A NEW “IMAGE” OF YOUNG ADOLESCENT SCIENCE IDENTITY

by

ANNE LOUISE HADDOX

(Under the Direction of Cory Buxton)

ABSTRACT

There are many studies about how prior knowledge and student interest affect student engagement in science. Do adolescent students understand what they already know and realize how they interact with science? This study explores how students view themselves as scientists, engage in science from their past and present, consider their hopes for future careers, and analyze their perceptions. All of this affects student science identity. This qualitative case study uses a cross-case analysis of auto-photography and Participant Photo Interviews (PPI) to understand student perceptions about science. Six adolescent participants took photographs in response to Photography Tasks that prompted them to photograph science in many aspects of their lives and photograph what may be their future careers. A constructivist epistemology was the framework for the participants to construct meanings through their interactions, engagements, and images they created within the context of science. Knowledge and meanings constructed during human interactions with the environment and the lens of adolescent science identity elucidated the results of how the participants viewed themselves as science people. The results demonstrated that those who were interested and capable in science tended to view themselves as a science person with a strong science identity. The reflections and stories about the photographic images gave a glimpse into the students’ science identities and let students realize that they do science every day, have been successful interacting with science in the past, and may want to consider a career in a science field. Teachers could use auto-photography and PPI to discover their students' interests and identities in science. These activities would highlight the students' prior knowledge and interest in science and would enable teachers to differentiate hands-on inquiry and discovery-type lessons. Those students with less interest in science would need additional engaging activities, peer collaboration, parental support, and innovative ways to study and remember the science content. Students with exceptional interest and experience with science as shown by their auto-photographs and PPIs would need the same support along with more challenging content and activities to enhance and enrich the knowledge they already possess. Additional research could explore student science identity and achievement.

INDEX WORDS: Early adolescents, Science, Science identity, Auto-photography, Participant Photography, Participant Photo Interviews (PPI), Differentiation, Middle School Science, Adolescent Identity, Case Study, Constructivist Epistemology

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DEDICATION

I dedicate this dissertation to my family. I give special thanks to my daughters, Kim Haddox and Kristen Haddox, and my sister, Catherine C. Steele. They were my supports, editors, sounding boards, and fibers that held me together while I taught full time and progressed through the Ph.D. degree program. I would like to thank my parents, now deceased, and my close friends for their encouragement and support for this long-term endeavor.

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CHAPTER 1

INTRODUCTION

"What do you want to be when you grow up?" When I ask young adolescents (ages 9-14) this question, the responses were immediate, confident, and definitive, or a mumbled "I don't know" accompanied by a shrug of the shoulders. The way children respond to this question can provide insight into how they feel about themselves and their aspirations for the future (Aschbacher, Li & Roth, 2010; Brickhouse, Lowery & Schultz, 2000; Olitsky, Flohr, Gardner, & Billups, 2010). The perception of what children want to be is a facet of identity (Aschbacher et al., 2010; Brickhouse et al., 2000).

I am a certified teacher in middle school science as well as a National Board Certified Teacher (NBCT) in Early Adolescent Science. I have been teaching over a 36-year period with 30 years of experience in both elementary and middle school levels. As insight into the students' identity, I often pose the question to my students about what they want to be when they become adults. In recent years, more and more students responded to this what-do-you-want-to-be question with "I don't know." Not only did the students have no idea what they wanted to do, they were apathetic about their future direction or goals. In contrast, I have wanted to be a teacher ever since my fourth grade teacher inspired me to be creative through hands-on activities. From that time on, I have worked toward becoming a teacher. Many researchers (Aschbacher, Li, & Roth, 2010; Carlone, 2004; Farland-Smith, 2009; Reveles & Brown, 2008; Roth & Li, 2005) share my concerns about students' present lack of focus and indecisiveness about their future educational direction.

Science and Scientists

My interest in science stems from my observations in the classroom over several years. When I proposed my research design in which I explore student perceptions of science and scientists to my committee, they turned the question around and asked me what *I* thought science was. The question surprised me and I had to think about how to respond. I told them science was the questioning and examination of the world around us. I surmised that a scientist is a person who questions, observes, and searches for answers about the environment. This exercise in thinking through these concepts helped me realize that it might be difficult for an adolescent to express their ideas about these concepts.

I became excited about the theory that the participants could take photographs to demonstrate their ideas and express their voices. Using Auto-Photography, I wanted to explore student perceptions of science. By seeing their images and listening to their voices, I let them tell their stories about their interactions with science in the past and present time, and explore their hopes for the future. Through these interactions with science, I wondered if students who identified with science and felt like scientists would feel more capable and confident about their work in science class.

I found through my teaching experience that many young adolescent students plan for immediate events, opportunities in the near future, and what classes they might take in high school. A few students do know what college or university they would like to attend. However, because of the lack of direction for what they want to do in the future, my evolving student science identity definition must include what they imagine they will do as an adult. In addition to what their future career may be, my science identity definition (See below) incorporates other facets of identity formation. These facets include student interactions and experiences in the present, the past, within the science classroom, and outside the classroom.

Definition of Science Identity

My interpretation of student science identity stems from a synthesis of identity definitions found in scholarly literature (Aschbacher, et al., 2010; Brown, 2004; Carlone, 2004; Erickson, 2005; Farland-Smith, 2009; Hall, 2005; Reveles & Brown, 2008; Reveles, Cordova, & Kelly, 2004; Roth & Li, 2005; Saltman, 2005; Tan & Calabrese Barton, 2007) coupled with my science teaching experience. My working definition of adolescent science identity is: *Adolescents understand science from their past, participate and internalize interactions with the daily science classroom and community, imagine who they hope to become, and begin to comprehend the sense of their science self.* I explored the perceptions of the students through their own words and photographic images. I analyzed their science stories and images of the past and present. This analysis examined the possibility of correlations between the students' reflection process and their perceptions of who they want to become.

Purpose of This Study

The purpose of this study was to explore how middle school students perceived themselves when "doing science" and "being scientists." Through qualitative case study research, the theoretical lens of adolescent identity, participant photography, and Participatory Photo Interviews, I explored student perceptions of themselves as scientists and science students "doing science" over a five-week period. I thought five weeks would be enough time to reflect on the task, to plan and take the photographs, and to participate in the interviews. Due to the end of the school year and the difficulty in locating participants for the study over the summer, I had to extend the time of the study to five months rather than five weeks. Various activities like family vacations, camps, school schedules, and extracurricular activities affected the time needed for the completion of the tasks and interviews. The students had time to create their photo-journals by writing down the time and place where they took the picture and their thoughts about the composition of the photograph. They printed their photographs in color from the computer and added them to their photo-journals. During the last week of the project, the photo elicitation interviews took place.

The study explored how adolescent perceptions of self through images and reflections might illuminate and enhance current understanding of student science identities. Students might realize that they can do science things, they have done science in the past, and they are capable of continually interacting with our scientific environment. This self-reflection through photographs and the stories they tell might let them see themselves as a science person and lead to classes and careers in science related fields.

Teachers may use the techniques such as auto-photography and photo-journals to understand students' science identity and analyze how students' past science experiences might influence the classroom learning community. Teachers assigning the use of current technology like digital cameras and cell phones for the auto-photography tasks should be motivating for students. Instructors might create learning communities within the classroom based on their students' interest level in science. Teachers might make decisions concerning what to emphasize in the curriculum based on what the students already know through the photographs and discussions with the students. This would be a novel way to access their students' prior science knowledge. Teachers might differentiate lessons derived from students' interest in science rather than their ability in science.

College professors might incorporate auto-photography and Participant Photo Interviews (PPI) with their teacher preparation classes. The professors would gain insight into the pre-service teachers' commitment to science education though the photography tasks and the stories they share. The photos and stories might give the professors a more personal view of what the future teachers know and where they want to go after graduation. Professors might gain insight into making assignments more personally relevant to individual students preparing to teach.

Other groups such as adult educators may utilize this technology of digital photography to motivate their participants to reflect and envision who they are and who they want to be. A novel approach to anyone presenting to groups could use current technology such as cell phones to motivate participants to emphasize their everyday interactions with their environment. Presenters could use this as a motivating starter to hook their audience into the topic of the day. The main research question that guided this study was "How do adolescent students view themselves as scientists or non-scientists, and how do these perceptions relate to their student science identity?" The following questions, as shown in Table 1, helped students formulate responses by using photography and Participatory Photo Interviews. Each rationale given indicated the facet of the students' science identity that I explored.

Table 1

Research Questions and Identity Rationale

Questions	Rationale
1. How can students represent themselves as "doing science" or "being scientists" in the past? What images remind them of past science experiences?	Perceptions of the past
2. How can students represent themselves "doing science" or "being a scientist" during science class?	Perceptions of the present
3. How can students illustrate themselves "doing science" or "being a scientist" outside of the school setting?	Perceptions of social/ community
4. How can students demonstrate how others regard them as science people?	Perceptions of social/ others
5. How can students portray what they would like to do as a job or career when they are an adult?	Perceptions of what they want to become
6. How can students represent "being a scientist" or "doing science" in the home, school, and environment daily?	Perceptions within community/environment

Significance of the Study

One may ask why student perceptions of science are important. Aschbacher et al. (2010) posited students should value and learn to enjoy science. These researchers also asserted more students would be interested in science careers if students explored and thought about possible careers and if the students' learning in science class was meaningful to their lives. Olitsky et al. (2010) concluded science is socially situated and students are valued contributors of knowledge, which in turn leads to discursive science identities. Olitsky et al. explained that discursive identities evolve from dialogues in the classroom that allow for social capital, (being recognized as helping others or adding information others do not know), rather than from a competitive atmosphere, and these dialogues or discourses are most conducive to developing identities within the science classroom.

In another study, Bouchey and Harter (2005) called for additional research on the social realm of adolescents including what students consider others believe about science and how this context affects the development of achievement motivation. These researchers (Aschbacher et al., 2010; Bouchey & Harter, 2005; Olitsky et al., 2010) postulated that science is valuable, it is socially situated, and self-concept may affect motivation and achievement. My research was an exploration of student perceptions about science. Through these perceptions, I uncovered students' ideas of their concept of everyday science, which could give teachers insight about students' personal experiences and prior knowledge. This information might lead to more meaningful science experiences and the development of novel techniques to motivate and inspire science students.

On a more global scale, Gordon (2007) suggested that conditions for future economic success included an education system grounded in math and science that would prepare students to succeed in science and engineering careers. Gordon cited three comparative indicators of United States student science achievement. According to the indicators, American science students' results were below science proficiency levels and ranked below many industrialized countries. The indicators Gordon cited were the National Assessment of Educational Progress (NAEP), the Program for International Student Assessment (PISA) and the Third International Mathematics and Science Study (TIMSS).

Along with these global indicators, the National Science Teacher Association (NSTA) is helping to develop the *Next Generation Science Standards* (Achieve, Inc, 2013). The push behind these standards is the belief that science education is important to the lives of all Americans through current events, the use of technology, the management of healthcare issues, and the ability to innovate and to create jobs for the future (Achieve, Inc, 2013). These were the beliefs I incorporated into my photography tasks by including examples of science occurrences in everyday lives, the use of digital cameras and cell phones and photographs and discussions with adolescents about their future careers. The development of these standards was a joint effort between the National Research Council (NRC), NSTA, American Association for the Advancement of Science (AAAS), and Achieve, a non-profit organization. Over 25 states were involved in the collaborative process of drafting these standards with the hopes that other states would adopt the standards as well. National science standards would provide a framework for all students to learn important science benchmark information to help them become functional members of society and be scientifically literate.

The standards to create scientifically literate students represent what the public and colleges want adolescents to know when they graduate from high school. Balancing the standards with teaching practices to encourage science identity is a difficult job (Mih & Mih, 2013; Smith & Darfler, 2012). In the Mih and Mih (2013) study, they surveyed 174 tenth grade students using a packet of various self-perception Likert rating scales (Mih & Mih, 2013, p. 297). The researchers posited, "Strong self-efficacy and positive self-concept lead students to persist longer on difficult tasks, feel less anxious in achievement settings, enjoy their academic work more, and feel better about themselves as a student" (p. 291). Mih and Mih concluded that promoting and incorporating autonomy teaching (i.e. getting to know the student, praise for correct responses, engagement in activities, and procedural, organizational, and cognitive student-made choices) predicted students' self-efficacy and academic self-concept. This in turn led to behavioral and emotional engagement that increased expectancy for success and facilitated academic performance (p. 289).

The Smith and Darfler (2012) research focused on what they termed identity work, where teachers are, "…creating conditions and mandating tasks that encourage, support, sustain, and validate adolescents' identity explorations and commitments" (p. 350). Their study included 22 secondary science teachers in a graduate program cohort 8-week course for engineering and engineering technology. The researchers' derived their information from on-line discussion forums that covered identity action theory, student self-determination needs, teaching students' self-regulation skills, and students' identity goals and science achievement (p. 352). These science teachers recognized that when their students have a better understanding of themselves, their interests and their goals, they become better students who are more motivated to learn and participate in science.

On global, national, and local levels, learning and understanding science is an important endeavor. My case study examined the very core of how an adolescent internalizes and perceives "doing science" and "being a scientist" with the hopes that novel ideas about student science identity emerge. I demonstrated innovative ways, such as auto-photography, so that teachers might incorporate students' prior knowledge and personal experiences to motivate and inspire the students. This new knowledge might influence the way teachers view students and how students internalize science learning.

The facets of student identity, past experiences, present day interactions, parent influences, communities of practice, and aspirations for the future are topics of recent scholarly literature. I approached the topic of student science identity from the direct perspective of the student through the photographs they created, their thoughts about their images, and their answers to the interview questions. In the Literature Review in Chapter 2, I addressed how I utilized case study design to explore the perceptions of students. I used the theoretical lens of student identity to frame my research questions and tasks for the participants. The facets of student science identity such as the students' past memories, present experiences, interactions inside and outside the classroom, and their aspirations for the future are the main concepts I explored through participant photography, photo-journals, and Participatory Photo Interviews (PPI). Through my research and readings of the literature, I have not found any studies similar to the one I am proposing.

Conceptual Framework

The purpose of this study was to explore how middle school students perceived themselves when "doing science" and "being scientists." The research question was "How do adolescent students view themselves as scientists and how do these perceptions relate to student science identity?" I explored the participants' interactions with science in their past, their present, and their hopes for the future. The idea to explore the interplay between the participants and their environment stemmed from the belief that humans construct knowledge through the interactions between humans and their world. The belief of knowledge, or epistemology, is the theory of knowledge concerning the underlying comprehension of how we know-what-we-know (Crotty, 2003).

Crotty (2003) organized epistemologies or human views on knowing into objectivism, subjectivism, and constructionism. In objectivism, the view is that an object has its own meaning, without human interaction with that object. Crotty used an example of a tree. The tree exists and has its own meaning whether a human is present or not. The meaning is there, waiting for humans to discover it (p. 8). Another epistemology Crotty discussed is subjectivism. Humans impose their meaning on the object. The object has no part in the creation of meaning. Humans can bring imagination and creativity into play when ascribing meaning to the object (pp. 8-9). In constructionism, humans interact with the objects or situations to construct meaning. Crotty (2003) posited that different people might see the object in different ways. “What constructionism claims is that meanings are constructed by human beings as they engage with the world they are interpreting” (Crotty, 2003, p. 43).

Each of these epistemologies frames different types of research inquiries. The objectivism epistemology is used in quantitative inquiries or designs by positivists and postposivitists who are looking at scienctific causes and effects. These researchers measure and quantify their observations of the phenomena. (Anafara Jr & Mertz, 2006; Creswell, 2009; Crotty, 2003).

On the other end of the spectrum of epistemological beliefs is subjectivism. The research inquiry typically used with this worldview design is qualitative research by advocacy and participatory researchers interested in change and politics. The researchers focus on marginalized groups who, the researchers perceive, need emancipation from subjective, socially imposed policies. Examples of the marginalized group theories are feminism, racial discourses, critical theory, queer theory, and disability theory (Anafara Jr & Mertz, 2006; Creswell, 2009; Crotty, 2003).

In the middle of Crotty’s (2003) spectrum of epistemologies is constructionism. Research strategies identified within constructionism include grounded theory, where researchers discover or uncover a new theory, and ethnography, where researchers utilize a longitudinal study to understand a cultural group. In phenomenology, researchers investigate the experiences of phenomena as described by people and the researchers bracket their experiences as to not interfere with those experiences reported by the participants. In case studies, researchers conduct in-depth explorations of individuals’ stories through rich narratives. The narrative research strategy includes researchers producing chronological narratives of the participants' life stories (Creswell, 2009).

Epistemology

The epistemology of this study was constructionism, which has its underpinnings in the belief that knowledge is constructed, not discovered. Crotty (2003) expounded,

> [Constructionism] is the view that all knowledge, and therefore all meaningful reality as such, is contingent upon human practices, being constructed in and out of interaction between human beings and their world, and developed and transmitted within an essentially social context. (p. 42)

This view of knowing, epistemology, or worldview (Anafara Jr & Mertz, 2006), emphasizes the interaction between the person, their world, and their environment. It is important to understand that in the constructivist vision of world life, the researcher becomes, "…acutely aware that their studies are collaborations between themselves and their participants, who may cooperate or not, reveal or conceal information, and even allow or refuse to grant the researcher any access at all" (Preissle & Grant, 2004).

The participants in my study engaged with the environment as they took photographs representing their interpretations of what "doing science" and "being a scientist" meant to them. Crotty (2003) continued his explanation of constructionism stating that various interpretations of the constructed world can be useful, fulfilling, liberating, or rewarding. The participants in my study interpreted their surroundings in relation to science through imagery within snapshots and stories about the images.

Definition of Terms

The following are key terms employed in this study. I defined the terms by synthesizing definitions found in current literature. These definitions are in the process of evolving as the findings of this study might alter or add to the definitions I present here. I utilized these terms during this study and I defined them here to provide clarity throughout this research.

1. *Science identity* **-** A synthesis of identity concepts (Aschbacher, et al., 2010; Brown, 2004; Carlone, 2004; Erickson, 2005; Farland-Smith, 2009; Hall, 2005; Reveles & Brown, 2008; Reveles, Cordova, & Kelly, 2004; Roth & Li, 2005; Saltman, 2005; Tan & Calabrese Barton, 2007) led to the following working definition used in this study. *Adolescents understand science from their past, participate and internalize interactions with the daily science classroom*
2. *and community, imagine who they hope to become, and begin to comprehend the sense of their science self.*
3. *Doing science – S*tudents were actively engaged and participated in experiments and activities that demonstrated or explained science questions, problems and concepts. In this study, "doing science" occurred within and outside the school environment.
4. *Being a scientist* – Students enacted scientific endeavors that they thought represented science where they felt accomplished and recognized by others as a science person. The definition in this study was flexible in that the individual participants determined what they thought it means to "be a scientist."
5. *Auto-photography / Participant Photography* – Study participants created and took the photographs in response to the research problem or questions (Jorgenson & Sullivan,

2010; Kolb, 2008; Nelson, 2007; Shankar-Brown, 2011). In this study, participants took photographs in response to six prompts related to the research questions.

6. *Photo Elicitation Interviews* (PEI) - Clark-IbaNez (2004) outlined the Photo Elicitation Interview (PEI) as an inductive research methodology where researchers take the pictures and then use them as interview stimuli.

7. *Participatory Photo Interview* (PPI) Kolb (2008) had her participants take photographs that addressed the research questions. She then had the participants use their photographs as stimulus for the Participatory Photo Interview (PPI). Student participants in this study composed and took the photographs and then used these photos as prompts for the PPI.

8. *Communities of Practice* – Communities of Practice are the practices and tasks of a particular situation that are dependent on environmental factors inherent to that particular space (Tan & Calabrese Barton, 2007). In my study, communities of practice refer to such spaces as the science classroom, the home environment, or the community.

CHAPTER 2

LITERATURE REVIEW: STUDENT SCIENCE IDENTITY, AUTO-PHOTOGRAPHY, AND PARTICIPATION PHOTO INTERVIEWS

The purpose of this literature review was to situate my study within the current literature on student science identity, participant photography, and Participant Photo Interviews. My study was exploratory in nature (Creswell, 2009) in that I have not found specific literature that addressed exploring and uncovering student perceptions about science in the manner of participant photographs and Participatory Photo Interviews. The research question of this case study was, “How do adolescent students view themselves as scientists and how do these perceptions relate to student science identity?”

The two main sections of this literature review were “Adolescent Identity and Student Science Identity” and “Using Photographs in Qualitative Studies.” Within the section about identity, I included the subsections of Historical Adolescent Identity, Current Science Identity, Exploration of Science Identity, and Definition of Science Identity. I concluded this part of the literature review with a Summary of Student Identity. The second section concerned the use of photographs and contained the subsections, The Use of Photographs, Photo Elicitation Interviews, and Participatory Photo Interviews followed by the section summary. I finished Chapter 2 with a Summary of the Literature Review.

As an experienced educator, teaching more than a thousand adolescent students over the period of 30 years, I have wondered what makes students interested or disinterested in school science. I realized not everyone is interested in science, just as not everyone is interested in other academic subjects such as language arts. Continuing this line of thought, I pondered what makes science interesting to one person, but not another. I began to consider why I like science and what influenced me become a science teacher. Have I always defined myself as a scientist? Have I always liked science? Do I *identify* with scientists and "being a scientist"? These questions led to researching identity and identity formation. Therefore, I began searching the literature to discover what researchers have written about student identity and science.

My belief in identity as a fluid construct that involves past experiences, present interactions, and future aspirations inspired me to examine student perceptions of how they interact with the natural world. While reading various studies about identity formation, I noted most of the researchers collected data through participant observations and interviews. I have chosen to use image-based research and a form of photo elicitation interviews called Participatory Photo Interviews (PPI). Photographs capture a specific moment in time and space and demonstrate everyday activities (Jorgenson & Sullivan, 2010). Kolb (2008) believes, "Visual data prove useful for envisioning and speaking about possible desired outcomes" (para. 7).

Researchers (Erikson, 2005; Hall, 2005) have written about student identity and student science identity (Brickhouse & Potter, 2001; Brickhouse, Lowery, & Schultz, 2000; Calabrese Barton, Tan, Rivet, & Groome, 2007; Farland-Smith, 2009; Kozoll & Osborne, 2004; Reveles & Brown, 2008; Tan & Calabrese Barton, 2007). No researchers have incorporated the method of Participatory Photo Interviews as the vehicle to examine student perceptions that reflect the past, present, and future aspirations of adolescent science identity.

Adolescent Identity and Student Science Identity

In order to examine science identity of a middle school student, I anchored the discussion with historical and current descriptions of what comprises identity. First, I situated identity as described in the early 1900s. The concept of "science identity" emerged in research in the late 20th century and progressed from the individual and one's interaction with society to one's psyche, interaction, and engagement in science practices within a science community. I examined the development of science identity in adolescents by synthesizing the literature that examines elementary, middle school, high school, and college students as data sources. While middle school students were my group of interest, research that involved elementary students provided a glimpse of developing science identities. Studies of high school and college students gave a retrospective view of science identity.

Historical Adolescent Identity

> The image of the child as an epigenetic and continuous creation of social and biological contexts is far more ambiguous and more difficult to paint than the relative simplicities of the traditional and culturally justified self-contained child; it may also illuminate our understanding of children and our science. (Kessen, 2005, p. 63)

As Kessen reflected on the dualism of inner self and communal culture in the above quotation, he emphasized the self-centered child is in conflict with his socially and biologically created self. Although Erik Erickson (2005) proposed stages of development bridging sexuality and physical and social growth, he also stressed his conceptualization of identity as a dualism of inner self and communal culture. My review set forth the integration of Erikson's identity theory and real-life project based units as a way to form adolescent identity. It was the situations and opportunities of the communal culture in relation to science education and the resultant effects on adolescent identity that was the focus of this synthesis.

Various theories of identity, social-cultural influences, and the impact of science education were the foundations in identity construction. Theories of identity "… open new ways of thinking about how teachers as meaning-makers can contribute to constructing student identities in ways that are more democratic, critical, egalitarian, and just" (Saltman, 2005, p. 241). Teachers can construct opportunities for group dynamics by the way they develop and create their science units and lessons. Ferguson (2005) stressed how the meaning of symbols were "struggled over by different groups" (p. 241) and formed a cultural order affecting students in schools. Ferguson examined symbols like affect, expressiveness, and language. Science instruction was full of symbols and concepts that required critical analysis for understanding.

In the life science classes I taught, topics such as genetics and evolution contained ethical questions and dilemmas. The genetics unit subtopics included the discovery of DNA, Mendel's Laws of Heredity, inheritance, genetic diseases, and genetic engineering. Students had a difficult time understanding the pros and cons of stem cell research and the ethical issues (symbols) of cloning. Students were just beginning to understand that in the early stages of stem cell research, scientist harvested stem cells from embryos that resulted in the inevitable loss of the embryo in the process. There was visible agitation as they pondered what this meant and if it is the "right" thing to do. The students in small groups thought through these symbols together. This communal conversation of ethical symbols might have influenced their individual identities.

Adolescent identity develops around the psyche and internal situation of socio-cultural events (Erikson, 2005). Psyche, a noun, means "The whole conscious and unconscious mind, especially when viewed as deciding or determining motivation, emotional response, and other psychological characteristics" (Psyche, 2012). Internal situation describes how adolescents absorb and internalize the relationships, events, and circumstances of their environment. The environments in these early definitions included groups of people with shared beliefs, interests, and culture, or as others referred to as society. G. Stanley Hall (as cited in Saltman, 2005, p. 238) positioned society as an important part in identity construction and described the connection between "self and society as inextricably woven." The individual responds to society in a fluid and self-altering way throughout one's life. Stuart Hall (2005) discussed the construction of social identities as ever changing and dynamic while Erikson (2005) proposed an ever-changing social identity when he stated, "There is interplay between the psychological and the social, the developmental and the historical, for which identity formation … could be conceptualized only as a kind of psychosocial relativity" (p. 248). These theories built upon each other and united the concept of societal impact on the formation of adolescent identity.

Each of these researchers recognized that the construction of adolescent identity had facets that involved the self and the interaction of the self with socio-cultural meanings and relationships. Over the span of one hundred years, G. S. Hall in 1904, Erikson in 1968, and S. Hall in 1997 reiterated the theory that something was going on within this period of adolescent identity construction. It was a time of crisis, or turning points, yet it was dynamic and ever changing throughout one's life span, but as Erikson notes, "adolescence is the pivotal time for its formation and stabilization" (Saltman, 2005, p. 239).

I have questioned the curriculum and the agenda of middle schools as did James Beane in the forward of Brown and Saltman's *The Critical Middle School Reader* (2005). Beane determined that middle schools have developed around the physiological development of the adolescent with little attention to a socio-historical and cultural construction. I hope the insights gained through my study of adolescents' science perceptions will help teachers recognize their students' psychosocial needs while following the protocol for standardized testing and mastery of the benchmark standards.

The mode of inquiry for my current research was unpacking Erikson's thoughts on identity and wrapping them around contemporary teaching of science. To do this, I examined Erikson's views on the construction of identity. Erikson developed a chart or framework to explain his theory of identity formation. Yet, through his discussions of identity, he also stressed the importance of social and cultural relationships and interactions. I used his social and cultural ideas to look at science instruction. Wrapping Erikson's views around science education means I connected and interwove certain aspects of teaching science in *today's* classrooms through the lens of Erikson's perceptions on adolescent identity.

As a teacher thinking through Erikson's views on identity, I felt the need to connect adolescent identity with teaching and learning in the classroom. The dichotomy of "teaching to the test" and teaching concepts for understanding presented a dilemma for both teachers and students. As Beane (2005) suggested, teaching the standards through a prescribed curriculum squashes adolescent spirits. Science education that incorporated service learning projects and field experiences within the community exposed the students to the community as well as the community to the students. As Erikson (2005) saw it, "a community's way of identifying the individual, then, meet more or less successfully the individual's ways of identifying himself with others" (p. 257). Investigation into how students, teachers, and community members perceived the effectiveness of real-life projects, yielded insights into the relationships of students to these "others." I propose the data such as students' auto-photographs and Participatory Photo Interviews will reveal the affective side of teaching and learning and will give insight into the relationships relative to a student's identity. Images created through photographs should give a personal insight into the interactions that the adolescents used to develop and form their inner and social identities.

The evidence of identity theories discussed in this review emanated from writings found in Brown and Saltman (2005) including Erikson's theories concerning the adolescent. The interest in connecting identity theory with science education originated from being a veteran teacher of 30 years and teaching seventh grade science for 12 years. Throughout these years of teaching, I wondered how I affected my students and how the presentation of the science curriculum and activities influenced their learning. I would like to know what they have become and where they are going with their careers. Do they think of themselves as scientists and are they able to relate to scientific methodology? Do their identities interweave science concepts into who they are and what they could become? Did the activities help them to work with others and see the outside world as something in which they are a part?

It is important to stress the benefits of teaching science through real-life situations in order to attach meaning to scientific concepts and enrich the adolescent identity. By enriching adolescent identity, I refer to enhancing the variety of learning modalities to target individual learning styles making the science information personally meaningful. Ideally, teachers present curriculum in a wide array of delivery methods in order for pupils to see, hear, write, manipulate, and reflect in an effort to help students fully experience science concepts and theories. The more ways a student can interact with the science concepts and ideas, the more personal and meaningful the tasks become. The student engages in the learning activities and internalizes the science material, hence affecting their competence and confidence as part of their inner core identity. A goal of this investigation is for adolescents to explore what "doing science" and "being a scientist" means by reflecting on the opportunities of science exploration inside the science classroom, outside of the classroom, and into the surrounding communities.

Three themes affecting the formation of adolescent identities emerged from the literature investigation of adolescent identity: group dynamics, cultural and community influences including family influences, and relationships within the classroom. These themes are relative to the history and study of science concepts and their connections with the real world.

Group dynamics. Group dynamics operates from the learning modality of small groups or cooperative groups. The teacher organizes small collaborative groups that place-students into small clusters or teams to accomplish tasks based on real-life situations. The group dynamic helps develop the adolescents' social identity. Erikson concluded, "It dawns on us then, that one person's or group's identity may be relative to another's, and the pride of gaining a strong identity may signify an inner emancipation from a more dominant group identity, such as that of the 'compact majority' " (Erikson, 2005, p. 247). Although Erikson based this concept on excerpts from incidental communications of Sigmund Freud in which Freud referred to his ethnic affiliations, Erikson applies it universally to all humans. In other words, observing what identity is in a trained mind such as Freud is theoretically applicable to all.

From Freud to Erikson and universal relevance, I now telescope the focus to application in the middle school. I feel by working successfully with a group or team, middle school students gain the sense of accomplishment, pride, and team spirit that in turn influences their social identity. This group recognition may not be in accord with the dominant group's identity, therefore transforming identities of those within the group. For instance, a group of my students presented a Power Point presentation on a body system to the class and used creative backgrounds and sounds to add interest to their presentation. The majority of the students in the class used the given templates and no sound. The group that went beyond the "compact majority" broke away from the "norm" and gained the identity of technology experts. This example demonstrates the adolescent power to pursue "…expanding technological trends, and thus [were] able to identify with new roles of competency and invention and to accept a more implicit ideological outlook" (Erikson, 2005, p. 253).

Another example of "breaking away from the norm" from my life science classes was a poster presentation where small groups of my students worked on a topic such as researching a specific genetic disease. While I provided adequate class time to complete the project at school, some students elected to work on it at home. What some of the students did not foresee was the absence of the one group member that had the entire project on a flash drive, leaving the group without their project. These students had some tough choices to make. They had to determine whether they should complete the project by themselves, somehow get in touch with the absent partner and work on it over the phone or e-mail, or just wait a day and hope their partner came to school. Decisions such as these either strengthen the work relationship or emancipate one student from the others by taking on the entire project themselves.

Culture, family, and community influences. Identity has dimensions that Erikson outlined from his readings of Freud and James. He posited that "…we deal with a process 'located' *in the core of the individual* and yet also in *the core of his communal culture,* a process which establishes, in fact, the identity of those two identities" (Brown & Saltman, 2005, p. 247). This process changes and develops as the adolescent's circle of significant others widens from the maternal to immediate family, to friends and significant persons, and to humankind. Erikson believes that the baby leaves the womb in exchange for a society where the infant meets the dichotomy of opportunities and limitations of its culture. The personality development is at the proper rate and proper sequence as determined by the culture that predetermines the child's readiness to interact with the environment and important individuals.

Family. Family and early development is important in the process of identity formation. As an infant, the child responds and interacts with those taking care of them. Usually this is the mother and as Kessen (2005) stated, "… [it was] the basic principle that children need home and mother to grow as they should grow" (p. 61). Kessen continued his discussion and admitted that today fathers are important in the early development of the child. Kessen also included the caregivers at daycare centers as significant and active in early development of the child.

Even as early as 1904, G. Stanley Hall (2005) thought that the home life should teach children nature. At home, parents should "…perpetually incite [their child] to visit field, forest, hill, shore, the water, flowers, animals, the true homes of childhood, in this wild undomesticated stage…" (p. 22). Families who vacation to National Parks, the ocean, the mountains, and travel outside of their home community provide opportunities for their children to experience nature and the world around them. Erickson (2005) and G. S Hall (2005) both encouraged parents or significant others to give their children opportunities to explore their environment. G. S. Hall (2005) surmised that parents told stories that reflected nature and culture and this served as a child's fundamental education.

In Erikson's (2005) work, he discussed the role of family as part of the significant others that raise the child. Erickson considered the experiences and inner conflicts that influence how an individual becomes a distinct personality. He explained, "Personality, therefore, can be said to develop according to steps predetermined in the human organism's readiness to be driven toward, to be aware of, and to interact with a widening radius of significant individuals and institutions" (p.250). Later in childhood, Erikson proposed that family, neighboorhood, and school gives the child the opportunity to imagine what it is like to be older and and what it felt like to be younger than others. These expectations of are part of identity and are verified in experiences of psychosocial “fittedness” (Erikson, 2005).

I see the public school system as one of the predetermining factors that influence adolescent identity. Our graded levels and curriculum scope and sequences determine when a student is ready for a particular level of material. By educating the masses and trying to have equal education for all, schools cluster the individual into generic grade levels and content areas regardless of individual student needs. I contend that by creating learning environments that teach to all learning styles and developing curricular activities that are real-life, hands on, and engaging, there is wiggle room for those students needing a more fluid program of study. By fluid program of study, I suggest that those who need help or extra time as well as those students who “get the material” the first time the teacher presents it has opportunities to succeed at their individual pace. Students continually recreate their inner core identity while their core of communal culture expands. As Erikson (2005) emphasizes, the complexity of identity is a simultaneous reflection and an observation on all levels of mental functioning of how one perceives oneself in relation to how others perceives oneself.

The core of communal culture expands by extending science learning outside of the classroom which is an idea supported by the recommendations of E. S. Rangel (2007) in her article, *Science Education That Makes Sense*. Taking fieldtrips that utilize community resources expand the scientific concepts taught in the classroom by integrating community resources in which the culture has placed great value. The people in the community determine the cultural value of particular community resources by public support, both monetary and attendance wise, people who work there, and people and corporations who make endowments to these places. The communal cultures, where devoted tax dollars and private endeavors interface, have recognized these types of resources as important and valuable to the surrounding communities. These types of assets support conservation of natural resources, preservation of endangered animals, and the safeguarding of historical documents and artifacts. Teachers need to organize their units around field trips to places like these in order to expose and enhance the communal identity for their students, and so they may make a connection between their inner core and their communal core identities. I believe students need to get out of their comfort zone inside the classroom and learn about what their community and culture have to offer. Just seeing and visiting these places does not necessarily guarantee a revelation on the part of the adolescent. However, I think that without this exposure, the sense of communal value is lacking.

Erikson (2005) concluded "…it is the ideological potential of a society which speaks most clearly to the adolescent who is so eager to be affirmed by peers, to be confirmed by teachers, and to be inspired by worth-while 'ways-of-life'" (p. 253). This addresses the need for real-life, hands-on learning that Rangel (2007) recommends. Students need to develop meaningful relationships with peers and significant adults and make connections between what they are doing in the classroom and what they may become. This inability of adolescents to decide on a career path or occupation is what Erikson believes is the most unsettling to them. I see this frequently with students as they are being pushed to determine a field of study before they register for classes in high school. In our middle school, only some of the students have a nine-week career class that can only begin to explore the myriad of possible career paths. By taking students out of the classroom and into the community, they can experience first-hand the types of occupations related to their topics of study. For instance, while we were at the zoo, my students observed veterinarians, zookeepers, zoology graduate researchers, animal food preparers, animal nutritionists, and volunteers trained as docents. These were just a few of the actual occupations related to a field of science, zoology, that the students were able to observe and interact with real-life scientists. The more opportunities adolescents have to see and observe people in the work force actually doing scientific applications and work, the more choices and possibilities they have of becoming an integral part of society.

Relationships within the classroom. Another focus of adolescents was peer relationships. There were many concepts Erikson (2005) considered in regards to group dynamics and interactions between adolescents. He discussed in-groupers and out-groupers in regards to adolescent intolerance of others who are different. Those who have different skin color, cultural backgrounds, and dress select those who are to be with the in crowd or left out. Erikson continued by saying that adolescents help each other by forming cliques and stereotyping their ideals and enemies, yet they test the loyalties of others during conflicts of values. By placing adolescents in groups that have scientific problems to solve, they have a common goal and the barriers and exclusionary behaviors fade. The students tend to focus on solving the problem and creating solutions rather than calling someone out because of the way they are dressed.

Erikson (2005) continued his discourse by highlighting how a democracy emphasizes self-made identities that adjust to the changing economic and political dispositions of society. He suggested, “Democracy, therefore, must present its adolescents with ideals which can be shared by young people of many backgrounds, and which emphasize autonomy in the form of independence and initiative in the form of constructive work” (p. 255). Constructive work equals a common goal towards which people strive. The space program is an example of this. The whole country was engrossed in space travel, from sending up satellites to orbiting Earth and eventually walking on the moon. The country employing a working military for various duties and responsibilities is another form of constructive work. On a local level, constructive work is a part of the service learning projects, hands-on activities that connect science to the real world, and field trips to community resources.

Erikson (2005) theorized that identity formation begins where the usefulness of identifications ends. By identifications, he means the familiar, trustworthy relationships forged with those closest to the child through family and friends. The individual's interactions with society, and society's perception of the individual, help to construct the adolescent's identity. Erikson's main points were that an individual's identity may be relevant to another's and identity is a combination of the inner core as well as the core of the communal self. It is important for adolescents to seek acceptance by others, to investigate worthwhile activities and be cognizant of group dynamics. Adolescents can be exclusionary and cliquish because they are intolerant of those different from themselves. Deciding on a career path is unsettling to most adolescents. It is up to society to create constructive work that unites young people towards a common goal.

I contend that science education can address these issues of adolescent identity and help with the construction of the inner core and the communal self. Through group work and problem solving, the utilization of community resources and real-life, hands-on projects, students gain acceptance of their peers and approval by their teachers. The focus on seeking real scientific solutions takes the center of attention away from the social exclusionary behaviors of any one particular group. The relationships adolescents form within the classroom, and specifically within the science classroom, are important to the development of adolescent identity.

Referring to Kessen’s quote at the beginning of this section concerning the biological and social selves in identity development, I have tried to create a version of adolescent science identity through Erikson’s lenses incorporating science education.

Current Science Identity

In contemporary science education literature, researchers narrowed the focus and specific concept of adolescent identity to science identity, a concept that described formation of identity through engagement with science context. Brickhouse, Lowery, & Schultz (2000) observed and interviewed 12 girls who indicated an interest in science through a written autobiography. The girls represented students not usually viewed by society as people that are scientific, such as, girls of color and poor backgrounds. The study took place over 18 months and the researchers highlighted four student cases to represent views on science identity. Brickhouse et al. discussed the four cases and then conducted a cross case analysis. Brickhouse, et al. (2000) described four seventh grade African American girls and their engagement in science. Through interviews, observations, journals, and focus groups the researchers viewed students’ representation of science identity as students who “…see themselves as the kind of people who want to understand the world scientifically and thus participate in the kinds of activities that are likely to lead to the appropriation of scientific meanings” (p. 443). They concluded that even though “all four girls constructed positive identifications with science, schools and teachers do not respond to these identities in valued-referred ways” (p. 456). The researchers based their conclusion on the way the schools placed students in science classes for the following school year.

Participation in science activities. Brickhouse et al. (2000) emphasized understanding how students engage in science and how this relates to who they think they are and who they want to be. Lave and Wenger (as cited by Farland-Smith, 2009) connected student identities with students' engaging in science class as a community of practice (p. 415). The Farland-Smith research explored 28 adolescent girls' attitudes and perceptions of science and scientists during a summer camp. A major part of the camp experience was for the participants to work-side-by-side with women scientists from different scientific fields such as physical anthropology, biology, chemistry, physics, and geology. The data collected included journals, attitude surveys, and drawing a scientist test. The researcher found that the girls maintained or increased their pre-camp positive attitudes toward science and scientists. However, Farland-Smith questioned whether these perceptions and science identities would carry over to other communities of practice when school began in the fall. Farland-Smith explained, "The community of practice is dependent on environmental factors inherent within that community as it is accepted that these identities are fluid and subject to change" (p. 415). Other researchers (Brickhouse & Potter, 2001; Calabrese Barton et al., 2007; Olitsky, Flohr, Gardner, & Billups, 2010; Reveles & Brown, 2008; Reveles, Cordova, & Kelly, 2004; Tan & Calabrese Barton, 2007) examined interactions between the science student, peers, and teacher in the science classroom.

The idea of how one "sees oneself" relates to the psyche and internal situation as encountered in the science classroom and other science situations. In a study concerning an urban young woman and a suburban young woman, Brickhouse and Potter (2001) monitored the internalization of a scientific worldview as part of science identity. This research emanated from the same data pool that Brickhouse et al. (2000) utilized. The Brickhouse and Potter article focused on two young females of color who attended a vocational high school. One girl was from an urban setting and the other lived in a suburban area. One girl, Crystal, had aspirations to take computer courses and learn computer programming. She was happier in the vocational school than she was in her high school, however she did not pass the computer program requirements. The student had to pass teacher exams as well as certification exams, in which she failed. The researchers concluded that she was a "silent, passive observer of the program" (p. 973). The instructor of the computing program noted the student did not have outside connections to computers, and that most students in the program had parents that were involved in the computing industry. The researchers concluded that the central identities of students in the computing program were far from Crystal's past and her desires for the future.

Roth and Li (2005) building on this idea of participation in science activities, declared that imagining oneself as a scientist, working as a scientist, and perceiving oneself in an interesting science area defined science identity. Roth and Li examined 129 tenth grade students from four different areas in Southern California. The participants in the study were Latino and African American boys and girls. The focus of Roth and Li's study was the participants' perceptions of interest in science, seeing themselves as scientists, and identifying support systems for the students. The researchers' findings of the study concluded that these students did not have school or family experiences that would encourage the formation of science identity. However, the students did have strong ethnic and gender identities. Roth and Li summarized their findings by stating, "Adolescents need meaningful experiences in science from more knowledgeable adults to demonstrate the relevance and necessity of science for their lives" (p. 35). I believe the researchers were calling for competent teachers with depth of knowledge in the content area as well as parents who believe in the relevancy of science classes and who support their children throughout their educational experiences.

An investigation by Bouchey and Harter (2005) of 378 middle school students revealed that the perceptions of teachers and parents concerning student competency predict students' own competency ratings. They found that what adults think and do predict student self-perceptions and current performance. Bouchey and Harter hypothesized that peers would have a greater influence on student science competence. They reasoned that their results came back differently than they expected because adults reward and punish academic performance when expecting a certain level of achievement indicated by grades. Parents offer money or other rewards for good grades and ground or take away privileges for poor performance. Their study demonstrated the importance of support and encouragement from teachers and parents. This result aligned with the call for knowledgeable adults to demonstrate relevance and the necessity of learning science as concluded by Roth and Li (2005).

Calabrese Barton et al. (2007) utilized case study methods to explore sixth grade girls from a high poverty urban middle school and the girls' practices within a science classroom. The researchers defined science practices as, "…actions that youth engage in that allow them to appropriate science in meaningful ways and toward multiple purposes in support of who they are and who they want to be" (p. 8). Calabrese Barton et al. conducted case studies with 13 girls in two middle schools and collected data through observations, field notes, individual and group interviews, and other artifacts such as journals, projects, and papers. Their coding of the transcripts led to two threads: events where girls were actively supporting engagement in science, and girls' participation in science class over time. The researchers developed three primary coding trees: 1) different kinds of science events where the girls noticeably shifted the discourse in the science classroom, 2) kinds of resources activated by the girls, and 3) cycle of actions. The findings of the researchers indicated, " through the practice of playing with identity, girls used both in school and out of school resources and experiences to construct novel identities that protected them in taking risks in the science classroom (i.e., to test out knowledge claims, to be seen as smart) and in bolstering peer support" (p. 28). Calabrese Barton et al. concluded that merging science practices was a way to understand that certain practices helped students bridge the world of school science with their life worlds (p. 35).

Tan and Calabrese Barton (2007) in their case study of a sixth grade girl's transformation from a marginalized member to a valued participant of the science classroom, defined "identities in practice" as an exercise in which students remake themselves by adjusting their perception of themselves in the current situation. I believe this way of seeing, imagining, and perceiving oneself is the psyche of the student. In order to move forward as believing one is a scientist, one must have the idea that it is possible and is something they want to develop within themselves. Hence, I want to explore how the students see themselves through the visual images of photographs.

Identity and the school science community. Research has evolved from perceptions, engagement, and participation in the science classroom to include studies on the interactions occurring in the school science community. Many researchers (Brickhouse & Potter, 2001; Carlone, 2004; Farland-Smith, 2009; Olitsky et al., 2010; Reveles & Brown, 2008; Roth & Li, 2005) cited Lave and Wenger's 1991 work on situated learning and communities of social practice. The science classroom, teacher, and students within the class comprise the community of learning and social practice. Reveles et al. (2004) studied a third grade classroom that focused on the activities and conversations that took place while students engaged in small group and whole class work. They found that the interactions between students and teacher taking place in the classroom constructed communal science knowledge and these interactions helped develop science identities and science literacy. "Rather than viewing literacy as a set of attributes to be acquired by the students, the teacher situated literacy in the collective actions of the community of learners and made connections to the disciplinary practices of science, mathematics, ethnography, etc." (Reveles et al., p. 1140).

Krajcik and Southerland (2010) identified five areas to help students develop science literacy. These areas included linking prior knowledge to new ideas, use questioning that includes meaningful scientific topics for students, utilizing multiple representations of scientific concepts, provide opportunities for students to apply science ideas and concepts, and support student interest and engagement with science discourse. McNally (2012) expanded upon Krajcik and Sutherland's five areas of science literacy instruction by suggesting activities to enhance lessons in those domains. He reported that by increasing early teen science literacy, inspired students might choose Science, Technology, Engineering, and Mathematics (STEM) careers.

Brickhouse et al. (2000) illustrated how these identities form within a science classroom as students decide which groups they identify with, ask other students to be part of the group, and determine what is required to be like those kinds of persons within the group (p. 444). The researchers' participants were four girls who saw themselves as being good at science or problem solving. Three of the four girls participated in class discussions and one was very quiet. Two of the girls were more actively involved in the science class when there were science experiments to perform. These girls tended to take on leadership roles if they were confident about the material they were learning or if they were doing experiments. All of the girls chose to interact in the science class. The way they interacted with the science teacher and other students was a choice and partially determined by what they thought others expected from them. This study noted the importance of how one perceives how others see them and expect from them as a facet of adolescent identity. I hope to gain insight into this aspect of identity through the student participant photographs and interviews.

Tan and Calabrese Barton (2007) noted that identities evolved with decisions students made about assignment completion and classroom participation, whether it was active participation, passive participation, or silence. Not only did Tan and Calabrese Barton analyze the degrees of participation, but they also looked at the classroom organization and suggested students developed "science classroom identity kits," or repertoires of identities (p. 570) that the students employed as they moved between group tasks, individual work, and whole class discussions. Tan and Calabrese Barton (2007) continued to explore the classroom interactions and defined discourses as "…ways of knowing, doing, interacting, valuing, thinking, believing, reading, writing, and representing oneself in social and cultural interactions" (p. 571).

Science literacy was the focus of a summary and discussion by Osborne (2010). In his research, Osborne summarized the literature on argumentation as a necessary skill in a science classroom. He declared, "Comprehending why ideas are wrong, matters as much as understanding why other ideas might be right" (p. 464). He posited that collaborative discourse and argumentation increased conceptual understanding with scientific reasoning. He discussed the different views on what scientific reasoning entails. Osborne reported, "More recent research has focused on a wider set of skills such as students' ability to develop testable hypotheses, to generate experimental designs, to control variables, to coordinate theory and evidence, and to respond to anomalous evidence" (p. 465). In order to do this, students need to have prior knowledge and interest in a research topic like those used in Science Fair projects.

In his article, Osborne (2010) gave results of studies that verified increased knowledge in science due to collaborative groups discussing, analyzing, and defending their positions on the skills like the ones mentioned above. The article also mentioned that argumentation and discourse force the comparing and contrasting of old models the student holds to new possibilities and ideas. I believe that this conflict is the connection to science identity. The student has prior knowledge and preconceived ideas that others test and challenge. Students must defend their ideas, compromise, or accept the new ideas or concepts. Osborne demonstrated through his research that students learn more concepts when there is discourse among peers.

In a study with three young college-aged migrant farm workers concerning the students' perceptions of science, Kozoll and Osborne (2004) discussed the student science identity and life world knowledge (knowledge gained through experiences). In this case, experiences included working alongside family members as farm and livestock workers, moving from place to place, following the growing seasons, and availability of jobs. The researchers interviewed three students and one pre-service science teacher as part of a larger study. All three students wanted to get away from the farm work in order to do something different. They saw education as a means to change. The researchers included the pre-service teacher in their study as an example of how a person's lifeworld, self, and identity merged to create a more integrated science person. Kozoll and Osborne concluded that the teaching of science should include "students' understanding of self in relation to others and how science may provide experiences that contribute to personal growth" (p. 158).

Brown (2004) videotaped high school science classroom activities and analyzed the videotaped interactions using discourse analysis. Brown utilized this notion of science discourse and separated it into what he called discursive identities. He categorized the discursive identities into four levels. The two lower levels of discursive identity, Opposition and Maintenance Status, involved little or no use of science discourse in the classroom. The level of Incorporation Status included students integrating science discourse into their daily routine and using cultural identities outside of class. Those students at the highest Proficiency level of Brown's discursive identities, where all teachers would like their students to operate, used daily science discourse that incorporated science terminology and concepts into their students' classroom situations. These studies demonstrated the researchers' increased interest in examining the discourse that occurs in a science classroom and how these interactions affected science identity. This interest in science classroom discourse and interactions are the origins for the adolescent participants to take photographs for my study that will depict them engaged in the science classroom.

Science identity and social communities. The science identity definition broadens from the self to science classrooms and classroom interactions to social communities and structures, including the environments and people outside the school setting. For science identity to have any individual meaning, " it must become one way of understanding our relationships to these others, thereby increasing, substantiating, and authenticating our relationship with people, nature, and the natural world" (Kozoll & Osborne, 2004, p. 174). Students must read the social situations and interactions as they internalize how to incorporate situations and relationships and then how to act in ways that they think best fits their ideas of self or identity. This knowing how to act and the will to follow through with the action is student agency.

Student science agency is a fusion of internal knowledge of science with interactions of the external situations within the environment. Calabrese Barton and Tan (2010) stated student science agency implies "…that students use the knowledge, practice, and context of science *to develop their identities, to advance their positions in the world, and/or to alter the world toward what they envision as being more just*" (p. 195). Student agency requires the students to determine what groups they want to be a part of, who they want to be, and how they can be a member of that desired group (Brickhouse et al., 2000). Reveles and Brown (2008) described the use of contextual shifting where students switch from one identity to another depending on the situation such as home, school, or outside of school culture. Reveles and Brown focused on two teachers and their elementary science classrooms and examined how students' academic identities in those two classrooms connected with scientific literacy practices. Social situations determined the formation of the individual, their surroundings, and their relationships.

Shanahan (2009) compiled studies on the agency and structure of identity. She focused her examination of the studies on three levels of identity analysis: personality, interaction, and social structure. Shanahan defined "agency" as an individual's ability to shape the world around them and "structure" as the expectations for individuals based on their position within a social group (p. 45). Olitsky et al. (2010) utilized this concept of agency and structure in their definition stating "… identity is continually constructed and emerging from a dialectical relationship between agency and structure" (p. 1212). In their study, Olitsky et al. (2010) explored an eighth grade socially diverse science classroom whose students had high interest and knowledge in science, but some students did not achieve in the science classroom. The researchers (Olitsky et al.) advocated co-generative dialogues, socially situated communities of practice, and unique student contributions to earn social capital in the classroom. Social capital meant how the students position themselves compared to other students in the science classroom.

Along the same lines of how students position themselves in the classroom, Carlone (2004) researched how high school girls positioned themselves in an Active Physics class in a suburban, predominantly white high school. From a larger study, Carlone observed, interviewed, and collected artifacts as data from an Active Physics class with 28 students (14 males, 14 females).The teacher in the Active Physics class arranged the curriculum around experiments and activities that encouraged participation from the students as well as lead them to discover scientific principles and concepts. Carlone relied on a perspective grounded in situated learning that "shifts the perspective of learning from an internalization of knowledge to a focus on how people organize the activity, represent science in activities, and the kinds of identities implied by the activities" (p. 397). She concluded that some girls identify with science learner identities represented by energetic problem-solvers and hard workers and these identities made the girls feel good and see themselves as capable in a learning community. Other girls contested the science learner identity and did not view themselves as "lab people" or "group people" as they were frustrated with the work and persistence needed to maintain good grades in the class. All of the girls took the Active Physics class because it would look good on their transcripts and college admission forms, not because they wanted to learn science and connect with the science community. Carlone called for more research in the area of school science reform and making meaningful real-life science available to all students.

While working on a study of science learning in a rural school in India, Sharma (2008) examined the nature of student participation in the discourse of electricity. His observations and field notes of the class of 47 students led him to explore the different forms of participation and factors that change the type of participation enacted by the students. Sharma searched for patterns of communication in the observed classroom discourse that indicated connections between the type of student participation and the students' experiences with electricity outside of the classroom in their everyday lives. He noted that the boys in class had more experience with electricity and its use around the home than the girls. Sharma interviewed 18 of the students and accessed the students' science notebooks, test answers, textbooks, and policy manual for the teacher. Sharma determined that if the specific topic of discussion had little to do with the students' experiences with electricity, the students were passive in the classroom and would respond only when the teacher asked a direct question. When the topic was relevant to the students, the boys would steer the discussion to something they wanted to know about like the difference in shock levels between AC and DC currents. Sharma concluded, “The students did not *have* agency, but rather under opportune circumstances, they enacted or exercised agency through their participation in the socioculturally mediated dialogues in the classroom” (p. 316). Sharma ended his research with a call for improving education in rural India by empowering the students with the tools and methods such as inquiry and manipulation of materials to understand the material world around them. Although Sharma does not mention science identity, I believe his study addressed student agency and participation, science class discourse and knowledge, and experiences students bring to classroom as tools to enable students to learn and improve their lives.

In a longitudinal study of 20 students over a two-year period, Logan and Skamp (2008) investigated student interest in science while transitioning between Levels 6 and 7 in school. They determined that the teacher’s pedagogical approach and the classroom environment were factors in students’ interest in science. More importantly, Logan and Skamp found that student voice concerning interesting topics and how they learn is a feature of student motivation and interest in class. The researchers also found that relevant practical work and class discussions promote science learning.

My interpretation of student science identity stems from a synthesis of identity definitions found in scholarly literature (Aschbacher, et al., 2010; Brown, 2004; Carlone, 2004; Erickson, 2005; Farland-Smith, 2009; Hall, 2005; Reveles & Brown, 2008; Reveles, Cordova, & Kelly, 2004; Roth & Li, 2005; Saltman, 2005; Tan & Calabrese Barton, 2007) coupled with my science teaching experience. Adolescents’ understanding of their experiences with science, participating in science class, and internalizing the classroom community interactions will develop how they define themselves as a science person.

Development of Science Identity

How does one explore students' science identity? My working definition of science identity is, "Adolescents understand science from their past, participate and internalize interactions with the daily science classroom and community, imagine who they hope to become, and begin to comprehend the sense of their science self. By unpacking the parts of my science identity definition and examining the different facets, exploring science identity can lead to understanding "who they are" related to their scientific thinking and "who they want to become" as a future member of a science-dependent society. Looking at the above definition, the first part concerning "understanding of the past" focused on students' thoughts about their own actions and interests.

Importance of Experiences in the Past

A few researchers referred to students' pasts as an element of science identity. Aschbacher et al. (2010) identified past knowledge and experiences as important to what the students bring to science classes. Aschbacher et al. followed 33 high school students through longitudinal surveys and interviews to explore why some students stayed interested in science and pursued science classes and why others dropped out of the Science, Engineering, and Math (SEM) pathway of science related careers. Carlone (2004), who studied girls' participation in a physics class, concluded that educators needed to mesh the science lessons and concepts with girls' agendas based on their motivation and interest. Carlone contended that students' experiences with science-related activities could help develop students' interests in science and serve as motivating factors. Calabrese Barton, Tan, Rivet, and Groome (2007) found that science content and concepts helped to determine girls' interest, engagement, and level of participation in science class. Although these studies (Carlone, 2004, Calabrese Barton et al., 2007) concentrated on experiences in the past through the lens of critical feminism, I feel these researchers' findings are applicable to both girls and boys.

The "understanding of the past" deals with those memories and stories the student has about "doing science" when they were younger. This is what Gee (2001) would consider core identity. A path through time, in a certain order, with specific experiences, through one's narrativization is what constitutes a person's "core identity" (Gee, 2000-2001, p. 111). As I envisioned it at the beginning of my study, students might tell stories of how they caught butterflies or a time when they played with a magnifying glass.

What is Happening in the Present?

Researchers (Aschbacher, et al., 2010; Brown, 2004; Carlone, 2004; Farland-Smith, 2009; Reveles & Brown, 2008; Reveles, Cordova, & Kelly, 2004; Roth & Li, 2005; Tan & Calabrese Barton, 2007) discussed the formation of science identity in the present. Specifically, Aschbacher et al. (2010) described the need for school science to be personally meaningful; Brown (2004) and Tan and Calabrese Barton (2007) called for facilitating positive identities and student images; while Carlone (2004); Farland-Smith (2009) and Reveles et al. (2004) explored students acting as scientists and being scientists. Roth and Li (2005) argued that teachers should nurture and respect student confidence and interest in science. Reveles and Brown (2008) suggested students who see themselves with capable and successful academic identities should concentrate on science literacy and school science. I infer that Reveles and Brown's use of science literacy is the ability to read and comprehend technical, complex texts and to be able to respond orally and in writing to science tasks. Therefore, to synthesize, I suggest "school science" is student participation and engagement with the more formal science lessons and tasks such as hands-on activities and experiments testing hypotheses within the classroom and school environment.

Participation and interactions within and outside the science classroom are part of the equation considered in the development of the current science standards. More recently, Bybee (2011) wrote about how to apply science and engineering practices as science education shifts its emphasis from science inquiry to science practices including engineering practices. He explained the shift from "science inquiry" popular in science standards from 1960-1990 to science practices in the proposed *A Framework for K-12 Science Education* published by the National Research Council. Bybee's explanation is more encompassing and comprehensive than the reference to science literacy and classroom science made by Reveles and Brown (2008). Bybee suggested, "When students engage in scientific practices, activities become the basis for learning about experiments, data and evidence, social discourse, models and tools, and mathematics and for developing the ability to evaluate knowledge claims, conduct empirical investigations, and develop explanations" (p. 10). Bybee concluded that the aim for all students is to use evidence including scientific models and current science knowledge "to formulate a logically coherent explanation of phenomena and to support a proposed solution to an engineering problem" (pp. 8-9). These researchers (Aschbacher, et al., 2010; Brown, 2004; Bybee, 2011; Carlone, 2004; Farland-Smith, 2009; Reveles & Brown, 2008; Reveles, Cordova, & Kelly, 2004; Roth & Li, 2005; Tan & Calabrese Barton, 2007) surmised that there is a relationship between the interactions and responses of students in the moment of the science situation within the classroom environment. The students' communication and understanding of evidence to support their solutions are important.

Several studies focused on the science classroom discussions between students and the science teacher. Researchers (Brown, 2004; Farland-Smith, 2009; Olitsky, Flohr, Gardner, & Billups, 2010; Reveles & Brown, 2008; Reveles et al., 2004; Roth & Li, 2005; Shanahan, 2009) discussed communities of practice and discursive practices within the science classroom environment. Brown (2004) surmised that science discourse develops positive student images. Olitsky et al. (2010) explained how cooperative dialogues help the students access resources for learning. Brown and Olitsky et al. also contended that the science classroom should be an environment that is socially and academically conducive to learning. Reveles et al. (2004) thought that students should participate in "doing science" within science communities of practice and that science should be a collaborative activity. Another group of researchers (Brown, 2004; Farland-Smith, 2009; Olitsky et al., 2010; Reveles & Brown, 2008; Reveles et al., 2004; Roth & Li, 2005; Shanahan, 2009) concluded that the science discourse that occurs between the teacher-and-students and students-and-their-peers helps them develop their science thinking and concepts. These researchers stressed the importance of dialogue and communication within the science classroom environment as important for understanding, learning, and creating a positive self-image, which develops into a facet of student science identity.

The middle part of my definition highlighted participation and internalization of interactions with the daily science classroom and the community. The interactions of students situate their negotiations with different forms of discourse and communication between the student and others. Tan and Calabrese Barton (2007) studied the interactions between science students and the teacher in a science classroom. They identified "identities in practice" where students remake themselves by adjusting their perceptions of themselves in the current situation. These perceptions of the students form are fluid. They change and morph as the conversations and dialogues (known as discourses with a lower case d as described by Gee, 2000-2001) formulate the kind of person one is. Gee described “Discourse” with a capital D as combinations that get one recognized as a certain kind of person. Gee continued to explain that combinations are actions at a given time and place that include speaking, writing, acting, interacting, non-verbal communication, ways of dressing, feeling, believing, valuing, and using objects (Gee, 2000-2001, p. 109). Therefore, the Discourse in a science classroom helps create and mold students’ perceptions of the kind of science students they were, *as recognized by others in the class*.

Adolescents internalize the interactions inside and outside the science classroom and communities of practice. Students create and enact their science identity within the environment as their life stories develop. In another study, Sfard and Prusak (2005) found identities form from the narratives or collections of stories about a person that are “reifying, endorsable, and significant” (p. 16). These researchers identified verbs such as *be*, *have*, and *can* and adverbs like *always, never,* and *usually* relate to repetitive actions and indicate reifying stories. An endorsable narrative is one that truthfully reflects the situation. A significant narrative represents any story where a change in the story has an effect on the storyteller’s feelings about the person of interest that implies inclusion or exclusion in a certain group (Sfard & Prusak, 2005). Using narratives and asking questions of others close to the student participant are indicative of how others perceive that student. Questions such as, “Are you a scientist?” “Do others recognize you as being good at science?” and “Do you think you are a good science student and what does that mean to you?” were ways for the students to communicate the social perceptions of their identity.

This middle part of my definition, “participation and internalization of interactions with the daily science classroom and the community,” also encompasses the students’ internalization of their present environment or situation. This environment determines the Discourse or “kind of person” (Gee, 2000-2001, p. 110) one is within communities of practice. I will use communities of practice as the operative concept for the situation in which identity is studied. These situations will naturally be part of narratives and Discourses of all involved (the others and self) in the formation of science identity. The situations may be at school, within the home, or outside of school/home activities. As Aschbacher, Li, and Roth (2010) concluded, “…within a situated learning framework, science identity is informed by students’ lived experiences and social interactions at home, in school, and in the larger world” (p. 566). The communities of practice as described by the participants help situate the facets of identity formation. Questions addressing communities of practice naturally included specific questions about the physical setting, but more importantly, questions included the atmosphere and climate of the classroom and the discourses within the setting. For instance, I might ask questions such as, “What is the relationship between the teacher and the students?” “Is the classroom environment comfortable and welcoming?” “Are there questions and dialogue between students and teacher and students with students?” “Is the classroom a cooperative climate or a competitive climate?”

A few researchers noted that what is true for girls should also hold for boys (Brickhouse, Lowery, & Schultz, 2000; Carlone, 2004). Brickhouse et al. (2000) found that research exaggerated the differences between girls and boys and they suggested researchers should attend to the differences within each gender group. Carlone (2004) indicated that the social construction of school science should hold for all populations, not just for girls. I am interested in both girls and boys and how they perceive their science identities in a middle school science classroom.

Students' Future Aspirations

The last part of my science identity definition stating, "Imagine hopes for the future and imagine who they want to become" lent itself to the student identifying career goals and aspirations. Brickhouse, Lowery, and Schultz (2000) examined how students engage in science, how this interaction relates to who they think they are, and who they want to be. Questions such as, "What do you want to be when you grow up?" or "What do you see yourself doing in 15 years?" prompted students to think about what they will be doing in the future.

Both Aschbacher et al. (2010) and Olitsky et al. (2010) had several recommendations for practices in the classroom and further research. Some of these recommendations included making students aware of science careers, creating a learning process that is more personally meaningful, and designing communities of practice that are socially situated. Aschbacher et al. (2010) and Olitsky et al. (2010) also recommended that teachers should acknowledge what students bring to science, recognize students as valued contributors, and provide a chance for students to model who they might want to be.

Brickhouse et al. (2000) were interested in how students' engagement in science related to whom the students were and whom they wanted to be. Brickhouse et al. (2000) surmised, "If students are to learn science, they must develop identities compatible with scientific identities" (p. 443). Other researchers (Aschbacher et al., 2010) suggested educators should understand how adolescents desire to learn and develop a sense of doing science. When students are "doing science," I infer that they are participating in experiments, tasks, and hands-on activities that demonstrate or explain science questions, problems, and concepts. Students may be "doing science" outside of the formal school setting. Developing a "sense of doing science" refers to the students realizing they observe, test, and do things related to science in their every-day lives. Not only do students need to develop a “sense of self doing science,” educators need to understand “… how they [adolescents] perceive and pursue their science interests and career options; and why so many young people initially interested in science eventually choose not to continue learning science or pursuing careers involving science” (Aschbacher et al., 2010, p. 565). These researchers identified students’ desires of who they want to be and their aspirations towards particular career fields as an important facet of science identity.

As described above, researchers have conducted studies about students’ ideas concerning their past, present, and future science aspirations and how these concepts related to student identity. I combined these ideas to create a study concerning students’ perceptions of their science identity. In the following sections, I will explain the purpose, significance, conceptual framework, and methodology of this study.

How to explore science identity. The definition of science identity denotes identity as interactions of personal and societal conditions. Therefore, to explore science identity, one needs to consider the thoughts and intentions of the students and to understand how the students internalize the science discourse occurring inside and outside the science classroom. I mentioned the science classroom because it is the focus and location where this study originated. Researchers utilized a variety of assessment tools to examine this interaction. The most notable method of analyzing science identity was through interviews. Several researchers (Aschbacher, Li, & Roth, 2010; Brickhouse & Potter, 2001; Carlone, 2004; Kozoll & Osborne, 2004; Roth & Li, 2005) conducted interviews with high school and college students while others (Brickhouse, et al., 2000; Reveles & Brown, 2008; Tan & Calabrese Barton, 2007) interviewed elementary and middle school students. Some researches (Brickhouse et al., 2000; Brickhouse & Potter, 2001; Reveles & Brown, 2008; Reveles et al., 2004) included interviews of teachers and parents as well as the students.

Aschbacher et al. (2010) described their interview protocol in detail and their probes reflected areas that other researchers inquired about as well. Their study examined tenth graders who were very interested in Science, Engineering, and Math (SEM) courses. However, these same students tended to leave or drop out of this path of study. The interviewers, therefore, questioned the students' past and present science experiences in and out of school. Other questions inquired about the students' perceptions of science, scientists, engineering, and engineers. The interviewers also explored the students' attitudes toward participating in SEM classes. The interview included culturally situated questions about the influence of ethnicity and gender on their lives as related to SEM opportunities, and the influence of teachers and families on their decisions. These are the types of questions and areas of interest that researchers used to explore how students felt about themselves in the past and how they looked toward the future in regards to science and being a scientist.

In another study, Seymour and Hewitt (1997) interviewed 335 students in seven colleges and universities with SAT math scores of at least 650 and had a declared Science, Math, or Engineering (SME) major. The focus of Seymour and Hewitt's research was to determine what factors influenced attrition and persistence of students maintaining or changing their SME majors. They identified four common concerns that lead to students switching their areas of study. These concerns included lack or loss of interest in science; belief that non-SME majors hold more interest or offer a better education; poor teaching by faculty; and feeling overwhelmed by pace and load of course demands (p. 32). More specifically, engineer switchers declared loss of interest in major, curriculum overload, fast pace, and poor teaching as the major concerns.

Science and Math majors were disappointed and anxious over career prospects. Seymour and Hewitt concluded that there were combinations of problems that led to students switching SME majors. Students' interest in the discipline and careers it leads to, and realism about career goals and altruism were conducive to persistence in maintaining an SME major. The researchers determined attitudes and strategies helped some of the students survive in their major fields of study. In order to retain future students in SME majors, the researchers surmised that students need "…sufficient academic and personal support to sustain motivation and morale" (p. 394). Science motivation stemmed from a student's science identity as feeling capable, or not capable in the math knowledge needed to succeed in science classes that students identified as difficult (Seymour & Hewitt, 1997). Using this insight into how college students view SME majors and what they perceive as hurdles to careers in SME fields, I think we need to explore how adolescents perceive science. By exploring their developing concepts about science and scientists, my study uncovered some insights into how to motivate and sustain student interest in science fields.

Videotaping and subsequent analysis of video clips was another popular method of examining student science identity. By videotaping classroom interactions, researchers could take field notes concurrently, and then have time to analyze the interactions and classroom dynamics later. Brown (2004) used videotaping and analysis of his high school sample to define the four domains of discursive identity. Olitsky et al. (2010) videotaped eighth graders and concluded that a socially situated classroom that operates as a community of learners was better than a classroom with a competitive atmosphere. Radinsky, Oliva, and Alamar (2010) studied sixth graders and their science discourses. Reveles and Brown (2008) evaluated a fifth grade teacher and a third grade teacher in their classrooms engaging in teacher-student discourses.

Radinsky et al. (2010) and Reveles and Brown used videotaping as the main data collection for larger studies in which they analyzed particular case studies. Case studies were the focus of Tan and Calabrese Barton (2007) as they wrote about one student and her transformation in the science classroom community after analyzing videotaped interviews.

Researchers also utilized surveys and questionnaires to assess science identity. In almost every study I reviewed, the researchers initially used surveys to identify members of the sample group. I planned to use a survey to identify the focus students in my study. In their interview protocol description, Aschbacher et al. (2010) described in detail what their ten-page survey included. Through the previously mentioned interviews and these surveys, Aschbacher et al. found some students thought science careers were too difficult and science courses required more effort than they were willing to give. These results presented the possibility of how motivation and the perception of the likelihood of pursuing a career in the sciences affected their choice of subjects to study in high school.

Glynn, Taasoobshirazi, and Brickman (2009) refined a questionnaire that examined motivation to learn science. This assessment tool explored college students' attitudes toward intrinsic motivation to learn science and extrinsic motivation to earn grades that are a means to an end. Farland-Smith (2009, p. 417) employed the "Attitude toward Survey" to help them assess middle school girls in a camp where the girls worked side-by-side with scientists from the community. This instrument helped the researchers determine that the girls had positive attitudes toward science before the side-by-side experience and remained positive after working with the scientists.

Another example of a large study that utilized surveys was the Leaper, Farkas, and Brown (2012) research. They used a questionnaire to survey 579 adolescent girls about social and personal factors affecting the girls' motivation in math/ science (M/S) STEM subjects verses English, a non-STEM subject. The results indicated that the girls' motivation in STEM subjects positively related to their mother's support in M/S, peer M/S support, and gender egalitarian beliefs.

Researchers examined various forms of student work or student artifacts as tools for assessing student science identity. Brickhouse and Potter (2001) used student autobiographies and journals as assessments. Calabrese Barton et al. (2007) employed reflective notes, journals, student science projects and written papers as part of their data analysis set with middle school girls. Reveles and Brown (2008) investigated elementary students' projects as part of the classroom community where the teachers emphasized academic identity that facilitated scientific literacy.

Other forms of evaluation such as Draw-a-Scientist (Farland-Smith, 2008) and "think alouds" (Calabrese Barton et al, 2007; Tan & Calabrese Barton , 2007) and "science talks" (Radinsky et al., 2010) were more unconventional ways to assess science identity. The drawing test (Farland-Smith, 2009) was an evaluation tool that examined how middle school girls viewed scientists before and after the camp where they worked with "real" scientists. The researcher judged the drawings on appearance, location, and activities. In all categories, there was an improvement in the girls' scores, which demonstrated a positive outcome of the side-by-side camp (p. 421). The "think alouds" (Calabrese Barton et al, 2007; Tan & Calabrese Barton, 2007) and "science talks" (Radinsky et al., 2010) were ways that allowed students to talk and think through their science ideas and concepts with the interaction and discourse of peers and the teacher. Through direct observations or videotaping these thinking-through sessions, the researcher tracked identity formulation.

Summary of Student Identity

Researchers such as Erickson (2005) and Hall (2005) theorized about identity formation in adolescents. Other researchers (Brickhouse & Potter, 2001; Brickhouse et al., 2002; Brown, 2004; Calabrese Barton et al., 2007; Calabrese Barton & Tan, 2010; Carlone, 2004; Farland-Smith, 2009; Kozoll & Osborne, 2004; Olitsky, Flohr, Gardner, & Billups, 2010; Radinsky, Oliva, & Alamar, 2010; Reveles, Cordova, & Kelly, 2004; Reveles & Brown, 2008; Roth & Li, 2005; Shanahan, 2009; Tan & Calabrese Barton, 2007) have explored how a student science identity can be built by constructing identity. Identity construction occurs between the students and the community of learners within a science classroom, experiencing situations outside of the classroom, and accepting attitudes and support of valued adults. Examining science identity is an arduous undertaking as students create and recreate identities during science discourse. I surmised that students adapt and change as necessary to fit into the class discussion, to contribute to the dynamics of the group, and to complete individual tasks.

Identity is constructed as a person negotiates the lived experiences in the present compared to their historical identity and their designated identity. Historical identity is how the person perceives themselves based on past experiences and situations, actual identity in present time, and the designated identity (Sfard & Prusak, 2005) of the future. Sfard and Prusak posited that learning is what closes the gap between a person's actual identity and their designated identity. Alsup (2006) suggested that metaphor creation and visual thinking or composition are ways to access thoughts and feelings that reveal human expression. Photographs are a means to express visual thinking and perhaps this is a method that will capture the learning taking place for students to construct more scientific ways of thinking and identifying themselves. Personal interviews allow researchers to ask prompting questions and then delve deeper into meanings and explanations as the interviews progress. One method of interviewing is the Photo Elicitation Interview (PEI) where the researcher uses photographs in the interview process.

Using Photographs in Qualitative Studies

In the next section of the literature review, I outline the use of photography in qualitative studies. I also discuss how various researchers utilized the researchers' photographs as prompts for interviews. Other researchers asked the participants to take photographs that led to participants' auto-driven interviews from their own photos.

The Use of Photographs

Harper (2002) historically situated the use of photographs in research. Researchers originally used photographs in ethnographic studies as field images used for record keeping and inventory of fieldwork. While reviewing the literature, Harper found few studies that incorporated photo elicitation. He posited that researchers may have used photographs in anthropologic studies, but did not write them up as photo elicitations. Eventually, researchers used photographs in the interview process to stimulate conversation about the culture. He classified the photo elicitation studies he found into four categories: social class/organization/family; community and historical ethnography; identity; and culture/cultural studies. The studies concerning identity included topics such as social identity of kids, drug addicts, ethnically different immigrants, work worlds, and visual autobiography (p. 18). His study also incorporated an example of the use of photographs that explored the phenomenology of farming and the skill of a working mechanic. He reported he "broke the frame" (p. 21) of the way people normally respond in interviews.

In two noteworthy books, *Visual Anthropology* (Collier & Collier, 1986) and the *Handbook of Visual Analysis* (van Leeuwen & Jewitt, 2001), the authors described the use of photographs in research studies, gave suggestions on how to incorporate the photographs in interviews, and discussed how to analyze the photographs and the interviewees' responses and stories. Researchers (Collier & Collier, 1986; Harper, 2002; Schwartz, 1989; van Leeuwen & Jewitt, 2001) utilized pictures they took as prompts for interview responses. Schwartz (1989) used photographs she had taken as stimulus for interviewing community members about farming. She viewed the photograph sets as a record of culture. The analysis of the photographs is what informed the audience, not the photos themselves. Schwartz took the position that the photographs were not inherently meaningful; researchers derived meaning through the eyes of the viewers and the viewers' interpretation of the photographs. In Schwartz's study, the viewers were the farming community participants in her study. Photographs utilized in qualitative research serve as a "medium for communication" (Schwartz, 1989, p. 152). Clark-IbaNez (2004) explained the Photo Elicitation Interview (PEI) and determined either the researcher (theory driven research) or the participant (inductive research) could take pictures as later stimulus for an interview. Others (Jorgenson & Sullivan, 2010; Kolb, 2008; Nelson, 2007; Shankar-Brown, 2011) reported having the participant create and photograph the image. Jorgenson and Sullivan (2010) employed participatory photos and the auto-driven interview to study aspects of middle school children's lives and their experiences with household technology.

In another study, Nelson (2007) used participant photos to explore adolescent perceptions of learning, identity, and their world. She concluded that the students generating the photographic data and taking the photographs themselves as response to prompts, "…extended their cognitive abilities, their personal confidence, and their engagement with their environment" (p. 132). Shankar-Brown (2011) also required her 7th grade students to take their own photographs and then create a photo journal to incorporate their pictures and narratives about each photograph. The researcher surmised that the photo journal "…values and leverages the developmental characteristics of young adolescents…by encouraging creativity, ownership, and voice in the learning process" (p. 28). A project like the photo journal empowers the student and supports their identity formation.

Elicitation Interviews

Researchers using photographs developed Photo Elicitation Interviews (PEI) as the main method of data collection. What is a Photo Elicitation Interview? Harper (2002, p. 14) credited John Collier with naming the responses people give about photographs as photo elicitation. Clark-IbaNez (2004) outlined the Photo Elicitation Interview (PEI) as an inductive research methodology where the researcher uses photographs as interview stimuli. Clark-IbaNez studied one fourth grade classroom in a charter school and another fourth grade classroom in a public inner-city school and had the fourth graders take their own photographs, which Kolb (2008) later called Participant Photographs. Clark-Ibanez (2004) concluded that photos gave a clear tangible prompt for children, which eliminated the awkwardness of a verbal interview and helped the child with linguistic communication. An advantage of photographs used in interviews allowed both the researcher and the interviewee to co-create understanding of the image leading to more in-depth interviews.

Photographs added validity and reliability to a word-based interview and captured an event in the past that the interviewee could retrieve through the image, which lead to interesting dialogue (Harper, 2002). Schwartz (1989) took photographs of a rural Iowa community and then showed the photographs to members of the community. She surmised that people viewed the photographs and they told stories about elements in the photo that seemed personally significant.

The social interactions that occurred while looking at photographs provided an arena for studying the meanings that viewers attributed to aspects of their daily lives (p. 122).

Participatory Photo Interviews

The Participatory Photo Interview (PPI) a more specific form of PEI, asks *participants* to take photographs and then explain how these photos answer the research question (Kolb, 2008). Kolb reported on two case studies that used PPI to gather data about six provinces in China and five Mediterranean Islamic communities. The PPI involved the local residents and elicited their perspectives on daily life. Kolb deduced that the Participatory Photo Interview starts with real places and real experiences. She outlined four phases of the PPI (Kolb, 2008, para. 8). The opening phase required participants to think about how they were going to take pictures that reflected the meaningfulness of their lives in relation to the research question. Phase two that Kolb described was the active photo stage where participants composed and took the photographs. The third phase was the decoding phase where the interviewer and the participant verbalized their thinking about the photograph and the research question. The last phase was the analytical decoding phase where the researcher analyzed all of the data including the photos, interviews, transcripts, and photo-journals.

In another study using participatory photo interviews, Jorgenson and Sullivan (2010) asked middle school students from a private school to take pictures that showed their family's use of technology around the house. The researchers intended to find out how the family responded to the availability of technologies in the home and what the role children assumed as technology "experts" in the home environment. Forty children received cameras and the children returned sixteen cameras with usable photographs. The researchers developed the pictures and then met with each participant for a 45-minute interview. During the course of the interview, the researchers asked the child questions about the content of the photographs and the significance of the shots. Jorgenson and Sullivan concluded, “The framing and styling of the picture embedded important information about the orientation of the participant toward the research task” (para. 38). The researchers surmised that the participatory photo interviews revealed personal significance and meaning, which in turn gained access to children’s voices and perspectives.

Avery and Kassam (2011) utilized photographs and videotaped interviews to explore fifth and sixth grade students’ experiences of learning science and engineering. The researchers gave the 20 participants from a high need rural school in upstate New York digital cameras to take pictures of how the participants saw science and engineering applied inside and outside their home in everyday life. Avery and Kassam analyzed 407 photographs, the transcripts, and videotapes of the semi-structured student interviews about the photographs. Their findings revealed that all 20 children found examples of engineering and science. The students learned by observing, participating, and doing things with their families and through their usual daily activities. A significant observation was that the students did not connect their daily use of science and engineering with what the teacher taught in their science classes. Avery and Kassam discussed critical pedagogy of space, or those places outside the classroom, and Aristotle’s phronesis, or practical wisdom. They determined that students know *that* and learn *that* from textbooks and science class activities and know *how,* and learn *how* to achieve through participation and experience. Avery and Kassam concluded that rural children’s science knowledge they bring to the classroom be the basis for science education to bridge the gap between what the students know and the school science curriculum.

Nelson (2007) devised a study where the adolescent students not only took the photographs and participated in the photo elicitation interviews; they were co-researchers in the study. Nelson used auto-photography and PEI as the vehicle to explore how early adolescent students perceive school, learning, identity, and the world around them. The 38 adolescent volunteers went to four different schools and worked as co-researchers with the research team. The researcher asked the students to complete nine auto-photography tasks to explore their learning and world experiences. The researcher then conducted photo elicitation interviews led by the student participants and focused on the students' photographs. The students were active in the analysis of the photographs and the interview transcripts. Key findings of student perceptions included the importance of the opportunity of students to work collaboratively with peers; having competent, personable teachers; and utilizing the depth of knowledge of students about preferences, needs, and aspirations in learning (p. 122). Nelson advocated the process of having students as co-researchers, which gave the students voice and insight to their learning. This study addresses some of the interests I had with auto-photography and Participant Photo Interviews. However, Nelson's study encompassed the broad concept of student leaning and identity, whereas my research focus was about student science identity. The Participant Photo Interview was personal and engaging, and co-created meaning between the participants and the researcher. I feel the PPI was a unique way to investigate a concept as personal as identity. Participant Photography encouraged the students to tell their stories about their experiences with science. The students and I co-created meanings and understandings of the students' perceptions of what it meant to "do science" and "be a scientist."

Summary of Using Photographs in Qualitative Studies

The researchers who utilized photographs in qualitative research and the Photo Elicitation Interview (PEI) determined the value and usefulness of these methods. These techniques allowed researchers to value participants' knowledge as Collier and Collier (1986) explained, "Images invited people to take the lead in inquiry, making full use of [the people's] expertise" (p. 105). Van Leeuwen and Jewitt (2001) suggested leaving the viewing of the photographs open-ended so informants say what they wish without the constraints of the interviewer's agenda and directed prompts. Several researchers also determined that using photographs in interviews gave rise to stories that were beyond the initial question and then became an important data source.

The focus of data collection is through digital photographs taken by the participants and photo elicitation interviews about the photographs. Harper (2002) historically situates the use of photographs in research. Harper found that researchers used ethnographic field images as part of record keeping and inventory of fieldwork. Eventually researchers used photos in the interview process to stimulate conversation about the culture. Some researchers (Harper, 2002; Kolb, 2008; Schwartz, 1989) indicated the researcher should take the photographs and use them as stimulus in the interview process. Other researchers (Jorgenson & Sullivan, 2010; Shankar-Brown, 2011) suggested that the participant should be the one to take the photographs as a response to the research question. Clark-IbaNez (2004) determined the researcher can take the photographs to expand the interview and participants can take the photographs to show a unique view of their lives. The research question and theoretical framework drives the decision on whether the researcher should take the pictures or the interviewees should create the images. In this study, my student participants will take the photographs in response to given prompts.

There were aspects of four studies that were similar to what I researched. The study by Reveles et al. (2004) examined students in a third grade classroom where the teacher co-constructed the science activities with the students. The goal of the teacher was to develop thinking skills that are associated with scientific practices (i.e., critical thinking skills, problem solving, and reflective thinking) by having the students "…carry out investigations in science, but also afford them the opportunity to learn discursive practices of science" (p. 1141). These students became more proficient at "doing science" throughout the year in ways that scientists participate in communities of practice. Through the participant photographs and stories about science in the classroom, this type of scientific practice and discourse occurred.

In another study, Shankar-Brown (2011) reported on photo journals her 7th grade language arts class created. She gave her students cameras to take pictures of their lives. They uploaded their photos on the computer, printed them in a format to mount in their photo journals, and then narrated their stories depicted by the photographs. I used a variation of the photo journals, but I had the students record the time, date, and location of the photograph and their thoughts about why they composed the picture in the manner that they did. The photo journal served more as a record of time, place, and thought during the moment they snapped the picture. Students used the photo journal as a prompt during the elicitation interview.

The last two studies that informed my research were the Jorgenson & Sullivan (2010) study and the Nelson (2007) study. Jorgensen and Sullivan asked middle school students to take pictures of the use of technology in their homes. The students' photographs visually depicted the home and family life through the lens of the camera and the images captured by the participants. The researchers explored a more personal facet of student identity and the use of technology. Nelson's (2007) research had early adolescent students take photographs demonstrating school learning, identities as young people, and their experience of their world. Nelson's study was broad in nature and described the methodology of students as researchers as well as their perceptions about school and the world. In Chapter 3 Methodology, I described the methods Nelson incorporated into her study that I used to explore the more specific concept of student science identity.

Some advantages of using photographs and PEI were that the participants contributed multiple orders of insight, personal significance, and meanings (Jorgenson & Sullivan, 2010). PEI engaged different parts of the mind than verbal interviews initiated (Harper, 2002). Participants and researchers co-created the meanings found in the images (Avery & Kassam, 2011; Clark-IbaNez, 2004; Collier & Collier, 1986; Harper, 2002; Kolb, 2008; Schwartz, 1989; van Leeuwen & Jewitt, 2001).

Summary of Literature Review

In this literature review, I have traced the development of student identity to the more specific concept of adolescent science identity. The research on science identity highlighted how students interact in the science classroom and suggested that students learn through collective collaborative activities within communities of practice (Brickhouse et al., 2000; Brown, 2004; Calabrese Barton et al., 2007; Carlone, 2004; Farland-Smith, 2009; Olitsky et al., 2010; Reveles & Brown, 2008; Reveles et al., 2004; Shanahan, 2009; Tan & Calabrese Barton, 2007). Others (Brown, 2004; Reveles & Brown, 2008; Reveles et al., 2004; Osborne, 2010) reported the way in which collaboration occurred and the discourse and flow of conversations were the most important aspects of developing science identity. Researchers such Calabrese Barton et al. (2007), Olitsky et al. (2010), and Tan and Calabrese Barton (2007) concluded that the students' ability to shift and change identities within the classroom to fit the activities and social groups demonstrated science identities conducive to engagement in the science classroom. In my study, one of the students' photography tasks included taking pictures of their experiences of science within the science classroom.

Some of the studies specifically mentioned parts of identity formation that I am interested in pursuing. Farland-Smith (2009) wondered if peers of a female student interacting with "real women scientists" would recognize that student as a "science person." Carlone (2004) suggested developing concepts of "science" and "scientist" to mesh with girls' perceptions of science, opening up possibilities for what it means to "be" a science person and "do" science (p. 411). Calabrese Barton et al. (2007) recommended students learn more than the science content to increase engagement in science and help advance science trajectories. The concept of looking at what one may become or who a person wants to be was part of my operating definition of student science identity.

Roth and Li (2005) advocated practical use of inquiry and experimentation in the students' daily lives, which would in turn increase interest and confidence. This would lead students to a more informed decision about going into science. Other researchers such as Aschbacher et al. (2010) and Farland-Smith (2009) surmised we should make students more aware of careers in science. They also determined learning should be more personally meaningful. Teachers should acknowledge what the students bring to science such as their prior knowledge and experiences and then give them a chance to enact who they might want to be. The auto-photography task that I had students compose was an image of them "doing science" in the past. This task addressed the students' prior knowledge or engagement with science as mentioned in the studies above.

The other major part of my study concerned the method I employed to examine student science identity. The participants of the study took their own photographs and participated in Participatory Photo Interviews. All of the research examined in this literature review was very positive about the benefits of photographs and photo elicitation interviews used in qualitative studies (Clark-IbaNez, 2004; Collier & Collier, 1986; Harper, 2002; Jorgenson & Sullivan, 2010; Kolb, 2008; Nelson, 2007; Schwartz, 1989; Shankar-Brown, 2011; van Leeuwen & Jewitt, 2001). Photographs provided a stimulus for participants to tell the stories of their everyday lives. Several researchers encouraged the participants to create and take the photographs to respond to the research problem or question (Jorgenson & Sullivan, 2010; Kolb, 2008; Nelson, 2007; Shankar-Brown, 2011). The auto-photography tasks that I proposed directly related to my research question and sub-questions.

The Participatory Photo Interview (PPI) is a rich source of data. Clark-IbaNez (2004) used PPI with elementary students and found the photographs helped eliminate the awkwardness of the interview by using the photographs as prompts. The combination of the participants' photographs and responses to the elicitation interviews gave them time to reflect on their own lives and take ownership of the process. I used the images students produced as stimulus for the Participatory Photo Interviews. These interviews were a rich source of data for me to analyze and interpret student science identity.

I explored student science identity by employing participant photographs, photo journals, and Participatory Photo Interviews. Identity involves past experiences, present interactions with the environment and others, and aspirations for the future. In order to examine students' perceptions of science experiences, the photographs uncovered information and memories that the participants might not have revealed through verbal-only interviews and questionnaires. Photographs were personal, creative, and participant centered. The pictures gave the participants a sense of ownership and involvement in the research process. The photo journals served as prompts for the Participatory Photo Interviews, were another source of data, and were a visual record of the participants' responses. Finally, the Participatory Photo Interviews allowed the participants to narrate the pictures and tell the stories of their real-life experiences.

By focusing the lens of adolescent science identity through participant photographs, photo journals, and Participatory Photo Interviews, I had a rich, deep, data pool exploring the science identities of these students. I reviewed literature that supports student science identity, but I have not discovered a study based on the lens of identity using participant photos to tell their stories of how they are “doing science” and “being a scientist.”

CHAPTER 3

METHODOLOGY

The purpose of this study was to explore student perceptions of “doing science” and “being scientists” and how these perceptions related to student science identity. In the beginning of this chapter, I described the case study framework based on the way Yin (2009) outlined case study design. I framed and focused the study through the lens of identity theory utilizing the medium of photo elicitation. I created the main research question through case study and identity theories. In the section on Data Collection, I outlined the research site, the process for data collection, the method of participant selection, and the multiple sources of data revealing student perceptions of “doing science” and “being a scientist.” In the section on Method of Analysis, I detailed the method of data analysis. In the last section, I revealed my own assumptions, biases, and ethics for this study.

Qualitative Research

For this study of students’ development of their identities as scientists, I conducted a qualitative case study. Marshall and Rossman (2006) defined qualitative studies as “… a broad approach to social phenomena” (p. 2) that take place in the natural world, use multiple interactive methods, and are both emergent and interpretive. Stake (1995) placed the researcher in the heart of the qualitative process and believed that “ Given intense interaction of the researcher with persons in the field and elsewhere, given a constructivist orientation to knowledge…, given the attention to participant intentionality and sense of self, … the researcher ultimately comes to offer a personal view” (p. 42). Marshall and Rossman (2006) also noted the importance of qualitative researchers being sensitive to their own identity and the researcher's impact on the study.

Another reason I will use a qualitative approach relates to the ultimate outcome of the research. Each case study is unique and as Hays (2004) posited, discovering the uniqueness in a case is the goal, not creating generalizations. The uniqueness of a case study also means that the case study need not be reproducible. "Qualitative case study is highly personal research…The way the case and the researcher interact is presumed unique and not necessarily reproducible for other cases and researchers" (Stake, 1995, p. 135). This case study was unique in that I examined student perceptions of "being a scientist" and "doing science" through auto-photography using the lens of science identity.

Case Study

In my study, I examined student perceptions of what it means to be a scientist or what "doing science" looks like. In the over-arching framework of case study, the individual is the unit of analysis (Yin, 2009) or "the case." I explored individual student perceptions and insights of student science identity. The lens (Creswell J. W., 2009) or foundation was identity theory. The focus of my study was, "How do adolescent students view themselves as scientists through auto-photography, photo journals, interviews, and observations?"

Yin (2009) enumerated characteristics of a qualitative case study and my research question met Yin's first criteria. According to Yin (2009), "… case studies are the preferred method when (a) 'how' or 'why' questions are being posed, (b) the investigator has little control over events, and (c) the focus is on contemporary phenomenon within a real-life context" (p. 2). I explored *how* students view themselves "doing science" or "being scientists," thus the construction of the research questions evolved into "how" questions that Yin described. This study met the second of Yin's criteria for case study as the investigator had little control over the events because the research data was student-driven. Yin's third criterion for case study was the focus on real-life context. In this study, I used real-life context represented by the photographs and perceptions of the students.

This study was an intrinsic case study as I was interested in this particular case (Stake, 1995). As the researcher, I positioned myself as a participant-observer as I was the only one in the field interviewing and collecting other sources of data. Marshall and Rossman (2006) believed, "Immersion in the setting permits the researcher to hear, to see, and to begin to experience reality as the participants do" (p. 100). I incorporated multiple sources of evidence that demonstrated the perceptions of the students in various formats (Creswell, 2009; Hays, 2004; Marshall & Rossman, 2006; Stake, 1995; Yin, 2009). The collection of data included narratives of students' experiences and photographs representing student perceptions from multiple sources. I presented the findings of this case through the lens of student science identity.

Theoretical Lens

I employed the theoretical lens (Creswell, 2009) of identity theory. By theoretical lens, I meant that identity theory was the viewpoint I used to formulate the case study research questions, purpose of the study, and analysis of the data.

Identity is a *complex*, *dynamic*, *negotiation* of the facets of self and society (Erikson, 2005; Hall, 2005). By complex, I mean there are many threads that weave the fabric of our being, our identity. Dynamic describes a morphing of consciousness as one thinks, believes, and responds to the environment. Negotiation represents the questioning and the give and take of beliefs and ideals, which leads to deciding how to position oneself within society in the present situation.

People construct identities as they negotiate the lived experiences in the present in relation to their historical identity, actual identity, and designated identity. Historical identity is how people have perceived themselves based on experiences and situations. Actual identity is the perceived self in present time or as Gee (2011) refers to *core identity*, the fixed sense of self that is the foundation of "contextually shifting multiple identities" (p. 41). The designated identity (Sfard & Prusak, 2005) is what the person expects to be in the future. The secondary research questions (See Table 1) I used to design the photography tasks addressed the historical, actual, and designated identities.

Research Design

The purpose of this study was to explore how middle school students perceived themselves when "doing science" and "being scientists." Through qualitative case study research, the theoretical lens of adolescent identity, participant photography, and photo elicitation interviews, I explored student perceptions of themselves as scientists and science students "doing science." The study explored how adolescent perceptions of self might illuminate and enhance current understandings of student science identities. The main research question that guided this study was, "How do adolescent students view themselves as scientists and how do these perceptions relate to student science identity?"

Data Collection

Data was collected using case study research design. There were various components to the case study data collection. The research site began in a suburban middle school in the southeastern United States. I used multiple data collection methods as suggested by Yin (2009). The process of collecting the data was to take place over a 5-week period within the public school calendar including summer vacation. The length of the data collection extended to 5 months due to the end of the school year, and continued over the summer break into the first few weeks of the new school year. The data collection incorporated multiple sources of data. One proposed data source was a questionnaire to identify student participants. However, I did not use the questionnaire. The eighth grade teachers had changed the schedule and I presented the research project to a group of eighth graders that their science teachers initially recommended. The teacher recommendation was based on those students who demonstrated class work completion behaviors and seemed articulate in class. Other data sources were student-composed auto-photographs, auto-photography journals, elicitation interviews about the photographs, and journal entries. The participants were the individual cases (Yin, 2009). The case bounded the criteria for selecting the participants. By bounded, I denote the criteria of the study will define the particular students within a predetermined science classroom environment, which will be early adolescent middle school students. I concluded the chapter with the method of analysis, the trustworthiness of the data collection, the researcher bias, and the ethical considerations of the study. I included examples of the interview guides and elicitation interview probes in the appendix.

Research Site

This study took place in a suburban school outside of a large metropolitan city in the southeastern United States. The school was in its fourth year of operation and the principal hired the teachers through a redistricting process of the growing suburban area. About a third of the faculty had their bachelor's degree, a third had their master's degrees, and about a third of the teachers had their education specialist degrees. Sixty three percent of the 56-member faculty has more than eleven years of teaching experience. There were approximately 1,000 students of which 43% were White, 35% were Black/ African American, and 11% were Hispanic or Latino.

A little over a third (37%) of the student population qualified for reduced or free lunch (Williams, 2012).

The middle school had four 65-minute academic classes with an 80-minute "Connections" period. During the Connection period, students took remedial reading or math, enrichment reading or math, physical education, band, orchestra, chorus, art, health, journalism, Spanish, and careers. Classes like band, chorus, orchestra, and Spanish had yearlong classes, and the students rotated every nine weeks through the other Connection classes. Therefore, not all students had the opportunity to take the careers class. This limited the number of students receiving the career class content, which might be a reason why so many of my students still did not know what they wanted to do as an adult.

Process for Conducting the Study

The process for conducting this study involves consent from the Internal Review Board (IRB) at the university where my major professor was supervising the research project. The county's local school principal had to grant permission to conduct this study. He gave consent for research to take place inside the school building with the student population.

After a short briefing about the research project, the early adolescent student participants and their parents or guardians signed a consent form that outlined the purpose of the research and the research design (See Appendix B). The consent form also explained the expectations of the participants, the use of pseudonyms for the anonymity of the participants ensuring the confidentiality of the research project, and the minimal risks that were inherent in the research procedure.

The students met with me for a briefing about the project and for the opportunity to receive their digital cameras and assignments. None of the students accepted the offer of the digital cameras. Instead, they said they would use their cell phone cameras or they had a digital camera at home. The students had two to three weeks to take the pictures, and put together their photo-journals. Different students joined the study during the summer. Due to their schedules, each participant took about two weeks to take the pictures and another week to get their photo journals assembled. During the last week, I completed the Participatory Photo Interviews. Two of the interviews took place at a convenient site chosen by the participants during the summer vacation. One interview was at a county park where her brother was playing in a baseball game and one was in a restaurant where we met after his karate practice.

Participant Selection and Criteria

According to Stake (1995), the participants are the case and the researcher pre-selects the participants who will share the most insight of the particular circumstances. The importance of this case was what I wanted to learn and understand about the participants' perceptions of "doing science" and "being a scientist." Stake also mentioned the participants must be available, easy to access, and hospitable to the research process. Employing these guidelines, my six participants were within the correct age limits and were available to volunteer for the project.

My research question involved early adolescent students, ages 11-14, and these were the ages of the participants. The students were predominantly of middle class socioeconomic status and had access to computers, cell phones, electronic tablets, and other high-tech devices. I mentioned this because I requested that my participants take digital pictures using a digital camera for a photo-journal and as the basis for the photo elicitation interviews. I observed that students take digital photos on their cell phones and knew how to use digital cameras. These students also knew how to use the Photoshop program or similar photo enhancing software to create special effects to print and create their photo-journals.

The six participants I selected for this study represented a purposeful sample for the "selection of information-rich sources" (Lapan, 2004). I planned to base this selection on participants' indications about their future goals and experiences as indicated on the initial survey (See Appendix A). Instead, I used feedback and interest demonstrated in the initial meeting for the two the eighth grade participants. Two of the participants were seventh graders at my school and I asked them if they wanted to participate. Two participants were sixth graders and were other teachers' children that participated in the data collection over the summer. All participants were volunteers who returned their parental permission forms and their student assent forms (Appendices B & C). These six participants were representative cases where "The objective is to capture the circumstances and conditions of an everyday or commonplace situation" (Yin, 2009, p. 48).

The participants were accessible (Stake, 1995) in that I had parent contact information and students' class and summer schedules. By utilizing the class and summer schedules, I arranged times to meet with the participants, explained the research procedure and picture-taking activities, and had time to complete photo elicitation interviews.

Methods of Data Collection

The process for data collection was to take place over a period of twelve weeks during the school year, summer vacation, and a few weeks at the beginning of the next school year. However, it took five months to collect the data. There was an initial interview planned to determine how the participants thought about science, being a scientist, doing science and about science inside and outside of school. However, due to time constraints and the end of the regular school calendar, I did not use the initial interview (See Appendix A). I explained the six auto-photography tasks and provided the students with a disposable digital camera to take photographs that represented themselves in the act of "being a scientist" or "doing science." The participants chose to use their own cameras or phones.

The first method of the data collection process (See Table 2) was the participant photography tasks. The student participants received an explanation sheet with the specific prompts and tasks (See Appendix D). I designed the prompts around the research question through the lens of student science identity. The research question was "How do adolescent students view themselves as scientists and how do these perceptions relate to student science identity?" The definition I had developed from the review of the literature was the following. Adolescents understand science from their past, participate and internalize interactions with the daily science classroom and community, imagine who they hope to become, and begin to comprehend the sense of their science self. After synthesizing the research question and sub-questions (See Table 1) and developing my definition of student science identity, I developed the students' proposed photography tasks.

These tasks comprised the focus areas involving "being a scientist" or "doing science" in the past, present, future, and how others view them as a science person. Each task required the participants to take one to two photographs of the prompt (Appendix D). Task 1 asked the participants to show "being a scientist" or "doing science" in the past or when they were younger. The stimulus for this task emanated from Gee's (2000-2001) discussion of core identity and his reference to a path through time and the memories of events as the basis of one's actual identity. Tasks 2 and 3 encompassed students' "identities in practice" as described by Tan and Calabrese Barton (2007). Those identities were actions in a given time and place (Gee J. , 2000-2001) and narratives or stories (Sfard & Prusak, 2005) of students "doing science" or "being scientists." For Task 2, students took photographs in the school setting and of school science items and situations. They took photographs outside of the school setting for Task 3. Task 4 involved how others viewed the participant as a science person. The concept of how the social situation and the participant's reactions and responses to the social perceptions of others was important in how the adolescent situated themselves in different communities of practice (Gee J. , 2000-2001; Sfard & Prusak, 2005; Tan & Calabrese Barton, 2007). Task 4 solicited the participants to show how others viewed them as a science person. Task 5 was a free choice for the participants. They chose to take one to two photos that represented "being a scientist" or "doing science" on a daily basis in their environment comprised of home, school, or the larger world (Aschbacher et al., 2010), or photos that showed changing identities (Gee J. P., 2011). Task 6 asked the participants to show what they would like to be or do when they are adults. This task related to Brickhouse et al. (2000) and their inclussion of studens't hopes, goals, and aspiration for the future as part of identity.

Photo journals, the second method of data collection, were a method of cataloguing and organizing photographs to tell a story. Shankar-Brown (2011) described using photo journals in a 7th grade language arts class. Students took photographs to tell a story of their lives and then they arranged the photos in a flipbook to tell their stories. The activity encouraged student engagement, enthusiasm, and creativity. Participants in my science identity study created a photo journal for a different purpose. They took their photographs and wrote in their journals to help organize their photos and record their thoughts when they took the picture (Nelson, 2007). Participants noted details such as the time and place they took the photo and the composition of the picture. The students jotted down their thoughts while they were composing and taking the picture and commented on how the picture represented them being a scientist or doing science. This was to capture students' reasoning and meaning of the picture as they produced it. After the students took the pictures, they uploaded them to a computer and printed a copy that they incorporated into their journal with the descriptions they have written. The information and reflections in the photo-journals were an aid in the Participatory Photo Interviews. The students' perceptions of how the photos addressed the research prompts and questions were the heart of my study.

Participatory Photo Interviews, a type of Photo Elicitation Interviews (Clark-IbaNez, 2004; Harper, 2002; Kolb, 2008; Shankar-Brown, 2011) was the third component of the data collection. Harper (2002) credited John Collier with naming the responses people give about photographs as photo elicitation (p. 14). Clark-IbaNez (2004) outlined the Photo Elicitation Interview (PEI) as an inductive research methodology where researchers took the pictures and then used them as interview stimuli. Kolb (2008, para. 8) outlined four phases of the photo interview, which I modeled for this study. The first stage was when the participants thought about the research question and how they were going to take the pictures. The active photo stage was where participants composed and took the photographs. The first two phases prepared the participants for the researcher's interview. The decoding phase, or actual interview, was where the interviewer and the participant verbalized their thinking about the photograph and the research question. I divided the PEI into two parts. Part 1 was the Elicitation Interview about the photographs. Part 2 consisted of follow-up questions that extended the ideas and concepts from the photographs to synthesize the participants' thoughts. The follow-up questions included: what is "science" , did the participants view themselves as "scientists" or not, were their parents involved in the study, have their parents influenced their child's interest in science, and would this project help their teachers understand their students (See Appendix E). The last stage Kolb

(2008) identified for the PEI was the analytical decoding phase where the researcher analyzed all of the data.

Table 2

Data Collection Methods

Method	Description	Purpose
Participant Photography Tasks	Photographs of their interactions with science in the past, present, and future and their everyday lives	Defines core identity and identities in practice
Photo Journals	Photos with date, time, location, and thoughts at the time picture was taken	Organization of photos; thoughts about the composition of the picture
Participatory Photo Interviews (PPI)	Part 1: Participants' stories and narratives about photographs and how the situations or objects demonstrate interacting with science. Part 2: Follow-up interview questions about the over-all project, their science beliefs, their parent involvement, and how teachers may use a similar project.	Student perceptions of doing science and being a scientist More in-depth information and extension of the photography tasks

Method of Analysis

The analysis of participant photographs and Participatory Photo Interviews occurred on several levels. Schwartz (1989) stated, "It is not the photographs themselves which inform, but rather, the analysis of them" (p. 152). Analysis began with an examination of the participant-produced photographs. As Harper (2002) noted, "Photo elicitation demonstrated polysemic quality of the image; it thrusts images into the center of the research agenda; it demonstrated the usefulness of images…" (p. 15). Researchers such as Jorgenson and Sullivan (2010) and Kolb (2008) looked at the images by themselves, irrespective of the photographer. The first viewing of the photos was to determine broad categories and a pattern of how children saw the research topic. Another way to view the photographs was through their content and spatial situations. Other categories and groups became apparent from this photograph review of specific content and location (See Table 3).

Table 3

Tasks, Participants, and Photographs

Task	Alex	Levi	Katie	Lexie	Harsha	Brendan
Task 1 - Past	Water filter	Tree	Cake - baking	Clouds	Mineral	BS Squid in bottle
Task 1 - Past	Dying tree	Dog	Cooking shrimp	Beach	Beach	Worms in a box
Task 2 - Sci Class	Herself thinking	Batteries	Science project	Rocks or fossils	La Brea Tar Pits	Class: worm in box
Task 2 - Sci Class	Lab preparation	Computer TEST	Board lights up	Earth Sci book	Snickers	Food web Chart
Task 3 - Out/School	Applying makeup	P Pt Nuclear E	Marshmallows	Measure water	Reading	Caving
Task 3 - Out/School	Cut on hand	Big 20 review	Make S'mores	Fire - lighter	Soccer Ball	Jekyll net fishing
Task 4 - Others see	Eyes,1 blue, 1 brown	100 class assign	Make cupcakes	-	Rocks/ Family	Mad Scientist
Task 4 - Others see	Present project	Carnegie Unit	-	-	Weather	Turtle shell / Manatee
Task 5 - Daily Life	Flash Mirror	Bowling	Sandwich rotting	Taking shower	Cooking	Kitten in lap
Task 5 - Daily Life	Fog	Skateboarding	Bird nest	Water plants	Car	Mouse rescue
Task 6 - As an adult	Stage actor	GT Cup	K with dog - Vet.	L with dog - Vet	GPS/ Physicist	CPR- save lives
Task 6 - As an adult	Drawing comics	Graphic design	-	Modeling	Stars/Astron.	Marine Bio/Vet

The next step in analysis was looking at the data generated by the Participatory Photo Interviews (PPI) and photo journals. The explanation of the participants' motivation for taking the photo was the first interpretation or "*participants' reading*" (Kolb, 2008). The photo journal served as a prompt for adolescents reading and interpreting the photo during the PPI. The interviews took place after the participants framed the image and snapped the pictures. Therefore, the recorded notes in the participants' photo journals reminded them what they were thinking at the time they took the photographs. The researcher and participants read the photograph together during the PPI and co-created meanings from the image. Kolb called this process “audiencing” the photo.

During the audiencing of the photograph, Kolb (2008) reported that the participants’ narratives revealed hidden feelings or concerns, details of social life, or other unpredictable meanings. An example of something revealed would be that Alex had concerns about her looking appropriate for school and if she could get her make-up just right. She revealed this while discussing how the trial and error of putting on make-up was a type of scientific process. As some of the participants told their stories about their photographs, the pictures reminded them of other places they had traveled, a vacation that they thought was cool, or other places they would like to visit. Harsha talked about rocks. His parents drove him to places to gather rocks that he added to his collection. Then he became excited and said he wanted to see the Grand Canyon someday. The participants’ narratives based on the photographs typically started out describing the scene or object in the picture. Then the participant would think of related concepts beyond the meaning of the photograph. For instance, Levi took a photograph of his dog as an example of body systems and animal movement. As he was telling about his photograph he remembered the shark dissections they did in science class and went on to tell about other dissections. The researcher and interviewee co-constructed the meanings and interpretations as they reflected on the research questions as viewed through the participants’ stories and photographs.

The last step of analysis is to explore the themes and patterns in the transcriptions of the PPIs. A second reading by the researcher may reveal additional details missed during the active co-construction of the elicitation narrative. Kolb (2008) also recommended a scientists’ reading of the images so that anyone reading the study might examine the photograph in the same manner as the researcher. She suggested that describing the forefront, the middle and then the background of the photograph would be a logical way to examine the content of the photograph. Finally, the researcher reviews the visual images, the participatory photo interviews, photo journals, and any field notes to create a holistic picture of the study.

I examined the photographs. I found that the photos were concrete in what they depicted. I compiled a chart of all of the tasks and photographs (See Table 3) so that I could make comparisons on how the participants responded to the individual tasks. I noted that Katie was missing a second picture for Task 4, "How Others See You," and Task 6, "What You Want to be as an Adult." The chart also made it easy to see that Lexie Skipped Task 4 and did not submit any photographs for that task.

I then examined each participant's photographs and transcripts together. I placed the two photographs for each task together on a page and then summarized what the co-created story was for each task. I created a summary of their responses to Part 2 of the PPI that included the interview questions (See Appendix E) about science, family influences, further classes and schooling, and what they thought about the project. I included their comments about how this study might help science teachers.

After analyzing each case or individual participant, I then did a cross–case analysis to find any common themes or concepts and any anomalous or inconsistent responses. I created charts to help me with the cross-case examination of the data. (See Tables in Chapter 4).

Trustworthiness

My study involved interviewing and working with children, who are a socially disadvantaged group. They are disadvantaged because children's' voices are not usually heard in social research. As the researcher, I was in a tenuous position as both a former teacher of three of the participants and as the researcher conducting the interviews and arranging the research tasks. I needed to convince the participants that they could trust my professionalism in keeping the two roles separate in this research process. Part of the challenge with the child's informed consent along with the parental consent was to convince the participants that there was no penalty for not participating in the study. Participation in the study had no reflection on grades or other assessments and there was no consequence for nonparticipation.

The research design included children's use of cameras and the creation and production of digital photographs. The students took these photos on his or her own without the researcher's interference or supervision. The participants had control over the images they produced within the confines of the school and home. To avoid the awkwardness of "regret pictures" as Clark-IbaNez (2004) referred to them, students deleted those unwanted photos and kept the ones they wanted to share with the researcher. A few of the participants said they had many other photographs, but chose the best ones they thought answered the photography tasks. Lexie did not have photographs for the task about how others saw her as a science person or not. She could not figure out a way to portray the fact that she did not feel like a science person, and therefore, could not conceive of how others would see her as one.

Student participants had the opportunity to review the photo journals and transcriptions of the PPI. Stake (1995) referred to this process as member checking. Wolcott (2009) suggested using triangulation of data sources and having participants read what the researcher has written. None of the participants requested reading over their transcripts. This would have been a check for accuracy of the information as well as the validity of the interpretations of the researcher. The participants might request a copy of the final research paper and they could keep copies of their photo journals.

Researcher Bias

This case study was of interest to me because I teach science to adolescents. It was an intrinsic case study as I was interested in exploring student perceptions of "doing science" and "being a scientist." The interviews about the photographs were participant driven and student led. I prompted them to reflect on the research questions. The Participatory Photo Interviews co-constructed meaning of the images with the participants. I highlighted the students' voices.

I was open to all participant explanations and viewpoints. I am a science teacher and love scientific activities and endeavors. I taught three of the participants in previous years. In those years, I taught Earth science and life science. All of the participants knew I was a middle school science teacher. When I briefed the participants on the project and the photography tasks, I explained that I was a student at the university doing research for my dissertation. I did not tell them I was a science teacher nor did I emphasize or introduce myself as a teacher. I did not coerce the participants to incorporate examples from those classes in which they were students, as I had no control over the photographs the participants took. I was surprised that some of the photographs and stories referenced things the participants had done in my classes. Harsha referenced one of the projects he did in my class a year ago and said it was his favorite project of the year. I never knew he was so enthusiastic and excited about the assigned fossil research project.

I positioned myself as an insider and co-creator of meanings with the participants and the stories about their photographs. The fact that I am a science teacher and the students already had the "science teacher" persona stored in prior knowledge, there is a possibility this might have influenced the way they responded to the photography tasks and interview questions. If the students had not known me, then their responses and my findings might have been different. The outcomes could be different if I was a different academic teacher such as a language arts or social studies teacher. Taking this analogy further, the results would probably be different if the researcher was not a teacher at all, as teachers hold an authoritative power over students. I realized I would like more students to be interested in science and pursue careers and jobs in scientific fields, but I took the position of information gatherer and interpreter to best portray the perceptions of the students.

Ethics

There was a balance of power achieved through Participatory Photo Interviews as the adolescent participant and the researcher co-constructed the meanings of the images. The co-construction of meaning allowed the adolescent participants' voices and perceptions to shine. There were some challenges involved with this type of research (Clark-IbaNez, 2004). The participants were sharing personal views and details about their lived experiences and they trusted me to treat this information with professionalism.

There were participant challenges such as keeping track of the digital cameras and the task list of photographs. Two of the participants asked for second copies of the Photography Tasks. There was a contingency plan if the students misplaced their camera or their pictures became damaged. None of the participants had this type of problem with the photographs. However, some of the photographs Harsha submitted looked as if he uploaded them from the internet. I would recommend that only pictures of things a participant cannot take a photograph of such as the night sky, be attained this way. Those that needed picture-taking tips had the freedom to ask for help when needed. They had the opportunity to remove any pictures they regretted taking to avoid any unnecessary embarrassment for something they did in a frivolous manner. None of the participants asked for help with the photography tasks or the actual composition and shooting of the photographs. No participants divulged that they took any embarrassing photographs.

Some challenges could have included financial considerations for the digital cameras and materials for the photo journals. None of the participants requested a camera because they used their cell phone cameras. There was a discussion with the participants about what could be included in a photograph and how to handle permission to include other people in their photos. Students were encouraged to complete the photography tasks by themselves and without conferring with other participants in the study. To my knowledge, the only help the participants received was from their families. If they had help, they revealed that during the PPI.

CHAPTER 4

PERCEPTIONS OF SCIENCE THROUGH THE EYES OF ADOLESCENTS

The purpose of this study was to explore student perceptions when “doing science” and “being scientists” and how these perceptions might relate to student science identity. My participants were three boys and three girls between the ages of 11-14. The adolescent participants were unique in their personalities and interests in science. The six participants completed all phases of the study.

The study phases included taking photographs in response to given photography tasks, placing their photos in a photo journal, recording the time, date, and location where they took the photos, and completing a participatory interview. The participants were to take photographs of their involvement in science as described in the following scenarios:

Task 1: (Past) Something they did in the past related to science

Task 2: (Science Class) Their interactions within science class

Task 3: (Outside of School) Their involvement in science outside of school

Task 4: (Seen as a Science Person) How others see them as a science person

Task 5: (Everyday Life) Science in their everyday lives

Task 6: (Future) Representations of what they would like to do as an adult

(See Appendix D)

In the interviews, the participants discussed how the photographs represented their responses to the photography tasks. At the end of the student interviews, I asked the participants about their thoughts on science and scientists, the participant's science capabilities, and their parent involvement with this project. I also inquired if there were science influences outside of the bounds of this project; including the science-related experiences that their parents may have provided. Finally, I prompted the participants to reflect on what they could have done differently for their photo responses to the tasks and to share their final thoughts on the project (See Appendix E).

Alex

Alex is a 14-year-old eighth grader who volunteered to participate in this study at the end of the school year. She is focused and attentive in class and is very bright. She is a talented singer and won the People's Choice Award for our school's Talent Show.

Task 1: Past

Figure 1a: Alex Task 1
Dying tree

Figure 1b: Alex Task 1
Water Filter

Alex began her photo journal depicting the past with a picture of a green plant that had a section of it dying (Figure 1a). She began her story,

> The first picture is about some sort of pine tree that has a large section of it dying. And it reminds me of a paper that I read it last year about why the leaves change color. I learned that's because a chemical that's in a plant, chlorophyll, can run out in a plant or in a section of it. The chlorophyll is what makes it green. So if it's not there, the color becomes dull over time as the plant dies.

Alex's second picture representing the past was a pitcher of water with a filter system (Figure 1b). She explained,

> This is a pitcher of water that we've had for a couple of years. It actually is a filter, in a way, and it reminded me of what I learned about solutions this year. Solutions are basically a kind of mixture or impure substance that involves something being dissolved into something else. Tap water in the pitcher is a type of solution of water and other sorts of minerals. It filters the minerals out of it so the water is pure again.

She mentioned that she learned about solutions and filtration in the beginning of the school year.

Summary. The science correlation is evident in Alex's selection and composition of these photographs. She remembered learning about chlorophyll and solutions. She found evidence to support her science knowledge. Her perceptions indicated knowledge that she used scientific understandings in her past.

Task 2: Science Class

Figure 2a: Alex Task 2
Preparing for an Experiment

Figure 2b: Alex Task 2
In-class Experiment

The first picture for this task was a photograph of Alex preparing for an experiment (Figure 2a). Alex mentioned,

> Science isn't all about using chemicals and conducting the experiments. It's about what happens before and after it. What I took here is specifically before a big lab. I'm thinking about the things that I need in order to protect myself to properly conduct the experiment.

The second photo for this task was a picture of the actual items needed for a particular experiment her science class performed (Figure 2b). She noted that there were measuring cups to get the precise amount of something. She could not recall what the specific experiment was, however, there were craft sticks (Popsicle sticks), bottles of liquids, and teaspoons along with the measuring cup in the picture.

Summary. Alex indicated she has a difficult time concentrating in science class. She takes her own time to think things out and plan on her next steps. She gets frustrated when others interrupt her thoughts, as she needs to go back over what she was thinking in order to move ahead with her thought processes. She likes things planned out and organized so she can complete the assignment or experiment.

Task 3: Outside of School

Figure 3a: Alex Task 3
Cut on Hand

Figure 3b: Alex Task 3
Applying Makeup

Alex chose to take a picture of a cut on the palm of her hand (Figure 3a). She had fallen and was observing her hand, trying to determine if she should wash it off and if she should go to a doctor. She decided to wash it off to make sure there was not any dirt in the cut.

The second picture for this task was of Alex applying make-up (Figure 3b). She explained,

> As you can see, I am putting on my makeup. This also has to do with conducting experiments. I experiment with my makeup every day. Have I put on too much blush; did I not put on and enough foundation? That is what scientists do with some kinds of elements. Putting on makeup relates to what scientists do with synthetic elements in the lab.

Summary. Although Alex did not state the reason behind washing her hand, she knew enough that washing the cut was necessary to remove dirt that might infect her hand. Her experiences and prior knowledge of cuts and scrapes helped her make the decision to wash it with water. Her perception of the degree of severity of the injury helped her determine whether she needed to go to a health care professional, or take care of the cut at home.

The remarks about the process of applying make-up demonstrated Alex's knowledge of how scientists ask questions and test things by trial and error. Alex also noted scientists in some way evaluate the results of their trials and tests.

Task 4: Seen as a Science Person

Figure 4a: Alex Task 4 Different Colored Eyes

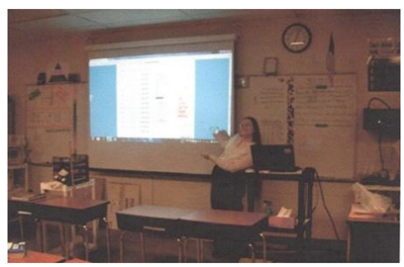

Figure 4b: Alex Task 4 Ring Tones Presentation

Alex's photograph for Task 4 was a close-up of her eyes (Figure 4a). Alex noted that her eyes are different colors, as shown in the photograph. I asked her how others see her as a science person. She explained,

People can see me as a science person even though I'm not interested in not pursuing a career in that sort of field. They can see me as something that is… I easily notice things,

> I'm observant, and I'm inquisitive about the world around me. Like why do people laugh when they get a punch line to a joke? Why are my eyes different colors? And they [questions] can pop into my head anytime. When I do have the time, I can find the right things that I need to answer the questions.

The second photograph was of Alex giving a presentation (Figure 4b). Alex interpreted that others see her as a science person. She clarified,

> People can also see me as a science person because of how easily I can argue how what I think is right. Like how my hypothesis can be correct. Here I'm on a web site that my science teacher showed me, that had ring tones that were really high pitched so that kids can use them in the classroom and the teachers can't hear them. [This is] because younger people can hear more high-pitched sounds than older people can. You can't see it here, but I have three to four people in a small audience. I challenged them to listen and see if they can hear all the different frequencies and settings on the web site.

Summary. Alex's first picture was of her eyes. She explained that she is inquisitive. Others see her as a person who asks questions like a scientist who investigates the world around them. Her eyes show in their inquisitiveness that she is asking questions in a scientific way. Regarding the second photograph of the class presentation, Alex was confident in front of her peers and excited to test out her hypothesis with the class because she was comfortable with her knowledge about the topic. The class participated in her trials of the sounds, and recognized her pension for asking questions. For these reasons, Alex believes others see her as a science person.

Task 5: Everyday Life

Figure 5a: Alex Task 5
Flash in Mirror

Figure 5b: Alex Task 5
Fog

Alex began her description of her first picture (Figure 5a), in everyday life, by referencing girls on the social network,

> You know how girls on the social network hold their phones up to the mirror and they take a picture? That’s what I did here. But, as you can see in the picture, (laughs) my phone was on flash. The mirror does not block out the flash. It reflects everything that it can. So, what I said in my journal is true, that I still have to turn the flash off.

She also referenced her photo-journal in her response. She had written out some of her thoughts in her journal about the photographs she took.

Alex took a picture of a building surrounded in fog or a low-lying cloud (Figure 5b). She predicted that it would rain near the building and not around the surrounding area. She based her prediction on what she learned about precipitation “and stuff like that.” Alex recounted that she made a prediction that would lead to a hypothesis and an investigation.

Summary. Alex chose current and relevant concepts to photograph. She utilized the concept of "selfies" or photographs a person takes of them self, to share on social media internet sites as a basis for her first picture. A picture of herself in a mirror shows her interest in an adolescent girl's everyday encounter with science. Alex wondered about the reflection of the flash from the phone camera. The photo of the fog and her thoughts about predicting what might happen illustrated her grasp of scientific inquiry and the process of the scientific method.

Task 6: Future

Figure 6a: Alex Task 6
Belle

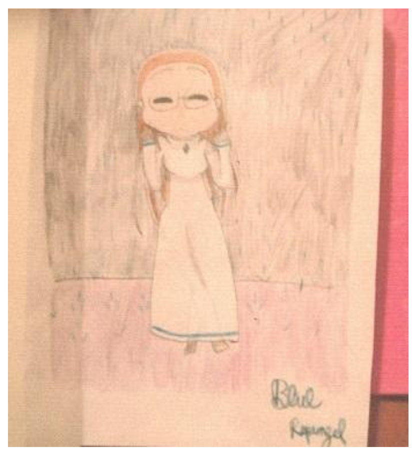

Figure 6b: Alex Task 6
Blue Rapunzel

Alex's first photograph about her future was a picture of her dressed as Belle from her performance in the school's spring musical, *Beauty and the Beast, Junior* (Figure 6a). She was holding a bouquet of roses that her parents gave her for doing a good job as one of the play's characters. This was her response to the task,

> Here I am in my costume for this year's *spring* musical (giggles) since it was in February. We were doing *Beauty and the Beast, Junior*. I played a rather minor role but it represents what I would like to do as an actress. It may not directly relate to science, but I am easily able to remember my lines, my cues, things like that. And that has to do with psychology and tricks that I have learned in order to remember what I have to remember.

In both her photo journal and her interview response, Alex remarked that she wants to be an actress. She considered that it did not have much to do with science except she could memorize her lines easily.

The second photograph for Task 6 was a drawing Alex did in the past of a girl in a long dress (Figure 6b). She took this photograph to represent her desire to draw or animate comics. Alex titled the drawing, *Blue Rapunzel*. She elaborated,

> Here is a drawing that I did quite a while back. I may also want to draw comics or be an animator. It is sort of being like an actress, it doesn't have anything hand-in-hand to do with science. It also has to do was psychology in a way because I can see what the picture should look like in my head before I even start drawing a rough sketch for it.

Summary. Alex was the most excited about the last task concerning what she would like to do as an adult. She is an accomplished vocalist and has participated in the middle school musicals for 3 years. She is proud of her starring role in the *Beauty and the Beast, Jr.* Musical. She also likes art as she would like to become a cartoonist or animator. She was apologetic that neither of these career paths had anything to do with science.

Discussion and Reflection on the Project

Science and scientists. The following dialogue (See Interview Protocol, Appendix E) with Alex illuminated her perceptions about science and scientists.

Researcher: In general, what do you think science is? When somebody says ‘science’ what do you think that is?

Alex: A foundation for an epic journey. You can ask a question about something and you can notice something about the same thing. You can guess an answer for your question and then you investigate more on it and see if you are right **or** wrong and that could go with anything. It could be like Abraham Lincoln, questions and learning about him. That is what science is, in my opinion.

Researcher: Along with that, what do you think a scientist is?

Alex: A scientist is someone who is always ready to make the discovery.

Researcher: Would you consider yourself to be a scientist?

Alex: Sort of. There are certain things that I know a lot about, like my eyes, for instance, and heredity. But some other things about that sort of topic I may not know.

She admitted there are other topics she does not know a lot about, but is willing to ask and answer questions when the opportunity arises.

Capability in science class, present and future. Alex believes she is capable in science. She explained,

> I know I’m capable because I don't need assistance all the time, a lab partner or my science teacher. I can pretty much make whatever I need to be a reality, even though it's great to have help from someone. It is almost as great to find things on your own.

Looking towards her future and high school and college classes, Alex predicted she would take sound technology where she can mix sounds and see how they work together. She also sees herself taking chorus and drama classes.

Parent involvement. Alex's Mom helped her compose her photograph of a pitcher, suggesting Alex use an infinity cove. I asked what an infinity cove was and Alex explained it is a white background to make the pitcher stand out. Alex shared that her parents, "… push me to gravitate towards questions that no one would really think about" which demonstrates Alex's curiosity. Alex used the question about why some hairs grow faster than other hairs as an example of something that others might not wonder about and question.

Alex responded to the question about her parents' careers relating to science by saying her parents are entrepreneurs, but they do not make their own products. She intimated that what her parents do could relate to science, but she did not elaborate what the connection might be.

Other influences over Alex's interest in science. Alex cited the kid shows on television that she watched when she was little gave her a head start in her interest in science. The shows "engaged me in sort of answer this question here." She also noted she asked her parents questions about the world around her.

Do anything differently. At the end of the interview, I asked the participants about the whole project and their thoughts about the experience. When I asked Alex if she would do anything differently or regretted not adding something to the project, she paused to think. She remarked that getting a better photo of the experiments or having a better camera is something she would change. She thought a better camera with improved focusing and lighting would make a better project.

Participant's final thoughts. Alex thought the project was interesting and she thought quite a bit about it. If teachers did a project like this at the beginning of the school year, would it help them be better science teachers? Alex replied in the affirmative and then added "to some extent." She explained this project was about basics of science experiments. She admitted she took more pictures than were required, and those pictures were about science in everyday life. She thinks those pictures she rejected would help the teachers and help them teach their classes.

Levi

Levi is a fourteen-year-old eighth grade student who is a bright and articulate adolescent. He does well in school, works hard to make good grades, and likes science. He has been a peer leader who has worked with different teachers and groups of students as a role model for others.

Task 1: Past

Figure 7a: Levi Task 1
Tree

Figure 7b: Levi Task 1
Pet Dog, Lucky

Levi's first picture was of a tree (Figure 7a). He recalled, "The tree, and how it reminded me of how we learned about plants. I believe in seventh grade we learned how they used photosynthesis and the sunlight." The class learned that photosynthesis is the process where plants convert sunlight, carbon dioxide, and water into glucose, oxygen, and energy.

His second photograph for Task 1 was a photo of his dog (Figure 7b), Lucky. He explained, "The second picture is of my dog and it reminded me of how we studied animal bodies in seventh grade and how they function and how their muscles and different organs work." In seventh grade, they studied body systems of different animals including worms, frogs, and sharks.

Summary. Levi remembered his Life Science classes and the concepts he learned. He recalled major concepts such as photosynthesis and animal functions. Bodies, systems, organs, and muscles are a small part of the Life Science curriculum. Dissections of frogs and sharks gave the students real-life, hands-on application of animal bodies and systems.

Task 2: Science Class

Figure 8a: Levi Task 2 Batteries

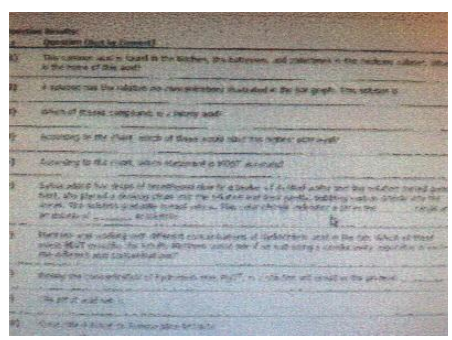

Figure 8b: Levi Task 2 On-line Test Practice

Levi's picture for interacting with science in the classroom was a photograph of AA batteries on a desk (Figure 8a). He described how he used the batteries in experiments to "learn how they function with wires and the loads and resistance and everything." Levi's eighth grade science class is physical science and the classes perform experiments about once a week.

His second science class photo was of a computer with a practice test in the window (Figure 8b). This is his story about the practice test.

Levi: Here's a picture of us studying for USATest Prep for our EOCTs.

Researcher: Okay for those people that don't know what USA Test prep is, could you describe that program?

Levi: USATest Prep is an online site that makes tests and assignments for study purposes that you can go on and use for different classes.

Researcher: Okay what does EOCT stand for?

Levi: End Of Course Test

Researcher: Do you think the online things helped you?

Levi: Yes, a lot.

Researcher: Did you have random tests or did you have assigned tests?

Levi: We had some assigned tests and then we could go back and do some random tests. That one, I think, is a picture of a random test that we could do.

The teachers can make a test from a bank of questions or the students can choose a randomly generated test for the Unit.

Summary. Levi chose equipment used for experiments and time on the computer completing practice tests as his school related photos. He focused on the interactive aspect of the science experiments and technology. His hands-on laboratory experiments helped him learn the

Physical Science concepts of electricity and circuits. He seemed to like the interactive aspect of the on-line review activities as well.

Task 3: Outside of School

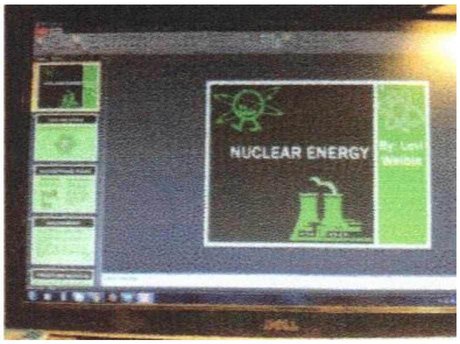

Figure 9a: Levi Task 3
Nuclear Energy Power Point

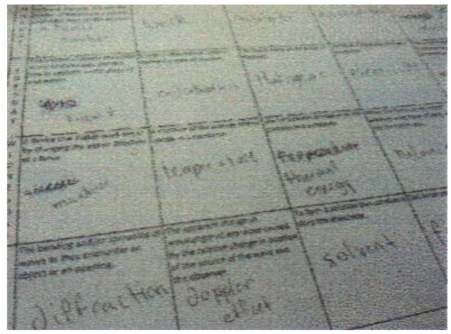

Figure 9b: Levi Task 3
Big 20

Levi took a photograph of his home computer screen showing a Power Point slide show about nuclear energy (Figure 9a). Levi made sure he had the title slide and the different slides on the left side of the window in the photo shot. He explained the project.

Researcher: Did you get to choose your topic?

Levi: No, I really had to do nuclear energy. There were different questions that were laid out that we had to answer.

Researcher: Did everybody answer the same questions?

Levi: Yes

Researcher: How long was your Power Point?

Levi: I believe it was 10 or 11 slides.

Researcher: Were you working individually or with a group?

Levi: Individually

Researcher: Did you present them?

Levi: No, we turned them in and the teacher graded them.

Levi's second snapshot for Task 3 was a picture of "The Big 20" (Figure 9b). He described it as review questions on what the class had previously done. The one in the photo was a vocabulary review. They received a Big 20 every week and completed five of the 20 questions every day, Monday through Thursday, and checked their answers on Friday. This type of assignment counted as a homework grade.

Summary. Levi seemed excited about the nuclear energy research. He was interested in the process of finding out about a topic that was unfamiliar to him. The fact that he kept "The Big 20" to review for tests demonstrated that Levi is organized and studious. When I asked Levi about the first three tasks that he completed, he responded that some might think that taking pictures of paper is "kind of odd." He continued his thought, "It was a fun task because I did think outside the box on how science related to my life outside of school."

Task 4: Seen as a Science Person

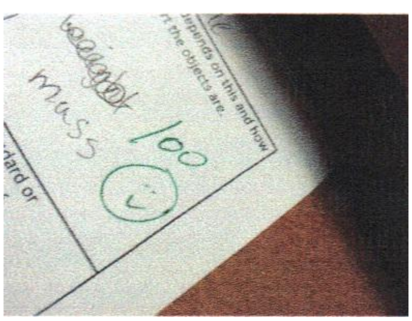

Figure 10a: Levi Task 4
Perfect Score

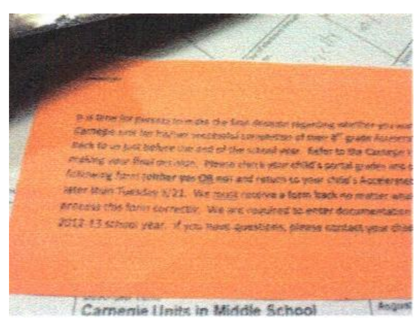

Figure 10b: Levi Task 4
Carnegie Unit

The first idea Levi had for this task, was to take a picture of a "100%" on a class assignment (Figure 10a). He stated that he does well in science and others think of him like that. The second photograph was of an invitation to count his 8th grade science class as a high school Carnegie Unit (Figure 10b). Levi commented,

Levi: That is a picture of the Carnegie unit that counted for this year. It was [an invitation] to count this year's eighth grade credit for high school and I figured it showed that I do well as a science student and in my classes.

Researcher: Did you go ahead and sign up for the Carnegie unit?

Levi: Yes

Researcher: So how does that affect you in high school?

Levi: It gives me a credit for my senior year, I believe, as an elective credit and so I can take a dual enrollment class or another class at the Technical High School.

Researcher: So it put you up a notch on your requirements for high school?

Levi: Yes

Levi's science teacher had his high school science certification and therefore the advanced curriculum met the qualifications for high school credit. Those students who maintained an A or B average in the class had the option of using the class for the high school Carnegie credit.

Summary. Levi is proud of his grades and the reputation of being a good student. He is confident in his role as one of the leaders of his science class.

The acceptance of the Carnegie credit demonstrates that Levi is motivated and thinking of his future. He has maintained his excellent grades and has researched what he needs to do to take the classes he wants by the time he finishes high school.

Task 5: Everyday Life

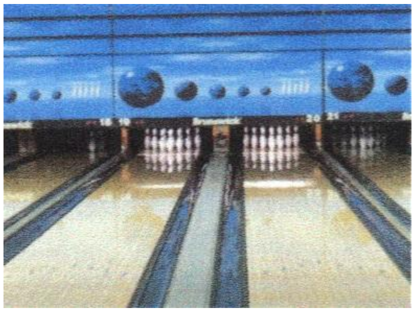

Figure 11a: Levi Task 5 Bowling

Figure 11b: Levi Task 5 Skateboarding

The picture Levi included for this task was a Mother's Day outing at the bowling alley (Figure 11a). He related, "The mechanical energy that comes from my body allows the ball to roll down the alley and knock over the pins."

Levi's second picture was of him skateboarding (Figure 11b). Again, he mentioned mechanical energy when he described pushing off the ground. He started to discuss friction and changed his mind. Instead, he explained that when the wheels roll forward, he rides his skateboard.

Summary. Levi probably referenced mechanical energy and friction because he studied these concepts during his 8th grade physical science class. The photographs depicted application of what he learned in class.

Task 6: Future

Figure 12a: Levi Task 6
Georgia Tech

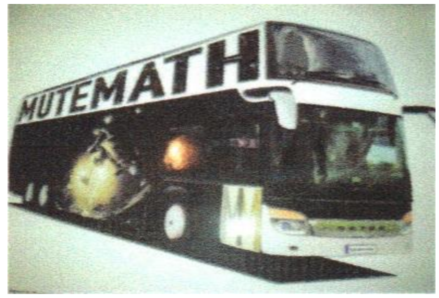

Figure 12b: Levi Task 6
Graphic Design for Band Bus

The first picture for Task 6 was of a Georgia Tech souvenir cup (Figure 12a). This is where Levi would like to go to college.

The second picture related to the first because it was Levi's graphic design for a tour bus for the band MuteMath (Figure 12b).

He shared his story:

Levi: I'll show you the next picture. That is a picture of a tour bus for a band that I designed at a camp last year using something like Photoshop, but I think it was another program. That's what I hope to do, that kind of designing and such.

Researcher: What kind of camp was it?

Levi: It was like an all-around camp at a high school. And one of the classes you to take was graphic design and that was the one that I took.

Researcher: Was it over the summer school period?

Levi: It was one week, I think.

Researcher: So is that through the community school or…

Levi: It was through the high school.

Researcher: How did you find out about it?

Levi: I think the middle school sent out a flier about it at the end of the school year.

Researcher: Did you go to any other camps?

Levi: No, I just went to the graphic design course.

The photograph was of his final project, which was to design a graphic design for a band's tour bus.

Summary. Levi brightened when I asked about his photographs previewing his future. He was excited about using his creativity and continuing his interest in graphic design. He seems set on making the grades he will need to go to Georgia Tech. He focused on Georgia Tech and did not mention any other colleges or universities that he would like to attend.

Discussion and Reflection on the Project

Science and scientists. I asked Levi what he thought science was (See Appendix E). Worded a different way, I elaborated, "When someone says that you are doing science, what does that mean to you?" Levi took a few seconds to think. He replied,

> It means a lot of things, like I think of biology for one and then it goes on to chemistry, which in my eyes is a completely different thing. So really, I think science is how we came to be, how we function, and how the world functions and there are different branches [of science].

When asked what a scientist is, he responded, "A person who studies all that." Then he laughed. He added, "… [The person] goes deeper in learning about how we all function in everything and explains that's really why or how everything works." When asked what he envisioned a scientist is in his head, he described a picture of a lab coat, goggles, and maybe looking through a microscope. When asked if he thinks of himself as a scientist, he said he considers himself as one in a way, but not like "…a major scientist." He thinks of himself as a student because he is "…still studying these things and it's not like I'm the first one to discover these ideas."

Capability in science class, present and future. Levi felt he was capable in science. He mentioned that he has taken accelerated science classes throughout middle school and has done well in those classes. He believes others see him as a science person and his grades on papers and tests place him at the top of his class. He said he did not want to brag, but he thought others see him as a math and science person.

In the future, Levi wants to take graphic design at the technical high school where the class is more computer-based technical stuff. He will take AP Biology in 9^{th} grade next year.

Parent Involvement. Levi disclosed that his parents had nothing to do with this project. Yet, he admitted that his dad has had some influence on him. His father is an electrical engineer and pushed Levi to acquire knowledge in the electrical field, which Levi declared is a branch of science.

Other influences over Levi's interest in science. Levi revealed that he has had "pretty good teachers that have inspired him to do well in science."

Do anything differently. When asked if he would do anything differently for this project, Levi remarked that he could have taken better pictures that would have shown better ways science was in his life. He gave the photographs for Task 5, Science in Everyday Life, as an example of what he meant. He remembered that both pictures were of mechanical energy and he believed he could do a picture of mechanical energy and the second photograph of some other kind of energy.

Participant's final thoughts. Levi had nothing to add to our conversation about science and his perceptions of science in his everyday life. He had mentioned that taking these photographs made him think "outside of the box" to respond to the photography tasks.

Katie

Katie is an 11-year-old sixth grader. She loves to play sports and this year was a cheerleader for the league football team through the county parks and recreation association. She likes being outdoors and playing with her dog, Diesel.

Task 1: Past

Figure 13a: Katie Task 1
Chocolate Cake

Figure 13b: Katie Task 1
Shrimp Dinner

Katie's first photograph was of a chocolate cake (Figure 13a). I asked her how baking a cake related to science.

Katie: Because with baking, I mix it all up and put it in the pan. It kind of flattened and once it bakes it gets tall, bigger, it rises and is not as 'liquidy.'

Researcher: Are there are any other things, scientific things, related to baking?

Katie: It's first kind of a liquid and then it comes out kind of like being a solid.

Researcher: How do you know how much of the things to use?

Katie: I read the directions. I use a half of a cup, or a fourth of a cup, or 1 cup and then mix it all together.

Researcher: Does that have anything to do with science?

Katie: Yes, because if you didn't have measuring cups you wouldn't know how much stuff to use and it might come out to be bad or not right.

The second picture was of shrimp cooking in a pan (Figure 13b). The shrimp were raw and she boiled them. Katie declared, "Then the shrimp became cooked." I asked Katie what happened from the raw state to the cooked state. She identified the heat as changing the shrimp.

Summary. Katie likes to bake and cook in her kitchen. Her photographs for the past demonstrated her knowledge of the scientific process of measuring and being precise with different measuring tools. She also realized the importance of accuracy in her measurements so that the things that she made would have the desired outcome of the prepared food. Katie knew that the cake and the shrimp both changed forms by heat. She did not elaborate on exactly what change occurred, such as a chemical or physical change of matter.

Task 2: Science Class

Figure 14a: Katie Task 2 Science Project

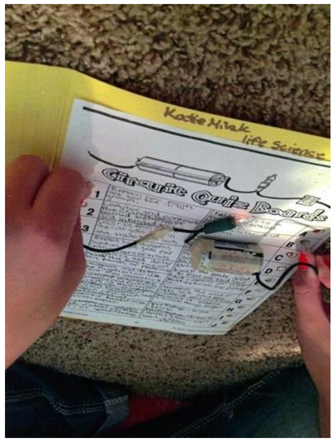

Figure 14b: Katie Task 2 Quiz with Circuit Board

Katie was excited to discuss her photograph of a science project for this task (Figure 14a). It was a homemade circuit board for a quiz. She described the project,

Katie: I did this science project from last year where you used tin foil. You first get a folder and a hole punch and punch holes. Then you get the tin foil and put it over where you punched holes. You would do strips and put tape over it to act as an insulator. You get two paper clips, two wires, and a battery and tape it all together. There would also be a little light bulb like Christmas lights. You put the paper clip on to the holes. If it was the right strip, the light would light up, but if it's wrong then it wouldn't.

Researcher: What were your questions you had on your paper?

Katie: It was a science project and we had to write down these questions with the answers.

Researcher: Did everybody make the same project?

Katie: Yes

Researcher: With the batteries and the light, what kind of science was that?

Katie: I would say it's like experimenting, not experimenting, but how you make it. I don't know what you would call it.

Researcher: Where you have a battery and something that you light up and wires, what is that called in your house?

Katie: Oh, electricity

Researcher: Electricity, so this would be an electric current?

Katie: Yes

Katie's second photograph for science in the class was a second photo of the circuit board project, only at a closer angle (Figure 14b).

Summary. Katie was excited about sharing this photograph of her circuit board project. She remembered how she put the project together and how it worked. She recalled the circuits she made with tin foil in order for the quiz-type format to succeed. She knew this was science, but could not explain exactly how to identify the connection. Together we co-created meaning from the stimulus of the photograph.

Task 3: Outside of School

Figure 15a: Katie Task 3
Fire Pit

Figure 15b: Katie Task 3
"S'mores"

Katie took her photographs for Task 3 outside in her backyard. The first photograph was of a portable fire pit (Figure 15a). There were pieces of firewood burning in the fire pit and a stick with a marshmallow on the end of it. Katie explained,

Katie: I was doing 'S'mores.' We had a fire pit and we put the 'S'more' over the fire and it cooked a little bit. The more you cooked it the blacker it got from the heat cooking it.

Researcher: What was the part of the 'S'more' that you put over the fire?

Katie: The marshmallow

Researcher: What are marshmallows made out of?

Katie: Sugar and syrup. It is called Caro sugar I think or something like that.

Researcher: So what do you think is turning black in the marshmallow?

Katie: Sugar

The second picture for Task 3 was of the completed "S'more" that Katie was eating (figure 15b). The "S'more" had a bottom layer of graham cracker, a chocolate bar, hot marshmallows right off the fire, and a top layer of graham cracker.

Summary. This was a good example of science outside of school. Katie used the fire as the heating source and discussed how the heat from the fire blackened the sugar in the marshmallow. Katie had happy memories of making this snack with her family and could connect it to science.

Task 4: Seen as a Science Person.

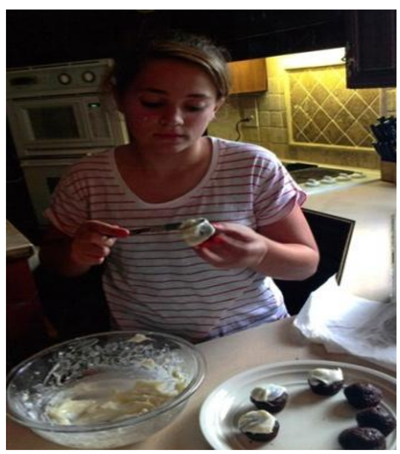

Figure 16: Katie Task 4 Baking

Katie took a photograph of her baking in her kitchen (Figure 16). She was making cupcakes and icing, and the photograph shows her icing the cupcakes. She stated this shows her as a science person because, "…she can make her own stuff and bake with all the ingredients and do it right, and it turns out okay." She recognized that her Mom, Dad, and brother see her as a science person.

Katie did not take a second photograph for this task.

Summary. Katie sees herself as a baker and a cook and feels others see her that way, as well. She enjoys working in the kitchen and making dishes from scratch. She acknowledged the science behind the baking, such as measuring, timing, and heating the items she is making.

Task 5: Everyday Life

Figure 17a: Katie Task 5
Spoiled Sandwich

Figure 17b: Katie Task 5
Bird's Nest

The picture Katie composed for Task 5 was of a sandwich in a zip-locked bag (Figure 17a). She reported,

Katie: I left my sandwich in my book bag over the week. I forgot about it and it got all moldy.

Researcher: What does mold show you?

Katie: It shows you that you can't eat it anymore, that it's rotten.

Researcher: What other senses did you use to look at that?

Katie: It didn't smell too good, either.

Katie included a photograph of a bird's nest in a flowerpot on their patio as her second photo for Task 5 (Figure 17b). She related that she did not see the birds make the nest. She and her Mom discovered the nest while they were watering their plants. I asked whether she thought the nest had babies in it. She replied she did, but even though they could see the plant and nest from their window, they never saw the birds.

Summary. Katie understood that she needed to eat the sandwich within a short amount of time, or put it in the refrigerator. Since she had forgotten the sandwich for a week, she knew it would not be good to consume it. She knew the signs of mold and the smell of something not healthy to eat. The mold and rotten smell related to the decay process of foods and thus was science encountered in everyday life.

The bird nest represented nature as part of science. Although Katie never saw the birds, she took a photograph of what the birds had made. She and her Mom were surprised to find it in the plant, and to realize that they had not noticed it until after the birds had finished with it**.**

Task 6: Future

Figure 18: Katie Task 6
Pet Dog, Diesel

The photograph for Task 6 that Katie snapped was of her dog, Diesel, giving her a kiss (Figure 18). When asked what she would like to do as an adult, she replied that she wants to be a veterinarian and help with animals. I asked Katie what kind of training she thought she needed to become a veterinarian.

Katie: You need to be good at science or math because if an animal is sick, the thing you need to be able to do is know the right medicine and how much to give. You also need to get a Doctor, not for people, just for animals.

Researcher: Have you had many pets?

Katie: Yes, I have.

Researcher: What kind?

Katie: I've had hermit crabs, Guinea pigs, fish, dogs

Researcher: At one time, I thought I saw a caterpillar cage or bug catcher cage on your front porch. What was that?

Katie: We ordered that online. It was these caterpillars. They had a couple of holes in the cage and it had food already in it. The caterpillars would eat the food. Then in the top of the cup in the cage, the caterpillars would make a cocoon. You would put it in; I don't know what you would call it, where you can put animals in it and air gets through it and they can still live. You would put them in there and they would turn into butterflies!

Researcher: Did yours turn into butterflies?

Katie: Yes

Researcher: And what kind of butterflies were they?

Katie: I think they were monarch or something

Researcher: You have a picture of your dog. What is your dog's name?

Katie: Diesel

Summary. Katie expressed that she wants to be a veterinarian, which is a career in the field of science. She has had experiences with many types of animals and has the compassion to want to care for them. Her photograph shows her love for her pet dog. She has observed animals in nature and in a controlled environment, such as the insect cage.

Discussion and Reflection on the Project

Science and scientists. When I asked Katie what science is, she responded, "Science in your everyday life, you're standing on the ground which is gravity, and there are trees which give you some oxygen, but oxygen mostly comes from algae in the water." I inquired what Katie thought a scientist was and she replied that they explore and get into ideas more. She gave the following scenario, "Let's say a human was dead. They would've never known it had cells unless they actually went into it and explored."

When asked if Katie thought of herself as a scientist, she replied, "Yes." I asked her to elaborate and she responded,

Katie: Well, I'm always baking, or not always, but I do bake some. And in science, I am always bringing in things. We were learning about rocks and minerals. I'll bring in rocks and show them. We have to name the five characteristics of a rock, which is a solid, but inorganic, it can't be from a living thing, made from something outside, it has to have a chemical compound, and crystal shape.

Researcher: Is that a rock or a mineral?

Katie: Oh mineral, sorry!

Capabilities in science class, present and future. Katie stated that she is a good science student and she makes the highest grade of “A” in her science classes. Continuing on the thoughts about classes, I asked Katie what kinds of classes she thought she might take in high school. She admitted she did not know the names of the courses, but she would definitely take science classes. Pressing on, I inquired what courses she thought she would need in college if she were going to be a veterinarian. She thought she would take science, math, and health courses.

Parent involvement. Katie maintained that her parents helped her prepare for participation in this study. I asked her how her parents influenced her interest in science. She declared,

> They let me go outside. Once I caught a frog. I could tell it was not happy because his leg was broken and all of his hands, or whatever you call them; they were cut off or someone hurt it. So my parents just let me dissect it.

Katie thought that was cool. She admitted she did use gloves and goggles to dissect the frog.

Other influences over Katie’s interest in science. Katie remarked that she likes to know more. When she was little, she wanted to know how people stay on the ground, which is gravity. She asked many questions. I asked if she liked her science classes. She responded that she did and she even has an extra science enrichment connections class. (Connections classes are those classes outside of the core academic classes.) When asked how the science enrichment class is different from her academic science class, she responded that they learn about what they are learning in her academic science class, but she felt free to ask more questions. They learn more about the concepts that they learned in their regular academic science class.

Do anything differently. Katie responded that she would not do anything differently. She was satisfied with the photographs she took and the way she answered the interview questions.

Participant's final thoughts. When asked if Katie had anything else to add about science she thought for a few minutes. I prompted her to talk about her science experience in elementary school. She recalled that her fifth grade teacher taught both social studies and science. They would have three weeks of social studies and then three weeks of science. The teacher would teach a unit and then give a test on the material. The teacher told the class that if the class average on the test was above 80, then they would do an experiment related to the unit. Katie thought this was a reward. Through the experiments, they would learn more and actually get to try things out.

Lexie

Lexie is 12 years old and in the seventh grade. She likes playing sports such as softball, soccer, and basketball. She also likes spending time with her friends. Lexie has a pet dog and has had many different kinds of pets over the past several years.

Task 1: Past

Figure 19a: Lexie Task 1
The Sky

Figure 19b: Lexie Task 1
The Beach

Lexie took a picture of clouds over the beach (Figure 19a). She said that the clouds made her think of how clouds form and how that is part of the water cycle.

Lexie's second picture was another aspect of the beach (Figure 19b). I asked Lexie what was the connection between the beach and science. She thought for a few seconds and responded, "There is a lot of life at the beach under the water. And there is sand, and shells that have been crushed up and made into sand." Lexie mentioned there are many sea creatures.

As Lexie was describing the beach photograph, she thought of something else related to Task 1. She declared, "Last year we did a bottle rocket with a 2 liter bottle. Every time I see a 2 liter bottle it reminds me of the rockets." There are no photos of this as she just thought about another instance of science in the past as I was interviewing her.

Summary. Lexie remembers concepts taught in class and makes the connections between what she learned and what she experienced in the past. She recalled the water cycle, formation of clouds, life at the beach and weathering of shells into sand. As we were talking, she remembered the rockets made from 2-liter bottles. The photos led her to reflect on past science experiences and those thoughts triggered another memory of science in the past.

Task 2: Science Class

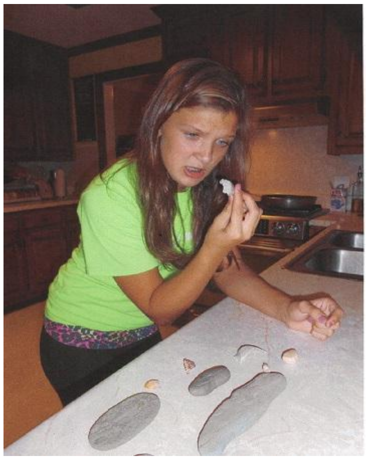

Figure 20a: Lexie Task 2 Rocks, Fossils, and Shells

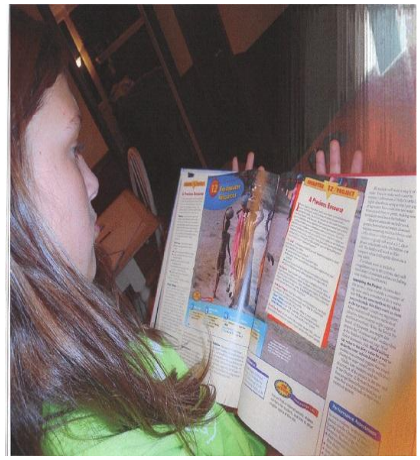

Figure 20b-1: Lexie Task 2 Science Textbook

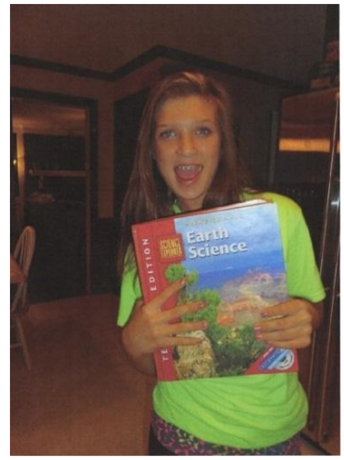

Figure 20b-2: Lexie Task 2 Science Textbook

Lexie took the first photograph (Figure 20a) of some rocks and fossils. I asked her what she was examining and she replied that they had picked up rocks and shells at the beach while they were on vacation. She described the items on the table,

Lexie: Well, there are shells, igneous rocks, and different pieces of granite.

Researcher: OK, what did you learn about in school?

Lexie: Well, we learned about igneous rocks, sedimentary rocks, and metamorphic change.

Researcher: OK, and then what does the shell show you?

Lexie: The shell, well those get crumbled up into rocks and make littler rocks. That is something that we had to do during science class.

The next two photographs (Figure 20b-1 & Figure 20b-2) were of Lexie's science textbook. She included these photos because they did a lot of work out of the Earth Science book. I asked her what science she has this year and she responded that she has life science. She noted that she likes life science much better than Earth science.

Summary. Lexie's responses to this task of science in the classroom were quite literal. She chose rocks and shells that she had at home and could photograph. She did make the connection to the rock cycle, even though she did not mention the specific term for the processes acting upon rocks as they change form. The pictures of the science textbook are concrete examples of what teachers use as a resource to teach the science concepts and skills.

Task 3: Outside of School

Figure 21a-1: Lexie Task 3 Measuring Water

Figure 21a-2: Lexie Task 3 Accuracy

Lexie composed a photograph of her measuring water to boil noodles (Figure 21a-1). She was going to cook something. I asked her if science is involved in cooking. Her response was there is water and fire. I asked if there was a heat source and she said yes and admitted that the water was to boil. I asked her how she knew when the water was boiling and she responded that it is boiling when you see bubbles. I asked her if she was using a quart measure and how many cups it would hold. Lexie guessed it was six cups. She stated that she filled the measuring cup to a cup and a half. Lexie described the photos as demonstrating her pouring water from a small measuring cup into a larger measuring cup to boil her noodles (Figure 21a-2).

Figure 21b: Lexie Task 3
Lighter Flame

This was Lexie's second example of science outside of school (Figure 21b). She is holding a lighter that has the flame burning. When I asked her what fire has to do with science, she explained, "Fire's like science, like how it's made all the chemicals and things like that."

Summary. Lexie knew there was science involved in cooking in some way. She was unsure of the direct connection. She understood that heat, boiling water, and fire are parts of science, but could not verbalize the exact processes taking place that produce chemical and physical changes. She realized that measuring is a task done in science and demonstrated measuring water in different measuring containers.

Task 4: Seen as a Science Person

Lexie did not have any photographs for Task 4. She declared that people do not see her as a science person. I asked her why she thought that. Lexie replied, "Well, because it is not my best subject. I am more of a math and social studies person."

Summary. I thought it was interesting that Lexie had no pictures for this category. She knew she did not do well in science and that is what she thought other people use to determine whether one is a science person.

Task 5: Everyday Life

Figure 22a: Lexie Task 5
Watering Flowers

Lexie believed watering flowers was an example of science in her everyday life. Lexie described the photograph (Figure 22a) as pouring water into a pot of flowers to help them grow.

Figure 22b-1: Lexie Task 5 Shower

Figure 22b-2: Lexie Task 5 Lexie in Shower

Lexie included photographs of the shower (Figure 22b-1) and of her in the shower (Figure 22b-2). She stated she included a shower,

Lexie: Because water, all the minerals, and heated water and all.

Researcher: Do you know how your water gets heated for your showers?

Lexie: Well, you turn it hot…

Researcher: It just magically comes out hot?

Lexie: Well there's some machine…

Researcher: A hot water heater?

Lexie: Yes!

Researcher: Did you learn about water in science last year?

Lexie: We talked about how there's these different minerals and about the water cycle and all.

Summary. Lexie photographed another use of water. Her hesitation to respond to where the hot water comes from demonstrated that she had not really thought or wondered about it. She related that the water is part of the water cycle, a basic principle taught in sixth grade Earth science classes.

Task 6: Future

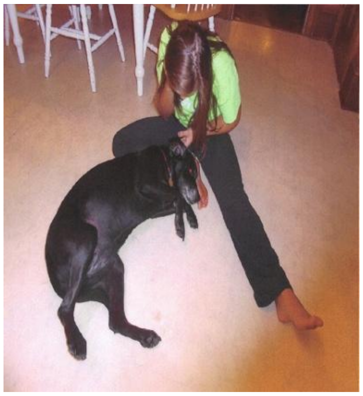

Figure 23a: Lexie Task 6
Pet Dog

Lexie's first photograph for Task 6 was of her and her dog (Figure 23a). Lexie would like to be a veterinarian. She described a veterinarian,

Lexie: Helps animals from getting sick and help them be healthy.

Researcher: Have you had a lot of pets?

Lexie: Well, yes, I've had a couple of dogs. I have had lots of fish, a turtle, and I've babysat some rabbits.

Researcher: Babysat – so you have a friend or neighbor with the rabbits?

Lexie: Yes.

Researcher: Anything else? What's your favorite animal?

Lexie: I like dogs a lot. I think sharks are pretty cool, but that’s more, like not a vet. [more like a marine biologist]

Figure 23b: Lexie Task 6
Modeling Poses

The second photograph Lexie submitted for Task 6, the future, was a trio of photos representing her as a model. She talked about how she liked to wear different outfits and create poses like a model (Figure 23b).

Summary. Lexie loves animals and thinks she would like to be a veterinarian. This would be a science field and would require many courses in science. There is a dichotomy between her sense of ability and lack of interest in science and her understanding of courses needed for a degree in Veterinarian Medicine.

Discussion and Reflection on the Project

Science and scientists. Lexie stated that when she thought of science, she thought of life. She went on to explain,

Lexie: Well, when I think of science I think of life: life, creatures, animals, plants, living things, and also rocks, water and ….

Researcher: What do you think a scientist is, then?

Lexie: A scientist is somebody that figures out things, about fossils, does tons of research, and then figures out what kinds of fossils, and how long ago they lived.

Researcher: Would you consider yourself a scientist?

Lexie: Well, not really, because I would rather be a social studies or math person. If I would, [be a scientist] I would be a marine biologist.

Capability in science class, present and future. I wanted to know if Lexie thought she was capable in science and if she earned good science grades. Lexie replied that earth science was not too good. She continued, "…When I'm interested in it more, I learn about it more. So this year I have a 90 [in life science] because I think it's interesting and I get it a little bit more."

Lexie skipped the photographs of how others see her as a science person. I asked her how she viewed others as science people and why she would identify them as such. Her response was, "They know a lot about it [science], and are interested in it, and talk about being one when they get older."

I reminded Lexie that she had mentioned marine biology and veterinary medicine as possible future interests. I followed up with inquiring what classes she thought she would need for those types of jobs. Lexie replied, Lexie: Well, for modeling, I don’t think there really is one, but I would still go to college and get my years done, and then go to classes for it but I don’t think there is actually a college for it. But for a veterinarian they probably have classes and I would probably end up taking lots of those. I would also be trying to get myself out there and volunteering at places.

Researcher: Where do you think would be a good place to volunteer? You’re going to be working with animals, what kind of jobs would be good to volunteer at …or help with?

Lexie: Maybe at the Humane Society? Or like at a doctor’s for them.

Researcher: Or a veterinarian’s office?

Parent involvement. Lexie revealed that her mom is a science teacher and helps her study. Her mom tries to help Lexie learn the material by helping her come up with ways to remember things.

Other influences over Lexie’s interest in science. Lexie stated that interest in science depends on the teacher you have. She continued,

> I like more hands-on things. So, if I have somebody that just reads the science books, then it doesn’t really interest me because it’s just a book and there’s nothing to do except to look at the words. But when you’re doing hands-on [activities] you’re actually getting to experience things.

Do anything differently. Lexie thought she could have done the fire picture differently. She stated that fire is a kind of science and the photograph she took of fire was one you do yourself. She reflected that she could have taken a picture of the fireplace or a picture off the internet of a wild fire.

Participant's final thoughts. I asked Lexie if she had any thoughts about science or likes or dislikes of it. She reflected,

Lexie: Ummm, nothing really, but I kind of wish I was more involved, interested in Science. Like robotics has anything to do with it, I just put myself out there in robotics club.

Researcher: What does the robotics club do?

Lexie: [You learn] to code and program a robot and how to control it by the computer. It's like math and science.

Researcher: Are there lots of girls in there or are there just a few?

Lexie: A lot of boys, probably only about 4-5 girls. I'm one of them.

Researcher: That's a competition, right? They do a competition with it?

Lexie: Yes, you go to different places and compete against different robots from different schools.

Researcher: And the robots have to do different things in the competition, right?

Lexie: Yes, you program it to do things and whoever has the best, they have different awards

Researchers: How did the team do last year – do you know?

Lexie: We didn't compete last year because it was our first year. So we were just getting the gist of it and seeing what it was like to build a robot. But this year we're going to start competing.

Researcher: Are the same high school leaders that helped you out last year there?

Lexie: Yes, and I think there is also one new one there.

Lexie was excited about joining the robotics club. She was interested in learning the coding and operation of the robots. She developed an interest in this science club during the weeks of this project. It might be possible that the reflections and photographs she took for the photography tasks sparked her interest in increasing her exposure to science.

Harsha

Harsha is twelve-year-old seventh grader. He is taking accelerated math and science classes. He is a diligent student who makes good grades and likes school. He plays soccer as an extracurricular activity.

Task 1: Past

Figure 24a: Harsha Task 1 Mineral

Figure 24b: Harsha Task 1 Sunset at Beach

Harsha's first photograph for Task 1 was of a crystal from a mineral (Figure 24a). Harsha reported,

Harsha: I was thinking that my sister loves rocks. That was what I was thinking.

Researcher: Then how do you relate that to science or what you know about science?

Harsha: I relate this to science because minerals help us in our everyday life, like lead is in pencils. That's how we write essays. It helps us in everyday life.

The second picture Harsha shot for Task 1 was a picture of the beach (Figure 24b). Harsha recalled,

> I took a beach picture because we learned about tides and waves. I remember this because we went to Hilton Head over Labor Day weekend. I was remembering what we did in science class. I was at Hilton Head at the beach, and it was very calm and we learned about waves and tides.

Summary. Harsha had drawn upon the things he learned in sixth grade science to create his photographs for science in the past. He remembered learning about rocks, minerals, tides, and waves and found real life examples of those concepts from his past.

Task 2: Science Class

Figure 25a: Harsha Task 2
La Brea Tar Pits

Figure 25b: Harsha Task 2
Snicker's Bar

Harsha included a photograph of the La Brea Tar Pits (Figure 25a) as his first picture for Task 2. He shared that he did "…a really fun project learning about the La Brea Tar Pits." He explained that the project related to science because it was fun to learn about what happened and how it happened. He commented that the La Brea project was his favorite project of his sixth grade year.

The second photograph for this task was of a Snickers candy bar (Figure 25b). Harsha reported that he, "… learned about compression, tension, and shearing" of the Earth's crust by using the Snickers bar to simulate the movements of the Earth's crust. It was around Halloween when he did this lab in class and the teacher gave the students Snickers bars to eat!

Summary. Harsha chose photographs of hands-on activities that he did in science class. He remembered the Tar Pit project because he was able to choose the topic of his research project and he was interested in the topic. He recalled the candy bar activity since it was a treat for students to receive candy as part of their learning experience. He learned the concepts involved with the candy bar as he manipulated the parts of the bar to simulate the Earth's crust. The activity utilized the senses of touch, smell, taste, and sight and made a long-term memory for Harsha.

Task 3: Outside of School

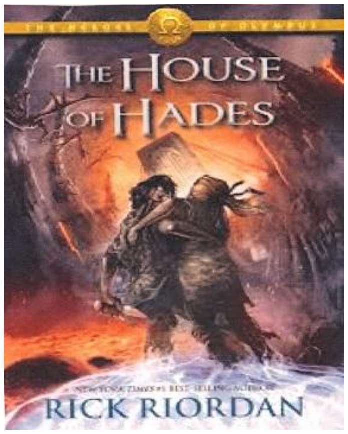

Figure 26a: Harsha Task 3 Reading

Figure 26b: Harsha Task 3 Soccer

Harsha snapped a photograph of one of his books (Figure 26a) for his first picture of Task 3. He explained, "Even though it's complicated, you use your eyes to read, and that's involved with science. I love to read because you hear about stories and this is one of my favorite books**.**" The title of the book was *The House of Hades* by Rick Riordan. He related it to science by describing how you use your eyes to read.

The second photo for Task 3 was of a soccer ball (Figure 26b). Harsha enthusiastically reported,

Harsha: Playing sports – you're using muscles to run, so that's involved with science. Your increased heart rate is related to science. I love sports – because my favorite sport is soccer. I do this out of school. I'm in a soccer league right now.

Researcher: Are you on a traveling team?

Harsha: Yes. We travel to different parks.

Researcher: Does your team do well?

Harsha: Yes

Researcher: What position do you play?

Harsha: I play midfield, offense, and defense

Researcher: Oh wow! So you must be a good runner?

Harsha: Yes, I ‘m sure I’m made for running!

Summary. Both of Harsha’s photographs of science outside of school represent functions of body movement. Harsha interpreted science as the internal processes dealing with reading and playing soccer. He was enthusiastic when he talked about reading and when he described his involvement in soccer. His enthusiasm reflected how much he enjoyed both of these activities.

Task 4: Seen as a Science Person

Figure 27a: Harsha Task 4 Rocks

Figure 27b: Harsha Task 4 Sky

Harsha’s first photograph was of rocks (Figure 27a). He collects sedimentary rocks because he likes the layers in them. He stated that his family knows he collects rocks because he likes to see rocks and the patterns in the rocks. His family has taken Harsha to different places to see rock formations, but he could not recall the specific names of the sites they visited. Harsha excitedly exclaimed that he wants to go to the Grand Canyon.

Harsha's second photograph was a picture of the sky (Figure 27b). Harsha expressed that he loves the weather,

Harsha: The weather – I love the weather because it impacts us – what we wear, when we go. I like the snow. I like to learn about warm fronts and cold fronts.

Researcher: So how does that relate to how others see you as a science person?

Harsha: My family knows I love weather – we see weather every day, they see what I wear, and I always go to weather.com to see the forecast.

Summary. Task 4 was about how others see you as a science person. Harsha interpreted "others" in this task as his family. He mentioned in both photographs that his family knows about his rock collections and his love of weather. He seems close to his family. Harsha did not mention any classmates or other friends as he spoke of how others saw him as a science person.

Task 5: Everyday Life

Figure 28a: Harsha Task 5
Boiling Water

Figure 28b: Harsha Task 5
SUV

Harsha selected a photograph of boiling water (Figure 28a). He stated,

Harsha: Cooking. Because you cook every day. You have to eat. I took a picture of boiling water – evaporation and then it cools down – condensation. That's why I did this one. We do this every day. In my house we don't go out to eat a lot so we cook a lot. I fix this every day.

Researcher: Do you cook, too? Do you like to cook?

Harsha: Yes - it's okay.

The second photograph for Task 5 was an SUV (Figure 28b) that represented transportation. Harsha explained that we take transportation for granted. He continued, "We have to go work every day, we go to school. Buses help us. We need to go places. We use that every day of our lives. It involves simple machines."

Summary. Harsha remembers the scientific principles that he learned in school. He alluded to the water cycle with the remarks about evaporation and condensation. He referred to simple machines that students learn about in physical science. He recognizes that we use science in our everyday lives.

Task 6: Future

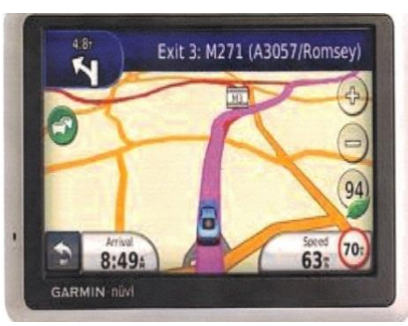

Figure 29a: Harsha Task 6 Global Positioning System (GPS)

Figure 29b: Harsha Task 6 Stars

Harsha's first photograph for Task 6 was of a Global Positioning System (GPS) screen (Figure 29a). He explained that he wants to be a physicist. Harsha's connection to the photograph was that he believes that physicists made the GPS and he wondered how they did it. He knew the physicists used satellites, but that was the only thing he knew about the GPS.

Harsha's second photograph was of stars (Figure 29b). He stated that when he was younger he wanted to be an astronomer. He expounded on his story,

Harsha: I could look up into the night sky and see some stars…see the constellations and I like to see the stories about science and astronomy. I love what we did sixth grade year in science.

Researcher: What was that?

Harsha: In second semester, we learned about astronomy. We learned about the galaxies, the stars, the eclipses, and all kinds of stuff!

Summary. Harsha wants to be a physicist or an astronomer. Both of these careers are in the science field. He was enthusiastic when speaking about what he would like to do in the future. Harsha is serious about his connections with science and has his sights set on working in a science field.

Discussion and Reflections on the Project

Science and scientists. Harsha responded to the question about what is science by stating that science is everything. He continued, "Like we do science when we are walking, talking, and it helps and impacts us in everyday life." I asked Harsha if he would then consider himself a scientist. He responded in the affirmative since he is considering jobs that involve a lot of science. Harsha used astronomy as an example and said it was full of science like galaxies and telescopes.

Capability in science class, present and future. Harsha admitted he is good at science.

Harsha: Yeah, I'm good at it.

Researcher: Okay, and how do you know you are good at it?

Harsha: Because this year in science I have a good grade and I interact with science.

Researcher: Do others see you as a science person, like your teachers or classmates?

Harsha: No, they see me as a math person for some reason.

Researcher: Math person – do you do really well in math?

Harsha: Yeah

Researcher: Do you see a connection between being a good math student and a good science student?

Harsha: Yes, because when my Math grade is up, my science grade is up.

Parent involvement. Harsha described his parent involvement in this study as helping him by taking him to places such as rivers. I expanded the question to include parental involvement in learning or experiencing science. Harsha explained that they help him study for tests and teach him things he does not already know. I asked him if his parents are involved in science related jobs and he replied, "No, my dad is a programmer for a company and my mom is an accountant." We concluded that his parents have math backgrounds.

Other influences over Harsha's interest in science. Harsha indicated astronomy has influenced his interest in science. He likes looking at the stars.

Do anything differently. Harsha said he had thought of something he could do differently, but he forgot what that was.

Participant's final thoughts. Harsha thought the project was fun in parts. He explained, Harsha: You had to think deep about what are you doing and what are you going to write.

Researcher: If a teacher asked her class to do this project, do you think it would help her be a better science teacher?

Harsha: Hmmmm. Yes, because you'll understand. For [Task] number 6, it is very good because you can see what they're interested in and you can help them in that class. So, I think you could make the teacher better.

Brendan

Brendan is a thirteen-year-old seventh grader. He is bright, enthusiastic, and enjoyed talking about his photographs. He is taking Tae Kwon Do lessons and is working his way through the different levels in that discipline.

Task 1: Past

Figure 30a: Brendan Task 1
Squid in Bottle

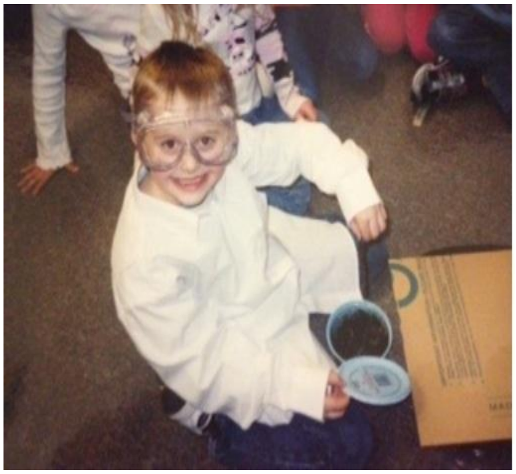

Figure 30b: Brendan Task 1
Worm Project

Brendan's first photograph for Task 1 was a Boy Scout activity (Figure 30a) that involved a 2-liter bottle, water, and a small, plastic squid. He explained that sometimes the squid stays down in the water and sometimes it goes up. He explained the activity,

Brendan: This picture is of us at Boy Scouts. We are doing a science activity with a giant bottle and a plastic little squid in there. Sometimes it stays down and sometimes it goes up like an actual squid would in the water.

Researcher: What is the thing that represents the squid?

Brendan: It's plastic

Researcher: Like a toy?

Brendan: Yeah, like a toy.

Researcher: How did you make it go up and down?

Brendan: The water and its buoyancy and pressure.

Researcher: Okay, did you squeeze the bottle?

Brendan: Ahhhh, Yes, we actually squeezed the bottle. When we squeezed the bottle it [the squid] went down and when we unsqueezed the bottle it came up.

Researcher: OK cool. So, you did that in the past – how old were you there.

Brendan: I was about 10, maybe.

The Scouts talked about how the increased pressure caused the squid to go down in the water and the released pressure let the squid rise to the top of the water.

The second photograph for Task 1 was a picture of Brendan in kindergarten (Figure 30b). Brendan enthusiastically described his worm experiment. He explained,

Brendan: I did a worm experiment. Basically, what I did was put worms in a cardboard box. One-half of the cardboard box was in shade and the other was in sunlight. The whole point was to see where the worms would move, the light or the darkness. They moved, almost all of the worms chose the darkness.

Researcher: Why do you think that is?

Brendan: Because worms live in the ground and fertilize the soil.

Researcher: Good, good! And why do you have goggles on?

Brendan: Just in case a worm comes up and doesn't slap me in the face

Researcher: (chuckle)

Brendan: Like dirt might come up in my face, or anything like that.

Researcher: Was that for a science fair or another type of project?

Brendan: In kindergarten we had this ABC list of things to do. "S" was a science thing and other kids made their own science thing and had to choose a topic. I mostly wore black because it made me look like the science guy.

Researcher: You're right – you look like a science guy. That's a lab coat you have on, or a white shirt?

Brendan: Yes, that's my mom's lab coat.

Summary. Brendan was enthusiastic about sharing his photographs that he chose to represent science in his past. He remembered the hands-on activities that he had done and can explain the scientific principles that connect to those activities. He was able to talk about pressure, buoyancy, animal behavior, and the possible reasons for the worms seeking dark spaces.

Task 2: Science Class

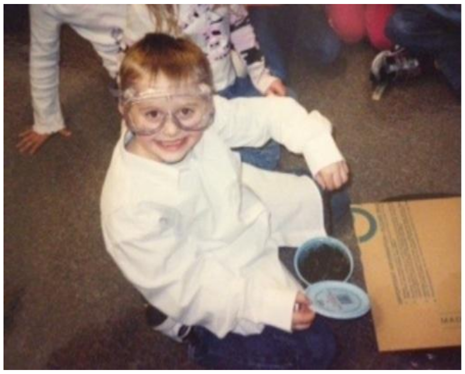

Figure 31a: Brendan Task 2 Worm Project

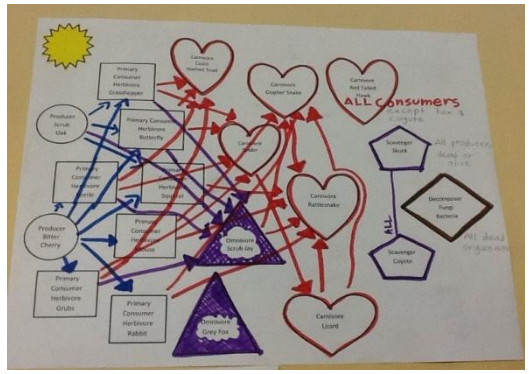

Figure 31b: Brendan Task 2 Food Web

Brendan’s first photograph he used for Task 2: Science in the Classroom was the photograph of the worm experiment (Figure 31a) because that took place in the classroom.

Brendan’s second photograph was a picture of a table (Figure 31b) the students were to memorize for science class. He described the poster,

Brendan: I took a picture of a table that I had to memorize. We were doing producers, primary consumers, carnivores, secondary consumers, and scavengers. Basically, this was like a chart. We were given animals and we had to show what ate what and what was eaten by those.

Researcher: You have all kinds of arrows going every which way.

Brendan: Most of the arrows are going to the carnivores because the carnivores are eating all the primary consumers….and the primary consumers are eating the producers.

Researcher: What do you call that whole thing? (Referring to the photo of the chart with the arrows and the producers and consumers).

Brendan: It's a food web.

Researcher: Food web, very good! Did you do that this year?

Brendan: Yes Ma'am, I did it this year.

Summary. Brendan had many photographs so I was surprised to see that he used the same photograph for two different photographic tasks. The worm experiment gave Brendan a chance to share his knowledge with his class. The food web activity was a group assignment. Brendan was impressed with all of the arrows. He seemed interested in the poster size graphic organization of the food web that included producers, consumers, scavengers, and decomposers. He remembered activities that engaged him as a learner.

Task 3: Outside of school

Figure 32a-1: Brendan Task 3 Caving

Figure 32a-2: Brendan Task 3 In a Tight Spot

Brendan’s first set of photographs for this task was pictures of him going caving with the Boy Scouts. The first photo was of the group going into the cave (Figure 32a-1). The second photo was Brendan going down a short slide inside of the cave (Figure 32a-2). The name of this feature in the cave was “The Birth Canal.” In the picture, he was half way out of the birth canal and he thought that was funny. I asked if everyone in the group was able to climb through that crevice. He responded that sometimes they would be stuck and worried, but it was easy to climb out. He thought the name of the cave was Cumberland Caverns in Tennessee. He described his experience of sleeping in the cave,

Brendan: We slept in the cave. We had a big open room with a giant chandelier that changed colors.

Researcher: Oh cool!

Brendan: …a giant glass chandelier that changed colors.

Researcher: Was it cold in the cave?

Brendan: Uh, not that cold. I was wearing a tee shirt over a long sleeved shirt. We went caving mostly a whole day without seeing the sunlight. So when we got out into the sunlight we were feeling a little woozy.

Talking about the caving experience reminded Brendan of another time he went caving at The Lost Sea, a cave system in Tennessee. He explained it was a different kind of cave,

Brendan: I spent the night there, too. The Lost Sea is basically an underground lake that’s very huge. It is home to fish. There’s a lot of fish down there like rainbow trout, but they don’t get that long.

Researcher: They live where they don’t have sunlight?

Brendan: There is light down there. Because we get to go on a boat – we can go in the lake. Not in it, we get to go on top of the lake in a glass-bottom boat and see all the fish in there because of the light from the boat.

Researcher: Were the fish very colorful? Or were they kind of…

Brendan: I couldn't see them. There were no ceilings with lights like these – it was all rock – it could tumble on you any second, but it wouldn't.

Figure 32b: Brendan Task 3
Fishing with a Net

In another photograph for Task 3, Brendan was stretching out on a dock with a hand-held fishing net (Figure 32b). It was a picture of him at Jekyll Island, Georgia, on the last day of a three-day seventh grade field trip. He related,

Brendan: Ok, this is me, not too long ago, three weekends ago at Jekyll Island. I went on a field trip with the whole 7th grade to Jekyll. In this picture, this was our last day at Jekyll. I think, our last whole day, at Jekyll and in this picture I am out on the board walk, the dock, and I am reaching my hand in the water with a big net, fishing for fish, I caught a lot, more than 20.

Researcher: What did you do with them after you caught them?

Brendan: We observed them in a big box full of water and we looked at the different types of them and we studied them. Then we let them back free in the water.

Researcher: Cool! What other things did you do at Jekyll Island?

Brendan: Oh, there was so much. My mom went with me. The best thing I think was when we went through the Maritime Forest. It looked like a whole different world because you couldn't see the sun, yet it was so bright down there. It was like a rain forest, but with Spanish moss and oak trees instead of tall rainforest trees.

Brendan was very animated as he shared these stories of his adventures outside of school. His interest and curiosity are evident in both the photographs and his descriptions.

Figure 32c: Brendan Task 3 Manatee

Brendan took another photograph for Task 3. This photograph was of a manatee looking at the camera (Figure 32c). He discussed how he goes to Crystal River, Florida, every year to swim with the manatees.

Brendan: This is a picture of a manatee that I took while I was snorkeling with my underwater camera. But this manatee right now is looking at me. And every year we go to Crystal River, Florida, where we swim with the manatees. We go to a hotel called the Best Western. We stay there over night, two nights. The whole day we go snorkeling with the manatees. They're very playful, there very color… they have very sweet qualities.

Researcher: Are they big?

Brendan: The biggest one we saw was about 20, the biggest one we saw was about 15 feet (taking time to think about the length of the manatees) and about bigger around than like a table (length) at Zaxby's. They are very huge. We saw mothers and their babies and it was very cool!

Summary. Brendan is a very active adolescent. He likes the science-type activities his class and family do outside of the classroom. He enjoys trying new things but also does not tire of doing the same excursions such as going caving or swimming with the manatees. These types of adventures hold Brendan's interest, curiosity, and sense of discovery in science.

Task 4: Seen as a Science Person

Figure 33a-1: Brendan Task 4 Mad Scientist I

Figure 33a-2: Brendan Task 4 Mad Scientist II

Brendan's first photographs for this task are of him dressed as a "mad scientist" (Figures 33a-1, 33a-2). He reported,

Brendan: People see me as a very smart kid in science. When it comes to science, I am … I always raise my hand.

Researcher: Ok so you're volunteering answers.

Brendan: Yes. And people think me of – in this picture – Character Day – I am dressed up as a "Mad Scientist" I'm at my Mom's school and I am putting chemicals inside of a beaker And I have that face like a mad scientist! My hair is sticking up like, yeah.

Figure 33b: Brendan Task 4
Turtle Shell

Another photograph Brendan chose for Task 4 was of him with a turtle shell on his back (Figure 33b). He explained that people see him as a nature lover. He put the shell on his back at the suggestion of his mother. Brendan declared that in this photograph it looked like he was a turtle lover, which he is. He thought it was a loggerhead sea turtle. Brendan's Mom took the picture in Grand Cayman Island at a turtle farm they visited last summer.

Summary. Brendan sees himself as a science person. He was excited when he had an opportunity to dress as a character for school. He chose to portray a mad scientist that emulated how he thinks others already see him. He was enthusiastic when he talked about his travels and the science adventures he has had, such as when he visited the turtle farm.

Task 5: Everyday Life

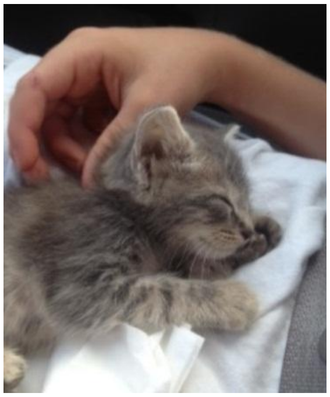

Figure 34a: Brendan Task 5 Rescued Kitten

Figure 34b: Brendan Task 5 Rescued Mouse

Brendan's photographs for Task 5 were of animals that he helped rescue (Figures 34a & 34b). He had a story about each photograph. He reported that he found the kitten (Figure 34a) one day while he was on the way back from Tae Kwon Do practice. He related his story,

Brendan: We were sitting in the car and my Mom was driving. I happen to look over at a little parking lot, an apartment parking lot, and see a little baby kitten wondering around. And I said, "Mom, we should stop." And Mom said, "Are you sure? It probably belongs to someone." So we went over there. That cat was a little skittish. We saw its whole backside was covered in its own poop, and it had like diarrhea, a disease. And so mom grabbed the box and the kitty and called the pet store to see if they could take it, and they said they'd see. So, we were just driving around to the Gwinnett Clinic and all that. The cat stayed in my lap. We were wiping the stuff off its back with tissues. It just slept in my lap. It was about less than a foot long including the tail, when it was all stretched out. It was very little. A few days later, it found a new home.

Researcher: You checked on it?

Brendan: Yep, we went to the pet store and it found a new home. The people said the cat was very playful. We saved its life. It could have died from that diarrhea, and we gave it a better life now.

Researcher: Good! And it's a cutie!

The second photograph for Task 5 was of another animal rescue (Figure 34b). This time it was a mouse. Brendan recalled that they found this baby mouse in his grandparents' garage trapped in a trashcan. He noted that the mouse had bruises and he inferred that something attacked the mouse. The mouse had blood and scratches on it. They took it out of the trashcan. Brendan held it in his hand and he said it did not bite him. He related that it looked like the mouse was going to die and a few hours later it did expire.

Summary. Brendan is compassionate towards other living things. He demonstrated this by the way he rescued animals. He encouraged his mom to stop the car and rescue the kitten. He was upset when the mouse they removed from the trashcan died. He respects nature and the living animals in his world. The photographs led to the stories about these rescued animals.

Task 6: Future

Figure 35a: Brendan Task 6 CPR

Figure 35b: Brendan Task 6 Tagging Sharks

Brendan's first photograph for Task 6 is a photograph of him performing Cardio-Pulmonary Resuscitation (CPR) on a practice dummy (Figure 35a). He stated, "This shows me right here doing CPR right now. This would be my first choice to be like a lifeguard or something, but save lives, you know – it means something."

The second photograph for Task 6 was of two men on a boat (Figure 35b). Brendan explained, "This shows two men on O-search.com. They're tracking great whites and they're putting a tracking device on their fin. So, when I grow up I would like to be a marine biologist."

Figure 35c: Brendan Task 6
Pet Dog, Marley

Brendan included a third photograph for Task 6, a photograph of him and his dog, Marley (Figure 35c). He remarked that the photograph reminded him "…of giving an animal a good life, saving animals, and giving this dog a good life." He wants to be a veterinarian and save animals all the time. Brendan continued, "There's nothing I'd rather do than save animals and do something I like."

Figure 35d-1: Brendan Task 6
Diving

Figure 35d-2: Brendan Task 6
Dive Master

Brendan also added a pair of photographs to Task 6 (Figure 35d-1 & Figure 35d-2). The first photograph was of Brendan in a wet suit on board a dive boat (Figure 35d-1). The boat was out in the ocean. The second photograph was of Brendan underwater scuba diving (Figure 35d-2). He exclaimed, “When I grow up, I think it would be cool to be a dive master to instruct other divers to go out there and look at Grand Cayman and visit all these dive sites every day.”

Summary. Brendan has many career ideas. He was excited about each photograph as he told his stories. He is looking at careers based in the science fields. He is very interested in oceanography and careers that have to do with the ocean. He has many opportunities through his mom’s job as a science teacher and the vacations they take. These opportunities expose him to a variety of possible careers.

Discussion and Reflection on the Project

Science and scientists. Brendan voiced his thoughts on science by saying, “Science is life.” He disclosed that a scientist is, “…a person who studies any parts of science, biology, oceanography, and chemistry.” Brendan considers himself a scientist because he does more science stuff than other kids do. He gave two reasons for this, “Um, one because my mom does labs all the time in her room [he is there every afternoon after his school lets out] and two, I get to go on all these cool vacations and learn about science.” He added that he learned about science even when he went snow skiing.

Capability in science class, present and future. Brendan related that science is his highest grade this year. He explained,

Brendan: I think others *do* see me as a science person because a lot of kids that know me, every year they know me as a smart kid. They ask something like, ‘Hey what is this?’ and I tell them.

'What is the mighty *what*?'

'The mighty mitochondria!'

'What stores food in a cell?'

'– a vacuole.'

Researcher: So, they go to you for answers?

Brendan: Yeah, sometimes like for morning work they ask our table and I'm the first one to reply.

When asked about what classes Brendan might take in high school and college, he responded with oceanography. He pointed out that the oceanography classes take many field trips. He is interested in learning about oceans. He related that one reason he likes diving is to see the fish and all the other creatures.

Parent involvement. Brendan informed me that his mom is an Advanced Placement (AP) Biology teacher and an Oceanography teacher at the local high school. He reported that she is only teaching Oceanography this year, but she still knows how to teach other subjects in science. She is always teaching him about science and helps Brendan with his study guides. She answers things quickly and can help him with huge word problems. He summed it up, "She helps me."

When asked about parental influence about learning or experiencing science, Brendan replied that his mom makes him note cards to study and quizzes him before every science test. He mentioned that even if he wants to study those cards or not, his mom has him get the note cards out and study every night. He agreed that studying like that works 99 percent of the time.

Other influences over Brendan's interest in science. I asked Brendan if anything else influenced his interest in science. After he pondered the question for a few seconds, he replied,

> Oh, I've got a big one, Steve Irwin! He used to be, he was, he was my hero until he died. It was shocking to me. I use to watch his TV show, his movies, I watched everything. And I *learned* so much stuff. A lot of stuff I know about animals I learned from him (excited) and I still know today!

Do anything differently. Brendan communicated that the photographs he submitted summarized everything he wants to be. He added there are other pictures that would represent him, but he was happy with what he did.

Participant's final thoughts. I asked Brendan about the amount of time it took him to get started on this project. He explained that he had tests in school and he has commitments like lacrosse and Tae Kwon Do. He reflected that he has a very busy life.

I inquired if Brendan thought this project would be easier if it was a class assignment where everybody took pictures about science in their life. He responded in the affirmative. He said that if he was in class, he does his work, so he would have completed this project much quicker.

I wanted to know what Brendan thought about the types of photographs he took and how that made him think about science. He replied that animals, light, anything reminds him of science. When I asked if a project like this would help teachers understand their students and teach science to them, he remarked, "Actually yes." He explained, "Teachers will see what kids are interested in and maybe they could teach them a little bit about ocean life, and teach them and let them learn a little extra." He added that teachers could see their students struggling in science and teachers could improve their strategies to help those students.

In Chapter 4, I presented the data from my study. I made the participant photographs the focus of the data collection by including the photographs with each participant's narrative for the six given tasks. The stories the participants told about their experiences with science revealed the student's perceptions about science. I also recorded the participants' responses to the interview questions about science and being a scientist. In Chapter 5, I presented the analysis of each participant and the analysis of the cross-case study. I discussed the photography tasks, the interview questions, and student science identity. After the analysis, I explored the limitations, challenges, and the significance of the study. Finally, I concluded the study with the participant photographs that I thought were the most poignant and with my final thoughts on this thesis.

CHAPTER 5

CROSS CASE ANALYSES AND FINDINGS: GIVING VOICE TO STUDENT PERCEPTIONS THROUGH PHOTOGRAPHY

The main research question of this study was "How do adolescent students view themselves as scientists and how do these perceptions relate to their student science identity." I wanted to know what students think about science and how that influences their capabilities in science class.

Utilizing the epistemology of constructionism where people construct meanings through human interactions with the environment, I explored adolescent perceptions of science. The participants took photographs in response to prompts about interactions of science in the past, present, and future. They constructed their memories of the pictures they composed and photographed, then correlated the memories and meanings through the photo journals and interviews.

The theoretical lens of identity theory helps us to understand how incorporating these science and environmental interactions into one's own core identity affects that person's sense of self in relation to the scientific world. The interactions of the individual with the environment and other people help the individual develop a sense of who they are and who they want to be. Therefore, the photography tasks prompted the participants to identify science situations from their past, present, and to predict what they would like to do in the future.

There were six participants in this study. I applied the methodology of case study to explore the perceptions these participants have concerning science. I examined their own concept of their capability in completing science endeavors and their perception of how others see them as a science person. Each participant had their own story to tell about the photographs that they took in response to the given photography tasks. The participants had a wide variety of ideas that depicted their individual ideas of science. I conducted a cross case analysis that compared the individual cases.

Cross Case Analysis and Findings

I examined the perceptions of the participants across photography tasks and then analyzed their responses with additional interview questions.

Task 1: Something the participant did in the past related to science.

Participants photographed objects and scenes of their outside environment such as trees, clouds, dogs, and the beach. They also snapped photographs of actions such as baking, cooking, water filtering, and water pressure with a squid in a bottle. These photographs prompted participants to discuss a variety of scientific concepts. The concepts included photosynthesis and chlorophyll; animal systems and behavior; measurement and accuracy; liquid solutions; heat energy; water cycle; weathering of rocks, minerals and shells; tides and waves; and buoyancy and pressure (See Table 4, Task 1).

Table 4

Task 1: Something They Did in the Past Related to Science (Past)

Participant	Pictures	Science Correlation	Perceptions
Alex	Dying tree, water filter	Chlorophyll and solutions	Science knowledge evident; used scientific understandings in her past
Levi	Tree, pet dog	Photosynthesis and animal systems	Dissections of sharks and frogs gave real-life hands-on application of knowledge
Katie	Baking, cook shrimp	Measurement, accuracy, heat	Application of measurements has direct effect on outcome of prepared dishes
Lexie	Clouds, beach	Water cycle, weathering of shells into sand	Clouds are part of the water cycle and sand comes from shells, 2-liter bottle rockets was another hands-on activity in the past
Harsha	Crystal, beach	Rocks, minerals, tides, waves	Concepts were from his 6th grade science class
Brendan	Squid toy in bottle, worms	Pressure/buoyancy animal behavior	Hands-on activities in Boy Scouts; remembered scientific concepts demonstrated by the activities

The participants were able to identify science opportunities they engaged in prior to this study. The participants thought of the past as a time from a few months before the study to five or six years ago. They composed photographs of experiences in the natural environment and in their home environment. Aschbacher et al. (2010) found that students add to what they bring to science class through their past experiences with science. Carlone (2004) surmised that students' experiences with science could help develop students' interest in science and increase motivation to participate in school science. Of the six participants, Lexie felt she was not that motivated or interested in science. Her pictures for the task of science in the past were of the beach and clouds. She was able to link the photographs to the water cycle and weathering of shells into sand. All of the participants identified images that represented prior knowledge and experiences to think about science. They shared their experiences and identified the science related to those experiences. Their experiences incorporated science concepts and reflections with who they are and how they identify themselves.

Looking at these responses through the lens of identity, past events and opportunities are an important part of how one views their being or sense of self. The participants were able to identify with science concepts through the photographs they submitted for their photo journals. Gee, (2000-2001) explained that core identity is the summation of experiences through time. The participants identified specific instances where they were doing something with science. The experiences were significant enough for them to remember and to re-create the situations in order to capture the moment in a photograph. The science concepts and situations were part of their core identity.

Task 2: Participants' Interactions within Science Class

The photographs the participants presented referred to experiments in the science laboratory: Alex preparing for an experiment, Levi using batteries to represent electric circuits, Lexie examining rocks and shells, and Harsha showing a Snickers Bar for the plate tectonics simulation. Participants also depicted technology (Levi and on-line test review), research (Harsha and the Tar Pit), and projects (Katie's circuit board, and Brendan's worms and food web) (See Table 5, Task 2).

Alex's photographs of science within the classroom were about her thinking of what she needed to do to prepare for an experiment and if she was wearing the appropriate lab safety gear. She did not include other students in her photographs nor did she share any group interactions. This could be an example of what Erickson (2005) described as investigating worthwhile activities and group dynamics. Alex tended to be exclusionary of others who did not relate or understand her.

Brickhouse et al. (2000) reported that understanding how students engage in science relates to who they are and who they want to be. The participants photographed items that represented engaging activities that they remembered. Katie and Levi photographed items representing electrical circuits. These symbolized their hands-on active engagement in creating circuits. Harsha snapped an image of a candy bar used as a simulation for plate tectonics. Not only was he engaged in manipulating the candy bar to represent the Earth's crust when plate boundaries compress and expand, but he could eat the experimental material as well!

Katie's circuit board was set up as a quiz board with tin foil currents lighting up a bulb for correct answers. Katie related that she worked on this project with others in the class by making up their own quizzes and then having classmates manipulate the quiz board. Erickson (2005), referred to democracy and preparing adolescents with ideals using constructive work as a common goal for which people strive. Katie viewed this science activity as important and useful. Therefore, she had done helpful, constructive work. Her class learned about circuits while creating a review and study resource that was practical and valuable.

Other participants shared photographs of activities involving groups or presentations. Lexie's array of shells and rocks on her table represented a class experiment where small groups identified the different types of rocks and minerals. Harsha shared his Tar Pit research and Brendan shared his worm project in presentations to their classes. Roth and Li (2005) determined that if one imagines oneself as a scientist, works as a scientist, and perceives oneself in an interesting science area, then that person has a strong science identity. These participants thought and worked as scientists while researching and presenting their science information.

Table 5

Task 2: Participants' Interactions within Science Class (Science Class)

Participant	Pictures	Science Correlation	Perceptions
Alex	Preparing lab, lab materials	Organization, plan, preparation	Materials and lab safety equipment needed for a lab experiment and steps required to complete an experiment
Levi	Batteries, USA Test Prep on-line	Electricity and circuits, review science concepts	Liked the interactive, hands on laboratory experiments and interactive technology to review science vocabulary and concepts
Katie	Circuit board project	Circuits made with foil, science quiz	Application of the concept of electric circuits, liked the hands-on aspect of the project
Lexie	Rocks and shells, textbook	Rock cycle, science resource	Rocks and shells are part of the rock cycle, science book is the main resource her teachers use - the textbook is boring, all you do is read
Harsha	Tar Pit, Snickers bar	Fossils, deformation of Earth's crust	La Brea Tar Pit was a research project of interest. They learned from the manipulation of the bar and then they could eat the candy bar.
Brendan	Worms, food web	Animal behavior, relationships of food chains	Worm activity showed worm preference for the dark, imitating the earth they live in, graphic organizer showed many arrows - group activity and visual representation of what they were learning

Task 3: Participants' Involvement in Science Outside of School

The photographs the participants took for Task 3 are as varied and unique as the participants. Three participants' photos referred to energy. Levi photographed a computer "screen shot" of his Power Point research project on nuclear energy. Katie photographed their backyard fire pit and discussed the heat energy that melted her "S'mores" marshmallow. Lexie described the boiling water and steam in her photo and the heat and light represented in the photo of the lighter flame. Two participants revealed photographs of something to do with the body. Alex photographed a cut on her hand and discussed problem solving about the likelihood of infection and the lack of need for a doctor. Harsha shared a picture of a book and talked about the process of reading and using your eyes. Harsha also had a picture of a soccer ball and reported how the body moves while playing soccer.

Brendan's photographs were unique because they depicted adventurous activities that he has done on vacations and class field trips. He discussed underground weathering as demonstrated by the formations in the cave, fishing with a net, and diving with the manatees.

These students were able to identify science interactions outside of school. None of them voiced any difficulty finding and composing a picture of science examples outside of school. Five of the participants found things inside or outside of their house. Alex identified individual examples of herself. Levi concentrated on things having to do with school science that he completed at home and used technology. Katie and Lexie included family activities such as cooking and making "S'mores" as their science interactions. Harsha chose the solitary activity of reading by using his eyes and the team activity of soccer. Brendan was the only participant who identified science interactions away from home (Table 6, Task 3).

The participants' perceptions of science outside of the classroom were examples of "identities in practice" as explained by Tan and Calabrese Barton (2007). The participants were "doing science" or "being scientists" in a given time or place (Gee, 2000-2001). The stories and narratives (Sfard & Prusak, 2005) shared by the participants revealed a rich science data foundation that they will carry with them throughout their lives.

Table 6:

Task 3: Participants' Involvement in Science Outside of School (Outside of School)

Participant	Pictures	Science Correlation	Perceptions
Alex	Cut on hand, make-up	Infection, trial and error experimenting	Knowledge of past cuts helped in decision-making process of how to handle the cut, experimentation with make-up is similar to what scientists do in experiments
Levi	Nuclear Energy Power Pt, Big 20	Nuclear energy, science terms and concepts	Is interested in researching an unfamiliar topic, keeps papers to review and study, this task made him think outside of the box
Katie	Fire pit, "S'mores"	Heat source, chemical change	Likes making "S'mores" with her family, fire is the heat source, the blackened sugar in the marshmallow represented a change in the marshmallow
Lexie	Measuring water, lighter flame	Heat energy, fire properties	Knows measuring and boiling water had to do with science, but could not articulate specifics. The flame from the lighter represented heat and light
Harsha	Book, soccer ball	Process of reading, body movement	Enjoys reading and explained the involvement of the eyes and thinking while reading. He loved soccer and described the ways the body moves when playing soccer.
Brendan	Caving, fishing, manatee	Underground weathering, erosion, marine life	Likes adventures such as caving, fishing, and diving. Likes the field trips his class took, vacations with his family, and the experiences of these activities.

Task 4: How Others See Them as a Science Person

Two photographs exemplified this concept. Alex composed a photograph of her eyes. Her eyes are two different colors. Others notice this unique characteristic and ask her about them. Alex talked about genetics and about how a person might have two different colored eyes. She also described how her eyes represented inquisitiveness and curiosity. Her classmates ask her questions, she answers them or looks them up, and she feels her classmates see her that way because of all the questions they ask her about different science topics.

The other photograph that exemplified this task was one Brendan submitted as himself dressed as a "Mad Scientist." He was in his mother's high school lab with her lab coat on, pretending to mix chemicals. He thought it was a funny picture, but it is how he sees himself and how others see him as well. As Brickhouse et al. (2005) noted of the girls in their study, the way students interact with the teacher and other students was a choice and was somewhat determined by what they thought others expected of them. Brendan chose to exemplify the connotation of being a scientist by exaggerating the character of a “Mad Scientist.” He spiked his hair to look crazy and had a wild looking expression in the photograph.

Levi photographed a “100%” on a paper and a Carnegie High School Unit invitation as his photographs for this task. He was the only one who used good grades as a measure of how others saw him as intelligent in science. Tan and Calabrese Barton (2007) mentioned assignment completion as one way others make decisions about another student being a science person.

Alex submitted the photograph of her eyes as well as a photograph of her doing a presentation on sounds. She related the sounds to cell phone rings and wondered if it was possible to have a ring tone that older people could not hear. Carlone (2004) discussed situated learning and how one arranges an activity and how others imply science identities by the activity. Alex’s presentation used the science of sounds from their science class instruction and related the concepts of sound to a real-life, high interest topic for her peers. Therefore, Alex perceives others as seeing her as a science person.

Brendan’s second photograph was of him with a giant turtle shell on his back. His classmates knew that he travels with his family on many vacations. He shared his adventures with his teachers and classmates. They saw him as a science person because he had many opportunities to go diving and exploring nature on his trips.

Two of the participants perceived “others” as their families and did not mention their classmates. Katie perceived others as thinking of her as a scientist because she is frequently in the kitchen baking and cooking. Katie took a photograph of her making and icing cupcakes for this task. She shared her food with her family and so they were the “others” that see her as a science person.

Harsha shared pictures of rocks and the sky for Task 4. He is a rock collector and his family helps him add to his collection. They also drive him to places so he can collect more rock samples. He specifically identified his family as the “others” who see him as a science person. His family encourages him to continue collecting rock samples. The picture of the sky Harsha included for this task represented his love of the weather. He checks the weather every day and watches weather reports on television. His family knows he will always have the daily weather report. They were the “others” in this instance as well, that see Harsha as a science person.

For Harsha, his family is part of what Erikson (2005) would call his communal culture. Maybe Harsha will remain focused on his family as his “others” and not move on to friends and other significant people. On the other hand, Roth and Li (2005) called for parents to be more involved in the relevancy of their child’s science classes and support them throughout their educational experiences. Maybe this is the case for Harsha’s family and he is not ready to move on to others, yet (See Table 7, Task 4).

Table 7

Task 4: How Others See the Participant as a Science Person (Seen as a science person)

Participant	Pictures	Science Correlation	Perceptions
Alex	Eyes, presentation	Inquisitive, scientific method, sound	Asks many questions and finds the answers. Presenting sounds within hearing range of adolescents, but not adults
Levi	Grade on paper, Carnegie Unit	High science achievement, high school science credit	Receives high scores on tests and quizzes and classmates recognize this. Achievement qualified him for high school credit for his work
Katie	Baking-making cupcakes	Measurement, timing, heat	Shares her food with her family. Sees herself as a baker, makes things from scratch.
Lexie	-	-	Does not do well in science and thought that is how others determine if you are a science person
Harsha	Rocks, sky	Rock collection, weather	Family knows he collects rocks and watches the weather reports. Saw his family as “Others”
Brendan	Mad scientist, turtle shell	Scientist, turtle preservation	Portrayed mad scientist for Character Day at school because he thinks others see him as this. He is excited about his travels and adventures with his family

Task 5: Science in Their Everyday Lives

Three of the participants referred to the water cycle when sharing their stories of their photographs for this task. Their photographs demonstrated connections to the water cycle: Alex’s photograph of fog, Lexie’s photos of watering plants and taking a shower, and Harsha’s picture of boiling water. Sharma (2008) explored the connection between students’ participation in class in India and the students’ experiences with science outside of school in their everyday lives. I investigated how others in their class viewed the participants as science people and how the participants connected the learning of science with their everyday lives. The participants connected the everyday use of water to what they learned about the water cycle in science class. Levi demonstrated this when he shared his photographs of skateboarding and bowling. He applied the principles of mechanical energy and friction when he discussed these photographs. Harsha also connected what he learned about simple machines and applied that knowledge to the combination of simple machines in a car.

Two of the participants took photographs of things related to nature. Katie took photos of a spoiled sandwich and a bird's nest, and Brendan took photographs of a kitten and a mouse that he rescued. Although these examples did not directly relate to specific concepts they learned in science class, they inferred cause and effect relationships built on scientific information learned in class such as bacteria, nesting, and animal survival. Avery and Kassam (2011) asked their 5th and 6th grade participants to take photos of how they saw science and engineering used inside and outside their home in everyday life. However, Avery and Kassam concluded that the participants in their study did not connect what they learned in science class with their daily use of science and engineering. I found just the opposite. The participants in this study composed their photographs on their own and made the connections to what they learned in science class as part of their stories about their photographs (See Table 8, Task 5).

This discrepancy between these studies of applying what participants learned in the classroom to situations outside of the classroom could be due to Task 2: Science Class. Task 2 asked the participants to take photographs of science within the classroom. The connection between interactions in science class and the participant was explicit to what the participants did for the task. This might have planted the idea of connecting the photographs they were taking to what they have learned since all of the task prompts were specific to science interactions.

It was obvious that the participants were able to recognize and capture science in their everyday lives. Alex, Levi, and Harsha identified mechanical things – cell phone camera, bowling and skateboarding, and the simple machines that comprise a car. These participants were interested in how things work. The other participants interacted with things in nature: Alex, fog; Katie, bird's nest; Lexie, water plants; and Brendan with photographs of the kitten and mouse.

Table 8

Task 5: Science in Their Everyday Lives (Everyday Life)

Participant	Pictures	Science Correlation	Perceptions
Alex	Camera flash, fog	Mirror reflection, water cycle	Referenced "selfies" that adolescent girls take and the science behind flash, light, and reflection. Also wondered about fog and the causes of it
Levi	Bowling, skateboarding	Mechanical energy, friction	Learned about the principles of mechanical energy and friction in his physical science class this year.
Katie	Sandwich, bird nest	Decay and mold, nature	Knew to refrigerate the sandwich, but had forgotten it. Found nest, yet did not see the birds build it or use it
Lexie	Water plants, shower	Water cycle	Knew there was hot water, but never wondered where the hot water came from, knew water was necessary for plants to live and grow.
Harsha	Boiling water, car	Water cycle, simple machines	Referred to the water cycle when describing the boiling water, the car represented how simple machines could be used to make a complex machine
Brendan	Kitten, mouse	Nature, survival of living things	Compassionate towards other living animals, rescues animals in need.

Task 6: Representations of What They Would Like to Do as an Adult

All participants except Alex, identified careers or interests in science related fields. Alex arranged a photograph of her with a bouquet of flowers after a musical and a drawing she created as responses to this task. Alex would like to be a vocalist and an actress as represented by the photograph after a lead performance in a musical. The photo of the drawing symbolized her desire to become an artist and animator. Alex's student agency, defined by Calabrese Barton and Tan (2010), helped her determine what group she wanted to belong to and how to act within that cultural and social situation. This led her to consider occupations outside the field of science. Although Alex does well in science, she has more interest in drama and music and that passion influenced her in how she envisions her role as an adult.

Two participants talked about wanting to become veterinarians. Katie included a photograph of her dog, Diesel. In her discussion about this photograph, she talked about her dog and other animals she has cared for and has had for pets. She wants to help animals and noted that veterinarians need science to know the correct medicine to use and to measure the amount needed to treat animals.

Lexie also wants to be a veterinarian and she incorporated a photograph of her dog in her photo-journal. She stated that she had fish, a turtle, and cared for a friend's rabbits. She based her interest in becoming a veterinarian on the fact that she likes dogs and thought sharks are "pretty cool." However, she was more excited about the prospect of becoming a model and wearing different style clothes and posing in a variety of ways for the camera.

The other participants in this study were more decisive and science oriented. Levi wants to become a graphic designer and utilize his creativity and technology skills. Harsha wants to become a physicist and an astronomer. Brendan has a variety of science interests and named a few paths he might take such a veterinarian or oceanographer. These three participants earned social capital in their science classroom by how they positioned themselves with others as described by Olitsky et al. (2010). Others saw them as scientists because of how they performed in the classroom and the knowledge they shared with their classmates and teachers. Their outside interests in the science community (Carlone, 2004) in graphic design and technology, physics and astronomy, and veterinary medicine and oceanography, combined with their classroom interactions helped them form identities consistent with people who wanted to identify with and become a valued scientist as adults (See Table 9, Task 6).

Table 9:

Task 6: Representations of What They Would Like to do as an Adult (Future)

Participant	Photographs	Science Correlation	Perceptions
Alex	Bouquet, Drawing of girl		Vocalist and actress, bouquet for performance for a musical lead, artist or animator
Levi	Georgia Tech Graphic on bus	GT is an Engineering & Technology Univ.	Graphic Designer where he can use his creativity and technology skills
Katie	Pet dog	Veterinarian	Many experiences with different animals, compassionate and caring towards animals, observed animals in nature and controlled environment
Lexie	Pet dog, modeling poses	Veterinarian	Loves animals, would volunteer at veterinarian office and Humane Society Modeling – loves fashion and posing for pictures
Harsha	GPS, stars	Physicist, astronomer	Physicists made the GPS and, he wonders how they made it. He has been fascinated by the stars and things in astronomy
Brendan	CPR, tagging sharks, pet dog, scuba diving	Pressure, buoyancy, animal behavior	Saving lives by learning CPR; Veterinarian – compassionate towards animals and has rescued several; Oceanographer – scuba diving and scientists tagging sharks. He is very interested in ocean life

Interview Questions

After each participant shared their stories about the responses to the photography tasks, I asked a few additional questions about the project (See Appendix E). The questions inquired about their thoughts on science, scientists, science capabilities, parent involvement and their final thoughts about the project.

Science

The participants recognized that science is a concept that is all encompassing. Lexie's response to the question, "**What do you think science is?"** was simple, "Life." She then continued, "Creatures, animals, plants, living things, rocks, water." Brendan also described science simply as "Science is life." Two other participants, Katie and Harsha mentioned that science is in your everyday life. Katie gave examples such as, "a person standing on the ground – gravity, and trees and plants giving off oxygen." Harsha said, "Science is everything" and added "…walking, talking, and it impacts everyday life."

Levi and Alex responded with slightly different views about what they thought science meant. This is what Levi responded:

> It means a lot of things the like I think of biology for one and like I said and then it goes on to chemistry which in my eyes is a completely different thing. And so really I think science of how we came to be and how we function and how the world functions and things like that. There are different branches.

Levi implied that science included concepts of evolution, body systems and functions, and environmental roles. As a 14 year old, Levi may have a more sophisticated concept of what science is than the 12 and 13-year-old participants.

Alex replied in a more philosophical manner about what she thinks science is. Her response was as follows:

> Sort of a foundation for an epic journey. Like you can ask a question about something and you can notice something about the same thing you can guess an answer for your

> question and then you investigate more on it and see if you are right or wrong. And that could go with anything. It could be like Abraham Lincoln, questions like those, learning about him, that sort of is what science is in my opinion.

Alex focused on the procedures or thought processes connected with science. She applied the scientific process of questioning, hypothesizing, and investigating to other disciplines such as history with her example of Abraham Lincoln. Bybee (2011) explained that science knowledge and investigations should lead to solutions to engineering problems. Alex was thinking along these lines as she described the process of science as what science means to her (See Table 10, Science and Scientists).

The participants' connection to science is an important part of my study. I wanted the participants' voices to come through on their perceptions of what science is. They all recognized that science is everywhere. Levi, Katie, Lexie, and Harsha all started to list things as examples of science and then realized it is "everything." Alex perceived science as a process of asking questions and finding the answers. Lexie and Brendan said it was "life." However, when Lexie began listing things she mentioned inorganic things like water and rocks. All of the participants inferred that science is all around us.

Table 10

Science and Scientists

Participant	Science	Scientists
Alex	"Foundation for an epic journey" question, observe, investigate – this process works for anything	Is someone who is ready to make a discovery.
Levi	Science means many things, examples biology, and chemistry. How we came to be, how we function, and how the world functions	A person who goes deeper in learning about how we all function in everything and explain why and how everything works; thinks of himself as a scientist, but more of a student - he is still studying things and he's not the first to discover ideas
Katie	Science is in your everyday life, examples person standing on ground – gravity, trees and algae giving off oxygen	Scientists explore and get into ideas more, like examining a dead body and discovering cells. She believes she is a scientist, she bakes, brings things in to share in science class
Lexie	Life – creatures, animals, plants, living things, rocks, water	Scientists figure things out and do tons of research. She does not think of herself as a scientist
Harsha	Science is everything – walking, talking, and it impacts everyday life	He considers himself a scientist since he is considering jobs that involve a lot of science – like astronomer
Brendan	Science is life	Scientist – anyone who studies any parts of science; biology, chemistry, and oceanography. He is a scientist because he does more science things than other kids

Scientists

Four out of the six participants revealed that they think scientists are people who are interested in science, but investigate, research, and study in a much deeper manner than other people study. Levi stated the following about scientists,

> They go deeper in learning about how we function in everything and explain that's really why or how everything works. I picture a scientist in a lab coat, goggles, and maybe looking through a microscope or something. I think I kind of in a way think of myself as

> a scientist, but not like a major scientist, more like a student right now because I'm still studying these things and it's not like I'm the first one to discover these ideas.

Katie also thought that scientists explored and went into ideas more. Her response was:

> I think a scientist is like they'll get that, for instance, something they explore more into …Let's say a human was dead. They would've never known it had cells unless they actually went way into it and explored, I guess.

When I asked Katie if she would consider herself a scientist, she stated, "Yes." I asked her to elaborate and she responded,

> I'm always baking, or not always, but I do bake some. And like in science I am always bringing in that, like we were learning about rocks and minerals. I'll bring in all rocks and show them and we have to name the five characteristics of a rock. Which is a solid, but inorganic, it can't be from a living thing, made from something outside, it has to have a chemical compound and crystal shape.

After she listed the characteristics, I asked her if those were characteristics of a rock or mineral. She was a little startled because she was proud she could remember the characteristics, but they described minerals not rocks. She responded, "Oh! Minerals! I'm sorry!"

Lexie stated that scientists do tons of research and figure things out, like finding fossils and how long ago the animals lived. Lexie did not think of herself as a scientist. She wanted others to think of her as a math or social studies person. Brendan is the fourth participant who referred to a scientist as a person who studies any part of science, biology, chemistry, and oceanography. He considered himself a scientist because he did more science things than other kids did.

Alex and Harsha had different views of what a scientist is or does. Alex stated, "A scientist is someone who is always ready to make the discovery." Again, she implied the importance of the scientific method or process. Alex did not answer the question about whether she thought she was a scientist. She admitted there are many things she knows, but there were things she did not know. Alex knew she had the tools and curiosity to find things out that she wanted to know. She never stated that she thought of herself as a scientist. Harsha considered himself a scientist because he considered jobs that involve a lot of science – like an astronomer. He continued, "Like astronomy is basically full of science, like galaxies, and telescopes." Harsha did not directly say what he thought a scientist was, but implied it was someone who works in a science job (See Table 10, Science and Scientists).

The way the participants positioned themselves within the classroom and the way they perceive themselves as scientists, or not as in Lexie's case, coalesces their internalization of who they are as a scientist. Alex inferred she was a scientist because she and her classmates ask questions and she has the curiosity and knowledge to answer these inquiries. Levi does well in science class and others see him perform well on tests and assignments. Levi believes he is a scientist. He admits he is still a student of science because he does not know all of the answers, nor does he develop novel ideas. Katie perceives herself as a scientist because she adds to her science class by bringing in examples of what the class is studying. Brendan also situates himself as a scientist and compares himself to other students. He perceives that he does more "science things" than others do.

Harsha perceives himself as a scientist because he is interested in pursuing scientific careers such as physics and astronomy. He does not need to situate himself with others to identify himself as a scientist. Lexie does not believe she is a scientist. She declared that scientists do “tons of research” and they figure things out. She does not place herself with others as being seen as a science person nor does she perceive herself as doing research and figuring things out. An important note is that Lexie did realize she does not interact much with science. But as a direct result of this study, she joined the robotics club and learned to write programs to operate the robots. She was very proud of her accomplishment to act in such a manner. Her decision to act in this scientific manner, or student agency, led her to begin readjusting her perceptions of who she is in relation to science.

The participants identified their own definitions of science and scientists that revealed how they perceived themselves in relationship to others and how they authenticated their relationship with people and the environment as described by Kozoll and Osborne (2004). Many researchers (Calabrese Barton & Tan, 2010; Olitsky et al., 2010; Reveles & Brown, 2008; Shanahan, 2009) proposed that agency and structure is a component of student science identity. The participants that identified themselves as scientists knew how to situate themselves among and within various groups within and outside of the classroom as a person of knowledge and action in the manner of a scientist.

If five out of six students perceive themselves as scientists, and the sixth one’s perceptions as a scientist is evolving, this helps the students internalize the perceptions of knowing science and doing science things.. The question arises, how can we expand this concept so all adolescents in the classroom feel they are scientists and can do science? I contend it is through collaborative groups ((Brown, 2004; Erikson, 2005; Farland-Smith, 2009; Olitsky, Flohr, Gardner, & Billups, 2010; Osborne, 2010; Reveles & Brown, 2008; Reveles, Cordova, & Kelly, 2004; Roth & Li, 2005; Shanahan, 2009) where student groups of varying interests and abilities in science work on solving problems and progress through the scientific process. The classroom atmosphere needs to be one of collaboration not competition.

Capability in Science Class, Present, and Future

All of the participants perceived themselves as capable in science. Alex enjoys finding things out for herself. Levi took advanced science classes throughout middle school and he thinks others see him as a math/ science person. Katie admits she was a good science student. Harsha excels in math class and by association; others see him as a math and science person. Brendan makes good grades in science and he feels that his classmates see him as a science person.

Lexie viewed herself as capable in science, but then added a disclaimer. This was how she responded:

> Well actually, my Earth Science wasn’t too good, but when I’m interested in it more I learn about it more. So, this year I have like a 90 because I think it’s interesting and I get it a little bit more.

I asked her if others see her as a science person. I reminded her that she skipped over Task 4, Seen as a Science Person, in her photographs. I encouraged her to tell me a little bit more about that. She replied, “Well, I didn’t really put in a picture because I don’t really think of myself as a science person. Because… I don’t know.” I inquired if there others in her science classes that she views as a science person and if so, why would she identify them like that. She pondered, “They know a lot about it [science], they are interested in it, and they talk about being one when they get older.” Lexie revealed some interesting concepts in her story. Although she did well in her life science class, she did not see herself as an overall capable student. How well she did in science class was dependent on whether she liked the science topic and the way the teacher taught the material (See Table 11, Capability in Science Class, Present, and Future).

What are the implications of this study for those who do not feel capable in science? I designed the Participant Photography Tasks to be motivating to the adolescent participants. The photo journal was an organizational tool to help the participants keep track of the time, date, location, and thoughts concerning the photographs they took. The Participant Photo Interview gave voice to the participants' perceptions concerning science. If teachers assigned Photography Tasks, Photo Journals, and Participant Photo Interviews at the beginning of a school year, the students might begin to realize that science is important to our everyday lives and they can find science everywhere. These activities might help to motivate even those students who do not think they are capable in science.

Table 11

Capability in Science Class, Present, and Future

Participant	Present	Future
Alex	Capable – enjoys finding things out for herself	Take sound technology, chorus, and drama classes.
Levi	Capable – taken advanced science classes throughout middle school, others see him as a math and science person	Take classes in graphic design and AP Biology
Katie	Good science student	Take science classes, some math and health courses
Lexie	Capable if she was interested in the type of science –she did not do well in Earth science, but she has an A in life science	Modeling classes, college to get it out of the way, some science classes for veterinarian
Harsha	Does well in math class, and then science class	Take many math and science classes
Brendan	He makes very good grades in science and others see him as a science person	Oceanography classes

Researchers (Aschbacher et al., 2010; Bouchey & Harter, 2005; Olitsky et al., 2010) determined that science is valuable, and is socially situated, and that a student's self-concept may affect motivation and achievement. The way the participants viewed their capability in science was a facet of self-concept. If the participants believed they were scientists and were capable in science class, then their self-concept and identity, actions, and discourse represented their motivation and perceived achievement in science. Lexie was the only participant who did not view herself or thought others viewed her as a science person. Her grades and achievement reflected her ambiguity towards science and she did not seem to have a strong science identity.

The participants' perceptions of their future goals reflected their possible choices of future classes. Alex wants to be an actress or a singer so she determined she will need technology, chorus, and drama classes. Levi wants to be a graphic designer and he will choose graphic design and Biology classes. Katie and Harsha decided they would need to take many math and science courses. Katie wants to be a veterinarian and so she will add health classes to her future courses. Brendan will select oceanography courses to help him become an oceanographer or marine biologist. Lexie realizes there are not really classes for modeling. She reported, "I would still go to college and get my years done, and then go to classes for it. But I don't think there is actually a college for it [modeling]". As for becoming a veterinarian, she admitted she would have to take many of those classes and she would get herself "out there" volunteering at places. When prompted for the types of places she would need to volunteer, she thought for a minute or two. I prompted again for her to think about where she might help animals and she finally thought of the Humane Society.

Katie and Lexie both had photographs that depicted possible occupations other than those they identified in the later part of the interview. Katie had a few baking pictures and Lexie had modeling pictures. Although Katie considers herself a scientist and Lexie does not, neither of them seemed to be convinced they would become contributing members of the science fields. Roth and Li (2005) declared that imagining oneself as a scientist, working as a scientist, and perceiving oneself in an interesting science field defines science identity. Katie thought she might become a veterinarian, but her first few photographs and stories indicated her love of baking and cooking. Lexie was more enthusiastic about her modeling photographs and the thought of becoming a model rather than a veterinarian.

Alex viewed herself as a scientist but admitted from the start that she wanted to be an actress, singer, or animator. I would agree with Roth and Lee (2005) that Alex can imagine herself as a scientist and working as a scientist. Alex has a science identity even though she does not see herself in a science career, which was part of Roth and Li's science identity construct (See Table 11, Capability in Science Class, Present, and Future).

Parent Involvement with the Project

All of the participants except Levi had some help from their parents on the photography tasks. Alex's Mom helped her set up a photograph of her pitcher of water. Her mother wanted her to put the pitcher in an "infinity cove." I had to ask Alex what was an infinity cove. She explained that it is an all-white background used to delineate objects in a picture. She ended up not using the infinity cove for the photograph submitted for the study. Both Katie and Lexie had their mothers help them organize and prepare for the project. Harsha's parents drove him places to take the photographs and most of the photographs Brendan took were at family vacation locations (See Table 12, Parent Involvement).

Parent Involvement with the Participants' Interest in Science

All of the participants' parents encouraged their child's interest in science. Roth and Li (2005) called for knowledgeable adults to demonstrate the relevancy of science for adolescents. I interpreted this to mean the necessity of parental involvement and support in the work done in the student's science classes. The occupations of the parents represented a variety of backgrounds. As entrepreneurs, Alex's parents encouraged her to ask questions. Levi's dad is an electrical engineer and taught Levi about electrical circuits. Katie's parents are both in the field of education. Her mom is a Health/ Physical Education teacher and her dad is an Assistant Principal. They encouraged Katie to play outdoors. They let her explore the environment. Katie recalled a time when she found an injured frog and her parents let her dissect it to see its insides.

Lexie's mom is a science teacher and her dad is a businessperson. Her mom helped her study for tests by making flashcards and other ways to remember things. Both of Harsha's parents work in math related fields. His dad is a computer programmer and his mom is an accountant. Harsha is very good at math and he reported that his parents helped him study for tests and helped him learn things he does not know. Brendan's Mom is also a science teacher. He explained that his mom helps him with flash cards, study guides, and note cards. He studies science every night (See Table 12, Parent Involvement).

Table 12

Parent Involvement

Participant	With Photography Project	With Interest in Science
Alex	Mom helped her set up one of the photographs of the pitcher of water	Parents encourage Alex to ask questions. Parents are entrepreneurs, they do not make the products they market
Levi	No parental involvement with this project	Dad is an electrical engineer and worked with Levi with electrical circuits.
Katie	Parents helped Katie prepare for this project	Parents encouraged her to play outside. Once found a frog that was injured and died. Her parents let her dissect it to see insides. Her mom is a health/PE teacher and dad is a businessman
Lexie	Mom helped her take some of the photographs	Mom is a science teacher. She helps Lexie study for tests and helps he come up with ways to remember things. Dad is a businessperson.
Harsha	Parents drove him to places to take photographs	His parents help him study for tests and help him learn things he does not know. Mom is an accountant and dad is a computer programmer – both math related fields
Brendan	Mom helped him with the photographs for the tasks	Mom is a high school science teacher and helps him with note cards and study guides

The participants in this study were middle class socioeconomic status (SES). The parents of children in this area of the school district tend to be involved and active in the school and their children’s education. This may not be the case for those whose parents are working two jobs and trying to bring in enough money to run a household, or single parent households. However, I have had parents of lower SES make the time to support their child and be a part of their education. Parental support is a major part of the “home” that researchers referenced in defining and explaining science identity (Erickson, 2005; Hall, 2005; Kessen, 2005).

Other Influences Affecting Participant's Interest in Science

Alex and Brendan mentioned television as an influence on their interest in science. Alex watched kid shows that asked and answered questions. She stated that this helped her to question the world around her. Brendan was more specific and named Steve Irwin as the major influence in his science interests. He viewed Irwin's television shows, movies, and read about him. Levi and Lexie mentioned their teachers as influencing their interest in science. Levi remarked that his teachers inspired him to do well in science. Lexie reported that her interest depended on the teacher. She liked teachers who did hands-on things where the students could experience things. Katie confided that she always likes to know more. She cited her science enrichment connections class where she asked many questions and learned more than in her regular science class. Harsha explained that astronomy influenced his interest in science. Harsha observed the sky and the celestial bodies he saw at night fascinated him. This was an everyday experience for him and influenced his interest in science and his performance and discussions within the classroom (See Table 13, Other Influences over Participant's Interest in Science).

Table 13: ***Other Influences over Participants' Interest in Science***

Participant	Other Influences
Alex	Kid television shows that asked questions and then answered them; led to her questioning the world around her
Levi	Teachers inspired him to do well in science
Katie	Likes to know more – asked lots of questions; science enrichment connections class – learned more than her regular science class
Lexie	Her interest depends on the teacher; she likes hands-on things where the students can experience things
Harsha	Astronomy has influenced his interest in science
Brendan	Steve Irwin – his TV shows, and movies

Participants' Final Thoughts

The participants' final thoughts at the end of the interview were varied and mostly positive**.** Alex thought the project was interesting and Levi thought composing the pictures made him think outside of the box. Katie would not do anything differently and she was satisfied with the photographs she submitted. Lexie realized she wanted to be more involved in science so she joined the robotics club during the course of this study. The most valuable insights were from Harsha and Brendan. Harsha thought the project was fun. It made him think deep about what you were going to take a picture of and how it would answer the photography task. He specifically pointed out that the pictures of the participants' hopes for the future would help science teachers identify student interests .This in turn would help the teachers work with and help the students in science class. Brendan thought this project would be easier if it were a class assignment, because students work for rewards or grades. He noted that teachers could also identify those students not as interested in science, not as motivated, and more likely to struggle and therefore need more help in class. The teachers could guide the students to understand associations to real-life, everyday science, helping students to make more meaningful, personal connections to school science.

The participants seemed to like taking the photographs for this study. It challenged the participants to devise scenes that met the requirements of the photography tasks. The reflection process of taking the photographs and then days later discussing them, led the students to realize they interacted with science every day. I designed the photography tasks for the participants to identify science situations and interactions from the past, the present, and to represent their hopes for the future. All participants followed through with the challenge of attempting or completing the tasks. All of the participants enthusiastically responded to the Participant Photo Interviews.

The photographs they submitted were representative of the tasks and the participants were able to articulate how the photos related to science. The participants gave thoughtful responses and recommendations on how teachers could use participant photography with their classes.

Student Science Identity

The research question for this study was "How do adolescent students view themselves as scientists and how do these perceptions relate to their student science identity?" I had six participants between the ages of 11 and 14 compose photographs depicting their science interactions in the past and present time, and visualizing their hopes for a future career. The students kept a photo journal in which they noted the time, date, location, and their thoughts about each photograph. The participants shared their photographs and perceptions of science in a participatory interview (Clark-Ibanez, 2004; Jorgenson & Sullivan, 2010; Kolb, 2008). They told me about their photographs and their memories about the science situations that led to the compositions of the images. Through these images and shared stories, I learned how each participant related to science both inside and outside the classroom, and I gained a sense of their student science identities.

The participants responded to the interview questions (See Appendix E) about viewing themselves as a scientist in a variety of ways. Alex would not say whether she thought she is a scientist or not because she knows some things, but does not know other things. Yet, she views herself as capable in science class and other students see her as a science person because of her inquisitiveness and curiosity. Alex does not plan to pursue a career in the science field because she is interested in acting, music, and animation.

Levi replied that a scientist goes deeper into how people function and how everything works. He thinks of himself as a scientist, but more like a student because he has not been the first person to discover a new idea. He is very capable in science and is proud of his academic standing in his science class. He believes other students see him as a science/math person and he plans to become a graphic designer when he graduates from Georgia Tech.

Katie responded to what a scientist is by stating that a scientist explores and "gets into ideas" more than other people do. Katie believes she is a scientist because she bakes utilizing skills such as measuring and mixing ingredients to create different dishes. She also contributes to her science class by bringing in examples of things to share with her classmates. She feels she is a good science student and wants to work in the science field of veterinary medicine.

Harsha answered the question about being a scientist with an affirmative response. He believes that because he is pursuing the science careers of physics and astronomy, which have numerous science concepts associated with those fields, that he is a scientist. When asked if he was capable in science, he replied he is more capable in math than science. His classmates see him as a math person as well. He noted that when he does well in math he tends to do well in science and vise-versa.

Brendan declared that a scientist is anyone who studies any part of science, like biology, chemistry, and oceanography. Brendan feels he is a scientist because he "…does more science stuff than other kids." He stated that he does very well in science class and others see him as a science person. He has a variety of scientific interests and he named four possible careers he would like to pursue. Some of these occupations included saving lives because he learned CPR and would like to be prepared if someone is in a health crisis. He identified with veterinarians because he showed compassion towards living things and he rescued several different animals. He would like to be a marine biologist or an oceanographer because he dives and he likes observing sea life.

Lexie was the only participant who does not believe she is a scientist. She thinks a scientist figures things out and conducts “tons of research.” She does not picture herself in this role, even though she thought it would be good to become a veterinarian. Lexie feels she is capable in science class only if she was interested in the topic and the teacher presents the material in a fun, hands-on manner. The other career Lexie considers as a possible future job is modeling. Lexie knew when she volunteered for this project that she was not a science whiz and was reluctant to admit that she really was not interested in science. However, during the course of this research study, she decided she should be more involved in science and joined the school robotics team!

Interpretation

The science identity definition I developed from the literature review was “Adolescents develop and define their science identity by understanding science from their past, participating and internalizing interactions of the daily science classroom and community, imagining who they hope to become, and beginning to comprehend the sense of their science self.” After my data collection, I realized that I needed to incorporate “family” into the science identity definition. The participants’ parents and siblings are part of the adolescents’ past and present. The connections to family and siblings enabled the participants to remember some of the science experiences outside of the science classroom. This became clear through the participants’ responses and photographs about science in their past and in their everyday lives.

I arranged for students to take photographs that represented science throughout their lifetime. I wanted to explore what their perceptions were of science in their everyday lives. Every participant submitted photographs for science in their past and their hopes for their future. The participants included photographs of science in their classrooms, outside of the classroom and in their everyday lives. Lexie was the only participant who was unable to compose a photograph that represented how others saw her. She really did not see herself as a science person and thought others would not view her as one either. Therefore, she did not submit any photos for this category. Lexie was the participant who identified modeling as her career and then veterinarian as a second thought. In the interview, I could tell she was enthusiastic about the modeling poses and the prospect of wearing designer clothes. She was not as confident when she talked about becoming a veterinarian and going to college to take the necessary science classes.

In all the photographs of science experiences in the past, the participants connected their photographs to a science concept or principle. These are the experiences they remembered and wanted to share in their classrooms. Student voice (Logan & Skamp, 2008) and student agency (Brickhouse et al., 2000; Calabrese Barton &Tan, 2010; Reveles & Brown, 2008; Shanahan, 2009) can be powerful motivators for students to learn science. The participants in this study were eager to share their images and stories and seemed to appreciate a serious listener, someone who was paying attention to their "voice."

The photographs of science in the classroom, science outside of the classroom, how others see the participants, and science in their everyday lives represented meaningful objects and concepts that interested them. Other photos were of active, hands-on, or participant-involved activities, which they reported as their favorite types of science activities. The more active and engaged the participants were, the more it helped them learn and remember the concepts. The participants' photographs helped them reflect on their personal connections to science and the environment. In turn, they realized that they are capable and confident in "doing science."

The photographs of what they might become as an adult emerged from their interests in certain science fields and hobbies. The interview questions (See Appendix E) served to focus the participants on aspects of science identity. These identity aspects included what they think science and scientists are. The interview questions also addressed whether the students feel capable in science class and if their parents are involved in their interest in science.

Science literacy. How does my study relate to science literacy? There are five areas Krajcik and Sutherland (2010) identified to help students develop science literacy. These areas included, linking prior knowledge to new ideas, questioning that relates meaningful learning to students' lives, connecting multiple representations of science concepts, providing opportunities to apply science ideas relevant to student opportunities, and using science discourse to support student engagement. The photography tasks of my study asked the participants to link their prior knowledge of science to what they believed science means to them in the present. The participants created their own opportunities to apply science concepts to their everyday lives in multiple representations through photography. The Photo Journals and Participant Photography Interviews allowed the participants to communicate their ideas and knowledge. In summation, the series of activities in my study promoted science literacy.

More recently, researchers (Aschbacher, et al., 2010; Bybee. 2011; McNally, 2012) connected science education to Science, Technology, Engineering, and Math (STEM) initiatives. These researchers emphasized the importance of student interactions, communication, and explanations as an important aspect of science literacy. They concluded that science classes should be interdisciplinary and incorporate STEM activities. Teachers should lead students to "want to know" and "need to know now" through relevant, meaningful opportunities and projects that connect to the natural world and everyday lives. The photography tasks in my study had the participants make the connection between real-life interactions with science and asked the participants to reflect, communicate, and explain how they encountered science in their everyday lives.

Science identity. Science identity is a complex and fluid concept. Through the review of literature, I identified six areas that I wanted to investigate though participant photography. These areas included the participants' science experiences in the past, in science class, outside of school, and in their everyday lives. The other two areas were how others saw the participants as a science person and what the participants hoped to become. The resultant photographs and participatory interviews combined to create a narrative about the participants' perceptions of science. I synthesized the results to examine how these perceptions related to and helped construct the participants' science identities.

I found implications for science identity that reinforces and enhances the findings from other researchers. Brickhouse, Lowery, and Schultz (2000) examined how girls engage in science, especially in group situations, and how these interactions relate to who they think they are as well as whom they want to become. The participants in the Brickhouse et al. study interacted with the science teacher and other students in the class as a choice partly determined by what they thought others expected from them. In my study, the Photography Tasks about experiences of "doing science" in the classroom and how others think of the participant as a science person revealed how the participants engaged in science and how others saw them. The photographs were just a snapshot of how the participants engaged in science activities, but the narratives in the Participatory Photo Interviews revealed a more complete story. All of the participants included photographs representing experiments that they did in groups within the science classroom. The experiments were hands-on investigations of science concepts. In the narratives, the participants were able to describe the science concepts within the experiments they were performing.

The Brickhouse et al. (2000) study emphasized how their participants identified with others in a particular group and how the group of girls invited others into their circle. Although my study did not include observations of science classroom groups in action, the perceptions of my participants in how others saw them as a science person implied that groups and other students in the science classes viewed them as knowledgeable in science. Alex indicated that other students sought her out to answer questions and she was comfortable presenting projects in front of the class. Classmates knew Levi as a very good science student and had the grades to substantiate that belief. He also was able to apply his excellent course work as a high school Carnegie Unit. Brendan portrayed a "Mad Scientist" for Character Day because that is how others saw him as well as how he sees himself. These three participants felt comfortable within the science classroom and accepted the roles as knowledgeable science people.

What happens to those students who do not have a strong science identity? Brickhouse et al. (2000) concluded that even if students have a strong science identity, teachers may not respond to these identities by recognizing the students' engagement and knowledge. Those students who do not have a strong science identity may not engage or push themselves in the science classroom. Brickhouse et al. concluded that in the school environment, the school placed the girls in classes for the following year based on "good student" and "good behavior" and not on strong student science identities.

In my study Lexie best exemplified this theory. She accepted that she had other, stronger interests than science and accepted the average grades she received. However, after reflecting on her experiences with science through my study, she joined the robotics club. Her science identity became stronger by association with other students with strong science identities and by learning the details of programming, designing, and building robots. It would be interesting for me to observe if Lexie holds on to her science classroom identity as an average science student, or if she asserts herself and her developing science identity in her physical science class in her next year at school.

Avery and Kassam (2011), who researched and observed twenty 5^{th} and 6^{th} grade students in rural New York, noted that all of their participants found examples of science and engineering in their everyday lives. What the researchers discovered was that the students had this wealth of knowledge acquired by observing and doing science and engineering activities with their families, but did not have the opportunity to apply this knowledge in the science classroom. They concluded that the educational system needs to bridge the gap between the students' science and engineering knowledge, and their formal science education. Otherwise, the school system will continue to see a decrease in student engagement and attitude in the science classroom. Avery and Kassam advocated for the educational system to recognize and value the knowledge students have coming into a classroom. The researchers concluded that the curriculum and teachers needed to connect the science classroom learning with the activities of the students in their everyday lives. My study outlines a method for teachers to learn about their students' experiences with science in their everyday lives. With this knowledge about their student's interests and identities, teachers might look for ways to incorporate those experiences into the classroom and close the gap between student science identities and classroom learning.

Tan and Calabrese Barton (2007) investigated ways girls represented themselves in social and cultural interactions. They concluded that students form "identities in practice" so they may change their identities to adjust to different social and cultural situations. These researchers noted that science identities evolve through decisions students make about assignment completion and classroom participation. They explained that students decided whether they were going to complete a task, actively participate in an activity, participate passively, or not participate at all. In my study, Lexie demonstrated that her decision-making process was dependent upon the type of activity the teacher presented. If the assignment was to read the text, Lexie admitted that she was bored and uninterested in the content because there was nothing to do but read and look at a few pictures. However, Lexie actively participated when the teacher presented a hands-on activity and activities with group interactions.

Another example occurred in my study of how students' developing science identities and behaving in the classroom depend on their social and their school science worlds (Tan & Calabrese Barton, 2007). The participants saw themselves one way at home and another way in science class. Their identities would change according to the situation and who "the others" were at the time. The participants acted and had one identity around their parents, another identity in a group situation in science class, and another identity when responding to questions from the teacher or their peers. Levi would be quiet in class and reserved until the teacher asked a question that he wanted to respond to because he knew the answer. Levi saw his science identity as one as an accomplished science student, but he was not a "show off" in front of his peers, so he kept quiet unless called on to respond to a question. His identity changed at home when he was with his parents and sister. He was serious and studious, completing all of his homework consistently and he was proud of his good grades. Lexie on the other hand, wanted her peers to know she was in the class and had a voice in subjects other than science. At home, she struggled with the science vocabulary and concepts so she was more attentive when her mom tried to help her with flashcards and mnemonics. Within the science classroom, Lexie's identity would change according to the daily activity.

Carlone (2004) noted that people shift their perspective of learning depending on the organization of the science activity. She studied girls in an active physics class. Some of the girls had science identities of energetic problem solvers and hard workers. Other girls did not consider themselves "lab people" or "group people" when they were frustrated with the work or length of time an activity took to complete. The participants in my study shifted identities with the science topics they studied. Many more of the students identified with Life Science than Earth Science. The Life Sciences classes were more hands-on with dissections and labs about bacteria and genetics. However, Harsha identified with Earth Science topics because of his experiences with rock collecting and his fascination with the stars and planets. Carlone concluded that science teachers needed to arrange activities based on the interests of the girls and include meaningful, real-life science.

More recently, Bybee (2011) posited that science education needed to shift from science inquiry, where teachers presented students with a stimulus that prompted questions, further investigations, and experimentation, to science practices. Through science practices, students would learn about experiments, science discourse, models, and math. Through these experiences, students would evaluate claims, investigate, and explain phenomena to propose solutions to real engineering problems. In my study, Levi had a photograph of a graphic design he created for a band's travel bus. He was excited about the real-life application as he learned the process of graphic design. Alex highlighted the real-life controversy over the high-pitched sounds of a cell phone. She explored whether adults were able to hear the sounds that her peers could hear.

Bybee would contend that through projects and practices such as these, students would identify and learn the scientific processes.

Sfard and Prusak (2005) looked at how others tell stories about a person and consequently how others see a person. They found that learning closes the gap between actual identity (identity in the present) with designated identity (what a person wants to be in the future.) Brendan is an example of this. His experiences with diving and the ocean environment have increased his interest in becoming an oceanographer or a marine biologist. Alsup (2006) discussed ways to access thoughts and human expression through metaphor creation and visual composition. Photographs are a means to express visual thinking. In my study, I was able to focus the participants' thoughts about science and consequently explore how science affects them in everyday life. They expressed their science identities through the participant photographs and their stories and narratives during the Participant Photography Interviews.

Limitations and Challenges

My research included individual case studies and a cross case analysis. It was a qualitative study meant to add to the current literature and give voice to adolescents concerning their developing science identity. This case study research did not generalize over school-aged populations. Rather it was a unique exploration of the participants' perceptions of how science experiences in their past, their interactions with others and their environment, and their views of what they want to do in the future clarify their science identity.

There were challenges with this study because I wanted to explore student perceptions. The Internal Review Boards tend to be very particular concerning the wording about the interview protocol and the use of photographs of minors. The approval delay from this board delayed the participant selection and data collection for this study.

Another challenge of this study was to find students to volunteer from lower SES backgrounds. The six participants were from the same middle class socioeconomic status (SES). The findings of this study may have been different if the participants were from lower SES. The reasons for the differences might be due to lack of parental support and negative peer pressure.

A better situation to collect this data would be to have it as a class assignment. The participants suggested this when asked what they might do differently for this study. They also suggested using better cameras than their phones to get clearer photographs for their journals. Some chose not to write the information requested in the journal and just submitted the photographs. One student took the pictures from images on the internet. In the future, I would make sure the participants understand that they are to compose and take the photographs. Participants should have another person take a photo of them in action, but only under unusual circumstances should they retrieve images off the internet.

Significance of the Study

My study revealed important information about how students view their world related to science. I examined the participants' perceptions of their science interactions in the past, at the present time, and their visualizations of their hopes for a future career. I explored how these perceptions affect student science identity. This research has added to the literature on Auto-photography, Participant Photo Interviews (PPI), and adolescent science identity.

Research Literature

Because I combined the use of Auto-photography and Participant Photography Interviews to explore student *science* identity, this is a unique study. I incorporated participant-composed photographs along with Participatory Interviews to examine the participants' world and their interactions with science. I connected the participants' perceptions and co-created meanings of their images with science identity formation.

This study has added to and extended the current research literature. Several researchers (Clark-Ibanez, 2004; Jorgenson & Sullivan, 2010; Nelson, 2007; Shankar-Brown, 2011) used Auto-photography to investigate adolescents and their interpretation of the world around them in connection with identity. Researchers (Avery & Kassam, 2011; Kolb, 2008; Nelson, 2007) specifically utilized photographs along with a Participatory Photo Interview (PPI). They identified the advantages of using PPI for gaining multiple insights into the students' personal past through their significant images (Jorgenson & Sullivan, 2010). Through PPI students engage different parts of the brain (Harper, 2002) and co-create meanings (Avery & Kassam, 2011; Clark-Ibanez, 2004; Collier & Collier, 1986; Harper, 2002; Kolb, 2008; Schwartz, 1989, van Leeuwen & Jewitt, 2001). Other researchers (Aschbacher et al., 2010; Calabrese Barton et al., 2007; Carlone, 2004; Farland-Smith, 2009; Roth and Li, 2005) studied various aspects of science identity that I explored by expanding and investigating the concept from a new direction. The aspects of science identity that I included are: interactions with real-life science activities and scientists; how students view themselves in science class; how others view them as a science person; and what they want to become.

This study is distinctive because it combines the use of auto-photography and PPI to explore specific aspects of student science identity. No one has used student-composed images and interviews to gain insight into student interactions, engagement, and perceptions of how they are a science person and how this shapes their science identities.

Significance and Implications for Teachers in Practice

The participants in this study suggested that teachers use this photography activity as a class assignment. The participants thought more people would "volunteer" to complete the activity if it was for a grade. Teachers could use this at the beginning of the year as a Science, Technology, Engineering, and Mathematics (STEM) activity incorporating cell phone or digital camera technology with science. The information gained through the students' images and perceptions of science could help teachers understand if their students know what science is, and learn if they have memories of doing science in the past, and if they can give examples of doing science in the present and predict what they would like to be as an adult. Teachers then have a sense of their students' prior knowledge in science and their confidence in ability to do science, and they would have an indication of which students foresee a science career. Teachers could then ask students to participate and engage in classroom discussions adding examples from the photographs and prior knowledge they shared in the project.

Using auto-photography or participant photography is a way to motivate those students who do not like to write. They can take photographs of what they want to portray or say. This is a novel idea for the use of cell phones, tablets, or cameras in the classroom. Students who do not have the technology with them or at home, should check out a camera through the school's media and technology department. Those students who are artists may want to draw the pictures. The idea is to use a different medium as a novel "hook" to the activity. The photographs are a quick, vivid way to understand how the student perceives or views the concept. I would encourage teachers to inform the parents of the activity so that parents can be involved and support their child.

Teachers should be able to identify students who struggled with the project because they did not know what to photograph, they could not connect their photo to science, or could not share a story about their photograph. On the other hand, teachers might identify those students who already have strong science identities and very explicit interests in particular science topics or concepts. Teachers could then enrich and extend lessons in those areas of interests to keep these student motivated and engaged in learning.

Significance and Implications for Teacher Educators of Pre-service Teachers

It is important to expose college students preparing to teach adolescent students to the concept of student science identity. Pre-service teachers would learn how important it is to get to know their adolescent students. The use of Participant Photography and Participant Photography Interviews gives the teacher a glimpse of who relates to science, who likes science, and who believes themselves to be capable in science. It can help their teaching be more personable and meaningful if they know from the photos and PPIs that someone is a rock collector, or one of their students has traveled beyond the community, or if one or more students have never seen the ocean. The photos and interviews are a quick and motivating way to get a “snapshot” of their students’ perceptions of science, prior knowledge, and possible interests that could create personal contributions to class discussions.

Teacher Educators could use the Auto-photography technique described in this study as an activity for pre-service teachers to discover what their perceptions are of their own science identity. The method presented in this study is combining photography with participatory interviews. The pre-service teachers could take pictures of their past, present, and possible future interactions with science. Then the pre-service teachers could interview each other and report their findings to the class. The professors would have an opportunity to get to know their pre-service teachers' views about science in a short amount of time. The activity may demonstrate how the images are important to pre-service teachers and they want to share them with other people. The photography activity may inspire the pre-service teachers to get to know their students as someone who hears their students' voices and make changes to become a better teacher.

Future Research

Teachers need to incorporate more technology into their classroom to keep up with the technology explosion their students utilize. This study uses digital cameras or cell phones to take photographs giving us insight into student perceptions of their interactions with science. We need to develop more ways to incorporate the technology adolescents already have and use to motivate and engage students in learning science. Research is leaning towards advocating the incorporation of STEM lessons into the science classrooms (McNally, 2012). Auto-photography and Participatory Interviews give students voice to what is working and what is in need of change. The images and discussions can aid in the understanding of science and the clarifications of misconceptions.

We need to examine how to connect the Science, Technology, Engineering, and Mathematics (STEM) disciplines with curriculum that is relevant and meaningful to students. Some researchers (Logan & Skamp, 2008; McNally, 2012) are promoting more collaboration and discussions where students can learn from the opinions and views of their peers and someone other than the teacher. The challenge for educators is how to integrate the hands-on, problem solving, relevant activities of STEM with collaboration and science discourse between classmates that help develop student science identity. This activity is an example of how to integrate technology, science, and collaboration through the Participants Interviews. Researchers need to find ways to provide teachers with lessons and activities that require materials that are available, student driven, high interest, and promote confident, capable science students.

This was not a longitudinal study. It would be interesting to follow these students and see if their perceptions of science and scientists change over time along with their science identities. In four or five years, it would be helpful to find out if they are continuing on to college and if they are majoring in a science field. Then it would be fascinating to find out what career they choose as an adult.

Longitudinal studies would help validate the foundation placed in this study with adolescent student identity. Having a larger sample size, a varied range of SES participants, and additional researchers to interview the cases would also help to test the concept of Participant Photography and Participatory Photo Interviews.

Conclusion

The title of this research project was "A New 'Image' in Adolescent Science Identity." The image emerged from using Participant Photography images and the individual driven Participatory Photo Interviews (PPI) to analyze the adolescent perceptions of science interactions. The purpose of the study was to explore how early adolescents perceive themselves "doing science" and "being scientists." I used a synthesized definition of science identity to help construct my research question and photography tasks. The science identity definition that led to the research question was, *Adolescents understand science from their past, participate and internalize interactions with the daily science classroom and community, imagine who they hope to become, and begin to comprehend the sense of their science self.* I did not include "family" as part of my original definition. I added "family" as I realized through the study that interactions with the family were an important facet of one's identity. So my definition of student science identity became *Adolescents understand science from their past, participate and internalize interactions with the daily science classroom*, **family**, *and community, imagine who they hope to become, and begin to comprehend the sense of their science self.* The research question was "How do adolescents view themselves as scientists or non-scientists and how do these perceptions relate to their student science identity?"

The photographs gave a unique window into the perceptions of how the participants related to science in their everyday life. During the PPI, the researcher and participants co-constructed the perceptions and meanings of the photos. This rich data led to facets of the participants' science identity revealing thoughts about science interactions in the past, present, and their hopes of who they want to become.

Five of the six participants had strong science identities. They remembered science interactions from their past. They were actively engaged in science in the classroom and recognized science interactions outside of the classroom. They felt like they were scientists, were capable in science, and others saw them as science people. Their family supported them with help on science assignments, traveling to places where they interacted with science, and the family made it clear to their children that science is important. The five participants interacted with science in their community through soccer, skateboarding, drama, camps, clubs, and travel.

Three of the five participants who had a strong science identity saw themselves as working in science fields as a veterinarian, a physicist or astronomer, and an oceanographer or marine biologist. These three realized that they would need to take science and math classes in high school and college. One participant with a strong science identity saw herself in as an actress, a singer, or animator. The other participant saw himself as a graphic artist/designer. He completed a camp in graphic arts and really connected with it. He would like to go to college to study this and become a graphic designer.

The sixth participant recognized science interactions from her past, did average in science class, and stated that she does better with topics of interest to her. Her family supported her in helping her learn science concepts and completing assignments. She did not feel that others saw as a science person and did not identify with science classes and concepts. She did not feel like a science person and would rather be associated with social studies or math. Her interactions within the community were usually around her neighborhood. She did not really see herself working in a science field. She decided if she had to choose a science career, it would be a veterinarian because she loves animals and she had several pets. She would like to be a model and submitted photographs of her dressed nicely and posing for the camera. During this study, however, she did join the robotics club because she realized she wanted more interaction with science!

Photographs

I found that the photographs that the participants took were creative and thoughtful. One of the most impressive photos was one that Alex took for the prompt about how others see you as a science person (Figure 36). There were multiple meanings wrapped up in this picture. Alex started the discussion by noting that her eyes are two different colors. This led her to talk about genetics. She also discussed that this represents how others see her as a science person. She is inquisitive and others see her as inquisitive and knowledgeable. They ask her questions that she answers or researches to find the answers.

Figure 36: Alex Task 4
How Others See You

Another photograph I found intriguing was one that Katie submitted of a spoiled sandwich (Figure 37). The colors were vibrant and the bright blue reminded me of the bright colors in the animal world that warn of poisons. Katie knew that the meat and other ingredients in the sandwich were spoiled and inedible. This was one of her interactions with everyday science.

Figure 37: Katie Task 5
Every Day Life

Brendan's photographs were action oriented. Two that I particularly liked were the Mad Scientist photo he submitted as one of his entries for Task 4: How Others See You (Figure 38). Not only does Brendan see himself as a scientist, he dressed as one for a "Character Day" at school. He perceives that others see him as a scientist so dressed as one! He is an example of an adolescent emerged in science all around him.

Figure 38: Brendan Task 4
How Others See You

The other photograph that made an impact on me was of Brendan diving (Figure 39). This photograph represented him as what he would like to do as an adult. He submitted this photo as one of four of possible career paths in the future, Task 6. He wants to help people by saving lives, perhaps by becoming a lifeguard. He would like to be a marine biologist, an oceanographer, a dive master, or a veterinarian. Any of these careers would make Brendan happy and all of them are in the science fields.

Figure 39: Brendan Task 6
Future

Final Thoughts

Participant Photographs are powerful images that reveal adolescents' inner thoughts, emotions, and desires. The Participant Photography and the Participant Photo Interviews (PPI) allowed the audience to hear the participants' voices. Although this was a qualitative case study with only six participants, what they perceived, remembered, and enacted in relation to science was powerful. These participants identified interactions with science in their past, present, and reflected on what they may become in or out of a relationship with a science field. During the course of this study, one participant who did not view herself as a science person recognized that she wanted more interaction with science and joined the robotics team!

These participants realized that they did science things in the past, they are doing science every day, and they are capable of doing science things in and out of the science classroom. If we as educators can use Participant Photography and PPIs to know our students on a more personal level, have our students realize they CAN do science, and give them a sense of accomplishment and confidence, students should become more successful science students. That is not to say that all students will like science, develop their science identities, or gain confidence in science. However, we are bound to reach more students that may make a contribution in science if they are encouraged in the middle school environment. Knowing your students' interests as demonstrated through the photographs and interviews will help teachers plan lessons and differentiate the content based on their interests rather than ability.

Additional research could be done to discover students' perceptions of science through a similar process and then see if these activities have any effect on student science achievement and their interest in STEM fields. Longitudinal studies would help to determine if photographs and interviews such as the one in this study encourage students to take up more science classes and consider careers in the sciences.

Through the type of reflection necessary for the activities in this study, students with average science abilities may recognize they are more capable and confident in doing science things than they previously thought. This may motivate them to do even better in science and therefore strengthen their science identity. Students with strong science identities are the ones we need to encourage to pursue scientific inquiries, discoveries, and inventions.

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APPENDIX A

Questionnaire for Participant Selection

Demographics

1. What is your name?
2. How old are you?
3. Where do you live?
4. With whom do you live?
5. Do you have brothers and sisters? How old are they?
6. Do your parents work? What do they do?

Background information:

1. What is your favorite academic subject in school?
2. Do you like science?
3. What is science?
4. Do you think you are a scientist?
5. What kinds of things do you do in science class?
6. Do you participate in your science class?
7. What kind of science things do you remember doing when you were younger?
8. What would you like to be or do when you grow up?
9. Who is you favorite teacher? Why is he/she your favorite?
10. Do you have a favorite science teacher from past years? Why was he/ she your favorite?

APPENDIX B

Parental Permission Form

Auto Photography, Photo Journals, and Participatory Photo Interviews as Reflective Tools for Teachers to Empower Adolescent Science Identity

I agree to allow my child, ____________________, to take part in a research study titled, "**Auto-photography, photo-journals, and participatory photo interviews as reflective tools for teachers to empower adolescent science identity"** which is being conducted by Ms Anne Haddox, from the Elementary Education Department at the University of Georgia under the direction of Dr. Cory Buxton. My child's participation is voluntary which means I do not have to allow my child to be in this study if I do not want to. My child can refuse to participate or stop taking part at any time without giving any reason, and without penalty or loss of benefits to which she/he is otherwise entitled. If I decide to withdraw my child from the study, the information that can be identified as my child's will be kept as part of the study and may continue to be analyzed. **My decision to allow or not allow my child to participate in any portion of the research will not influence his/her grades or class standing.**
The reason for the study is to find out how young adolescent students perceive or think of themselves as interacting with science. Their photographic images, insights, and perceptions about their experiences with science may help them see themselves as capable science students and may lead to an increased interest in pursuing science studies.
What are the expectations of the participants? If I agree to allow my child to volunteer to participate in this research study, he or she will be asked to do the following things:
1) –use his/her cell phone, his/ her digital camera, or a disposable digital camera provided by the researcher to take photographs in response to six photography tasks that demonstrate experiences with science:

a. from their past
b. in the present within the classroom
c. outside of the classroom
d. in their everyday lives
e. in how others see them as science people
f. representing what they would like to be as an adult

2) - create a photo journal. For each of the six photograph assignments, he/she be asked to record where and when he/she took the picture, what he/she was thinking as he/she composed and snapped the picture, and how the image relates to him/her interactions with science. He/she will be asked to take the pictures on his/her own time.
3) - upload the photographs he/she took to a computer and print a copy. He/she may use his/her own computer or a computer at school. He/she will be asked to add the photos to his/her journal with the descriptions he/she has written.

4) – participate in a Participatory Photo Interview where the researcher will show him/her the pictures and the journals he/she has created and he/she will be asked to tell the researcher his/her stories about the pictures. The interview will be digitally audio-recorded and transcribed. The interview will be approximately 30 minutes.
5) - provide any additional artifacts he/she identifies as having an impact on how he/she does science or how he/she views himself/herself as a scientist. These artifacts may include any written assignments, projects, experiments, or other activities to include in his/her stories.
When taking pictures during this research study, my child will be instructed not to take pictures of images of faces of non-research participants. If my child captures any images of faces of non-research participants, the researchers will redact the images (e.g., blur/black out any images of faces) from the research records.
My child will be offered a $10 I-tunes gift card as an incentive to participate in the photo tasks in the main portion of this research study. He/she will receive this incentive even if he/she begins the photography tasks and then is withdrawn from the main portion of the project.
Confidentiality: All individually identifiable information will be held confidential unless required by law. The researcher will keep all individually identifiable information (e.g., names, images of faces) in a secured location and will destroy all individually identifiable information within three years after completion of the data collection. All audio-recordings will be destroyed within one year following completion of data collection. The researcher will make a summary report from the analysis of the photographs, photo journals, and interviews. This information will be the research project for the student co-investigator's dissertation, shared with her Doctorate Committee, and published as a dissertation. The researchers may also use this data and information for additional published papers. If the researcher uses the photos, excerpts from the interviews, and/or pages of the photo journals in any professional presentations and/or publications, the researchers will blur any images of faces and change/alter any information that could identify the information as my child's or as being affiliated with my child's school.
Is there danger or risk to your child? While there are no foreseeable risks associated with this research, some research participants may regret a picture they have included in their photo journals and others may feel nervous about sharing their stories and being audio-recorded. To minimize this possible discomfort, participants may remove any pictures from the journal as a "Regret" photograph and not share it with researchers. Additionally, the researchers will demonstrate how the digital recorder works and let participants hear their recorded voice to help alleviate any pre-interview anxiety. Participants can choose not to answer questions that they do not want to answer. Participants may withdraw from the study at any time without penalty. There is no grade or advantage to participating or not participating in the study.
Benefits: Participants may keep a copy of their photo journals and any artifacts they produce. They may learn something new about themselves, about their interests related to science, about possible science courses, and about careers in the science fields.
Notification of Invitation to Participate in Main Research Study: My child was one of twenty-four students recommended to participate in this study by my child's 8th grade science teacher. All 24 students were briefed about the study, invited to participate, and given parental permission/ minor assent forms to take home and discuss with their parents. As the researcher is

looking to recruit 6-12 research participants, if more than 12 students return the parental permission and minor assent forms within 3 days, the researcher will draw up to 12 names out of a hat (at least 3 boys and 3 girls) to select the participants who will take part in the main research study described above. If my child is selected, the researcher at school will notify my child verbally, and I will be notified through e-mail and/or a phone call that my child is one of the participants for the main study. If my child is not selected, my child will not take part in the photo journaling activities described above.

The researcher will answer any questions about the research now, or during the course of the project, and can be reached by telephone at 678.407.7272 or email at ahaddox@uga.edu. I may also contact the professor supervising the research, Principal Investigator Dr. Cory Buxton, at 706.542.4244 or buxton@uga.edu

I understand the project described above. My questions have been answered and I agree to allow my son/ daughter to participate in this project. I have received a copy of this form**. Please sign both copies, keep one, and return one to the researcher.**

___________________________	_________________________	___________
Name of Researcher	Signature	Date
___________________________	_________________________	__________
Name of Parent	Signature	Date

Parent e-mail:___________________________ Parent phone #:_________________________

Additional questions or problems regarding your child's rights as a research participant should be addressed to The Chairperson, Institutional Review Board, University of Georgia, 629 Boyd Graduate Studies Research Center, Athens, Georgia 30602; Telephone (706) 542-3199; E-Mail irb@uga.edu.

APPENDIX C

Minor Assent Form

Auto Photography, Photo Journals, and Participatory Photo Interviews as Reflective Tools for Teachers to Empower Adolescent Science Identity

I am pleased to have you participate in this study. I am a teacher at Couch Middle School and a doctorate student at the University of Georgia. I am designing a research study about student science identity to find out how young adolescent students perceive or think of themselves as interacting with science. Your photographic images, insights, and perceptions about your experiences with science may help you see yourselves as capable science students and may lead to an increased interest in pursuing science studies. This study may lead teachers to use the tools of auto-photography (pictures taken by the students), photo journals, and interviews to incorporate their students' prior experiences and knowledge into the science curriculum to empower students' science identity.

What are the expectations of the participants? If you agree to participate in this research study, you will be asked to:

1) - take photographs in response to six photography tasks that demonstrate experiences with science:

g. from your past
h. in the present within the classroom
i. outside of the classroom
j. in your everyday lives
k. in how others see you as a science person
l. representing what you would like to be as an adult

2) - create a photo journal. For each of the six photograph assignments, you will record where and when you took the picture, what you were thinking as you composed and snapped the picture, and how the image relates to you and your interaction with science.

3) - upload the photographs you took to a computer and print a copy. You may use your own computer or a computer at school. You will add the photos to your journal with the descriptions you have written.

4) – share in a Participatory Photo Interview where I will show you the pictures and the journals you have created and you will tell me your stories about the pictures. These interviews will be digitally audio-recorded and transcribed.

5. - be observed during science class activities. I will take field notes while observing you interacting in the science classroom.

6. - provide any additional artifacts you identify as having an impact on how you do science or how you view yourself as a scientist. These artifacts may include any written assignments, projects, experiments, or other activities you would like to include in your stories.

Confidentiality: In writing about this study, I will use pseudonyms for all students, and no identifying names will be on the photo journals or other artifacts. The school will be given a different name. All information will be kept in a secured location and all individually identifiable information will be destroyed after 1 year. I will make a summary report from the photographs, photo journals, and interviews. This information will be the research project for my dissertation, shared with my Doctorate Committee, and published as a dissertation.

Is there danger or risk to you? I will ask you to reflect on how you see yourself as doing science or being a scientist. Your photographs, photo journals, and interview transcriptions are part of this study. You can choose not to answer questions that you don't want to answer. You may withdraw from the study at any time without penalty. There is no grade or advantage to participate or not participate in the study. You may keep a copy of your photo journals and any artifacts you produce. You may learn something new about yourself and your interests related to science.

If you agree to participate, please print your name below and sign the form. If you have any questions or concerns, you can call (770-972-1251), or e-mail me (ahaddox@uga.edu).

Sincerely,

__________________________ _______________

Anne Haddox Date
Name of Researcher
Telephone: (770) 972-1272
E-Mail ahaddox@uga.edu

I understand the project described above. My questions have been answered and I agree to participate in this project. I have received a copy of this form.

Name of the Student Participant: ____

Signature of the Student Participant: ____

Please sign both copies, keep one, and return one to the researcher. Additional questions or problems regarding your rights as a research participant should be addressed to The Chairperson, Institutional Review Board, University of Georgia, 629 Boyd Graduate Studies Research Center, Athens, Georgia 30602-7411; Telephone (706) 542-3199; E-Mail Address irb@uga.edu

APPENDIX D

Photography Tasks

Task 1: Take 1-2 pictures of something that reminds you or represents you "doing science" when you were younger.

Task 2: With your teacher's permission, take 1-2 pictures of you "doing science" or "being a scientist" during science class.

Task 3: Take 1-2 pictures of you "doing science" or "being a scientist" outside of school.

Task 4: Take 1 -2 pictures that demonstrate how others think of you as a science person.

Task 5: Take 1-2 pictures that represent you "doing science" or "being a scientist" at home, school or other environment on a daily basis.

Task 6: Take 1-2 pictures that show what you would like to do as a job or career when you are an adult.

APPENDIX E

Interview Protocol – 2nd Part of PPI

I'm going to ask you some questions about the project in general.

Are there any pictures you would have done differently or regret not doing?

If somebody came up to you and asked you what science was, what would you say? What do you think science is?

What do you think a scientist is?

Would you consider yourself a scientist?

Do you think you are capable in science, do well in science?

Do you think others see you as a science person?

What kind of classes do you think you'll take in high school and college?

How are your parents involved in this study?

How have your parents involved you in learning or experiencing science?

What else has influenced your interest in science?

What did you think of the project overall?

Do you think this would be easier if it was a class assignment, that everybody in the class took pictures about science in their life?

Do you think a project like this would help your teachers?

Is there anything you'd like to add that we haven't talked about?