

**Identity Development of Middle School Students as Learners of Science during Learning Conversations at an Informal Science Education Camp**

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## **Abstract**

This study investigated middle school students' identity development as learners of science during learning conversations at an informal science education camp. The central research question was: What is the role of conversation in influencing science learner identity development during an informal science education camp? Identity in this study was defined as becoming and being recognized as a certain type of person (Gee, 2001). This study focused particularly on discursive identity, defined as individual traits recognized through discourse with other individuals (Gee, 2005; 2011). The study used an exploratory case study. Data collection included videotaped observations, field notes, interviews and participants' reflective journal entries. Each source of data was examined for the conversation that it generated. I used qualitative methods to analyze the data including discourse analysis and the constant comparison method for emergent themes. From the findings of this study, I theorized that learning conversations played a role in developing participants' identities as learners of science. Participants used language in the following ways: to make sense of science content, to position themselves, to align their discourse and practices with science, to communicate with others which resulted in engagement, to re-negotiate power, and to see others in new ways. The findings of this research support and extend the research literature on identity, learning conversations and science camp programs. This study has implications for those involved with informal education program and exhibit development.

## Introduction

Learning science is not confined to schools; students learn in a variety of contexts and from a number of sources, including learning in informal learning environments. Rennie (2007) stated that “most people spend less of their lives in school than out of it, and they continue to learn throughout their lifetime in many places other than educational institutions” (p. 125). The public learns science in a variety of contexts and from a number of sources, including learning science in informal learning environments (Dierking, Falk, Rennie, Anderson, & Ellenbogen, 2003; Falk, 2001; Falk & Dierking, 2000).

Science education researchers, practitioners and policymakers are increasingly recognizing the role of informal learning environments to complement and support learning in the classroom (Bybee, 2001; Falk, 2001). The *National Science Education Standards*, for example, stated that the classroom is a limited environment and learning should extend beyond the classroom (National Research Council, 1996). Similarly, in *Ready, Set, Science!*, the National Research Council (2007) suggested that experiences outside the classroom support and shape the science knowledge that students bring with them to the formal classroom. In their position statement on informal science education, the National Science Teachers Association (2001) encouraged links between informal science education and formal classrooms. The NSTA’s position statement asserted, “Informal science education complements, supplements, deepens, and enhances classroom science studies” (p. ix). The National Research Council (2009) suggested that schools cannot act alone in meeting the goals recommended in science reforms. They stated that learning science continues in a number of informal contexts and it is important to understand how informal learning environments can support schools in meeting the goals of reform.

One way that the unique characteristics of informal learning environments might support and complement science learning in the classroom is by fostering students' identity development as learners of science. Learning is as much about becoming as it is about knowing (Nasir, 2002). Identifying as a learner influences what activities we participate in, our motivations and interests toward learning, and how we see ourselves fitting within different communities. Anderson (2007) argued that one aspect of learning is enculturation. In this view, learning is about acquiring the skills, concepts, and practices of a community, what Anderson refers to as identity. Enculturation and identifying as a learner, he argued, occurs through social participation. Informal learning environments provide numerous opportunities for social participation (Dierking et al., 2003; Falk & Dierking, 2000; Falk & Storksdieck, 2005; National Research Council, 2009). Many of these contexts prompt social interaction as participants attempt to make meaning from content.

Identity in this study was defined as becoming and being recognized as a certain type of person (Gee, 2001). Identity is socially constructed and can be influenced by the practices of a given community. Informal science education settings are structured to provide multiple opportunities for visitors and participants to socially interact with one another during learning conversations. A growing body of research in informal science education examines how groups engage in learning conversations to make meaning from content and exhibits. I defined learning conversations as social interactions between group members as they make meaning from content and exhibits in these settings. The National Research Council (2009) speculated that individual and group identity might be shaped and reinforced during these learning conversations in informal science education settings.

By informal science education, I refer to opportunities to learn science outside the formal classroom context. These experiences include, but are not limited to, museums, science centers, zoos, aquaria, botanical gardens, nature centers, afterschool programs, science camps, the internet, television, and film (NSTA, 2001; Dierking et al., 2003). These types of experiences often have several characteristics in common. Crane (1994) indicated the following features are common to informal science education: “activities that occur outside the school setting, are not developed primarily for school use, are not developed to be part of an ongoing school curriculum, and are characterized by voluntary as opposed to mandatory participation as part of a credited school experience” (p. 3). Hofstein and Rosenfeld (1996) also suggested that informal science education experiences are often non-assessed and non-competitive. Dierking et al. (2003) added that informal science education is characterized as being driven by the needs and interests of the learner.

Science camps are one type of community-based, informal science education context. Nicholson et al. (1994) and Rennie (2007) characterized science camps as short-term programs that are intensive with regard to involvement in science activities. Science camps are often residential or day camps (Fields, 2007) and usually focus on promoting confidence and competence to pursue science (Rennie, 2007). Fields (2007) indicated that science camps are typically offered during summer and winter breaks from school. The camps focus either on science generally, or on specific sub-disciplines such as marine science, astronomy, environmental science, physics, or nanotechnology. Another distinguishing feature of science camps is they are often homogenous with regard to participants’ age, grade, and socioeconomic status (Fields, 2007).

Fields (2007) and Johnsen (1954) both described that science camps address affective aspects of learning and attempt to increase motivation and confidence among participants. This goal is accomplished in numerous ways. Science camps are commonly held in novel, exotic locations such as the marine environment, mountains, wilderness, and university campuses. These novel locations may spark interest for students and provide a memorable experience. Learners often participate in authentic science projects and learning activities that foster curiosity and exploration (Fields, 2007; Johnsen, 1954). Science camps focus on apprenticeship models, hands-on activities, and inquiry methods which researchers theorize may be more motivating for students (Barab & Hay, 2001; Gibson & Chase, 2002; Markowitz, 2004; Sondergeld, Rop & Milner, 2008). Science camps can provide participants with access to resources not typically available in the formal school setting. Laboratory equipment, research methods, and professional scientists are examples of novel resources provided by science camps that may influence participants' identities as learners of science (Barab and Hay, 2001; Markowitz, 2004; Robbins & Schoenfisch, 2005).

The study reported here was motivated by several gaps in the corpus of research on learning conversations in informal science education settings. First, studies of learning conversations often focus on museum-like settings but applications to other informal learning environments are still lacking. We know very little about how the unique characteristics of other informal science education contexts, such as afterschool programs and science camps, influence learning conversations between participants. This study sought to address this gap by investigating learning conversations at a science camp. Second, previous research on learning conversations centered on learning between family groups, or adult-child interactions. Peer interactions have been less well-documented (Astor-Jack et al., 2007). There is reason to believe

that the interactions between peers during learning conversations might differ from those between parents and their children. Finally, examinations of how conversations in informal learning environments foster identity development as a learner of science are lacking. If a view of identity as situational is adopted, the novelty of an informal learning environment could prompt changes to an individual's identity. Although studies in informal learning environments have examined the influence of identity on the experience, these studies have failed to look at how identities might be constructed during the experience as participants socially interact with one another during learning conversations.

### **Research Question**

The gaps in the literature suggest a need for research examining peer conversations and the construction of identities as learners of science in informal science education contexts that differ from museum-like settings. The following central research question guided the study:

*What is the role of conversation in influencing middle school science learner identity development during an informal science education camp?*

This study was designed to gain insight into the ways that the unique characteristics of an informal science education camp and engagement in learning conversations with peers in such a context shaped middle school students' identity development as a learner of science. Of particular interest was the role that discourse played in the process of identity development as a learner of science for middle school students attending an informal science education camp program.

### **Theoretical Framework**

My analysis of middle school students' identity development as learners of science builds on sociocultural theories of learning and theoretical views of identity development. I combine the

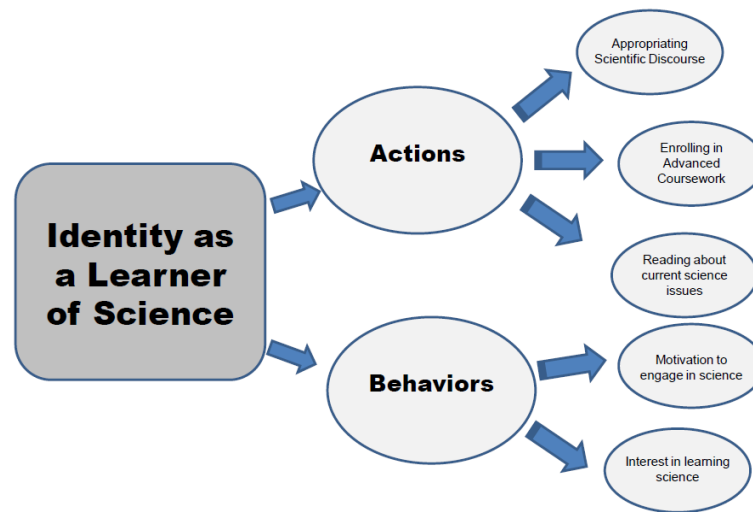
two streams of literature to articulate the theoretical grounding of the study. I discuss the socio-cultural aspects of the camp which lend themselves to learning conversations. During these learning conversations, middle school participants engage in discourse during which discursive aspects of their identity as a learner of science are shaped. The unique characteristics of an informal science education camp offer affordances that may guide this process of identity development as a learner of science.

Identity in this study was defined as becoming and being recognized as a certain type of person (Gee, 2001). This study focused particularly on discursive identity, defined as individual traits recognized through discourse with other individuals (Gee, 2005; 2011). The construct of identity is very broad; as a means to focus my analysis of identity, I collected data specifically with regard to participants' identities as a learner of science. My analysis of participants' identities as learners of science was based on their responses to how they portrayed themselves, rather than using a priori categories such as ethnicity, primary language spoken and other factors.

I believe that identity development as a learner of science is an important area of investigation. Our identities drive our actions and behaviors and influence our motivations and interests (Brickhouse, Lowery, & Schultz, 2000; NRC, 2009). How one identifies as a learner of science influences the practices the individual engages in as well as the trajectories available to the learner. Learning and achievement are enhanced when students build strong identities as learners of science (Nasir, 2002). It further influences motivation and interest. An individual who identifies as a learner of science is likely to engage in science learning and possibly even choose science as a career. The importance of an identity as a learner of science is exemplified in Figure 1.



**Figure 1.** *The influence of an identity on an individual's actions and behaviors related to science learning.*

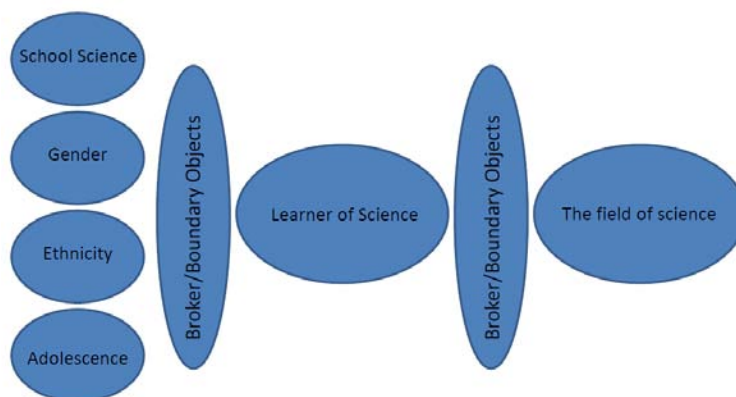


Students' identities as learners of science have largely been framed within the context of school science (Brickhouse et al., 2000; Olitsky, 2007). However, I view that identity is dynamic and situated in the specific affordances of each context. I believe that informal science education contexts may influence students' views of themselves within the context of learning science. In this regard, their identity may shift from that of a school science identity to an identity as a learner of science. The unique aspects of informal science education settings may positively influence an individual's identity as a learner of science.

Before describing the ways in which an informal science education camp may influence learners' identities, I will define my use of identity, drawing on the theories of identity articulated in the literature. I draw largely on Wenger's (1998) framework of a community of practice to consider what it means for an individual to identify as a learner of science. Through participation in these communities of practice, learners engage in mutual practice, imagine and consider other identities, and align their efforts to those of the community. Identity might be expressed through the actions of the individual, or might be represented in their discourse.

Wenger (1998) contended that individuals can participate in multiple communities of practice at one time. That is, an individual may have multimembership in numerous communities of practice such as a school science identity, an identity as a teenager, an identity as a female, or an identity with a particular ethnic background (to name a few). The learner must negotiate these multimemberships and imagine themselves as full members in the community of practice. The process of brokering helps to connect the boundaries of these various communities. In terms of learning science, the various communities to which the learner belongs must be connected for the individual to imagine a trajectory of full membership in the community of science learners (Figure 2).

**Figure 2.** *Theoretical model of boundary objects and brokers in communities of practice.*



Brokers and boundary objects help to negotiate the brokering process. In the context of the informal science education camp, the educators and tools of science serve as brokers and boundary objects that guide learners in viewing themselves in the community of practice of a learner of science and possibly even eventually in the community of science.

Wenger's (1998) account of communities of practice and the process of brokering lacks a mechanism by which this process may take place. Wenger suggests that the use of boundary objects such as tools may aid in the brokering process. My argument further examines the

brokering process and posits that language and engagement in conversation could be a mechanism for the brokering process. As learners engage in conversation with their peers and science camp educators as well as the tools of science provided at the informal science education camp, they may begin to connect their membership in various communities of practice and visualize an identity that is a nexus of multimembership.

In speculating about the role of language in the brokering process, I posit that discursive identities are an important notion to explore. I adopt Gee's (2001; 2005) notion of identity and view that individuals use discourse to enact a particular identity in a given context. As Brown (2004; 2006) and Brown, Reveles, and Kelly's (2005) work pointed out, some students may engage in the brokering process and begin to connect various communities as was evident in their discursive identities. However, for some, the two communities were seen as conflicting and some students rejected the use of scientific discourse as evident in their discursive identities.

Wenger (1998) mentions issues of marginality but does not expand in detail on the notion of marginality with regard to identity. I draw on Holland, Lachicotte, Skinner, and Cain's (1998) work and consider that some forms of membership are afforded greater privilege and power in the society of science than other communities. Such privileging and power in society might influence an individual's identity as a learner of science depending on how they view their position in these groups. Carlone and Johnson (2007) argued that a view of identity opens up new ways of viewing science teaching and learning and to ask questions about the kinds of people that have been promoted and marginalized by the practice. Marginalization of certain groups may lead to trajectories of participation that do not lead to full membership. Polman and Miller (2010) suggest that positioning is an aspect of marginality. Categories of social identification "thicken" or "accrete" on individuals as they repeatedly position themselves or are

positioned by others as belonging to a particular category (p. 884). Individuals that are from backgrounds that have been historically underrepresented or marginalized in the community of science have additional boundaries to negotiate in entering the community of practice that is science and science learning.

I further use the work of Gee (2001) and Sfard and Prusak (2005) for methodological considerations. Gee (2001) suggested that one component of identity is a discursive identity. Discursive identities are individual traits that are recognized through discourse with other individuals. Gee's work implicates an examination of students' discourse as they engage in identity work during the science camp program. Sfard and Prusak (2005) viewed identity as narratives and through storytelling, identities are negotiated and constructed. Bamberg and Georgakopoulou (2008) suggested that individuals tell stories of themselves and use narratives to position themselves and display contextualized identities. Paris and Mercer (2002) indicated that narratives might be particularly relevant for identity exploration in informal science settings. They posited that participants in informal learning environments search for meaning to negotiate identities during explorations in these environments. They argued that narratives are fundamental to this process of meaning making in informal settings. As a source of data collection, science camp participants maintained journals during the program. I believed the journals helped engage students in telling their personal stories and provided me with access to their second person identity narratives.

In adopting a view of socially constructed identities, I believed it was fitting to examine identity construction in informal learning environments. Informal learning environments provide multiple opportunities for social interaction during which learners can engage in identity work. Specifically in the science camp context, the program activities prompted discussion during

which students engaged in making meaning of science content and negotiated their identities as learners of science.

The social interactions that take place during learning conversations in informal learning environments may be influential in the construction of students' identities as learners of science. The National Research Council (2009), for instance, speculated that individual and group identity might be shaped and reinforced as an outcome of museum learning conversations. Leinhardt, Crowley, and Knutson (2002) stated that conversations both reflect and change a museum visitor's identity. Identities might be shaped as visitors seek personal meanings from museum content that confirm, disconfirm, or extend understandings of their own identities (Paris & Mercer, 2002).

If identity is treated as situational and influenced by the social context, there is reason to believe that identity might be influenced by the novelty of a new context. Fienberg and Leinhardt (2002) described how a new context, such as an informal learning environment, might shape an identity. They theorized that there are social dynamics (e.g., turn taking, topic control, methods of interaction) that have been established by a particular group for the settings in which the group normally interacts. A novel situation might disrupt this balance, necessitating a renegotiation of the group rules. The novelty of an informal learning environment and learning conversations that take place in this context might prompt the development of students' identities as learners of science. As members of the group socially interact and attempt to jointly construct meaning in a novel setting, their identities as learners may be transformed. Through social interactions, the learner has an opportunity to explore a new identity and have that participation recognized (Luehmann, 2009).

Informal science education environments may provide learners with real-world connections and further guide the identity development process. Gallas (1995) commented that school science often makes few connections with the real-world and students are unable to see how the subject fits into their lives. Science becomes viewed as for school and learners may come to see themselves as not good at science or not fitting in the community of science. Gallas speculated that when students are given opportunities to talk science, they see how science fits into their lives and see themselves as identifying with learning science. In informal science education, learners are given multiple opportunities for talk and learning in these settings is often situated in real-life problems and contexts. This unique characteristic of informal learning environments could influence students' identities as learners of science.

I draw on Holland et al.'s (1998) work and consider that power relations can influence an individual's identity. Power, status, privilege and marginalization are all aspects that play a role in how an individual sees herself as a learner of science. Informal science education camps may help to mitigate this power dynamic. Learning conversations in this setting involve peer-peer interactions and more equitable conversations. Connecting with Lemke's (1990) work, he suggested, "We communicate best with people who are already members of our own community: those who have learned to use language in the same ways that we do" (p. x). The absence of a teacher allows the students to use activity structures that are familiar to them and that are more equitable. As learners engage in equitable conversations, they have a safe environment to explore and negotiate new identities.

Informal science education camps are also non-assessed and non-competitive. The teachers and educators in these contexts are not evaluators but rather mentors and role models for the students. The cultural norms of the classroom and resulting procedures and roles are no

longer prevalent in the informal science education context. As a result, the teacher exerts less power over the learner. The lack of power and competition creates a safe and supportive environment which I believe influences students' identities as learners of science.

Finally, I believe the informal science education camp provides learners with access to tools and norms of science that may not necessarily be available in the school setting. For example, at the science camp, students have access to oceanographic research equipment such as organism collection nets, research vessels, refractometers, and organisms. Through exposure and use of the authentic tools of science, learners are able to imagine themselves using the equipment of science and possibly see themselves as a scientist or learner of science. The use of these authentic tools in the informal science education camp context may help to shape and facilitate identity development as learners of science.

### **Study Design**

Stake (1995; 2008) suggests that the strength of a qualitative case study approach is its ability to provide a greater understanding of a case by gaining an appreciation of its uniqueness and complexity. The purpose of this study was to gain a deeper understanding of how students learn in a science camp setting; thus, a qualitative case study approach was an appropriate method.

**Case Selection and Description.** The science camp program at the Marine Science Consortium (MSC) was selected as a case for this study for several reasons. The *Coastal Ecology* field trip program offered at the MSC represents a typical science camp program in that it embodies many of the characteristics common to science camp programs. This study represents an exploratory case study due to a lack of research studies in science camp contexts; a typical case is ideal for gaining an initial understanding of what learning in these environments looks

like. An earlier pilot study revealed that student participants at the MSC setting engaged in learning conversations and identity-work. Thus, the activities embedded in the MSC's science camp program were an appropriate site to gain insight into the research question. I bounded the case by focusing on the science camp field trip program and specifically the middle school groups attending the program during a three week study period in the spring of 2010.

The MSC is an environmental learning center and field station located in Wallops Island on the Eastern Shore of Virginia. The MSC's mission is to provide multi-disciplinary education and research opportunities through field-based and hands-on science learning. The consortium uses as its classroom the bays, marshes, beaches, maritime forests, dunes, off-shore waters of the surrounding Eastern Shore of Virginia.

One of the education programs offered at the MSC was the *Coastal Ecology* field trip program. As part of this four day program, groups of students visited the consortium with their classroom teachers and stayed on campus in student dormitories. Thus, the program was residential in that participants were housed on campus and ate all meals at the campus dining center. Participants engaged in a variety of science activities through the day as well as leisure activities intended to unify students and create a community. Each day, participants engaged in a full day of science activities designed to be hands-on and mirror the research practices of professional marine scientists, ecologists, and oceanographers. Typical science activities included: research cruises, lectures, hands-on science activities, laboratory activities, organism collection and maintenance, and field-based experiences (Appendix A).

**Participant Selection.** Student participants were selected from three middle school groups attending the *Coastal Ecology* field trip program at the MSC during the study period. All three groups were from public schools located in Mid-Atlantic States and enrolled between 700-



1000 students in grades 6-8. Two of the schools were located in rural areas in their respective states and the third was located in a suburb outside a large city.

With each of the three schools that attended, all of the students that had signed parent consent and student assent forms participated in videotaped learning conversations as well as the completion of reflective journal prompts throughout the program. I also selected three students from each school group for a more detailed case analysis (total n=9). I used a purposeful sampling strategy to select these student cases. The sample was purposeful in that the ability to communicate effectively was essential for my analysis of learning conversations. I contacted the students' classroom teacher prior to the schools arrival at the MSC to request recommendations for student case studies. I requested the teachers recommend students that were verbal and expressive. Table 1 illustrates demographic information for each of the student case participants.

**Table 1.** *Demographics of case participants across gender, ethnicity/race, and grade level placements.*

Case Participant <sup>1</sup>	School	Gender	Ethnicity/Race	Grade
Hannah	Patriot MS	F	White	8 <sup>th</sup>
Brynn	Patriot MS	F	White	8 <sup>th</sup>
Dale	Patriot MS	M	White	8 <sup>th</sup>
Celeste	Thomas Jefferson MS	F	African American	7 <sup>th</sup>
Jordan	Thomas Jefferson MS	M	White	7 <sup>th</sup>
Emma	Thomas Jefferson MS	F	White	7 <sup>th</sup>
Addison	Brownsville MS	F	White	7 <sup>th</sup>
Gretchen	Brownsville MS	F	White	7 <sup>th</sup>
Everett	Brownsville MS	M	White	7 <sup>th</sup>

**Data Collection.** Nasir (2002) suggested that identity develops through both individual agency and through social interactions. Thus, data was collected from both perspectives. Data sources included field notes, videotaped observations of learning conversations, students' responses to reflective journal prompts, student focus group interviews, and individual

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<sup>1</sup> Students' names disguised for anonymity purposes.

interviews with classroom teachers. Sample interview questions and reflective journal prompts are listed in Table 2.

**Table 2.** *Sample interview questions and journal prompts use for data collection.*

<b>Data Source</b>	<b>Sample Items</b>
Student Focus Group Interview	<ul style="list-style-type: none"> <li>• In thinking back over the science camp experience, what are some of the activities that influenced how you think and feel about science?</li> <li>• How has the science camp changed how you see yourself as a learner of science?</li> </ul>
Teacher Interview	<ul style="list-style-type: none"> <li>• How do you see (student) as a learner of science?</li> <li>• How do you think (student) has changed as a result of the science camp?</li> </ul>
Reflective Journal Prompts	<ul style="list-style-type: none"> <li>• How have today’s science activities influenced how you see yourself as a learner of science? Are you different in the science camp setting than you are in the classroom? Please feel free to write your response and/or include drawings.</li> </ul>

### **Data Analysis**

Each source of data was examined for the conversation that it generated. Videotapes of interviews and observations of science camp activities were transcribed for both verbal and non-verbal interactions. I used an iterative process to examine the videotaped data which involved going back and forth between the video recordings and transcripts to develop preliminary codes. Transana, a qualitative data analysis software program designed specifically for video data, was used to manage and organize the data analysis process. The software assisted in marking, moving and coding data segments. I developed the themes for the analysis based on the conceptual framework and using methods of discourse analysis (Gee, 2005; 2011) and the constant comparative method (Charmaz & Henwood, 2008; Huberman & Miles, 1994). Table 5 summarizes the data collection and analysis methods I implemented in the study.

**Table 3.** *Corpus of data and analysis methods*

<i>Event/Participants</i>	<i>Data Collection Method</i>	<i>Analysis</i>
<b>Observations of conversations during science camp activities</b>	Videotape Researcher Field Notes	Transcription for verbal and nonverbal interactions

		Discourse Analysis
<b>Focus group interviews with middle school program participants</b>	Audiotape	Transcription for verbal and nonverbal interactions
	Videotape	
<b>Individual interviews with classroom teachers</b>	Audiotape	Discourse Analysis
		Transcription for verbal interactions
<b>Middle school program participants reflections on program</b>	Student Reflective Journal Entries	Discourse Analysis
		Selective coding used to construct narratives, or thick-descriptions of case participants

As a means to address issues of trustworthiness, reliability, and bias, I engaged in the following procedures: crystallization of data (Charmaz, 2000), member check, peer and advisor debriefings, checking rival explanations, and maintaining a chain of evidence (Yin, 2009).

### **Findings**

In this section, I highlight one of the ways language played a role in developing science camp participants' identities as learners of science and then discuss broadly the themes that emerged from my inspection of the data as related to the guiding research question. I begin by highlighting a case participant, Hannah, and the ways she used language to negotiate her identity as a learner of science during the science camp program. The section concludes with a summary of the influential characteristics of the informal science education and the role of learning conversations in shaping participants' identities as learners of science.

#### **Hannah:**

One way participants used language during learning conversations was to negotiate power dynamics which influenced their identities as learners of science. By power dynamics, I refer to the ways that individuals exert power and control over one another. Lemke (1990) posited that in the classroom, teachers use activity structures such as teacher monologue and triadic dialogue to maintain control over the classroom and their students. Further, in school

science setting, the teacher is an assessor and evaluator making them in a position of power. However, the unique characteristics of the science camp setting prompted a renegotiation of these power dynamics. The case of Hannah highlights the ways that language was used to renegotiate power which shaped her identity as a learner of science.

Hannah was a white female that participated in the science camp program as an 8<sup>th</sup> grade student from Patriot Middle School. Hannah came to the informal science education camp as a learner who had some interest in science but that lacked confidence in her abilities as a learner of science. Her classroom science teacher, Mr. Malone, supported this characterization of Hannah and commented that at times she “stood back” which he attributed to her lack of confidence (pre-camp teacher interview, May 2010). In the pre-camp focus interview, Hannah made the following statement: “I find myself liking science and um, I wouldn’t say I’m the best at science, but I’m working for it, and I love to learn about it.” Although Hannah expressed that she liked science, it was an area of her identity as a learner of science that was just emerging. Hannah explained that in previous years, she did not enjoy learning about science. She wrote in her journal, “In earlier years, learning science [has] been not as interesting as this year” (Day 1 journal entry, May 2010).

The use of language during the learning conversations with her peers helped the Hannah to re-negotiated power dynamics and come to see herself as a capable and interested learner of science. The opportunity to engage in peer-peer learning conversations that were equitable helped Hannah to feel more comfortable and free to try on a new identity as a learner of science. The conversations shifted from what Lemke (1990) identified as language structures that helped teachers to maintain power and instead prompted learners to engage in more equitable learning conversations with their peers. Hannah remarked in the post-camp interview that when mistakes

were made, accountability was spread throughout the group. Further, she felt less under the watch of the teacher when they were able to work in groups as compared to individually.

At times when Hannah engaged with adults (i.e., MSC educators, the classroom science teacher, and adult chaperones) the conversations were more equitable than they might traditionally be in a science classroom setting. For instance, the classroom science teacher, Mr. Malone, was not an assessor or evaluator in this setting. This helped diminish, to some extent, the power dynamic between the educator and learners. The opportunity to learn about their teachers on a personal level while living on campus during the science camp also helped the Hannah and her peers to feel more comfortable around their teachers. Further, some of the learning conversations between the learners and educators were more equitable because both were in a position of not knowing the answer. In this way, the learner and educator were learning alongside one another. Finally, the language structure of the science camp did not always focus on triadic dialogue or teacher monologue, activity structures that Lemke (1990) suggested were used in the classroom by teachers to maintain power and control over their students. There were times during the science camp conversations where the learners had information that the teachers did not yet know. During these times, the teachers were asking questions to which the learners had the answers. These opportunities prompted a shift in power in which the learner and educators were participating in equitable conversations. Expertise was distributed among the participants and learners in these conversations. This aspect of the camp helped to foster a supportive environment in which Hannah and her fellow participants could try on new identities as learners of science.

As an example of this shift in power dynamics, I present an episode of Hannah's participation during the organism lab. Hannah was working with her group members to correctly

identify a species of seaweed. A teacher comes over to interact with the group. The teacher does not know the correct identification of the organism either and works with the girls to correctly identify the organism.

**Mrs. Carnetti:** Do you guys have sea lettuce? ((The group has already identified sea lettuce. Hannah points to the plate of algae and indicates for the teacher which of the samples was sea lettuce)).

**Hannah:** That one is.

**Paula:** We don't really know what to do after we've found it. ((The group moves on to ID a new algae sample)).

**Hannah:** We looked in here. ((Hannah points in the book to the descriptions they have been reading.))

**Mrs. Carnetti:** You found it in here? ((Points to the field guide. The teacher starts to work with the girls to identify the new species)).

**Hannah:** We found it in here. ((Teacher takes the field guide and begins to read through the descriptions the group has been evaluating.))

**Mrs. Carnetti:** [??] ((Reads a description in the book and compares it to the sample they are attempting to identify)).

**Paula:** ((points to the algae.))

**Mrs. Carnetti:** Is it a sponge? ((She continues to read a description. Jocelyn comes over to help the group. She redirects them to the appropriate descriptions in the field guide.))

**Allison:** What's that? ((She stands up and reaches for a new field guide. The teacher starts to flip through the new descriptions in the guide with Hannah and Paula.))

**Paula:** Right here.

**Allison:** Brown seaweed. ((Points to the description in the field guide.))

From this interaction, we see that the learners and the teacher were positioned as equals during this activity in the science camp setting. Neither the teacher nor the learners knew the answer regarding the correct identification of the organism. The opportunity to engage in equitable conversations with the teachers may have helped reduce the power structure that is typical in the

school setting. In this way, expertise was distributed amongst both the teacher and the learners. This aspect of the science camp may have influenced participants' identities as learners of science. For Hannah, this distribution of expertise may have contributed to her feelings of comfort, freedom and less pressure in the science camp setting.

For Hannah, participating in the equitable learning conversations with her peers and teachers helped shape her identity as a learner of science. Hannah commented that engaging in conversation with her peers helped her to feel more "comfortable" and she felt more "free" in the science camp setting. She contrasted this with the classroom setting in which she claimed she felt "more confined" (Journal entry, May 2010). In Hannah's view, this level of comfort and feeling of freedom by engaging in conversations with her peers helped her to take risks. Hannah wrote in her journal reflection (May 2010), "I think it gave me, the, a, the push I needed, to do some of these things that I normally wouldn't have done." Particularly for Hannah, language played a role in shaping her identity as a learner of science as she engaged in equitable learning conversations with her peers and adults. The power dynamics in the science camp setting shifted, helping Hannah see herself as a learner that "opened up" and was "willing to take risks."

### **The Role of Learning Conversations**

The themes that emerged from my inspection and analysis of the data from the case participants suggested to me that the unique characteristics of the science camp context influenced participants' identities as learners of science. Table 4 highlights the characteristics of the informal science education camp that influenced participants' identities as learners of science.

**Table 4.** *Influential characteristics and identity resources of the informal science education camp.*

Characteristics of Informal Science Education Camp Experience	Description	Ways in which characteristics afforded benefits and change	Example
<p><b>Supportive Environment</b></p> <p><b>Definition:</b> The lack of grading pressures, competition, rules and procedures created a safe environment for learners to try on new identities.</p>	<p>There was less of a focus on assessment at the informal science education camp. There was less accountability and fewer constraints such as standardized tests and timed class periods. The teacher and learners had more equitable relationships. Thus, expertise was distributed among the teacher and learners. Participants worked in collaborative groups. The expectations in this setting were unique and different from the culture of schools. Both the teachers and learners had new roles. The routines, practices, and procedures were new in this setting (e.g., fewer rules, different classroom procedures).</p>	<p>The supportive setting helped participants to feel safe to try on new identities. They had an opportunity to work in a safe, low-stakes environment.</p>	<p>-Hannah was able to work equitably with a teacher to identify a seaweed species during the organism lab.</p> <p>-Dale felt more relaxed in the science camp setting because he felt less pressure.</p> <p>-Hannah felt more “comfortable” and “free” in this context.</p> <p>-Brynn commented that the science camp “opened her up.”</p>
<p><b>Focus on Affective Dimensions of Learning</b></p> <p><b>Definition:</b> Affective dimensions of learning emphasize such aspects as feeling, emotion, interest, enthusiasm and motivation.</p>	<p>At informal science education contexts and at the science camp, the learning objectives focused on feelings, emotions, and attitudes. The activities were fun, enjoyable, sparked participant’s interest and increased their motivation.</p>	<p>Rennie (1994) suggested a focus on affect facilitates learning. The affective focus in informal science education can increase motivational and engagement. The focus on interest, motivation, and enthusiasm can positively influence a participant’s identity as a learner of science.</p>	<p>-The participants get to play in the marsh mud. They are encouraged to jump in the puddles. The MSC educator asks all of the participants to jump in the marsh to notice its spongy quality.</p> <p>-Many of the participants commented that the science camp activities were fun and developed their interest in science.</p> <p>-Gretchen, on the marsh field experience, yells out, “OMG, that was amazing!” She commented that the marsh trip was so much fun, she wanted to have her next birthday party there.</p>
<p><b>Access to Science Tools</b></p> <p><b>Definition:</b> The</p>	<p>In the science camp setting, the participants had access to the authentic tools of scientists that they may not have access to in the school science classroom.</p>	<p>The opportunity to use the authentic tools of science guided participants and trying on an identity as a learner of science and seeing themselves as a scientist. The tools may serve as boundary objects</p>	<p>-Participants attended a cruise on a research vessel. On the vessel, they had access to such tools as Van Dorn water sampling bottles, refractometers for testing salinity, secchi disks to test water turbidity</p>



<p>tools and equipment used by professional scientists for science investigations.</p>		<p>to bridge communities of practice. That is, access to science tools may have provided a trajectory toward participation in the community of science.</p>	<p>and the current cross to measure current speed and direction.</p>
<p><b>Novelty</b></p> <p><b>Definition:</b> The opportunity to engage in learning experiences that are new and unique to learners. Opportunities that learners would not normally experience in the classroom.</p>	<p>The learning activities at the science camp provided novelty for participants. Some of the activities were new to the participants and they had the unique opportunity to learn in the field. The unique activities contrasted with the typical activities of school science.</p>	<p>The new environment and activities may positively influence participants' identities as learners of science. The novel setting can spark curiosity and inspire motivation. The novelty may help participants to see themselves in new ways.</p>	<p>-Hannah suggested that the dunes field experience to Wallops Island was a novel and unique experience, one in which she may never have another opportunity for in her life.</p> <p>-Another novel aspect of the science camp was working with organisms. The chance to work with organisms is not something that ordinarily takes place in the science classroom.</p> <p>-Everett, Addison and Gretchen visit the aqua lab to see the green moray eel, Mo. They watch up close as Braeden feeds Mo. They excitedly ask questions about Mo and moray eels.</p>
<p><b>Authentic Science</b></p> <p><b>Definition:</b> Learning activities that mirror the practices and contexts of practicing scientists. To “do science where scientists do science” (Barab &amp; Hay, 2001, p. 6).</p>	<p>At the science camp, participants were engaged in the real work of scientists. Science was situated in the real-world context, participants learned about the importance of science in everyday life, and participants engaged in authentic experiments and inquiry practices.</p>	<p>The authentic science activities prompted participants to re-imagine what it meant to be a learner of science. Science was no longer about memorizing facts and following recipe-like experiments.</p>	<p>-Participants collected authentic science data on the research cruise.</p> <p>-MSC educators shared many stories that demonstrated the science in everyday life. For example, during the organism lab, Margot explained that carrageenan, an extract from seaweed, was used in chocolate milk as a stabilizer.</p> <p>-The participants learned in the field. They were able to apply what was learned in the classroom in the real-world during the field experiences.</p>

The informal science education camp was influential in shaping and reinforcing participants’ identities as learners of science. As their identities as learners of science were developed during the program, learning conversations played an important role. I viewed identity as socially constructed and developed through interactions with others. The discourse that was inherent during the learning conversations in the informal science education camp setting served a role in developing participants’ identities as learners of science in the following ways: participants used language for sense-making practices, to position themselves in certain ways with the community of practice, to align their practices and discourse, to engage in learning activities with their peers, to negotiate new power roles, and to see others in new ways. The ways in which learning conversations played a role in developing participants’ identities as learners of science are illustrated in table 5.

**Table 5.** *The role of learning conversations on participants’ identity development as learners of science.*

<b>The role of language in learners’ constructing identities as learners of science</b>	
<p><b>Sense-making practices</b></p> <p><b>Definition:</b> The act of making meaning of science content through social interactions with others. How someone comes to attribute meaning to a phenomenon that they experience.</p>	<p>-Brynn used everyday language to make sense of organism characteristics during the organism lab. The everyday terms helped her to understand the description in the field guide and appropriately identify rough tangleweed.</p> <p>-Emma used everyday language to help herself and her group members make sense of scientific terms such as “adipose fin” and “keel.” She was able to describe the features she saw and match them to the descriptions in the dichotomous key. This helped her to make sense of and use these terms.</p>
<p><b>Positioning</b></p> <p><b>Definition:</b> The ways that individuals put themselves in categories relative to</p>	<p>-Dale used language to position himself as an “over-achiever” within the norms of the classroom.</p> <p>-Brynn used language to position herself as the type of person that would interact with and hold organism, a category that might be considered a norm for individuals working</p>

<p>other in relation to cultural and social norms and practices.</p>	<p>with animals in science fields.</p> <p>-In Addison and Gretchen’s group at the current cross station, the group used the compass incorrectly. When Lilly used the compass, she did it correctly and got an appropriate compass bearing reading. She makes a statement that they aren’t so smart. With this statement, she positions herself as someone that is smart and can appropriately complete the science activity. Lilly distances herself from the other group members who could not complete the task correctly and in doing so, attempts to position herself as someone that is smart at science.</p>
<p><b>Alignment</b></p> <p><b>Definition:</b> Coordinating one’s energy and activities to fit within broader structures and contribute to the enterprise.</p>	<p>-The participants in all three school groups conversed about the need for repeating three trials during data collection.</p> <p>-Jordan used language to provide evidence for substantiating his assertions during scientific argumentation. During the organism lab, Jordan used language to provide evidence for his decisions in rejecting or accepting certain descriptions. When he checked his guess with Margot, he provided evidence to support his guesses.</p> <p>-At time during the organism lab, Brynn chose not to use the appropriate procedures for using the field guide to identify organisms. There were times when she looked at the pictures rather than going through the descriptions and weighing evidence as suggested in the guide.</p> <p>-While collecting water quality data, Addison, Everett, Gretchen and their group members use scientific terms such as, “Celsius,” “Creosol read,” “refractometer,” “dissolved oxygen,” and “density.” They started to appropriate scientific discourse as a means to align their practices with those of scientists.</p>
<p><b>Engagement</b></p> <p><b>Definition:</b> Active involvement in the process of negotiation of meaning. Our direct experience of the world and our active involvement with others.</p>	<p>-Jordan described that in the classroom, he sometimes found the lectures boring which resulted in his disengagement. In the science camp setting, he worked with friends and had fun which helped him to feel focused. The classroom teacher noted this change and suggested that he participated more often in the science camp activities. Jordan used language to discuss the content in ways that he viewed more fun than listening to a lecture in the classroom.</p> <p>-During the early activities of the science camp, Everett is quiet and stands back observing the group rather than participating in the activities. Throughout the program, Everett appeared to become more comfortable and confident by conversing with his peers in groups. He further commented that the activities were fun to participate in. As the camp continued, he started participating in the group conversations, getting more involved in the learning activities and even offering suggestions at time.</p>
<p><b>Power Dynamics</b></p> <p><b>Definition:</b> The ways that individuals exert</p>	<p>-Hannah suggested that in working with peers, she felt more “comfortable” which helped her to “open up” and take risks. She felt less confined and not always being watched by her teacher because the accountability was shared throughout the group.</p>

<p>power and control over one another.</p>	<p>-While working to identify a fish species, Emma participated in an equitable conversation with her classroom science teacher, Ms. Tanner. Both Emma and Ms. Tanner did not know the correct identification for a fish that was collected in the field. They both struggled through the dichotomous key and the descriptions of the fish. As the group worked with Ms. Tanner, expertise was distributed among the learners and the teacher. This helped to diminish power relations between the teacher and learners.</p> <p>-In some cases, the adults exerted control of the conversation in ways that shut off communication and identity work within the group. On the research cruise, Mr. Crawford and Mrs. Roberts directed the data collection activities and dominated the conversation. The participants had less of a need to converse with one another to negotiate the procedures and data readings. Without opportunities to converse, their identities as learners of science did not seem to be positively influenced.</p>
<p><b>Seeing Others in New Ways</b></p> <p><b>Definition:</b> Learning more about members of a community and developing new views of others.</p>	<p>-Jordan suggested that the learning conversations at the science camp helped him to show his peers another aspect of his identity as a learner of science. He believed that his engagement in the hands-on and field-based activities of the science camp would help others to see that he was not “afraid” to get involved. He believed others would come to see a wider range of his personality and identity as a learner of science. Instead of just seeing him as a “book learner,” “nerd,” or “science geek,” they would come to see him as a learner of science who also enjoyed learning in a hands-on manner.</p> <p>-Emma indicated that by engaging in conversations with her peers, they would come to see her as less quiet and not just the girl that sits in the back corner asking questions.</p>

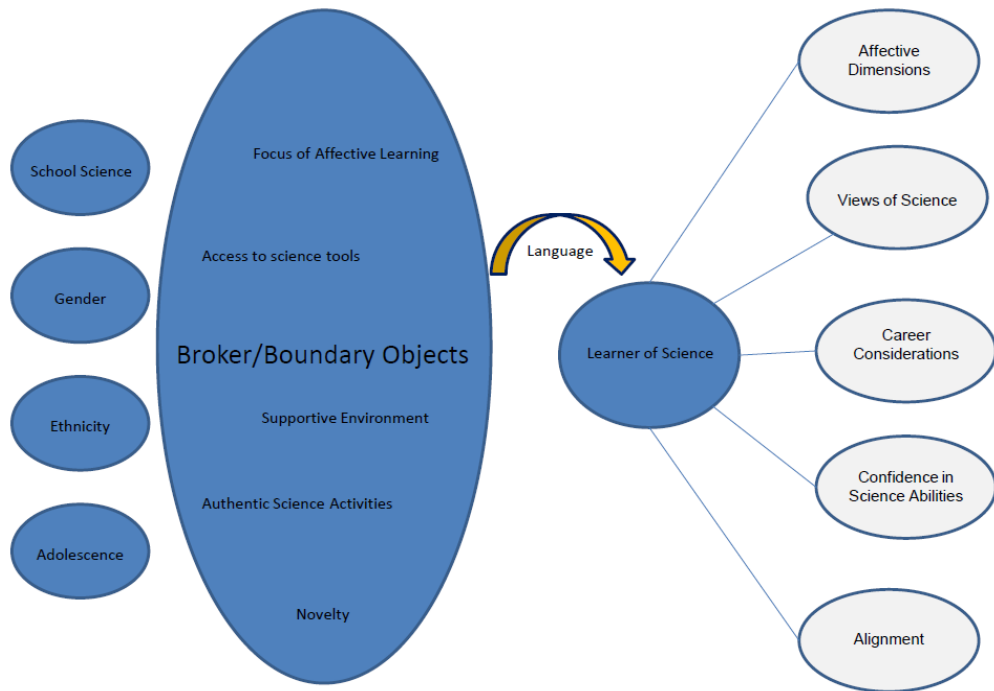
The themes that emerged from my inspection and analysis of the data from the case participants suggested that the unique characteristics of the science camp context influenced participants’ identities as learners of science. These features included: a supportive environment, a focus on affective dimensions of learning, access to science tools, learning in a novel environment, and participation in authentic science activities. The science camp developed and reinforced several aspects of an identity as a learner of science. Participants’ affective dimensions of identity developed, they aligned their practices and discourse with those of scientists, they broadened their views of science, they gained confidence in their abilities in science, and they were interested in pursuing science careers. The learning conversations played a role in developing these aspects of participants’ identities as learners of science. Participants used language for sense-making practices, to position themselves in certain ways, to align their

practices and discourse, to engage in learning activities with their peers, to negotiate new power roles, and to see others in new ways.

### Discussion

I return to the research questions that framed the study to discuss the ways in which the characteristics of the science camp influenced participants' identities as learners of science and the role that learning conversations played in this process. Figure 4 summarizes the theoretical model I developed from my insights in this study as related to the research question: *What is the role of conversation in influencing middle school science learner identity development during an information science education camp?*

**Figure 3.** Model of the Role of Conversations in Identity Development as Learners of Science.



Participants of the study had membership in multiple communities of practice which initially influenced their identities as learners of science. They belonged to various communities of practice based on their gender, ethnicity, and age. Particularly notable in this study was the tension between participants' membership as an adolescent and their membership as a learner of science. Membership as an adolescent influenced their perceptions of self within the community of practice as a learner of science. The informal science education camp served as a boundary between these various communities of practice. The unique features of the science camp program helped to broker the process of connecting communities of practice to influence participants' trajectories as full members in the community of science learners. These unique features of the science camp program included a focus on affective dimensions of learning, access to science tools, a supportive environment, authentic science activities and novelty.

The use of language during learning conversations served as a mechanism for the process of brokering the boundaries of various communities of practice. Participants engaged in learning conversations and used language in several ways to connect their communities of practice and develop their identities as learners of science. Language was used to develop an identity as a learner of science in the following ways: participants used language to make sense of science content, to position themselves in certain categories relative to others, to align their practices and discourse with those of the scientific community, to engage in science learning activities, to negotiate power dynamics and to see others in new ways. As participants used language during learning conversations, their identities as learners of science developed with regard to several areas. The affective dimensions of participants' identities as learners of science developed. Participants were interested, enthusiastic and motivated to learn about the world scientifically. They developed their views of science and came to see a need for science and connections with

science in everyday life. The participants used alignment to connect their practices and discourses with those of the scientific community. Participants came to recognize themselves as having confidence in their abilities as a learner of science. Finally, the participants began to consider pursuing a career in science.

The findings from this study extend theories of identity specifically with regard to discursive identity. This study also adds to the literature on learning conversations, particularly research on peer-peer conversations. Finally, it builds on research related to learning in informal science education contexts such as science camp programs.

**Discursive Identity.** The theory of discursive identity suggests that identity is socially negotiated through language. Gee (2001) defined discursive identity as individual traits recognized through discourse during social interactions. Gee (2001; 2005) argued that we use discourse to enact identity at the right time and in the right context to get recognized as a certain type of person.

There are few studies situated in the context of science education that explored discursive identities. Brown's (2004; 2006) work provided initial insights as to students' discursive identities as learners of science. Brown (2004; 2006) learned that students in the science classroom adopted four different levels of discursive identities. One discursive identity that Brown (2004) identified was that of opposition status. Brown (2004) learned that students in the opposition status rejected the appropriation of scientific discourse. For these students, the discourse of science was perceived as in conflict with their cultural backgrounds. These students believed that adopting scientific discourse would require abandoning their cultural identities. The findings from Brown's (2004; 2006) studies had implications for marginalized students in science education classrooms.

The insights from this study build on the research related to discursive identities in science education. Like Brown (2004; 2006), I found that one aspect of participants' discursive identities as learners of science was appropriation of science discourse. Additionally, I found that participants' at the informal science education program used language in other ways to build their identities as learners of science. Participants used discourse during learning conversations in additional ways such as to make sense of science content, to position themselves within the community of practice, to engage in the learning activities, to negotiate power dynamics and to see others in new ways.

**Learning Conversations.** This study of learning conversations between peers at a science camp program addresses several gaps in the research literature. The research on informal science education has primarily looked at learning conversations in the context of museum-like settings. Crowley, Callanan, Jipson et al. 2001), for example, explored learning conversations in the context of a children's museum. Allen (2002) investigated learning conversations at *The Exploratorium*, a science center. Similarly, Zimmerman, Reeve, and Bell (2009) also explored learning conversations in a science center context. Studies that investigated learning conversations in new contexts such as science camp settings were lacking in the research literature. This study adds insights from a science camp setting. The findings demonstrate how learning conversations transpired in the new context of the science camp. One aspect of the science context that uniquely influenced learning conversations was the field-based nature of the activities. Learning conversations in the science camp setting included talk about learning outdoors and the ways that field-based learning influenced participants' identities as learners of science.



In addition, much of the literature on learning conversations in informal science education settings has focused on the nature of family conversations and adult-child interactions. (Ash, 2003; Crowley, Callanan, Jipson et al., 2001; Ellenbogen, 2002; Zimmerman et al., 2009). The findings from research on family conversations suggested that families interact socially in informal science education environments to jointly construct meanings of the content presented in exhibits. Family members have shared experiences, beliefs and values that influenced the meaning making process (Ellenbogen, 2002). The findings from family learning conversations provided a baseline for understanding learning conversations in informal science education environments. However, studies investigating learning conversations between peers were lacking. Astor-Jack et al. (2007) called for similar studies that investigated learning conversations between peers.

Rogoff (1998) suggested that collaboration between peers would lead to more equitable conversations. I posited that the equitable relations during peer-peer learning conversations would create a supportive environment, one in which participants would feel comfortable to try on new identities as learners of science. The insights gained from this study support this contention. The participants reported feeling more comfortable in group conversations with their peers. They indicated that they were less under the watch of teachers and less accountable because responsibility was distributed throughout the group. These insights add to the literature on learning conversations. This study explored learning conversations between peers and found that they were distinct from those between adults and children, particularly with regard to the influence of power on learning conversations.

The conversations between adults and learners at the science camp also add to the literature on learning conversations. The insights from this study, in some ways, contrast with the

findings of research on adult-child conversations. For instance, Crowley, Callanan, Jipson et al. (2001) reported that children engaged more meaningfully with exhibits when an adult was present to scaffold their learning. My findings contrasted with those of Crowley, Callanan, Jipson et al. I found that at times, adults dominated the conversations and controlled learning activities in ways that interfered with science learning and identity development. As the adults took control of the conversations, participants were observed talking less often and did not have a need to converse to negotiate the procedures and meaning of the data collected. Further, they appeared to enjoy the science activities less when the adults dominated the conversations. That is, when adults were not present, participants shared stories, jokes and analogies to understand the science content. However, when an adult was present, they did not engage in this way while conversing with one another.

**Informal Science Education Camps.** This study extends research on learning in informal science education camps. Previous research on learning in informal science education settings has focused on museums and science centers. Schauble, Beane, Coates, Martin, and Sterling (1996) argued that other informal science education settings have been understudied or ignored. Dierking et al. (2003) suggested that although data from museum studies can serve as a baseline for understanding learning in other informal science education contexts, comparable studies in venues such as science camps were still needed. Science camp settings have characteristics that are distinct from other informal science education settings and as such, a study of a science camp setting was warranted.

Previous research on science camp settings relied on quantitative instruments such as questionnaires and surveys to assess the outcomes of these programs. Stevens et al. (2007), for example, administered a survey to assess the influence of a science camp on participants'

attitudes and found that over 90% of the participants maintained a positive attitude toward science after the program. Gibson and Chase (2002) administered two quantitative surveys and concluded that participants of a science camp program maintained positive attitudes and greater interest in science careers than non-participants. Likewise, Markowitz (2004) examined long-term gains of a different science camp program by administering a survey to participants one to seven years after they completed a science camp program. They found that the science camp program positively influenced participants' perceived abilities in science, participation in extracurricular science activities, and interest in pursuing a science career.

Although these quantitative studies of science camp programs provided an initial understanding of this context, they failed to take an in-depth look at how such programs influence aspects of participants' identities. This study builds on the literature related to science camps by using case study methodology to provide a rich, thick description of the science camp context. By providing a descriptive account of a case of a science camp, this research provides insights into how a science camp program influenced aspects of participants' identities as learners of science in relation to the outcomes reported in the previous studies mentioned. The description of the science camp provided an understanding of how the science camp context influenced participants' attitudes, interest in science and pursuit of a science career as mentioned in previous studies.

### **Implications**

I believe that the rigor of my study and the conclusions drawn can have implications for other science educators, particularly those in informal science education environments. Although my study is limited by being a single case study, I think my insights add to research on science camps and learning conversations. I do not claim that the insights of this study are universally

applicable nor do I contend that the same results would happen in a different setting, context or with different participants. However, I do argue that there are some aspects of this study that have broader implications for science education and particularly informal science education.

First, an implication of this study relates to the design of science camp programs. The findings of this study offer aspects of a science camp program that support identity development as learners of science for participants. Designers of science camp programs should create opportunities for participants to engage in group learning conversations during the science learning activities. In this way, participants would have ample opportunities to engage in equitable conversation with their peers. The learning conversations could foster positive identity development in science.

A second implication would be to develop science activities that use language activity structures that do not include triadic dialogue or teacher monologues. Although the science camp provided many opportunities for participants to engage in group learning conversations, there were still times when MSC educators used triadic dialogue and teacher monologue. Specifically, most of the science camp activities began with a lecture back at the MSC campus. These lectures ranged from 15 minutes to three hours. During the longer lectures, participants reported feeling bored. I further observed participants disengaging from the activities as evidenced by their falling asleep, talking with one another and looking around the room. There were also times when MSC educators used triadic dialogue to prompt recall of the information presented in the lectures. I argue that these uses of language did not foster positive attitudes or identities as learners of science at the science camp. I believe another implication of this study is to develop science camp programs that avoid activity structures such as lectures and triadic dialogue. I argue that the content could be presented to participants in ways other than lecture. For example,

designers of science camp programs could encourage science talks or student questioning to convey science content in ways that differ from lecture. I further believe that the use of triadic dialogue at the science camp encourages rote memorization of facts in ways that are parallel to the school science classroom. An additional implication would be to at times use open-ended questions in the science camp rather than exclusively relying on recall questions.

A third implication of this study would be to provide adults with a background for interacting with science camp participants. There were times when adults dominated the conversations and controlled learning activities. When adults dominated the conversations, participants had fewer opportunities to contribute and their identities as learners of science did not seem to be positively influence by such conversations. Science camp program designers could provide a brief introduction session with suggestions for ways of engaging with participants. In this way, parent chaperones would learn ways to appropriately engage with science camp participants.

### **Areas for Future Research**

Although for the purposes of this study I end my discussion of my insights in this report, I believe there are areas for future research that might build on the insights gained from this research. Questions for future research include: (1) How do other science camp cases support or extend the research findings from this study? (2) How are aspects of participants' identities as learners of science supported, reinforced, or abandoned as they return to the school science setting and the conflict between the norms in each of these science learning settings? (3) What are the long-term, longitudinal influences of the science camp program on participants' identities as learners of science? (4) How are teachers' views of science teaching and learning influenced by participation with students at the science camp field trip program? (5) How are the identities

as learners of science influenced by a science camp program for participants from groups that have been traditionally underrepresented in the field of science?

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**Appendix A:** Description of the *Coastal Ecology* science camp activities.

<b>Science Camp Activity</b>		<b>Description</b>
<b>Research Cruise</b>	Water Quality	The camp participants collected water samples to test for the following data related to water quality: salinity, temperature, pH, and dissolved oxygen. To measure these aspects of water quality, participants used a refractometer, thermometer, pH test kit and oxygen titration kit, respectively.
	Navigation	At the navigation station, the boat captains taught the participants nautical navigation using the triangulation method. The boat captain showed the camp participants how to use a navigation chart, compass and parallel ruler to determine the latitude and longitude of the boat's position.
	Physical Observations	As a means to collect physical oceanographic data, camp participants used a current cross and stopwatch to ascertain the direction and speed of the current. They used a secchi disk to determine the turbidity of the water and a color chart to measure biological productivity.
	Sediment sampling	The research vessels were equipped with a benthic grab and winch which was used to obtain a sediment sample for investigation. Camp participants learned how to deploy and retrieve the sediment sample as well as how to analyze the sample for color, grain size, odor and presence of organisms.
	Biological sampling	Two methods of biological sampling were used during the research cruise: a plankton net and an otter trawl. Both the plankton net and otter trawl were towed through the water for a period of time to collect macro- and micro-organisms.
<b>Organism Lab</b>	Plankton Lab	The plankton lab typically begin with a brief lecture during which MSC instructors provided relevant definitions they believed were essential to understand plankton. Following the lecture, participants used water samples collected from the plankton tow to create slides that they viewed under microscopes. They used keys and field guides to identify the plankton in their samples.
	Macro-organism Lab	The macro-organisms also began with a lecture on organism classification and taxonomy. Participants were then asked to use dichotomous keys and field guides to correctly identify the organisms collected and maintained in the labs and aquaria. The camp participants identified organisms such as algae, marine invertebrates and fish.
	Data Analysis	A brief component of the organism lab involved examining the data collected from the research cruise. Each group of participants from the cruise created graphs of their data which they presented to the whole group. MSC instructors then discussed how to analyze the information collected to interpret patterns and trends in the data.
<b>Intertidal Trip</b>	Sensory Observations	As a first activity on the intertidal trip, MSC instructors encouraged participants to sit quietly and use all of their senses to observe the environment. Following these observations, individuals shared their observations with the whole group.
	Zones Lecture	The intertidal trip involved MSC instructors lecturing about the

		various zones of the intertidal ecosystem as well as pointing out the characteristics, dominant vegetation and organisms in each zone.
	Biological Sampling	Participants engaged in sieving and seining as a means to collect organisms during the intertidal field experience.
<b>Dunes Trip</b>	Dune Formation Lecture	MSC instructors commenced the dune field experience with a lecture on dune formation and the process of longshore drift. They used dunes along the beach that were in different stages of development to illustrate the process they were describing to the participants.
	Organism Collection	Following the dune lecture, participants were encouraged to scour the shore to collect shells and organism skeletons. MSC instructors provided scientific information about the collected artifacts to the camp participants.
<b>Marsh Trip</b>	Marsh Lecture	The marsh field experience began with a lecture about the zonation of the marsh ecosystem. MSC instructors showed camp participants the various zones of the marsh and discussed the prominent features, dominant vegetation and organisms that characterized each zone.
	Data Collection	Participants collected data related to the salinity, pH and density of the water in the zones of the marsh. They also noted flora and fauna in each of the zones they explored. As a large group, they compared their findings to other zones of the marsh as well as to other ecosystems they had visited during the trip (e.g., salinity readings from the research cruise).
	“Productivity Plunge”	A highlight of the marsh trip was the “productivity plunge.” During the “productivity plunge” MSC instructors and camp participants jumped into the mud holes in the marsh. The participants enjoyed getting dirty and playing in the marsh mud.
<b>Maritime Forest Trip</b>	Lighthouse Hike	For the maritime forest field experience, MSC instructors led campers on a hike to the lighthouse on Assateague island. Along the hike, they provided scientific information about maritime forests and identified trees and organisms they encountered on the hike. The lighthouse hike concluded with an award ceremony during which each camp participant received a certificate of completion from the MSC staff.