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Identity Development of Youth during Participation at an Informal Science Education Camp

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In this exploratory case study, I investigated the ways that youth engaged in negotiating their identity during learning conversations at an informal science education camp. In particular, I was interested in exploring the ways that youth positioned themselves within their learning group and how this influenced their identities as learners of science. The research question that guided the investigation was: What is the role of learning conversations in influencing youths' identities as learners of science during an informal science education camp? In particular, I was interested in elucidating the ways in which youth socially constructed their identities relative to others in their learning group and how the social context shaped this process. Identity in this study was defined as the socially constructed sense of self derived from one's position relative to others in a social group. Data collection included videotaped observations, field notes, interviews and journal entries. Findings from my analysis and interpretation of the data collected suggested that identity developed in the following ways: (a) members of the learning group derived their sense of self and identity from their perceived position relative to others and (b) power dynamics and social roles within the learning group were negotiated and redefined within the specific affordances and norms of the informal science education camp context. These findings lend support to the assertion that identity develops during learning conversations in informal science education settings and adds to the corpus of research in this area.

Keywords: informal science education, out-of-school learning, environmental education, science camps, identity development, learning conversations

INTRODUCTION

Learning science is not confined to schools. Bransford, Brown and Cocking (1999) estimated that students spend, on average, less than 14% of their time in schools. Rennie (2007) echoed this notion and 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). Out-of-school contexts for learning are often referred to in the literature as informal science education. Informal science education contexts included, but are not limited to,

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museums, science centers, zoos, aquaria, botanical gardens, afterschool programs, science camps, and media (Anderson, Druger, James, Katz, & Ernisse, 2001; Dierking, Falk, Rennie, Anderson, & Ellenbogen, 2003). The National Research Council in the United States (2009) argued that informal science education can offer opportunities for learners to engage in science in ways that are relevant, rewarding, and enjoyable. These statements emphasize the importance of informal science education and the need to better understand how people learn in these contexts.

In 2009, the National Research Council in the United States published a report that proposed a six strands learning outcomes framework to document science-specific capabilities supported by informal learning environments. Among these six strands, one particular learning outcome centered on the importance of developing an identity in science:

> Strand 6: Learners in informal environments think about themselves as science learners and develop an identity as someone who knows about, uses, and sometimes contributes to science. (p. 4)

Additionally, the report identified a need to broaden the literature and research on learning science in informal environments, particularly by collecting evidence related to the six strands of the learning outcomes framework. The report suggested that evidence to support the identity strand, Strand 6, is emergent and as such, the National Research Council in the United States recommended systematic studies to investigate identity as an area for future research.

This study sought to address this gap in the literature identified by the National Research Council in the United States (2009). In particular, the study focused specifically on the identity development of youth engaged as a learning group[i] at an informal science education context. The National Research Council in the United States speculated that group identity might be shaped and reinforced during social interactions in informal learning environments. This article contributes to science education scholarship by seeking evidence related to this assertion; that is, this study explored the ways in which youth engaged in identity development during social interactions within their learning group while participating in an informal science education camp.

Science camps

Science camps represent one type of informal science education learning environments. Nicholson, Weiss, and Campbell (1994) and Rennie (2007) characterized science camps as short-term programs that are intensive with regard to involvement in science learning activities. Fields (2007) and Johnsen (1954) both contended that science camps focus on affective aspects of learning such as motivation, attitudes, interest, and confidence in science and may positively influence these aspects of learning for youth participants. This goal is often accomplished in numerous ways. Science camps are commonly held in novel locations such as in marine environments, the mountains, wilderness, or university campuses. These novel locations may spark interest for youth and can provide a memorable experience. Learners often participate in authentic science projects and learning activities (i.e., learning activities that mirror those of practicing scientists) as part of science camp programs (Fields, 2007; Johnsen, 1954). Science camps commonly focus on apprenticeship models, utilize hands-on activities, and employ inquiry-based instructional strategies which researchers theorize may be more motivating for youth participating in these programs (Barab & Hay, 2001; Gibson & Chase, 2002; Markowitz, 2004; Sondergold, Rop, & Milner, 2008). Science camps can provide participants with access to resources not typically available in the formal school science setting. Laboratory and data collection equipment, research methods, and professional scientists are examples of novel resources provided by science

camps that may positively influence affective dimensions of learning (Barab & Hay, 2001; Markowitz, 2004; Robbins & Schoenfisch, 2005). Finally, science camp programs are non-competitive and non-formally assessed which may result in youth feeling more relaxed and free in these settings without the pressure of performing on tests and other formal assessment.

Prior research conducted in science camp contexts have identified a number of learning outcomes that result for youth participants. Primarily, these studies have provided evidence to demonstrate that science camps foster interest and excitement (Rath & Brown, 1996), develop positive attitudes toward science (Gibson & Chase, 2002; Stevens, Shin, Delgado, Cahill, Yunker & Krajick, 2007), engagement in science activities (Markowitz, 2004), youths' perceptions of their science skills (Know, Moynihan, & Markowitz, 2003; Riedinger, 2011) and encouraging youth to pursue careers in science (Johnsen, 1954; Markowitz, 2004; Moore, 2003; Riedinger, 2011). These studies have predominately relied on survey instruments and questionnaires to documents outcomes that result from a science camp experience. More studies that offer an in-depth understanding of learning in this context are still needed.

A limited number of studies have explored the influence of a science camp experience on youths' science identities. For example, Frost and Wiest (2007) found that a math and technology camp positively influenced girls' identities, particularly by improving the girls' confidence in their math skills. Wheaton and Ash (2008) conducted a longitudinal study to explore the impact of a multi-year science camp experience on girls' identities. Findings from the study demonstrated that ongoing, yearly engagement in the science camp influenced aspects of girls' identities, specifically their views and definitions of science. Bhattacharyya, Mead and Nathaniel (2011) explored how a summer science camp experience influenced aspects of youths' identity such as their future career plans. Bhattacharyya et al. contended that the science camp experience positively influenced aspects of high school youths' identities, particularly their attitudes toward science and their career choices. These studies provided a preliminary understanding of potential identity-related outcomes that result for youth participating in science camp experiences. The study reported here seeks to add to the literature in this area to generate a more complete understanding of learning and identity development in these settings.

Learning conversations

A growing body of research examines how groups engage in learning conversations to make meaning from content and exhibits in informal learning environments (Allen, 2002; Ash, 2003; Crowley, Callanan, Jipson, Galco, Topping, & Shrager, 2001; Kim & Crowley, 2010; Kisiel, Rowe, Vartabedian, & Kopczak, 2012; McClain & Zimmerman, 2014; Tunnicliffe, 1994; Riedinger, 2011; Riedinger, 2012; Zimmerman, Land, McClain, Mohney, Choi, & Salman, 2013; Zimmerman & McClain, 2014; Zimmerman, Reeve & Bell, 2010). The notion of a learning conversation is grounded in sociocultural theories of learning in which learning is viewed as a "joint collaborative effort" (National Research Council, 2009, p. 33). Crowley, Callanan, Tenenbaum, and Allen (2001) indicated that previous research on learning in informal science education contexts focused on nonverbal behaviors such as the length of time visitors engaged with an exhibit. A new line of research in these out-of-school environments shifts away from such measures and instead examines how visitors interact in these settings and specifically the ways they engage in discourse with one another to make sense of exhibit and program content. This notion draws on sociocultural theories of learning and is referred to in the literature as a learning conversation. The National Research Council in the United States (2009) commented that research on learning conversations has added an important thread to

discussions on learning in informal science education contexts. The examination of learning conversations has shifted the focus away from the individual to the group as a unit of analysis.

Zimmerman et al. (2010) provided a characterization of meaning-making in the course of learning conversations. They framed meaning-making within constructivist theories and considered how people construct an individual and shared understanding of new information. Individuals within the group contribute to the conversation as part of a larger negotiation for meaning. Ash (2003) similarly explained that group conversations are opportunities for the co-construction of knowledge by various members of the group engaged in activities together. The conversations that take place within the group support each individual's museum experience. Each member of the group contributes to the joint meaning-making activity as they elaborate with stories and shared experiences (Fienberg & Leinhardt, 2002).

The National Research Council in the United States (2009) speculated that individual and group identity might be shaped and reinforced during these learning conversations. That is, visitors are not only engaging in sense-making practices related to the science content presented, they are also negotiating and constructing identities as learners of science. The National Research Council in the United States (2009) alludes to a distinction between individual and group identity and posited that both develop during learning conversations in informal science education settings. Similarly, Ellenbogen, Luke, and Dierking (2007) suggested that during group conversations in informal learning environments, group members learn about one another, members explore new roles within the group, new power relations play out and the group constructs shared meanings. An individual's perceived sense of self within the group may influence aspects of learning (e.g., ability to collaborate and learn from others, ability to see oneself as a capable learner). This study sought to explore how identity as a learner of science is negotiated and enacted within the group during learning conversations between youth at an informal science education camp.

Though the National Research Council in the United States (2009) and researchers such as Ellenbogen et al., (2007) have posited that group identity may develop during learning conversations, there have been few systematic studies investigating this assertion. The study reported here examined a science camp program to gain an understanding of how identity develops during learning conversations between youth participants in a learning group. The research question that guided the study was: *What is the role of learning conversations in influencing youths' identities as learners of science during an informal science education camp?* I was specifically interested in understanding the ways youth socially constructed their identities relative to other members of their learning group.

Theoretical framework

The theoretical framework for this study builds on notions of situated and distributed cognition as well as sociocultural perspectives on learning. These theories are predicated on the idea that learning is socially mediated and context specific. Cognition and knowledge are not confined to an individual but rather are socially shared and distributed across individuals. These social learning models are particularly applicable in informal learning environments where learners visit or attend as groups, often with their families or as school groups. It follows, then, that the theoretical framing for this study focuses on identity development within a group and in particular, examines how learners derive aspects of their identities relative to other members of their learning group.

Identity as a learner of science

For the purposes of this study, identity was defined as becoming and being recognized as a certain type of person in a social context (Gee, 2001). I was particularly interested in how learners' sense of self is derived from their perceived membership in a learning group. When we interact socially with other members of a group, we are likely to derive aspects of our identity from our perception of self relative to others in the group (Chen & Li, 2009). Within a learning group, individual learners are engaged in social interactions with one another, have a relationship with one another, are interdependent, and engage collaboratively in learning activities. Zimmerman and McClain (2014), for example, explained, "When engaged in shared social practices, groups structure their activities to organize involvement, including opportunities to contribute in the shared activities" (p. 180). They referred to these structures as "participation frameworks" and asserted that through conversation, members of the group create structures that are both inclusive and exclusionary, and that position members in a social hierarchy. These social structures, negotiated and enacted through interactions within the learning group, may influence aspects of youths' identity as a learner of science. Building on these concepts, I was interested in gaining insight in to the ways that youth constructed their sense of self within the social group and in relation to other learners.

Social practice theory

To understand the socially constructed nature of youths' identity within a learning group, it was important to understand how youth authored their identities within the specific affordances of a social context (Holland and Lave, 2009). Authoring refers to how we represent ourselves to others, what Johnson, Brown, Carlone and Cuevas (2011) described as "identity-related performances of self for others" (p. 344). This authoring process is a socially mediated and reflexive process; that is, one can author an identity but this identity has to be recognized and taken up by other members of the social group (Calabrese-Barton & Tan, 2011).

Holland, Lachicotte, Skinner and Cain (1998) stated, "We are interested in identities, the imaginings of self in worlds of actions, as social products; indeed, we begin with the premise that identities are lived in and through activity and so must be conceptualized as they develop in social practice" (p. 5). Our identities are fluid and dynamic and constantly being negotiated depending on the specific norms and affordances of the social context (Tan, Calabrese-Barton, Kang, & O'Neill, 2013). These multiple, fluid identities are carried out within different figured worlds. Holland et al. (1998) described a figured world as, "a socially and culturally constructed realm of interpretation in which particular characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued over others" (p. 52). In each figured world, particular discourses, practices and outcomes are valued over others. Further, these valued discourses, practices, and outcomes are negotiated and determined within the social group and are influenced by the norms and affordances of each figured world.

Holland et al. (1998) offered the notion of a "relational identity" (p. 127). By relational identity, they referred to one's identity as a product of social relationships with others. Specifically, a relational identity refers to how one identifies and authors their position relative to others with the social group, which is mediated through interactions and discourse with others in a particular social context. That is, social groups engage in jointly negotiating the figured world and participating within it while also positioning each participant relative to one another. Holland et al. (1998) expanded on this notion by explaining that social group members engage in conversations and interactions through which they invariably constructed their

own social positions and relations with one another. These relational identities may be specific to a figured world or they may be maintained across multiple figured worlds. In either scenario, the relational identity must be negotiated amongst the social group in the new figured world depending on the norms and social dynamics in each context.

This theoretical construct provided a framework for thinking about the identity development of youth interacting as a learning group at an informal science education camp. Youth participate in several figured worlds of science including school science as well as science in out-of-school settings such as the informal science education camp. Each figured world offers specific norms, affordances and constraints, which may prompt youth to negotiate and reconsider their position and relational identities within the social group. This is accomplished through interactions with others; therefore, exploring the identity of youth during learning conversations offered insight regarding how youth's perceived sense of self was derived from their membership and role within the learning group.

METHODS

Yin (2009) stated that the research methods employed must align with the nature of the research question being investigated. This study sought to gain insight into the following research question: What is the role of learning conversations in influencing youths' identities as learners of science during an informal science education camp? Given the lack of prior studies on learning in science camp settings, coupled with a dearth of research on how identity develops during learning conversations in these contexts, an exploratory, qualitative case study design was warranted. Stake (1995; 2008) suggested that the strength of a qualitative case study approach is its ability to provide a greater understanding of the case by gaining an appreciation of its uniqueness and complexity. A case study analysis provided rich, thick descriptions that offered a nuanced understanding of the ways in which identity developed during learning conversations in these settings.

Case selection

Merriam (2009) identified a case as the object of study, a unit around which there are clear boundaries. Stake (2008) indicated that a case is a bounded system — commonly defined by time or activity — and the case study is an intensive study of this bounded system with an in-depth account of the phenomena as an end product. This study focused on one program as a case example of a science camp. Merriam (1998; 2009) recommended using purposeful sampling strategies when using case study methods of research in order to select a case that is information-rich for an in-depth study. A criterion-based selection strategy is essential in selecting a case that will provide such a study. The criteria I used for selecting a case included: a program that met the essential characteristics of science camps (i.e., a short-term, science intensive program; offered in a novel setting; focused on motivation, attitude, interest and persistence in science; and provided access to the authentic tools of science), was a residential camp, and offered multiple opportunities for conversation. It was important that the program was offered year round (rather than just during the summer) as the study took place during the spring.

The *Coastal Ecology* science camp program at the Chincoteague Bay Field Station (formerly the Marine Science Consortium) in the United States was selected as a case for this study for several reasons. The *Coastal Ecology* field trip program offered at this environmental education center represents a typical science camp 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 youth participants at the Chincoteague Bay Field Station engaged in learning conversations and identity-work. Thus, the activities embedded in the *Coastal Ecology* 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 environmental education center during a three week study period.

Study context

The Chincoteague Bay Field Station is an environmental education learning center and field station located on the Eastern Shore of Virginia in the United States. The mission of the Chesapeake Bay Field Station is to provide multi-disciplinary education and research opportunities through field-based and hands-on science learning. The environmental education center uses as its classroom the bays, marshes, beaches, maritime forests, dunes, off-shore waters of the surrounding Chincoteague Bay. One of the education programs offered is the *Coastal Ecology* field trip program. As part of this four-day, science camp program, groups of youth visit the field station with their classroom teachers and stay on campus in student dormitories. Thus, the program is residential in that participants are housed on campus and eat all meals at the campus-dining center. Youth participants engage in a variety of science activities throughout the day as well as leisure activities intended to create a sense of community. Each day, youth participate in a full day of science and environmental education activities designed to be hands-on and mirror the practices of professional marine scientists, environmental scientists, ecologists, and oceanographers. Typical science and environmental education activities included (but were not limited to): research cruises, field-based organism sampling, laboratory activities, hands-on activities, and lectures. Examples of science and environmental education activities completed as part of the *Coastal Ecology* science camp program can be found in Appendix A.

Participant selection

Data for the study was collected from school groups attending the *Coastal Ecology* field trip program at the Chincoteague Bay Field Station during the three-week study period. All school groups (N=3) attending the program during the study period were included in the research and data collection procedures. All three groups were from public schools located in Mid-Atlantic States and included 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 of a large city.

With each of the three schools that attended, all of the youth who had signed parent consent and student assent forms participated in videotaped observations as well as the completion of reflective journal prompts throughout the program. In total, 45 of the youth attending the *Coastal Ecology* program participated in the videoing and reflective journal data collection activities.

From this pool of participants, I also selected three youth from each school group for a more detailed case analysis (total n=9). These youth participated in the focus group interviews and were followed closely during the videotaped observations. I used a purposeful sampling strategy to select these youth as cases. The sample was purposeful in that the ability to communicate effectively was essential for my analysis of learning conversations. I contacted the classroom teachers prior to the schools arrival at the environmental education center to request recommendations for youth case studies. I requested the teachers recommend youth that were verbal

and expressive[ii]. Table 1 illustrates demographic information for each of the case participants.

Table 1. Demographics of case participants

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

Data sources

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, youths' responses to reflective journal prompts, focus group interviews with youth participants, and individual interviews with classroom teachers. Sample interview questions and reflective journal prompts are listed in Table 2.

Table 2. Sample interview questions and journal prompts

Data Source	Sample Items
Focus Group Interviews	• In thinking back over the science camp experience, what are some of the activities that influenced how you think and feel about science? • How has the science camp changed how you see yourself as a learner of science?
Teacher Interview	• How do you see (youth participant) as a learner of science? • How do you think (youth participant) has changed as a result of the science camp?
Reflective Journal Prompts	• 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.

Data analysis

Each source of data was examined for the conversation that it generated. Merriam (1998) viewed qualitative case studies as emergent in that working hypotheses and educated guesses guide the researcher's analysis and attention to certain data. The process of data analysis is recursive and dynamic and allows for emerging insights, hunches and tentative hypotheses to direct the next phase of the data collection and analysis. In using Merriam's approach, I iteratively reviewed the videotapes and other collected data to find confirming and disconfirming evidence for emerging assertions.

As a means to analyze the videotaped observations, I used a whole-to-part, inductive approach as recommended by Erickson (2006). 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 and my emerging theory.

I began the analysis by reviewing the entire recordings as a whole, in real-time without stopping the videos. While first viewing the videos, I maintained the equivalent of field notes, noting the general nature of participants' interactions as well as the times of transitions between activities. A first watch of the video provided a preliminary understanding of youths' learning conversations and the nature of their identity-related talk. As a second step, I watched and transcribed the interactions between youth including both their verbal and non-verbal interactions. Data reduction was the next step in analyzing the videos. This was necessary to focus attention on aspects relevant to the research question. I reduced the data by excluding participants' non-relevant talk such as discussion unrelated to the content of the science camp (e.g., youth commenting about leisure activities in the evening or attempting to guess the menu at the campus dining room). After reducing the data, I segmented the tapes into episodes. Lemke (1990) suggested that episode changes are marked by a change in the activity type or a change in topic. In the context of the science camp, a segment of talk included a series of conversation turns that centered around topics such as the interpretation of a particular idea presented by a field station environmental educator or classroom teacher, talk related to identifying an organisms, or attempts to solve a problem. Through this process, I was left with segments of talk that could be coded using qualitative data analysis software. Figure 1 provides an overview of the procedures I used for preparing and analyzing the videotapes.

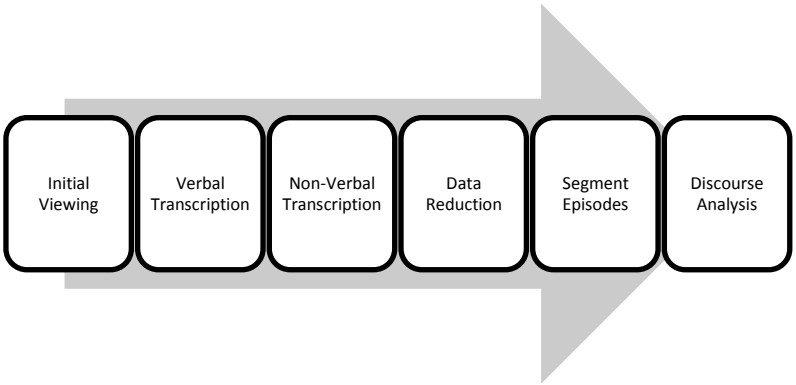

Figure 1. Procedural framework for preparing and analyzing video data

The participant reflective journals were used to gain insight into youths' backgrounds and prior experiences as well as provide participants an opportunity to reflect on their science camp experiences. I primarily used the journal entries to construct narratives for each case participant and school group. The narratives helped to provide a rich, thick description of each case participant and a detailed account of their experience and related identity work as a learner of science during the science camp program.

Transana, a qualitative data analysis software program, was used to manage and organize the data analysis process. Transana is a software program designed specifically for the analysis of video and audio data in education. Using Transana, I was able to identify and code clips as a means of analyzing the data. 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 and the constant comparative method. Discourse analysis is a methodological approach used by social science researchers as a means to study discourse-in-use (Bloome & Clark, 2006; Greckhamer & Cilesiz, 2014). Gee's (2005; 2011) framework focused particularly on how discourse is used

to enact an identity in a certain context; as such, it was an appropriate approach for this study. Gee's (2011) toolkit for discourse analysis suggests specific questions to ask of the data to understand what speakers or writers mean, intend or seek to do, and accomplish in a social context by how they use language. Gee asserted that application of these tools will help the analyst pay attention to the details of language to make meaning in a given context. Gee (2011) argued that some of the tools work better for certain types of data and research questions than they do for others and advocated for flexible application of the model. Guided by this recommendation, I drew on Gee's (2005; 2011) model as a template and used the tools that I felt were most closely aligned with the research question and theoretical framework. Appendix B lists the tools and questions from Gee's discourse analysis toolkit that were applied to each of the data segments for this analysis.

I used a constant comparison analysis process to determine themes in relation to the research question (Charmaz & Henwood, 2008; Huberman & Miles, 1994; Merriam, 1998; Strauss & Corbin, 1998). The theoretical framework was used as an analytical lens for developing the themes in relation to the research question. Using Gee's toolkit, I developed an initial set of codes, framed by this analytic framework. These preliminary codes were applied to the corpus of data collected and through an iterative process, I was able to refine the codes, collapse categories and identify meaningful patterns and trends.

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). As a means to address issues of trustworthiness, I used crystallization of data to include multiple perspectives including those of the teachers, the youth participants, and myself (Charmaz, 2000). Another method for addressing the trustworthiness employed in this study was the implementation of a member check strategy (Stake, 1995). A sample of youth participants was invited to review the preliminary case narratives. I sent sections of the narratives to study participants via email and asked the youth participants to review the narratives and provide their feedback and reactions to my interpretations.

FINDINGS

The themes that emerged from my inspection and analysis of the data from the case participants provided evidence to support the assertion that the affordances, norms, and constraints of the science camp figured world prompted participants to negotiate their identity in the following ways: (a) youth derived their sense of self and identity from their perceived membership in the learning group and (b) power dynamics and social roles within the learning group were negotiated and redefined within the specific affordances and norms of the informal science education camp context. The discourse that was inherent during the learning conversations served as a mechanism by which youth negotiated their relational identities within the learning group and provided a means to author their identities as learners of science within the figured world of the science camp. In this section, I present the case of Patriot Middle School as evidence to support these assertions. This case provides a rich, in-depth account of how one group engaged in learning conversations to negotiate identity within an informal science education camp context and is representative of the findings across cases from this study.

Patriot middle school

The case of Patriot Middle School is illustrative of the ways in which youth derived their sense of self relative to others within the learning group. Within the

figured world of the science camp, the rules, norms, and practices were new and prompted negotiation of power dynamics and social roles within the group. The learning conversations offered a space were youth could negotiate and author new identities within their learning group.

Brynn, Dale, and Hannah attended the science camp program as 8th graders and all three were in the same science class at Patriot Middle School. Throughout the *Coastal Ecology* science camp program, they worked together during a majority of the science learning activities. The following vignettes highlight their identities prior to and following the science camp experience and is illustrative of the ways in which the figured world of the informal science education camp necessitated the negotiation of social dynamics and roles and encouraged each member to author new identities within the group:

> **Kelly**: How do you think of yourself as a science learner?
>
> **Dale**: Umm, I see myself this year in science as more of a memorization rather than analysis of topics. I think as we move later in to science, I will more have more difficulty, but right now, I feel like I'm a decent science learner.
>
> **Hannah**: Umm. 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 and I like, I'm not really good at memorization, so it's kinda been a trouble, well not a trouble, but a problem this year. And, um, I'm hoping that next year, it'll, I'll get more interested in it, cause we're [all 3] moving on to honors bio. I'm really excited about that.
>
> **Brynn**: Umm, I think that, I'm more like Hannah, that like I'm good at certain parts of science but unlike Dale I'm not really good at the whole memorization.

The excerpt highlights how the youths' views of themselves in science were initially framed within the figured world of school science. For instance, Dale viewed himself as a science learner based on his memorization skills, which he perceived to be important for succeeding in school science. This view of Dale's was also corroborated in his initial journal entry before beginning the science camp. Dale wrote,

> I achieve exceptional grades in science…I am extremely confident in my science abilities. I see myself as a good science learner in the memorization of facts which I believe allowed me to succeed in previous years. I am extremely confident in my ability moving forward. I believe my memorization ability will be vital for me to succeed no matter the difficulty of the topic. Science could be classified as a talent of mine.

This journal excerpt demonstrates how he authored his identity within the norms of the school science figured world. In Dale's view, science required memorizing facts for which he believed he had a talent. As such, Dale was confident in his abilities in science and viewed himself as a "good science learner." On the other hand, Brynn and Hannah did not believe they were as strong at memorization compared to Dale and therefore, had different views of themselves in science. Hannah, for example, stated that she would not identify as "the best at science" while Brynn claimed that she was not good at memorization. Brynn and Hannah both derive aspects of their identity relative to members in the social group as they position themselves compared to Dale.

Later in the discussion, I prompted the youth to articulate how others would view them in science. As identity is a reflexive process, I was interested in not only how the youth viewed themselves but also in how they believed others viewed them in science.

> **Kelly**: How do you think other people see you as a learner of science?

Dale: (Brynn and Hannah laughing and looking at Dale). Umm, well I guess I would be considered an overachiever. I mean it's not that I try *too* hard.
Hannah: He is a very good student.
Dale: Umm, I would say people think of me as an overachiever, maybe a little bit over the top. So every day during class I guess I raise my hand and sometimes even have side conversations with Mr. Truman. And, some of my questions are…they're farther in to the topic than my classmates.
Brynn: I think that people don't see me as much as an overachiever, but I'm not an underachiever. Um…science isn't my life. Like, it's something I like and I could go into doing but, it's not really my life, so, I don't think they'll, they see me growing up to be a scientist.
Hannah: Um, I think people see me as an average student. I don't know all the answers all the time, but sometimes I know the answers. I don't think, I'm…above average. I think I'm just…a regular average girl.
Kelly: So what do you base your, what do you base your comments on? What makes you think that other people think you're just average?
Hannah: I base it on, um, I base it, I'm basing off of how often Mr. Truman calls on me and how often I answer his questions correctly. Um, yes I am always on task, and I get my work done, but um, um, it's just still the memorization thing and knowing the answers off hand.

Again, the youth derived aspects of their identity in science relative to others in their learning group. Dale positioned himself relative to others by stating that he was an over-achiever and had more in-depth questions than his classmates. In his view, his understanding of science was deep enough that he could engage in conversations with the classroom science teacher, rather than just with his peers. Brynn and Hannah consistently positioned themselves relative to Dale. Brynn stated that others would not consider her an "overachiever" as they would Dale while Hannah explained that others would view her as average because she gets called on to answer questions less frequently than Dale and her answers, at times, were incorrect.

The learning activities that took place during the science camp program offered spaces where youth could socially interact with other members of their learning group and author their identities. Initially, Dale led the activities while other members of his group consulted him for direction and approval. For example, on the first full day of the science camp, the youth went on a research cruise where they engaged in several data collection activities including water quality testing. Dale primarily dominated these activities, giving his peers directions, telling them what to do, and checking behind them after they provided a data reading. There were times when Dale took materials from youth, presumably because he did not trust their data readings or the procedures that they were using (Researcher Field Notes). The other members of the learning group appeared to accept Dale's position as the leader and authority within the group. Hannah and Brynn, as well as the other youth, waited for Dale to give instructions and checked with him to ensure that their data readings were correct.

During the post-science camp focus group, Dale noted the way he initially positioned himself within the learning group. He commented,

> In the beginning of this experience, I would say that others saw me more as an independent power keeper…now they see me as a group member as opposed to a dictator. Um, because before this experience, I would say that I thought I was more of a, I only trusted myself. But I learned to trust other people and rely on them, to work and do an effective job. So I would say they more, I would say, I calmed down. And I relaxed and I

> learned to trust other group members, because, um, they're obviously capable as well.

This change was apparent later in the science camp experience. During the field experience to an intertidal ecosystem, Dale began asking questions of other group members, solicited feedback from his peers as to how to use the equipment, and divided up the tasks rather than trying to complete them on his own (Researcher Field Notes). Dale came to view other youth in the group as capable science learners and developed his skills in collaborative teamwork throughout the science camp experience.

Dale attributed this change to a variety of factors such as lack of pressure, complexity of the tasks, and the fact that the experiments did not have a predetermined outcome. Dale explained, "I couldn't do all of the tasks by myself" and later he stated, "I liked not having the pressure on my back." Dale points to how the figured world of the informal science education camp prompted him to see others within his group as more capable learners. As a result, he no longer positioned himself as superior to his peers but rather saw them as equally capable learners and members of a collaborative learning group. Given that identity is a reflexive process that includes having others recognize your identity, this was an important way that the group socially negotiated aspects of identity within the figured world of the informal science education camp.

In contrast, Brynn and Hannah shifted their views of themselves within the learning group and developed greater confidence in themselves as science learners. For Brynn and Hannah, the figured world of the informal science education camp provided an authoring space where both could re-envision themselves as learners of science within the learning group. The novelty of the science camp, coupled with the unique norms and characteristics of the new figured world, prompted Brynn and Hannah to position themselves in new ways relative to their social group. Hannah, for example, began taking leadership roles and was more assertive in communicating within the learning group as the science camp progressed. On the day before the conclusion of the camp, the group participated in a field experience to an intertidal habitat. The vignettes presented in what follows highlights the ways in which Hannah began to take a leadership role and to see herself as a science learner within the learning group. During the intertidal field experience, the youth worked in teams using a sieve box to collect organisms from each zone in the ecosystem. Notably, Hannah takes on a leadership role during this activity and contributes often to the learning conversation. This is in contrast to her interactions during the research cruise where she quietly waited for others — particularly, Dale — for directions as to how to proceed with the data collection.

> **Hannah**: You hold it (refers to the sieve box). Ready, now go.
> **Allison**: Ah, watch out!
> **Hannah**: (screams)… (to Bryce) it was a clam.
> **Grayson**: I wanna do it.
> **Hannah**: Alright. Alright. Ready?
> **Grayson**: Ready AND dump it!
> **Hannah**: Gotta get down here. (Stands lower and puts the box lower in the water to get the mud to move more and go through the sieve box.) Oh, that's not a mussel. We got a stone. Alright (To Allison) you try. Lift it. What is this? (reaches into the sieve box).
> **Grayson**: Ah, ew. (lets go of the box and steps back.)
> **Hannah**: Ah, it looks like-
> **Bryce**: I lost the crab.
> **Hannah**: There's more snails.
> **Bryce**: It's a mud walloper.
> **Hannah**: A mud wallop?

Alyssa: It's neat.
Hannah: WHAT is a mud wallop?
Bryce: It gets mud stuff.
Grayson: Wait, wait, wait (The group is lowering the sieve back in the water.)
Bryce: Mud dog.
Hannah: Mud whelp. Here, Darren. You try it.
Darren: Let me try this again.
Alyssa: I wanna do it after her.
Hannah: You guys. WAIT.
Grayson: (squeals) I'm afraid to touch it. (The group has found an organism in their sieve box).
Hannah: It's a crab. Okay, carry it. (directs her group members to carry the sieve box to deeper water)
Darren: But Allison's going next than I can.
Hannah: Okay.
Alyssa: I want to carry it. (Alyssa takes the shovel that Darren hands to her.)
Hannah: Try and do it over here. Try it in the grass.

Similarly, Brynn demonstrated new roles within the learning group as the science camp progressed and began to position herself as a capable science learner. In the early stages of the science camp experience, Brynn was often observed drawing doodles or goofing around with her close friend, Regan. Early in the science camp experience, she appeared to take on a role in which she had limited engagement with the learning activities and relied on others to complete the tasks. Over the duration of the science camp, Brynn was observed making more substantial contributions within the group during learning activities. For instance, during the marsh field experience, she participated in the data collection activities and even led her peers in quantifying the flora and fauna to complete an assigned task.

Brynn: Do you want to hold one? (Asks me if I want to hold one of the coffee bean snails she has collected).
Kelly: Sure.
Brynn: They live, like underground. They're not really, they're not really like, in the water, they're more, underground. They're like, under the grass, like, the soil under the grass.
Regan: We're seeing all of them, like here.
(Brynn walks around looking for flora and fauna to record in the group's field book).
Brynn: Like, that's the kind of mud that we like, dig in to.
Juliet: That's all, here, Brynn, can you hold this for me?
(Brynn takes the bucket to get a sample of the marsh water)
Regan: Wait, weren't we supposed to write coffee, uh, bean down?
Brynn: Yeah. I'll write it. I got it. Coffee bean snails, there was *a lot*! So, do I just write, a lot? How do I spell the grass?
Jocelyn: The grass? *Spartina alterniflora*.
Brynn: How's the grass? Do we count that too? (looks over her shoulder as if counting) *A*-lot. (Brianna records and then walks around to look for fauna in the marsh grass to record in the group's field book.)

Following the experience, both Brynn and Hannah came to consider themselves as learners of science independent of Dale. During the pre-interview, they specifically gauged their ability relative to Dale's performance in the classroom. In the post-camp interview, they made no mention of Dale and instead talked about their abilities independent of other members of the learning group. Brynn commented that the science camp experience "opened her up a little bit" and made

her feel more comfortable asking questions of others. Brynn's shifting confidence was also evidenced throughout the interview. In the post-camp interview, she contributed more often, provided more in-depth answers, was more animated while giving responses, and at times jumped in first to answer a question (post-camp focus interview). During science learning activities, she took leadership roles, volunteered to answer questions and participated more assertively. Likewise, Hannah indicated that she came to see herself as a more capable science learner. In her view, the informal science camp program encouraged her to "step out of [her] comfort zone" and to be more willing to take risks. Hannah believed that she felt more free in the science camp context and "not so confined to a tight classroom" (post-camp focus interview). Hannah stated that this atmosphere allowed her to express herself more freely because she felt less pressure in the science camp setting (Day 3 journal entry; Day 4 journal entry).

SUMMARY

The youth from Patriot Middle School illustrated how identity as learners of science developed during the learning conversations that transpired during the science camp experience. The vignettes highlighted in this section provide evidence for the assertion that youth derived their sense of self and identity as a learner of science relative to others in their learning group. This was illustrated in Brynn and Hannah's perceptions of self as compared to Dale prior to the informal science camp experience. Further, their identities were framed by the norms of the figured world of school science. The figured world of the science camp offered new norms and activities, which influenced how the youth perceived themselves in science relative to others. The figured world of the science camp context prompted youth to negotiate new social roles, power dynamics, and ways of being a member within the learning group.

The case of Patriot Middle School was an illustrative case that highlighted how youth engaged in socially negotiating aspects of their identity during conversations within the learning group. The data collected from the two other schools as part of this study— Thomas Jefferson Middle School and Brownsville Middle School — resulted in similar research insights. Youth who participated in the informal science education camp from Thomas Jefferson and Brownsville Middle School similarly engaged in learning conversations during which they socially negotiated new participation roles within the learning group over the course of the Coastal Ecology program. For instance, youth who were described by their school teachers as having limited participation in the classroom were observed progressively taking on leadership roles over the course of the informal science education camp. With the case of Brownsville Middle School in particular, the group shifted from relying on only one or two learners to complete the activities to shared, collaborative work in which each member of the learning group took on various aspects of the learning tasks. These findings parallel the research insights from the case of Patriot Middle School. All three cases provided evidence regarding the ways youth negotiated participation frameworks and group dynamics within the new figured world of the science camp, which influenced how they perceived themselves relative to other members of their learning group.

DISCUSSION AND IMPLICATIONS

This study sought to understand the socially constructed nature of youths' identities as learners of science and the ways in which identity develops through learning conversations in informal science education settings. I investigated youth engaging in science learning activities at an informal science education camp, which

provided insights regarding how youth authored their identities during learning conversations. This study helped to elucidate the ways in which youth derived aspects of their identity relative to others within their social group. Further, the study provided evidence regarding how power dynamics and social roles within the learning group were negotiated and redefined within the figured world of the informal science education camp.

The case presented here demonstrated the ways that youth perceived their sense of self relative to others within their social group. Youths' perceptions of self in science were framed by the specific affordances and constraints of the school science and informal science education camp figured world. That is, the rules, norms and ways of being in each of the figured worlds influenced the ways that youth authored their identities within each context and relative to others in their social group. Because being able to answer questions correctly and memorizing facts for tests was perceived as a norm within the figured world of school science by the youth, they defined their sense of self against these norms as well as in relation to others within their social group. This was apparent in Brynn and Hannah's authoring of their identities in relation to Dale and by their comparisons of themselves with Dale in terms of answering the teacher's questions correctly and their ability to memorize facts for assessments. This research insight corroborates assertions put forth by the National Research Council (2009) that argued, "Many children who fail in school, including those from non-dominant cultural or lower socioeconomic groups, may show competence on the same subject matter in out-of-school contexts" (p. 40). The National Research Council attributed this to the unique factors of out-of-school, informal learning contexts such as the lack of a rigid schedule or timetable—a norm in formal, school-based settings— which provides greater freedom for youth to explore scientific phenomena in ways that are personally meaningful and more engaging than they might be in school.

The figured world of the science camp offered diverse opportunities for the youth to interact and renegotiate the social dynamics and roles within their social group. Additionally, the figured world of the science camp offered new affordances and constraints for youth to author their identities. For example, the lack of formal assessment in the informal science education camp context altered the power dynamics within the learning group. The science camp also offered new norms for participation such as novel activities (e.g., research cruise, field-based activities) and new patterns of discourse (e.g., discourse between peers, joint meaning making). As the science camp transpired, youth had many opportunities for interaction to negotiate these new norms and ways of participating within the learning group. These interactions helped develop the group's identity, particularly with regard to developing new perceptions of self within the group, renegotiating power, taking on new roles, and learning more about other group members. This relates to the notion of participation frameworks (Zimmerman & McClain, 2014); that is, as youth engaged in learning conversations within their group in the new figured world of the science camp, they reorganized roles, negotiated new participation structures, and developed new social positions within the learning group. This influenced how youth perceived their sense of self relative to other members of their learning group in the informal science education context.

Prior research on identity suggested that individuals perceive their sense of self based on their membership within a social group (Ahmed, 2007; Chen & Li, 2009; Solow & Kirkwood, 2002). Earlier work by Ahmed (2007) and Chen and Li (2009) suggested that one's sense of self relative to others in a social group influences an individual's decision-making, behaviors, and actions. Therefore, understanding identity in education settings is important as it may drive learners' behaviors and actions. Similar to prior research, this study found that youth derived aspects of their identity relative to others within their social group. The cases of

Dale, Brynn and Hannah, presented in this study, are illustrative of how youth positioned themselves related to others within their learning group as well as the ways in which their identity drove particular actions and behaviors.

The findings from this study offer an empirical basis for understanding how identity develops and is negotiated during learning conversations in informal science education contexts. Both the National Research Council in the United States (2009) and Ellenbogen et al. (2007) posited that group identity might develop during learning conversations in these contexts. The findings presented in this study provide preliminary evidence to support the notion that identity is socially negotiated and constructed during learning conversations between members of a learning group. The informal science education context provided an authoring space where youth could re-envision their sense of self relative to other members of their learning group.

Additionally, the findings from this study support and extend what we know about learning conversations in informal science education contexts. Prior studies suggested that groups, such as families and school groups, engage in meaning making tasks to make sense of science content presented. This study further adds that learning conversations offer a space were members of the social group, in this case youth at a science camp engaged as a learning group, can negotiate and author their identities as learners of science.

The results of this work suggested that informal science education settings can offer opportunities for youth to interact with their peers to negotiate and author identities as learners of science. This study also demonstrated the importance of offering opportunities for youth to socially interact with one another in learning environments. Informal science educators who develop and implement youth programs can offer opportunities for social interaction and collaborative teamwork to prompt identity work. Science educators in formal settings can also leverage these opportunities to help foster youths' authoring of identities in school science. For example, implications for science educators in formal settings include using new patterns of discourse, offering opportunities for social interaction, and considering alternative forms of assessment. Teachers might consider shifting away from discourse patterns in the classroom such as traditional triadic dialogue/IRE (initiate-respond-evaluate) patterns (Cazden, 2001; Lemke, 1990) to offer more opportunities for youth to engage in peer discussions and open-ended conversations.

This study represented a preliminary effort to understand how youth author identities as learners of science during learning conversations at an informal science education camp. While this exploratory case study provided an initial, detailed understanding of how youth authored their identities within one context, future research could explore the generalizability of this finding. Specifically, future studies investigating additional programs and informal science education contexts is warranted and would build on the findings that emerged from this case study.

Notes

[i] I define a social group as more than one individual engaged in social interaction with one another and whose activities are mediated by tools, signs, artifacts, language, and actions. Prior research indicates that families and schools groups constitute social groups and are the most prominent groups in informal learning environments (Ash, 2003; Dierking & Falk, 1994; Kisiel, Rowe, Vartabedian, & Kopczak, 2012; McClain & Zimmerman, 2014; Tunnicliffe, 1996; Zimmerman & McClain, 2014). In this study, the social group refers to youth (and at times, the classroom teacher or environmental educator) engaged with one another as a learning group.

[ii] Teachers were asked to recommend youth who were verbally expressive as well as diverse in terms of academic achievement, gender, race/ethnicity to ensure that the sample represented diverse perspectives

REFERENCES

Ahmed, A. M. (2007). Group identity, social distance and intergroup bias. *Journal of Economic Psychology, 28*, 324-337. DOI: 10.1016/j.joep.2007.01.007.

Allen, S. (2002). Looking for learning in visitor talk: A methodological exploration. In G. Leinhardt, K. Crowley, & K. Knutson (Eds.), *Learning conversations in museums* (pp. 259-303). Mahwah, NJ: Lawrence Erlbaum.

Anderson, A., Druger, M., James, C., Katz, P., & Ernisse, J. (2001). An NSTA position statement on informal science education. In P. Katz (Ed.), *Community Connections for Science Education* (pp. ix-xi). Arlington, VA: NSTA Press.

Ash, D. (2003). Dialogical inquiry in life science conversations of family groups in a museum. *Journal of Research in Science Teaching, 40*(2), 138-162. DOI: 10.1002/tea.10069.

Barab, S. A., & Hay, K. E. (2001). Doing science at the elbows of experts: Issues related to the science apprenticeship camp. *Journal of Research in Science Teaching, 38*(1), 70-102. DOI: 10.1002/1098-2736(200101)38:1<70::AID-TEA5>3.0.CO;2-L

Bhattacharyya, S., Mead, T. P., & Nathaniel, R. (2011). The influence of science summer camp on African-American high school students' career choices. *School science and mathematics, 111*(7), 345-353. DOI: 10.1111/j.1949-8594.2011.00097.x

Bloome, D., & Clark, C. (2006). Discourse-in-use. In J. L. Green, G. Camilli, & P. B. Ellmore (Eds.), *Handbook of complementary methods in education research* (pp. 227-242). Washington, DC: American Educational Research Association.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How people learn: Brain, mind, experience, and school*. Washington, D.C.: National Academy Press.

Calabrese-Barton, A., & Tan, E. (2011). We be burnin'! Agency, identity and science learning. *Journal of the Learning Science, 19*, 187-229. DOI: 10.1080/10508400903530044.

Cazden, C. B. (2001). *Classroom discourse: The language of teaching and learning, 2nd edition*. Portsmouth, NH: Heinemann.

Charmaz, K. (2000). Grounded theory: Objectivist and Constructivist Methods. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research*, 2nd edition (pp. 509-536). Thousand Oaks, CA: SAGE Publications.

Charmaz, K., & Henwood, K. (2008). Grounded theory. In C. Willig & W. Stainton Rogers (Eds.), *The SAGE handbook of qualitative research in psychology* (pp. 240-259). Thousand Oaks, CA: SAGE Publications.

Chen, Y., & Li, S. X. (2009). Group identity and social preferences. *American Economic Review, 99*(1), 431-457. DOI: 10.1257/aer.99.1.431

Crowley, K., Callanan, M. A., Jipson, J. L., Galco, J., Topping, K., & Shrager, J. (2001). Shared scientific thinking in everyday parent-child activity. *Science Education, 85*, 712-732. DOI: 10.1002/sce.1035.

Crowley, K., Callanan, M. A., Tenenbaum, H. R., & Allen, E. (2001). Parents explain more often to boys than to girls during shared scientific thinking. *Pyschological Science, 12*(3), 258-261.

Dierking, L. D., & Falk, J. H. (1994). Family behavior and learning in informal science settings: A review of the research. *Science Education, 78*(1), 57-72. DOI: 10.1002/sce.3730780104.

Dierking, L. D., Falk, J. H., Rennie, L., Anderson, D., & Ellenbogen, K. (2003). Policy statement of the "Informal Science Education" Ad Hoc Committee. *Journal of Research in Science Teaching, 40*, 108-111. DOI: 10.1002/tea.10066.

Ellenbogen, K. M., Luke, J. J., & Dierking, L. D. (2007). Family learning in museums: Perspectives on a decade of research. In J. H. Falk, L. D. Dierking & S. Foutz (Eds.), *In principle, in practice: Museums as learning institutions* (pp. 17-30). Lanham, MD: AltaMira Press.

Erickson, F. (2006). Definition and analysis of data from videotape: Some research procedures and their rationales. In J. L. Green, G. Camilli, & P. B. Ellmore (Eds.), *Handbook of complementary methods in education research* (pp. 177 192). Washington, DC: American Educational Research Association.

Fields, D.A. (2007). What do students gain from a week at science camp? Youth perceptions and the design of an immersive, research-oriented astronomy camp. *International Journal of Science Education, 30,* 1-21. DOI:10.1080/09500690701648291.

Fienberg, J., & Leinhardt, G. (2002). Looking through the glass: Reflections of identity in conversations at a history museum. In G. Leinhardt, K. Crowley, & K. Knutson (Eds.), *Learning conversations in museums* (pp. 167-211). Mahwah, NJ: Lawrence Erlbaum.

Frost, J. H., & Wiest, L. R. (2007). Listening to the girls: Participant perceptions of the confidence boosting aspects of a girls' summer mathematics and technology camp. *The Mathematics Educator, 17*(2), 31-40.

Gee, J. P. (2001). Identity as an analytical lens for research in education. *Review of Research in Education, 25*, 99-125.

Gee, J. P. (2005). An introduction to discourse analysis: Theory and method. New York, NY: Routledge.

Gee, J. P. (2011). *How to do discourse analysis: A toolkit*. New York, NY: Routledge.

Gibson, H. L., & Chase, C. (2002). Longitudinal impact of an inquiry-based science program on middle school students' attitudes toward science. *Science Education, 86*, 693-705. DOI: 10.1002/sce.10039.

Greckhamer, T., & Cilesiz, S. (2014). Rigor, transparency, evidence, and representation in discourse analysis: Challenges and Recommendations. *International Journal of Qualitative Methods, 13*, 422-443.

Holland, D, Lachicotte, W., Skinner, D., & Cain, C. (1998). *Identity and agency in cultural worlds*. Cambridge, MA: Harvard University Press.

Holland, D., & Lave, J. (2009). Social practice theory and the historical production of persons. *Actio: An International Journal of Human Activity Theory, 2*, 1-15.

Huberman, A. M., & Miles, M. B. (1994). Data management and analysis methods. In N. K. Denzin & Y.S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 428-444). Thousand Oaks, CA: Sage Publications.

Johnsen, R.H. (1954). The summer science camp as a means of attracting talented students to science careers. *The Scientific Monthly, 64*(1), 37-39.

Johnson, A., Brown, J., Carlone, H., & Cuevas, A. K. (2011). Authoring identity amidst the treacherous terrain of science: A multiracial feminist examination of the journeys of three women of color in science. *Journal of Research in Science Teaching, 48*(4), 339-366. DOI: 10.1002/tea.20411.

Kim, K. Y., & Crowley, K. (2010). Negotiating the goal of museum inquiry: How families engineer and experiment. In M. K. Stein & L. Kucan (Eds.), *Instructional Explanations in the Disciplines* (pp. 51-65). New York, NY: Springer.

Kisiel, J., Rowe, S., Vartabedian, M. A., & Kopczak, C. (2012). Evidence for family engagement in scientific reasoning at interactive animal exhibits. *Science Education, 96*, 1047-1070. DOI: 10.1002/sce.21036.

Know, K. L., Moynihan, J. A., & Markowitz, D. G. (2003). Evaluation of short-term impact of a high school summer science program on students' perceived knowledge and skills. *Journal of Science Education and Technology, 12*(4), 471-478.

Lemke, J. L. (1990). *Talking science: Language, learning, and values.* Norwood, NJ: Ablex Publishing Corporation.

Markowitz, D. G. (2004). Evaluation of the long-term impact of a university high school summer science program on students' interest and perceived abilities in science. *Journal of Science Education and Technology, 13*(3), 395-407.

McClain, L. R., & Zimmerman, H. T. (2014). Prior experiences shaping family science conversations at a nature center. *Science Education, 98,* 1009-1032. DOI: 10.1002/sce.21134.

Merriam, S. B. (1998). *Qualitative research and case study applications in education*. San Francisco, CA: Jossey-Bass Publishers.

Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation*. San Francisco, CA: Jossey-Bass Publishers.

Moore, J.E. (2003). Girls in science rule! *Science and Children, 40*(7), 38-41.

Nasir, N. S. (2002). Identity, goals, and learning: Mathematics in cultural practice. *Mathematical Thinking and Learning, 4*, 213-247. DOI:10.1207/S15327833MTL04023_6.

National Research Council. (2009). *Learning science in informal environments: People, places, and pursuits*. Washington, DC: The National Academies Press.

Nicholson, H. J., Weiss, F. L., & Campbell, P. B. (1994). Evaluation in informal science education: Community based programs. In V. Crane, H. Nicholson, M. Chen, & S. Bitgood (Eds.), *Informal science learning: What the research says about television, science museums, and community based projects* (pp. 107 176). Ephrata, PA: Science Press.

Rath, A., & Brown, D.E. (1996). Models of engagement in science inquiry: A microanalysis of elementary students' orientations toward phenomena at a summer science camp. *Journal of Research in Science Teaching, 33*(10), 1083-1097.

Rennie, L. J. (2007). Learning science outside of school. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of research on science education*, (pp. 125-167). Mahwah, NJ: Lawrence Erlbaum.

Riedinger, K. (2011). *Identity development of middle school students as learners of science at an informalscience education camp*. Unpublished doctoral dissertation. University of Maryland, College Park, MD.

Riedinger, K. (2012). Family Connections: Family conversations in informal learning environments. *Childhood Education, 88,* 125-127.

Robbins, M. E.-, & Schoenfisch, M. H. (2005). An interactive analytical chemistry summer camp for middle school girls. *Journal of Chemical Education, 82*(10), 1486-1488. DOI: 10.1021/ed082p1486.

Solow, J. L., & Kirkwood, N. (2002). Group identity and gender in public goods experiments. *Journal of Economic Behavior & Organization, 48*, 403-412. DOI:10.1016/S0167-2681(01)00243-8.

Sondergeld, T. A., Rop, C. J., & Milner, A. R. (2008, April). *Environmental education professional development programs: Characteristics that bring positive change*. Paper presented at the annual meeting of the National Association of Research in Science Teaching, Baltimore, MD.

Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, CA: Sage Publications.

Stake, R. E. (2008). Qualitative case studies. In N. K. Denzin & Y. S. Lincoln (Eds.), *Strategies of qualitative inquiry*, 3rd edition (pp. 119-150). Thousand Oaks, CA: SAGE Publications.

Stevens, S., Shin, N., Degado, C., Cahill, C., Yunker, M., & Krajcik, J. (2007, April). *Fostering students' understandings of interdisciplinary science in a summer science camp*. Paper presented at the annual meeting of the National Association for Research in Science Teaching, New Orleans, LA.

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory*, 2nd edition. Thousand Oaks, CA: Sage Publications.

Tan, E., Calabrese-Barton, A., Kang, H., & O'Neill, T. (2013). Desiring a career in STEM-related fields: How middle school girls articulate and negotiate identities-in-practice in science. *Journal of Research in Science Teaching, 50*(10), 1143-1179. DOI: 10.1002/tea.21123.

Tunnicliffe, S. D. (1996). Conversations with primary school parties visiting animal specimens in a museum and zoo. *Journal of Biological Education, 30*, 130-141. DOI: 10.1080/00219266.1996.9655491

Wheaton, M., & Ash, D. (2008). Exploring middle school girls' ideas about science at a bilingual marine science camp. *Journal of Museum Education, 33*(2), 131-143.

Yin, R. K. (2009). *Case study research design and methods*, 4th edition. Thousand Oaks, CA: Sage Publications.

Zimmerman, H. T., Land, S. M., McClain, L. R., Mohney, M. R., Choi, G. W., & Salman, F. H. (2013). *Tree Investigators:* Supporting families' scientific talk in an arboretum with mobile computers.

International Journal of Science Education, Part B: Communication and Public Engagement. Advance online publication. DOI: 10.1080/21548455.2013.832437.

Zimmerman, H. T., & McClain, L. R. (2014). Intergenerational learning at a nature center: Families using prior experiences and participation frameworks to understand raptors. *Environmental Education Research, 20*(2), 177-201. DOI: 10.1080/13504622.2013.775219

Zimmerman, H. T., Reeve, S., & Bell, P. (2010). Family sense-making practices in science center conversations. *Science Education, 94*(3), 478-505. DOI: 10.1002/sce.20374

APPENDIX

Appendix A: Sample of coastal ecology activities

Science Camp Activity		**Description**
Research Cruise	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, youth used a refractometer, thermometer, pH test kit and oxygen titration kit, respectively.
	Navigation	At the navigation station, the boat captains taught the youth nautical navigation using the triangulation method. The boat captain showed the science 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, youth 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. Youth 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.
Organism Lab	Plankton Lab	The plankton lab typically begin with a brief lecture during which Marine Science Field Station educators provided relevant definitions they believed were essential to understand plankton. Following the lecture, youth 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. Youth were then asked to use dichotomous keys and field guides to correctly identify the organisms collected and maintained in the labs and aquaria. The youth 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 youth from the cruise created graphs of their data and they presented these to the whole group. The Marine Science Field Station educators then discussed how to analyze the information collected to interpret

		patterns and trends in the data.
Intertidal Trip	Sensory Observations	As a first activity on the intertidal trip, educators encouraged youth 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 Marine Science Field Station educators 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	Youth engaged in sieving and seining as a means to collect organisms during the intertidal field experience.

Appendix B: Discourse analysis tools (Gee, 2011).

Discourse Analysis Tool
The Fill in Tool "For any communication, ask: Based on what was said and the context in which it was said, what needs to be filled in here to achieve clarity? What is not being said overtly, but is still assumed to be known or inferable? What knowledge, assumptions, and inferences do listeners have to bring to bear in order for this communication to be clear and understandable and received in the way the speaker intended it" (Gee, 2011, p. 195)?
The Making Strange Tool "For any communication, try to act as if you are an 'outsider.' Ask yourself: What would someone (perhaps even a Martian) find strange here (unclear, confusing, worth questioning) if that person did not share the knowledge and assumptions and make the inferences that render the communication so natural and taken-for-granted by insiders" (Gee, 2011, p. 195)?
The Activities Building Tool "For any communication ask what activity (practice) or activities (practices) this communication is building or enacting. What activity or activities is this communication seeking to get others to recognize as being accomplished? Ask also what social groups, institutions, or cultures support or set norms for whatever activities are being built or enacted" (Gee, 2011, p. 198).
The Identities Building Tool "For any communication, ask what socially recognizable identity or identities the speaker is trying to enact or to get others to recognize. Ask also how the speaker's language treats other people's identities, what sorts of identities the speaker recognizes for others in relationship to his or her own. Ask, too, how the speaker is positioning others, what identities the speaker is 'inviting' them to take up" (Gee, 2011, p. 199).
The Relationships Building Tool "For any communication, ask how words and various grammatical devices are being used to build and sustain or change relationships of various sorts among the speaker, other people, social groups, cultures, and/or institutions" (Gee, 2011, p. 199).

The Situated Meaning Tool

"For any communication, ask of words and phrases what situated meanings they have. That is, what specific meanings do listeners have to attribute to these words and phrases given the context and how the context is construed" (Gee, 2011, p. 200)?

The Social Languages Tool

"For any communication, ask how it uses words and grammatical structures (types of phrases, clauses, and sentences) to signal and enact a given social language. The communication may mix two or more social languages or switch between two or more. In turn, a social language may be composed of words or phrases from more than one language (e.g., it may mix English and Spanish)" (Gee, 2011, p. 200).

The Figured Worlds Tool

"For any communication, ask what typical stories or figured worlds the words and phrases of the communication are assuming and inviting learners to assume. What participants, activities, ways of interacting, forms of language, people, objects, environments, and institutions, as well as values, are in these figured worlds" (Gee, 2011, p. 201)?

The Big "D" Discourse Tool

"For any communication, ask how the person is using language, as well as ways of acting, interacting, believing, valuing, dressing, and using various objects, tools, and technologies in certain sorts of environments to enact a specific socially recognizable identity and engage in one or more socially recognizable activities. Even if all you have for data is language, ask what Discourse is this language part of, that is, what kind of person (what identity) is this speaker or writer seeking to enact or be recognized as. What sorts of actions, interactions, values, beliefs, and objects tools, technologies, and environments are associated with this sort of language within a particular Discourse" (Gee, 2011, p. 201)?