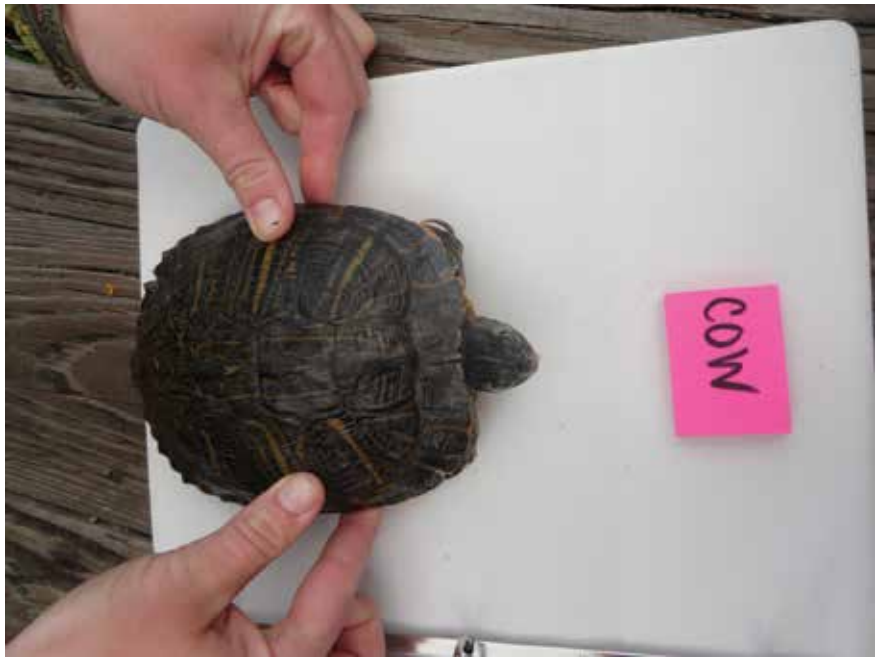
Research Question 2: What meanings do participants make of their experience with citizen science and how it applies to the classroom?

Through interviews, field observations, and social media posts, three

major themes emerged to describe participants' meaning making. The three themes were: (a) a sense of social responsibility, (b) ownership of the project, and (c) a desire to teach children about the importance of the local environment.

The focus on social responsibility, as well as ownership of the project, emerged in interviews, social media, and observational data. Part of this resulted from the campus police destroying the turtle traps set by the preservice teachers. The police had received a phone call from concerned students that thought the turtles were being maliciously caught. The police cut apart the traps with box cutters to free the turtles. Simultaneously, the concerned students began tweeting about the turtles being hurt, causing a campuswide concern. In response, participants began their own Tweets about the project and taught other university students about the project. This catalyst was repeatedly brought up by participants in the study, who felt "we have to teach others what we are doing, so that they understand," and who stated "it just made me so mad, because our work had to stop because they didn't get it [the purpose of the traps]." Their efforts resulted in three news stories (two campus, one local), explaining the project to the public and the rationale behind their work.

Participants' ownership of the project emerged through other events as well. In one instance, for example, the university photographer walked by the students while they were in the pond collecting turtles and began taking photographs. The students approached him to let him know that "we're education students, make sure you write that down. This isn't biology class!" Similarly, participants repeatedly referred to the project and the turtles as theirs, making statements related to "*our* work," "what *we* are doing," and "*my* turtle." One participant would wear her waders to the pond and back to the classroom again each time participants collected data, stating, "It's good advertising. These should say 'Ask me about my turtle!'"



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A preservice teacher collects morphometric data on a turtle.

Finally, a desire to teach children about the local environment was the third theme that emerged from qualitative data. Participants wanted to help their students understand important local issues; in this instance, the risk of introducing a nonnative species (red-eared sliders) to the pond. Participants repeatedly noted the trash in the pond and cleaned it up when collecting turtles. They also noted the aquarium gravel that came up in the nets—evidence from students' depositing pet turtles into the pond. In interviews, participants discussed how they could involve students in learning more about their environment and were witnessed repeatedly sharing information about the importance of protecting a habitat while interacting with students at the campus event. Additionally, all of the interviewed participants, and many observed in field work, stressed the importance of not just teaching children about the benefits of scientific research, but also the importance of communicating the purpose of the study and the reason the turtles were being trapped to the general public so that people understand the reasons behind what was happening.

Jenkins's (2011) theoretical assertions that citizen science provide participants a context in which to make sense of science align with the evidence found through this study. Because of the personalized nature of the project, and the direct impact that the trap destruction had on the preservice educators, the meanings that they made of their experience tied directly to the events that occurred. Additionally, the opportunity to work with the children in context provided them an opportunity to witness how children would react in such an environment, causing changes in their perceptions of the use of citizen science in the classroom. As Jenkins (2011) pointed out, when students make "connections between the data, their community, and environmental health, then the work and data collection becomes meaningful" (p. 507). In The Turtle Project, the meanings the participants made of the project and their roles

as educators were entirely linked to context and the series of events that transpired.

There are limitations to this study, including the limited number of participants and the nature in which some participants were engaged in the project. Because the project was part of a class activity for the participants, those students may have participated or provided information that they thought would benefit them in terms of grading or classwork. However, member checking was used to assist with validity, and data were triangulated to ensure an accurate representation of the project and findings.

Discussion

The data from this study show that involvement in an informal science learning opportunity, such as a citizen science project, does improve preservice teachers' content knowledge and impact their attitudes toward incorporating similar projects into the classroom. These findings provide clear implications for those working with preservice teachers, suggesting that pursuit of similar projects in teacher preparation programs may prove beneficial to preservice educators, particularly when considering the use of projects that focus on local context and personal connections. Moreover, it shows not only that context and experience influence participants' meaning makings of the activities, but also how these activities can impact students in the classroom, something missing in the current literature on citizen science projects in informal settings.

Participants viewed these activities as potentially teaching students about both civic responsibility and environmental health, again adding to the literature on the use of citizen science projects in the classroom. Future studies can address whether these ideas are supported and may also follow these preservice educators to determine whether they enact similar programs in their classrooms, and for what purposes. ■

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