"I Could See Myself as a Scientist"

The Potential of Out-of-School Time Programs to Influence Girls' Identities in Science

Kelly Riedinger and Amy Taylor

"The activity where we collected organisms was a good influence 'cause I could see myself as a scientist. I got to do the actual thing." These words from Celeste, a girl who participated in the Coastal Ecology program at the Chincoteague Bay Field Station on the Eastern Shore of Virginia, are not unique. Other girls who participated in the program offered similar input, suggesting that engaging in science in this out-of-school time (OST) setting enhanced their identity and sense of self as learners of science.

OST programs like the Coastal Ecology science camp can positively influence science identities, particularly for youth from groups historically underserved and underrepresented in science, technology, engineering, and math (STEM). OST STEM programming gives youth opportunities to learn science outside the formal classroom in such settings as afterschool programs, science camps, outreach programs, internships, and scouting. OST science programs often do not formally assess participants or assign grades. They provide opportunities for authentic, meaningful learning that may be more comfortable for some youth than school curricula (National Research Council, 2009; Rennie, 2007, 2014). Further, OST programs may give youth access to resources and to scientific practices and tools not typically available in classrooms (Luehmann, 2009). This access may be especially important for youth from underresourced schools.

Many programs allow youth to explore science in ways that support their identities. Our study explored how the Coastal Ecology science camp helped participants, specifically girls, develop science identities. We

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also studied how the girls' social interactions supported their identities as learners of science.

Underrepresentation in STEM

The historical underrepresentation of women, people of color, and persons with disabilities in STEM has not abated. A recent report published by the National Science Foundation (2013) suggested that, although more girls and people of color are taking science courses and pursuing degrees and careers in areas such as life sciences, notable discrepancies persist, particularly in physics, chemistry, and engineering. White males still dominate the science and engineering workforce; women of color constitute only about one in ten employed scientists and engineers (National Science Foundation, 2013). The statistics are similarly problematic for persons with disabilities; individuals whose disability occurred between birth and 29 years of age comprise only about 10 percent of scientists and engineers.

In order to participate in science, a girl has to see herself as the type of person who knows about, uses, and sometimes contributes to science. Archer and colleagues (2012) contend that "the development and cultivation of science aspirations requires girls to engage in considerable identity work" (p. 982).

Although policies have been put in place to address these gaps, they have had minimal effect on the participation of girls and women, particularly those from nondominant backgrounds. This continuing gap has been attributed to many factors: girls' perception that science is masculine, science instruction that does not align with girls' interests, the persistence of historical stereotypes of who can do science, girls' lack of access to support in science, and a lack of role models and mentors (Archer et al., 2012; McCreedy & Dierking, 2013).

The inequalities in STEM fields may contribute to girls' perceptions of who does science and to their own views of themselves as science insiders or outsiders. In order to participate in science, a girl has to see herself as the type of person who knows about, uses, and sometimes contributes to science. Archer and colleagues (2012) contend that "the development and cultivation of science aspirations requires girls to engage in considerable identity work" (p. 982).

OST programs that seek to provide motivating and memorable experiences in science may be one way to address the underrepresentation of women, people of color, and people with disabilities in science. Tan, Barton, Kang, and O'Neill (2013) argue that "while decades have been spent addressing the academic achievement gap between girls and boys, very little time has been spent addressing the "*science identity gap*" (p. 1144). Building strong identities in science among girls may influence their interest in and motivation to pursue science, their self-efficacy and confidence in science, and their ability to persist when presented with challenges. OST programs that develop positive identities may be particularly relevant during adolescence, a significant period of identity formation (Osborne & Dillon, 2008) during which youth make critical course choices that affect their later careers (Adams, Gupta, & Cotumaccio, 2014; Barton, Birmingham, Sato, Tan, & Barton, 2013).

Identity Development and OST Science Learning

Identity is a reflexive process; it is both how individuals view themselves—their sense of self—and how they are perceived by others. Identity development is an ongoing process that is influenced by experiences across settings as well as by everyday moments (Bricker & Bell, 2014).

Earlier studies have suggested that participation in OST science learning results in a number of identity-related outcomes, such as broadening youths' views of science and what counts as science (Gonsalves, Rahm, & Carvalho, 2013; Wheaton & Ash, 2008). After participating in OST science programs, youth demonstrated more positive attitudes toward and interest in science (Bhattacharyya, Mead, & Nathaniel, 2011; Farland-Smith, 2010; Riedinger, 2011, 2015) and exhibited greater confidence in their science skills (Bhattacharyya et al., 2011; Riedinger, 2011, 2015; Tan et al., 2013). OST science programs have also been demonstrated to influence youths' career choices (Bhattacharyya et al., 2011; Farland-Smith, 2012). An OST science camp program for African-American high school students in Louisiana was shown to positively influence participants' attitudes toward science careers (Bhattacharyya et al., 2011).

Coastal Ecology Science Camp

Coastal Ecology is an OST science camp offered at the Chincoteague Bay Field Station. The field station is also a marine science learning center that provides multidis-

ciplinary education and research opportunities. It uses as its classroom the bays, marshes, beaches, maritime forests, dunes, and offshore waters of the coastal areas surrounding Chincoteague Bay.

Coastal Ecology is a four-day residential science camp in which youth engage in field-based, hands-on science activities designed to mirror the research practices of professional marine scientists, ecologists, and oceanographers. Most youth participate in Coastal Ecology with their school or scout group, accompanied by their classroom teacher or scout leader and adult chaperones. Typical science activities include research cruises, lectures, laboratory activities, and organism collection and maintenance. Youth also participate in leisure activities intended to create a sense of community. During our study, the science camp instructors were predominately women; they were experienced educators with STEM degrees.

Influence of the Science Camp on Girls' Science Identities

To explore how girls developed science identities in the Coastal Ecology program, and specifically how their social interactions supported their identity development, we used a collective case study approach. During the summers of 2011 and 2013, we collected data from five school and scout groups who visited the Chincoteague Bay Field Station to participate in Coastal Ecology. With each group, we videotaped observations of all science camp activities, conducted pre- and post-camp focus group interviews with youth participants and their teachers or chaperones, and collected youths' responses to daily reflective journal prompts. For example, one prompt asked youth to reflect on the day's activities and consider how the experience influenced how they thought about themselves in science.

The 12 girls included as cases in this study were all in middle school. This article highlights responses from six of the girls: Addison, Gabriella, and Gretchen, white seventh graders; Brynn and Hannah, white eighth graders; and Celeste, an African-American seventh grader. The collective case study approach enabled us to identify similarities across cases while noting differences. This process guided us in identifying themes and drawing conclusions.

The field station is also a marine science learning center that provides multidisciplinary education and research opportunities. It uses as its classroom the bays, marshes, beaches, maritime forests, dunes, and offshore waters of the coastal areas surrounding Chincoteague Bay.

Our exploration of girls' participation in the Coastal Ecology science camp provided evidence that an OST program can offer positive experiences that help girls to see themselves in science. The themes that emerged from our study reveal characteristics of the Coastal Ecology program that positively influenced girls' science identities:

- Authentic opportunities for active learning
- Novel learning experiences in the outdoors
- A comfortable and personally meaningful setting
- Use of multiple types of language
- Opportunities for social interaction

These characteristics both support and extend findings from earlier studies. The social interactions in which girls engaged at the OST science camp enabled the girls not only to develop a shared understanding of the science content but also to negotiate aspects of their identities, author new identities, and have others recognize these identities.

Authentic Opportunities for Active Learning

Celeste, whom we quoted at the beginning of this article, developed her identity in science through active engagement in learning that mirrored the practices of scientists. Celeste was a student at a rural public school in the mid-Atlantic. Before she came to the science camp, Celeste's identity as a learner of science was largely framed by the rules and norms of school science. During the pre-camp focus group, she said that her teachers and peers saw her as "a good worker in science." She explained that she was good in science because she "took a lot of notes," but she also noted that some topics in science made her "sorta lose my interest."

The OST science camp gave Celeste opportunities to engage actively in organism collection, which she believed was the work of scientists. Her participation in these authentic activities enabled Celeste to "see myself as a scientist." Her case illustrates how participating in authentic science activities can prompt youth to re-envision themselves in science, thereby positively influencing their identities.

Novel Learning Experiences in the Outdoors

Another theme that emerged in our data was that learning in new ways and in a novel setting, the outdoors, influenced the girls' identities. Hannah particularly noted this aspect of the science camp program. She felt that the science camp helped her to be more assertive and "take risks." She explained:

> It's just so much fun being away from school and somewhere new, not having everybody in the classroom around you in the outdoors.... It's just amazing to learn the things you never would have before, about the ocean, the tides, and plankton.

The science camp introduced Hannah to novel topics that she had not yet learned in school.

The novelty of the setting also influenced Hannah's views of science. One of the program's field experiences was a trip to an undisturbed dune ecosystem located on a military base to which the general public does not have access. The fact that the girls got to visit a place that they could not otherwise have experienced was exciting to Hannah.

> … my favorite part was going on the private beach and collecting the shells. We combed the part of the beach. But that was one of my most favorite parts 'cause it was basically untouched, and we'll never get to go back there again. And that was just so amazing.

These novel experiences helped Hannah to view science as "fun": "I didn't even realize I was learning." She said, "This experience really changed my perspective of the science field."

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Comfortable and Personally Meaningful Setting

Another theme that emerged from our data was that the opportunity to learn science in a comfortable and personally meaningful way positively influenced the girls' identities. Gretchen, who identified as being on the autism spectrum, particularly benefited from this aspect of the program. In school, Gretchen explained, her teachers would see her as "inattentive" because she did not look at them during instruction. She commented, "I don't necessarily need to look at them to know, to learn stuff." Her mother, who attended the OST science camp as a chaperone, added that Gretchen often struggled with interactions in the classroom. Though she had an inclination toward science coupled with a strong interest in animals, Gretchen feared that her teachers and peers would judge her.

After the Coastal Ecology program, both Gretchen and her mother noted that Gretchen felt "safer" at the OST science camp. Her mother commented, "This is nice here, because I don't think she fears that anybody is going to be like, 'No, Gretchen, that's stupid.' … I don't think she was as intimidated as she sometimes is with kids in a classroom situation."

The OST science camp program also gave Gretchen many opportunities to work with animals in ways that were personally meaningful to her and that aligned with her interests. Gretchen explained that she enjoyed collecting and learning about organisms: "I liked doing the stuff out in the field better than just sitting in a boring old classroom all day, just sitting and writing." According to Gretchen's mother, the science camp was "more her thing"; Gretchen enjoyed interacting with animals because "the animals aren't going to criticize her, so she's more receptive to them, and she doesn't fear them at all…. She relates to animals better than she does people." For Gretchen, the OST science camp offered a space for learning science where she felt comfortable. The program also aligned with her interests, specifically her love of animals. Through this experience, she came to see herself as a capable science learner, in contrast to her experiences at school.

Use of Multiple Types of Language

The fact that use of multiple types of language was encouraged at the OST science camp appeared to influence aspects of the girls' identities. The types of language we observed included the academic language common in the classroom, the scientific discourse that is the norm in scientific fields, and the everyday language of the youth. Participants in the science camp were encouraged to use everyday language to make sense of scientific terminology. In turn, their growing ability to understand scientific terminology and use it appropriately encouraged the girls to see themselves as capable science learners. Further, in appropriating scientific discourse, they began to align their talk with that of scientists—another important component of their identities in science.

Brynn was described by her classroom teacher during the pre-camp interview as "goofy." The teacher said that Brynn sometimes engaged in science, but only if nothing

more exciting caught her attention. When Brynn thought a science task was too challenging, she disengaged and relied on her peers to complete the task. Brynn echoed these characterizations of her identity before the program, saying, "Science is not my overall strength."

During the science camp, we saw Brynn using everyday language to make sense of scientific concepts. After observing a plankton under a microscope, Brynn described her observation: "I saw the thing on the sides hang out to the sides." She accompanied her words with hand motions demonstrating how "the thing[s] on the sides" waved back and forth. Jocelyn, the field station instructor, recognized and encouraged Brynn's use of gestures and everyday language. Copying Brynn's gesture, she explained that the things Brynn observed in the microscope are called "cilia." Using this new knowledge, Brynn correctly—and excitedly—identified the plankton as "an Atlantic crab!" She then described her observation using the correct scientific terms, "plankton" and "cilia." Jocelyn's support for Brynn's use of everyday language and gestures helped Brynn understand and appropriately use scientific terminology. Brynn's excitement at identifying the plankton illustrates how experiences of success can influence girls' science identities—in contrast with Brynn's pre-camp comment that science was not her "overall strength."

Opportunities for Social Interaction

A second aim of our study was to understand how social interactions during the OST science camp offered a space for the girls to engage in identity work. Verbal and nonverbal communication in OST settings can help youth to develop a shared understanding of science content while also learning about the members of their group. As identity development is a reflexive process, we were interested in how social interactions enabled the girls to negotiate their identities, author new identities (that is, see themselves in new ways), and have these identities recognized and accepted by other youth in their social group. Our iterative analysis of social interactions in the science camp showed that the girls used social interactions both to position themselves relative to others in their social group and to align their behavior with scientific practices and discourse.

Positioning refers to the ways that youth present themselves as science insiders and how they view themselves in relation to other group members. For instance, Brynn positioned herself as a scientist during one of the organism identification tasks. Offered the opportunity to hold a hermit crab, the other girls refused, indicating that they were scared of the crab or found it "gross." Brynn, in contrast, indicated through her social interactions that she is the type of person who is not afraid of organisms and is willing to touch a hermit crab.

> **Paula:** Look at it, look at it. Oh my god. [Raises her hands and turns away.] That is the grossest thing I have ever witnessed. [Brynn pulls out the hermit crab. Paula flips her hair over her face and covers her eyes with her hands.] *Oh no! No!*
>
> **Brynn:** *It's just a hermit crab!* It's not going to eat you. [She holds up the crab for others to see.]
>
> **Paula:** Oh my god. [Gets up and stands away from the crab.]

Brynn used both verbal and nonverbal interactions to position herself as the type of person who is interested in organisms and willing to interact with them as a scientist might. In contrast to other youth in her social group, Brynn made what appears to be a strategic decision to hold the crab that others found "gross." This identity move was recognized by her classroom teacher as well as the other members of her group. The teacher commented, "Brynn used to be afraid of this, and now she's comfortable." Similarly, the other girls asked Brynn to hold the crab for them to see, thereby recognizing her positioning of herself as someone who acts like a scientist. These exchanges were important in Brynn's development of her identity as a science learner.

> Participants in the science camp were encouraged to use everyday language to make sense of scientific terminology. In turn, their growing ability to understand scientific terminology and use it appropriately encouraged the girls to see themselves as capable science learners.

Girls at the science camp also used social interactions to enact identities as science learners by aligning their behaviors with scientific practice and discourse. For example, during the field trip to the intertidal ecosystem, the youth collected and analyzed data such as pH and temperature. Across the groups we observed, youth used scientific discourse; for example, they would say that they had to "complete three trials" in testing the water samples. During the research cruise, when the group was measuring water quality data, Addison and Gabriella used such scientific terminology as "Celsius," "creosol read," "refractometer," "dissolved

oxygen," and "density." They were using social interactions to convey their identity as science insiders.

Encouraging Girls in Science Through a Focus on Identity

Our exploration of girls in the Coastal Ecology program provided evidence that OST programs can offer positive experiences to help girls see themselves in science. Throughout the science camp, the girls were working in the field as scientists, engaging in authentic science practices and using the actual tools of scientists. These opportunities helped the girls to see themselves as scientists and fostered positive science identities.

These positive experiences address the factors identified in the research as limiting girls' identification with science. For instance, our findings provided evidence that such experiences as field trips and organism collection aligned with girls' interests. Moreover, being able to learn science by collecting and maintaining organisms may have challenged the girls' perception that science is a masculine pursuit. The science camp also offered female science educators from diverse racial and ethnic backgrounds as role models and mentors. Further, the Chincoteague Bay Field Station is an active science research lab; the girls could see and interact with practicing scientists, including many female scientists. These experiences helped to challenge stereotypes of who does science.

Because identity work is an ongoing process that develops over time and across contexts, OST programs have the potential to positively affect girls' views of themselves in science. As McCreedy and Dierking (2013) note:

> [L]earning is the process and product of a series of cascading influences. Ideally, informal STEM learning experiences for girls, along with experiences they have at home, school, university, and the work place, build upon one another, as well as connect to and reinforce the countless other experiences in a woman's lifetime. (p. 3)

They go on to claim that, "informal STEM programs can give rise to memorable experiences that cascade over time" and that affect women in many ways (p. 3).

Based on our findings, we advocate for strategically designing OST science learning programs to nurture girls' science identities, connecting to and building on other life experiences. Specifically, OST science programs should be designed to:

1. Solicit girls' input in designing curricula and activities to ensure that they are personally meaningful, relevant, and aligned with girls' interests.
2. Provide a comfortable and safe learning environment where girls can try new things, consider themselves in new ways, and build confidence in themselves as capable science learners.
3. Offer opportunities for girls to share their expertise and to have ownership of their learning tasks. Such opportunities will help girls visualize themselves as people who have something to share with others and point out that all participants are valued for the knowledge they bring to the group.
4. Encourage and support girls' use of multiple types of language, including the everyday language and dialects with which they are familiar.
5. Include opportunities for active learning and authentic tasks that mirror the activities of scientists.
6. Foster social interactions in which girls can engage with others. Our study suggests that, through these social interactions, the girls were able to negotiate and author new identities and to have those identities recognized by others.

Following these data-driven design principles can enable OST programs to give girls ongoing opportunities to engage in science identity work. The Coastal Ecology program is aligned with many of these ideas; it provided the girls in our study, some of whom came from nondominant backgrounds, with positive identity-building experiences. Building on these principles, OST programs can continue to provide memorable science learning experiences for girls.

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