Science Identity in Informal Education

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Authorization to Submit

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Abstract

The national drive to increase the number of students pursuing Science Technology, Engineering, and Math (STEM) careers has brought science identity into focus for educators, with the need to determine what encourages students to pursue and persist in STEM careers. Science identity, the degree to which students think someone like them could be a scientist is a potential indicator of students pursuing and persisting in STEM related fields. Science identity, as defined by Carlone and Johnson (2007) consists of three constructs: competence, performance, and recognition. Students need to feel like they are good at science, can perform it well, and that others recognize them for these achievements in order to develop a science identity. These constructs can be bolstered by student visitation to informal education centers. Informal education centers, such as outdoor science schools, museums, and various learning centers can have a positive impact on how students view themselves as scientists by exposing them to novel and unique learning opportunities unavailable in their school. Specifically, the University of Idaho College of Natural Resources' McCall Outdoor Science School (MOSS) focuses on providing K-12 students with the opportunity to learn about science with a place-based, hands-on, inquiry-based curriculum that aims to foster science identity development. To understand the constructs that lead to science identity formation and the impact the MOSS program has on science identity development, several questions were explored that examined how students define the identity constructs and if the MOSS program impacted how they rate themselves within each construct.

A mixed-method research approach was used consisting of focus group interviews with students and pre, post, and one-month posttests for visiting students to look at change in science identity over time. Results from confirmatory factor analysis indicate that the instrument created is a good fit for examining science identity and the associated constructs for students attending the MOSS residential program. Analysis of results from paired-samples t-test indicates that MOSS does contribute to a positive change in science identity and this change does persist one month following the visit to MOSS, although a slight decline is seen. The results from this research and creation of this instrument provide useful tools for educators interested in understanding students' science identity as a result of STEM programming.

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Chapter 1: Introduction

Recent research efforts in education have been focused on understanding what factors lead to students' commitment and perseverance in Science, Technology, Engineering and Math (STEM) careers (American Association for the Advancement of Science, 2009; National Research Council, 2013). Educators and administrators nation wide have been striving to motivate students in STEM related careers and improve their academic performance in STEM subjects in school (President's Council of Advisors on Science and Technology, 2012). Idaho represents a slightly lower than average example for the nation for student proficiency in math and science; 28% of Idaho eighth graders are proficient in math and 36% are proficient in science (National Center for Education Statistics, 2011). A study funded by the Micron Foundation in conjunction with the University of Idaho found that students' interest in STEM related topics in school plummets between fourth grade and tenth grade (Micron, 2014). The Micron-Funded STEM Education Research Initiative surveyed students in regions around Idaho that, at the time, were in fourth, seventh, and tenth grade. Students in fourth grade reported 92% agreement with the statement "I like science." Seventh graders agreed 86% of the time, and tenth graders agreed 67% of the time, indicating the middle school years as a point of departure from enjoying science. Capturing and maintaining students' interest in science is necessary in the younger years to help propel students into STEM related degrees in college (DiLisi, McMillin, & Virostek, 2011). Interest in science can be understood and developed through many pathways; identity is one theoretical framework that has shown promise in explaining and predicting student interest and persistence in science fields.

Rationale

The impetus for this research is based on several interrelated themes. The first is science identity and STEM careers and the relationship between student's developing a science identity and potentially pursing STEM careers. A motivating factor behind this research is the theme to include and encourage all students in science education. Helping students develop a stronger science identity is one aspect of providing support for students. The other theme in this research is the role and benefit of informal education centers as tools for classroom teachers and their contribution to science identity, which brings up the last theme: science identity and informal education. To further define the rational behind this research, the informal education center study site will be explained.

Science identity and STEM careers

Many factors contribute to a student's interest in science and STEM related subjects and their plan to pursue a STEM related career, including, but not limited to: motivation (Glynn, Tasoobshirazi, & Brickman, 2007; Zimmerman, Bandura, & Martinez-Pons, 1992), self-efficacy (Bandura, Barbaranelli, Caprara, & Pastorelli, 1996, 2001; Bandura, 1977, 2006; DiLisi, McMillin, & Virostek, 2011), science identity (Carlone & Johnson, 2007, 2008; Fraser & Ward, 2009; Krogh & Anderson, 2013), science agency (Bandura et al., 2001; Calabrese Barton & Tan, 2010), gender, parents' education, socioeconomic factors, teachers, and rural versus urban location

(Bonous-Hammarth, 2000; Eccles & Barber, 1999; Krogh & Anderson, 2013; Osborne & Walker,2006). Among these factors, understanding a student's science identity offers "the most complete understanding of students' trajectories" in science and STEM careers (Krogh & Andersen, 2013, p. 712). Science identity offers an important predictor of participation and persistence in science careers (Fraser & Ward, 2009).

Identity is defined as the "kind of person one is recognized as being, at a given time and place" (Gee, 2001, p. 99). Identity is embedded in an individual and continually defined and redefined in social circumstances as the individual negotiates given tasks and situations (Kozoll & Osborne, 2004). As students learn and interact within their school environment they are practicing and partaking in various roles and identities, exploring how various identities feel and fit with who they are at that time and who they are recognized for being by their peers and teachers (Calabrese Barton & Tan, 2010; Gee, 2001).

There exist several working definitions of science identity. Fraser and Ward (2009) define science identity as the ability for a person to think of him or herself as a science learner and as someone who can or does know about science, uses science, and contributes to science. Another definition for science identity is an individual's understanding of her or himself as a separate entity, as a scientist, both how they see themselves and how others see them as a scientist (Brickhouse & Potter, 2001; Brubaker & Cooper, 2000; Calabrese Barton, 1998). Carlone and Johnson (2007) define a person having a science identity as someone who feels competent in science, can perform as a scientist, and recognizes him or herself as a scientist and is recognized by others as being a scientist.

The ability to develop a science identity is influenced from other factors mentioned earlier, such as family opinons, gender, and socioeconomic status, in that it is malleable and not pre-destined by social or cultural contexts (Krogh & Anderson, 2013). It is important to note that identity is ever evolving, not static. Students have the ability to relate to and identify with science in a unique way to others around them or other students that share similar demographic information. However, identity is not completely free of socio-historical contexts either (Brown, Revels, & Kelly, 2005). It is important to note that students are influenced in how they view science and interact with science by their peers and family members. How students are viewed by those closest to them can greatly influence how students identify with science.

Informal education centers as a tool for classroom teachers

As classroom teachers and educators look for resources for teaching and motivating students in the STEM fields, informal education centers can supplement, augment, and enrich STEM related curriculum. Several studies indicate that support from informal education centers benefit students and extend the learning from the classroom environment into students' daily lives (Calabrese Barton & Tan, 2010; Brown et al., 2005; Fraser & Ward, 2009; Orion & Hofstein, 1994; Roth & Lee, 2002, 2004). Informal education centers span a wide range of types, locations, and content. Museums, learning centers, and residential programs offer students educational experiences including local and/or global topics and include various content areas such as science, history, math, and music. Gerber, Cavallo, and Marek (2001) define informal learning as learning that takes place on a daily basis in any type of setting ranging from home to an after school program to a camp. Although informal education centers vary widely, they all converge on one point: to offer valuable learning experiences, providing both resources and hands-on activities often unavailable in the classroom.

Another aspect on which informal education centers converge is the need for assessment. Most informal educational centers are dependent on grants and participant fees to help fund their educational programing. Both funders and participants need evidence of learning to support the center; what are students gaining from the experience and how will the center demonstrate what students have gained? It is valuable for informal education centers to have an accountability strategy in place to capture how students benefit from their time at the center.

Science identity and informal education

Informal science education can complement, scaffold, and extend learning opportunities for students, providing a valuable opportunity for students to enrich their science education (National Research Council, 1996). Science centers and similar informal education sites can provide students the opportunity to explore and develop their science identity in ways that are hindered in the classroom (Fraser & Ward, 2009), providing a valuable resource to classroom teachers.

Aside from the new learning experiences informal education centers provide, they also provide a change in environment that can help foster science identity growth (Fraser & Ward, 2009). Students may feel bound by how they are perceived by their teachers in their schools and their family at home, at times at odds with how they would like to be perceived (Carlone & Johnson, 2007; Dweck, 1986; Gee, 2001; Hansen, 1999; Taniguchi, Freeman, & Richards 2005). Interacting with a new group of adults and curriculum in a novel format, which informal education centers provide, can offer students the opportunity to explore new identities previously unavailable to them. Exposure to science content in a new environment or in a different context can spark interest that was previously lacking (Hansen, 1999). The hands-on and/or interactive nature of many informal education centers often entices students that previously lacked interest on the same topic when read out of books (Fraser & Ward, 2009; Hansen, 1999; Taniguchi et al., 2005). Exposure to different adults' teaching styles and/or enthusiasm towards science can also elicit change in students' perspectives towards science (Carlone & Johnson, 2007). The change in environment, curriculum, and instructional styles can be the catalysts students need to further foster their science identity formation.

Informal education center study site: MOSS

The University of Idaho McCall Outdoor Science School (MOSS) is an informal education center that offers five-day residential programs for students. MOSS programs offer place-based, inquiry-based science education that utilizes the surrounding state park as the outdoor classroom. Teachers bring their students to MOSS to stay for four or five days for the opportunity to use various technologies and field research practices, develop team-building skills, and to learn in an outdoor setting often not available near their schools.

MOSS also operates a graduate program within the University of Idaho's College of Natural Resources. Graduate students come to MOSS for one year to participate in a graduate residency in environmental education, which includes coursework in place-based education, ecology, leadership, science communication and research methods, and a teaching practicum with the MOSS K-12 residential program. The MOSS graduate students are the field instructors for the K-12 program. Students are divided into field groups of five to eight students, providing small groups for a hands-on, personal learning experience. MOSS curriculum includes geology, forest ecology, water ecology, and animal adaptations in the spring and fall and snow science and winter ecology in the winter.

MOSS relies largely on grants and participant fees to fund the program. Funders, teachers, and parents are equally interested in the value of the MOSS program for students attending; this value determines if they will continue to fund the program or return with other students or children. Therefore, it is important for MOSS to have an accountability strategy that can inform all stakeholders of the benefits the program offers to students.

Statement of the Problem and Importance for Research

Time, space, and resources make assessment more challenging in informal educational settings than in a traditional classroom environment. Informal education centers may have as little as an hour or as long as week with a group of students; allowing for little time to spent on testing that would distract from the intended learning experiences. Having teachers give assessment to students before and/or after the field trip is an option, but often one that teachers forget about or are unable to make time for, leaving it up to the informal education centers to handle the assessment in house. A need for a simplified assessment strategy for informal education centers is required to provide valuable information about the benefit of their programs.

Assessing science identity is something that has scarcely been explored in the literature. Currently a quantitative method for identifying the constructs contributing to science identity development is lacking (see Chapter Two). For informal education centers, which lack in contact time and assessment time with students, an efficient and effective means to define the impact these centers have on reconstructing science identity for their population is needed.

Purpose of Study

To understand the constructs that lead to science identity formation and the impact the MOSS program has on science identity development, the following questions will be explored:

(1) How do students define what it means to be a scientist? What evidence do they look for to define someone who is competent as a scientist, can perform as a scientist, and is recognized as a scientist?

(2) How does the MOSS program impact emerging science identity for students?

(3) Do changes in scores over time (pre, post, one-month posttest) for emerging science identify vary by students' gender, field instructor gender, city, or Title 1 status of school?

The goal of this study is to understand more about developing science identity in 5th and 6th grade students at MOSS and if the MOSS programing helps develop emerging science identities through building competence, performance, and/or recognition. The end product will be a quantitative instrument for determining if science identity as a whole has changed, or any of the constructs within science identity (competence, performance, recognition). Using a Likert scale (ranging from 1-5), change in ranking will indicate a change in science identity, at that point in time and according to the constructs as defined by questions generated, as a result of MOSS programing. A student that largely answerson the lower end of the scale for the Likert questions at the beginning of the week and answered on the higher end of the scale at the end of the MOSS program would show a positive change in science identity. The creation of the instrument utilizes the framework developed by Carlone and Johnson (2007) and helps to validate how their constructs (competence, performance, and recognition) fit within science identity for students attending MOSS programing.

The process of creating a quantitative tool will also be useful in helping other informal education centers understand if their programing fosters science identity development in their participants. Informal education centers need, but sometimes lack, an effective and efficient evaluation process to be employed to inform participants and donors of the benefit of their program. Modeling the process at MOSS for developing a method for demonstrating change in emerging science identity for other informal education centers to utilize can potentially help strengthen the relationship between formal and informal education. If informal education centers are better able to describe the benefit of their programing and impact it has on students, they are more likely to attract participants and donors. Teachers and administrators are encouraged to use school funding for field trips and camps that offer concrete benefits for their students. Similarly, donors, grantors, and supporters put their funding towards educational programs that offer the greatest good. The iterative process of assessing and evaluating programing can help informal education centers improve their design and delivery based on research findings.

Further understanding the constructs within science identity development, (i.e. competence, performance, and recognition) (Carlone & Johnson, 2007) and how informal education centers can complement these constructs will help not only informal education centers but also formal educators. There is a need to continue developing an understanding of science identity development in informal science education to operationalize theory into practice, assisting science identity formation in both formal and informal educational settings (Fraser & Ward, 2009). Having an instrument to assess the level of science identity, or change in science identity formation can help educators, formal and informal, strengthen their curriculum to nurture their students' science identity. This study focuses on the emerging, developing science identity of students attending the MOSS program for the purpose of understanding if programs like MOSS help students to further develop their science identity and potentially pursue an education and career in science.

Theoretical Framework

The theoretical framework used for understanding science identity at MOSS comes from the research conducted by Carlone and Johnson (2007) and the science identity constructs they defined. The three constructs of science identity are performance, competence, and recognition. To foster science identity students need resources to increase their competence in science knowledge, an aspect often afforded in the classroom. From there, students need to practice their science skills and socially perform these practices, which leads to the third construct: recognition. Lastly, students need to be recognized by themselves and others for their involvement and role in science. This framework is further defined and examined in the next chapter.

Research Hypotheses

I hypothesize that the MOSS program increases students perceived science identity. I also hypothesize that the students demonstrate greater change in areas of recognition than the other two constructs: competence and performance, although positive change can be seen in all three constructs following the MOSS program. I hypothesize changes in scores over time (pre, post, one-month post) for emerging science identity vary by students' gender, city, and Title 1 status of school, but not by field instructor gender.

Several specific elements of the MOSS program have the potential ability to cultivate science identity development for students, such as *Inquiry Day*. The last full day at MOSS is designated for what is titled *Inquiry Day*. Inquiry Day begins with the field group of students brainstorming questions they would like to explore, such as where are older trees found in the park, or what macro invertebrates are at different spots along the marsh? Once a field group has selected one question, the students then formulate their hypotheses, design their methods, collect the data, analyze the results, draw conclusions and prepare a presentation to be presented on their last morning at MOSS. This process and the continued science focus throughout the week, allows students the opportunity to gain competence, perform, and be recognized as scientists, the three constructs of Carlone and Johnson's (2007) science identity framework.

Context

It is important to note the various paradigms within this study. MOSS, and similar informal education centers, often employ a constructivist approach to their curriculum and hands-on learning experiences. Informal education centers rely on the concept that the learner is an active participant in the learning process and the learner interacts with their environment in a way that will hopefully enhance their own cognitive schemas. Relying on the individual's experience with the environment around them provides utility for informal education centers in emphasizing the organic and often spontaneous learning environments that are common with informal education centers.

Many informal education centers are reliant on grant funding to keep their programs running. Grants, schools, and participants are often interested in quantitative data to describe the learning experience and outcomes for students. An empirical approach to evaluation of informal education centers better aligns with these reporting needs, providing quantifiable data that is easy to collect and analyze (National Quality Council, 2009). However, quantitative testing is often in contrast to the constructivist learning/teaching philosophy found in informal education centers that favor learning experiences that are hands-on, inquiry based learning (Anderson et al., 2003; Bandura, 1977; Vygotsky, 1987). A pragmatic approach can help navigate the difference between these two paradigms. Utilizing a pragmatic focus on outcomes can help explain the benefit of an outdoor science school without altering or sacrificing the curriculum. Understanding science identity at MOSS is approached from a pragmatist perspective. The aim is to create a strategy for determining salient aspects in science identity formation at MOSS without greatly distracting or diminishing the hands-on inquiry approach to the MOSS curriculum. Although the end product, a quantitative tool, caters to a positivist paradigm to satisfy reporting needs, the creation of the tool will come from a pragmatic approach, utilizing student opinion of what questions should make up the quantitative tool.

Summary

Science identity is a valuable lens for understanding what propels students to enter into science coursework and persistent in science related careers (Graham, Frederick, Byars-Winston, Hunter, & Handelsman, 2013; Fraser & Ward, 2009). This research aims to understand the formation of science identity in an informal education center and the constructs within science identity, potentially leading to the encouragement of students pursuing and persisting in science related careers. As students move through grade school they have the ability to develop their science identity. There is little research about the factors that contribute to science identity formation and the role informal education centers can play in that formation, as will be seen in the next section. The three constructs of science identity, as defined by Carlone and Johnson (2007) and described above are competence, performance, and recognition. Using these three constructs, the aim is to understand what aspects of MOSS programing contribute to an emerging science identity through a quantitative tool.

The following chapters further explain the research, the data collected, and the results. Chapter two delves into the literature behind assessment in informal education, science identity, and the theoretical framework for this research. Other factors that can influence science identity are examined, as well as the link between science identity and informal education and specifically the link between MOSS and science identity, and finally other related learning theories are noted. The third chapter is devoted to explaining the methods of the research in detail, the population being studied, the analysis conducted, and the limitations of the research. Chapter four reveals the findings from the research and the results from the analysis conducted. The fifth chapter reviews the findings and their derived meanings with a discussion about these findings, their implications, and possibilities for future research.

Chapter 2: Literature Review

The literature review aims to accomplish the following goals: address the need for better assessment tools for informal education, define science identity in further detail, explain the theoretical framework that is used for defining science identity, address other factors influencing science identity, and explain the importance of science identity in an informal educational setting. The final section within this chapter will highlight the related learning theories to both MOSS and science identity.

Assessment in Informal Education

Assessment is defined as providing evidence that students can apply acquired knowledge and demonstrate growth in skills and understanding (Schweingruber, Keller, & Quinn, 2012). The NRC (2009) states that a significant difficulty in assessing informal science education is the diversity of the type of programs offered. It is difficult to create a template to be used by all informal education centers and residential programs when each center offers such different programs in both style and content. The NRC (2009) also suggests standard multiple-choice questions used on pre and posttests do not reflect the type of hands-on learning that is associated with informal science learning experiences; the assessment should fit the type of learning experience in which students are engaging in without taking away from it. Requiring students to complete a lengthy test upon arrival and prior to departure distracts from the site they are visiting. The goal, then, is to create a concise assessment tool that captures the objectives of the informal education center (National Quality Council, 2009). The literature indicates most organizations have previously used a quantitative or mixed-methods approach to achieve this goal (Bourdeau and Arnold, 2009; Campbell & Carson, 2005; Division of Research, Evaluation and Communication, Directorate for Education and Human Resources, n.d.; Hosty, Arnold, Dalton, Livesay, and Galloway, 2006; Kearney, 2009; Leeming, O'Dwyer, & Bracken, 1995; Program in Education, Afterschool, & Resiliency, 2009).

In 2008, the National Science Foundation (NSF) held a workshop on how to evaluate informal science education. Throughout the report of the workshop there is a theme present in what needs to be determined to develop assessment for informal science education: impact, impact category, audience objectives, and evidence (Allen et al., 2008). Allen et al. (2008) further articulates categories of impact such as knowledge, engagement, attitude, behavior, and skills and other. These categories are very similar to the strands of informal science learning defined by National Research Council (National Research Council, 2009). There are six strands, one of which relates to engagement, two to knowledge, two to behavior and skills, and one to attitude. Informal education centers can choose to focus on one or several of these categories for evaluation, science identity, the focus of this research, can straddle aspects of all of these categories.

There are many tools available for informal education centers to use for a variety of evaluation and assessment needs. The degree to which the various tools meet the needs of individual programs and their practical application may vary, however. An example of one tool is the *Science Process Skills Inventory* (SPSI), a quantitative test developed by Bourdeau and Arnold (2009), for a 4-H Youth program involves an 11-question quiz that uses a four-point Likert scale (a scale that ranges from “I do this all of the time" or “I agree completely with this statement” to “I never do this” or “I never agree with this statement”). This concise scale, however, is limited in scope as it only assesses science skills, which may not address all the objectives of most informal organizations. Hosty, Arnold, Dalton, Livesay, and Galloway (2006) also used a 4-point Likert scale to assess their 4-H Wildlife Stewards schools by asking students if the program made learning science fun and their ability to make scientific observations, however this scale contains only four questions, which just meets the requirements of at least four items or questions per construct to accurately determine reliability (Dillman, Smyth, & Christian, 2009). A scale, like the SPSI, can be used for a pre and posttest design completed in-house or several months following the site visit to determine retention following the visit (Stern, Powell, & Ardoin, 2008, 2011). Informal education centers can pull from various online tools available as well, such as the *Assessment Tools in Informal Science* website (Program in Education, Afterschool, & Resiliency, 2009) or the Online Evaluation Resource Library (Division of Research, Evaluation and Communication, Directorate for Education and Human Resources, n.d.).

Other programs have used a mixed-methods approach incorporating both quantitative and qualitative approaches. The mixed methods approach is appropriate as it creates a richer picture of student learning, where as quantitative data alone is limiting in understanding broader categories such as affect and behavior (DeWaters & Powers, 2012). *Explore It!*, a program funded by the National

Science Foundation, uses informal science education in museums, after school centers, and the National Institute for Out-of School Time. Explore It! uses hands-on, inquiry-based activities in an out of school setting (Campbell & Carson, 2005). To assess the program, Campbell & Carson used a pre and posttest that used a combination of open-ended questions, a five point Likert scale, and a challenge activity to assess student learning and interest in the program.

IslandWood, a residential outdoor program, recently assessed their students' learning outcomes with the help of an external evaluator. The assessment process included a pre and posttest questionnaire, a concept map, and narrative assessment of science content and skills (Kearney, 2009). Hiring an external evaluator is ideal but often not feasible, as most informal education centers have a paucity of resources available for their assessment.

Informal education centers will likely have many different types of objectives they hope to address with the assessment process. A useful approach to addressing various objectives is the Archipelago Approach to Mixed Method Evaluation (Lawrenz & Huffman, 2002). The various objectives are seen as separate islands but are joined by the underwater foundation, the archipelago, or overarching goal of the program. The mixed-method approach created by Lawrenz and Huffman (2002) includes multiple-choice questions, open-ended questions, hands-on skills tests, and a hands-on experiment design test. It should be noted that this approach was used in a classroom setting, but could be adapted to fit in an informal education setting, similar to both Explore It! and IslandWood's approach.

Two different tests address attitudes and opinions about science from different directions. The Children's Environmental Attitude and Knowledge Scale (CHEAKS) contains questions that use Likert scale questions and open-ended questions to determine students' awareness and attitudes towards environmental issues (Leeming, O'Dwyer, & Bracken, 1995). CHEAKS focuses on students' opinion of their ability to change and the importance of science to assist in this change. Another test utilizing both a Likert scale and open-ended questions is the Student Understanding of Scientific Inquiry (SUSI) (Liang et al., 2005). SUSI seeks to determine how students feel about science, an aspect that can be informative to understanding science identity formation. SUSSI and CHEAKS are both ten-plus page tests that require a significant amount of time for students to complete.

Informal education centers often lack time with students for lengthy assessment strategies, and need to find a way to assess student learning and growth in an effective and succinct manner. Multiple choice questions or scales assist in providing data that are simpler to obtain and analyze. Science identity is often addressed using a qualitative approach that requires lengthy interviews (Brown et al., 2005; Calabrese Barton & Tan, 2010; Carlone & Johnson, 2007; Gee, 2001; Herrera, Hurtado, Garcia, & Gasiewski, 2012; Kozoll & Osborne, 2004), which is often not a possibility during a short visit to a museum or a couple day stay at a science camp.

One science identity scale created uses a 5-point Likert scale ranging from 1 (not at all) to 5 (very true) (Pugh, Linnenbrink-Garcia, Koskey, Stewart, & Manzey, 2009). The scale includes the following four statements: I can imagine myself being involved in a science related career, being involved in science is a key part of who I am, I consider myself a science person, I can see myself doing science in the future. This scale meets the requirements of at least four items or questions per construct to accurately determine reliability (Dillman, Smyth, & Christian, 2009), but lacks any ability to address any constructs within science identity, as defined by Carlone and Johnson (2007). Other than Pugh et al.'s (2009), four question Likert-scale there are no other quantitative tests to determine science identity that are currently available in published literature. It should be noted that the lack of quantitative tools measuring science identity is due to the nature of science identity, addressed further in the following sections.

The various options for assessing students, such as multiple choice questions, open-ended questions, observations, and interviews, all come with challenges for informal education centers utilization. Multiple choice and Likert scale questions can fail to accurately capture student growth and attitudes (DeWaters & Powers, 2012), since students are limited in their choices and options for expressing their complex thoughts. Students who aren't equipped to express their ideas leave open-ended questions blank or answered with few words, which leaves evaluators without data to use (Liang et al., 2005). External evaluators or staff designated to observe student learning would be ideal, for organizations that are able to budget for the expense (Brandon, Taum, Young, Pottenger, & Speitel, 2008). However, a mixed methods approach using a shorter test like the SPSI and a challenge activity or project that is assessed using a rubric address the concerns raised in this literature review both for brevity and depth reached. What is lacking in the literature, however, is a blueprint to assist informal education centers in creating a tailored assessment process (Stern, Powell, & Ardoin, 2011). Informal education centers need a method that will provide evidence and support of student learning that is unique to the site and content taught (Stern, Powell, & Ardoin, 2011) without sacrificing validity or reliability of the assessment tool. A tool of this nature could assist informal education centers in having freedom of topic choice for their assessment, such as science identity.

Science Identity

Before moving into defining science identity, it is necessary to define identity and the types of identity as defined by Gee (2001). Gee denotes four types of identity, which are Nature-identity, Institution-identity, Discourse-identity, and Affinity-identity. Nature identity refers to who we are defined by nature, “a state,” and not a result of our doing (Gee, 2001). Gee gives the example of being an identical twin and the identity that is associated with being a twin. He also points out “natural identities can only become identities because they are *recognized*” (Gee, 2001, p. 102). This recognition comes from the cooperation of the other identities; again to use Gee’s example, having a spleen, something we are born with, does not create an identity unless is it is recognized as being uniquely us by the other identities.

Institutional-identity refers to “a position” we may have attained and not a result of either nature or anything that can be accomplished individually (Gee, 2001). Being a student is a position this researcher is in, but it is not possible without a University, the faculty, advisors, other students, and so forth. These institutional identities can either be “an imposition rather than a calling,” such as being labeled as ADHD (Gee, 2001, p. 103).

Discursive-identity is a result of “an individual trait, a matter of one’s individuality” (Gee, 2001, p. 103). Being funny, kind, or charismatic is due to one’s Discursive-identity; how other’s view that person and identify that person as being. For children, this is often still evolving and is largely defined by how they are recognized by others around them. Discursive identity can be seen as being “an ascription or an achievement” (Gee, 2001, p. 104).

The fourth identity is the Affinity-identity and refers to an affinity group (Gee, 2001). Individuals may align with others across time and space as a identifying with a certain group. Science teachers may use organizations such as the National Science Teacher Association to identify with and belong to. Affinity-identity is one of the identities that allows an individual choice in how they are labeled.

Throughout the explanation of these four identities the emphasis is placed on recognition, how others acknowledge individuals as being or what identities they belong to. Some of this may come from being recognized for things that are outside our control (Nature-identity), being recognized for being a part of a larger process or entity (Institution-identity), being recognized as having a certain trait or style of behaving (Discourse-identity), or being recognized as being involved in something we have self-selected into (Agency-identity). Of these four identities there is much that is still being defined for students and that is still malleable. How students see themselves as scientists or interacting with others in a science community is still being defined in grade school.

Science identity, as defined by Fraser and Ward (2009), is the ability for a person to think of themselves as a science learner and someone who can or does know about science, uses science and contributes to science. There is a distinction here between “being a scientist” and “doing science,” as was also made by Archer et al. (2010). Archer et al. (2010) found that students may like science but not necessarily that they also associate themselves as being a scientist. Identities are negotiated from moment to moment as students interact with their peers, a topic or challenge, and in their daily lives (Gumperz, 1982; Hymes, 1974; Kozoll & Osborne, 2004).

Identity pulls from an interplay of sociolinguistic and sociohistorical aspects of an individual (Brown et al., 2005; Krogh & Anderson, 2013). The interplay of language and communication is entangled in identity (Brown et al., 2005; Nasir & Saxe, 2003). Phrases, words, and tone that students use in their daily vocabulary add to their identity and can also define and limit this identity (Brown et al., 2005; Krogh & Anderson, 2013; Nasir & Saxe, 2003). By including scientific words in a student’s daily vocabulary, or shying away from these words, students are further defining their identity. As students learn and interact within their school environment they are practicing and partaking in various roles and identities; exploring how various identities feel and fit with who they are at that time and who they are recognized for being by their peers and teachers (Calabrese Barton & Tan, 2010; Gee, 2001).

Students have the ability to relate to and identify with science in a unique way to others around them, regardless of or in spite of how their family or friends feel about science (Krogh & Anderson, 2013). As a student might assume a role in a play or activity, they will try on various identities, determining what they perceive fits them best. How identities may fit and feel for a student can be largely informed by their family members and peers (Brown et al., 2005; Krogh & Anderson, 2013).

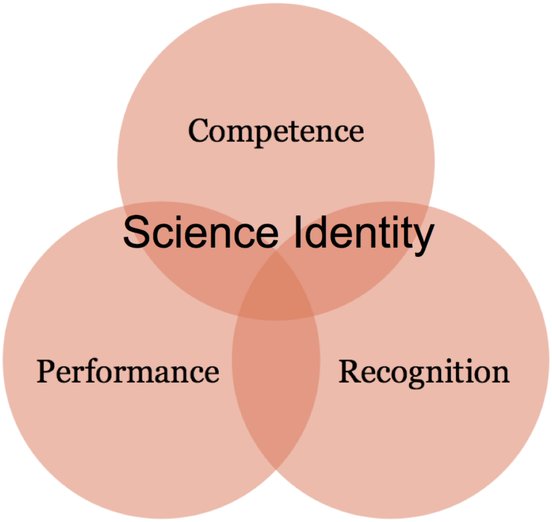
Using science identity development within the educational context, students make up each other's community of practice (Lave & Wenger, 1991; Wenger, 1998). This community helps to acculturate and negotiate cultural norms for science identity for the individuals within it; understanding these nuances can empower educators to help students navigate within their communities (Carlone & Johnson, 2007).

It is valuable for educators to understand how teaching and learning translate for a student and the impacts of their learning environment can have on science identity development (Carlone & Johnson, 2007). Science identity is an important predictor of science participation and persistence in STEM fields (Fraser & Ward, 2009; Graham, Frederick, Byars-Winston, Hunter & Handelsman, 2013). Using identity as a lens to understand the impacts on learners and the outcomes of those impacts we can begin to understand who is promoted or marginalized in science teaching; how students interact with science and develop skills and understandings; and how their emerging ideas about science can be evolved or changed (Carlone & Johnson, 2007; Cobb 2004). The "lens of identity aids in the quest for a more equitable science education" (Carlone & Johnson, 2007, p.1192).

Theoretical Framework for Research in Science Identity

Identity is an individual's understanding of her or himself as a separate entity, both how they see themselves and how others see them (Brickhouse & Potter, 2001; Brubaker & Cooper, 2000; Calabrese Barton, 1998). Fostering identity comes from a threefold effect outlined by Carlone and Johnson (2007) associated with competence, performance, and recognition (see Figure 1). Students need an opportunity to develop skills to feel competent, to then be able to perform and demonstrate these skills and to be recognized for this effort to change their identity. For students to assume a science identity they need to have an opportunity to develop each construct. Therefore, Carlone and Johnson (2007) define a person who has a science identity as someone who feels competent in science, can perform as a scientist, and recognizes themselves as a scientist and is recognized by others as being a scientist.

Figure 1: Carlone & Johnson, 2007 STEM Identity Model



Carlone and Johnson (2007) sought to describe and define science identity to "better understand how and why some students persist in and others opt out of science" and point out "cultivating short-term knowledge and interest are not enough to develop sustained interest in science" (p.1190). Understanding the development of science identity is the key to changing the picture of those that pursue science from being a white-male dominated profession (Brown et al., 2005; Calabrese Barton & Tan, 2010; Kozoll & Osborne, 2004).

As mentioned earlier, Gee pointed out the importance of recognition in his four identities, which Carlone and Johnson (2007) build their framework from in part. In creating an identity, a person should rate him or herself and be rated by others as having characteristics associated with the specific identity (Carlone & Johnson, 2007). For this internal and external recognition to occur a student needs to perform in manners associated with having a science identity. Performance takes place after competence is built in the foundation of knowledge and understanding of science. Competence, the first step in science identity creation, is the least public of the constructs. After students have developed understandings of science principles they can then work to practice performing these skills. Carlone and Johnson (2007) define performance as including ways of talking and using scientific language, practice using tools, and other relevant practices. The development of these three constructs leads to the development and fostering of a science identity, being "both situationally emergent and potentially enduring over time and context" (Carlone & Johnson, 2007, p. 1192) as students repeat the performance and recognition, making them habitual and stable over time. In a later article, Carlone et al. elaborate on identity to say that "all learning entails a change in identity, as the meaning that individuals make of their place within the communities of practice in which they participate changes their view of themselves" (Carlone, Cook, Wong, Sandoval, Calabrese Barton, Tan, & Brickhouse 2008, p.1). This definition places much emphasis on recognition and how a community perceives an individual and that "identity construction requires the participation of others" (Carlone et al., 2008, p.1).

Krogh and Anderson (2013) refer to identity consisting of three levels: social identity, personal identity, and ego identity that make up the *Late Modern Identity theory*. Social identity is defined by how a student "is acknowledged when she enacts particular social roles (Krogh & Anderson, 2013, p. 714). Personal identity is the perception of participation in activities, or how they think others identity them as being. “Ego-identity is narratives about self-beliefs, personal motivations and values as guiding principles” stemming from social interactions (Krogh & Anderson, 2013, p. 714). All three identities are suffused with the narrative students tells themselves and hears from others around them, again the emphasis here is on recognition from others as it is with Carlone and Johnson (2007) and Gee (2001).

Krogh and Anderson (2013) used various methods to understand science identity for students in their last years of upper secondary school. Methods included: students’ written applications, pre and post-tests, interviews, observations, evaluation of mentoring program (mentoring of college of bound students), and email logs between students and mentors. The dependence of identity development on others’ view of individuals makes operationalizing science identity difficult, since it cannot be “reducible to a set of core defining characteristics” (Carlone et al., 2008, p. 2). In other words, creating a quantitative tool assessing change in science identity does not come without flaws; justification for the research methods chosen in relation to these authors view is discussed in the Methods chapter.

Other Factors Influencing or Influenced by Science Identity

For a student to be recognized as a scientist they need to have first developed the basic skills and knowledge pertaining to these skills, performed the skills, and gained confidence in this performance. Interplaying and embedded within the constructs of science identity is also motivation, self-efficacy, and agency. To move towards an identity, a student must feel they want to and can be good at science (Krogh & Anderson, 2013).

Motivation

Motivation can be defined as the “internal state that arouses, directs, and sustains students’ behavior toward achieving a certain goal” (Glynn, Tasoobshirazi, & Brickman, 2007). Tolman (1952) defines motivation as composing of expectancy and value. Expectancy refers to what a student sees as being a successful outcome of their actions. Value refers to the importance a student attaches to the outcomes of their actions. Using this definition, motivation to be “good” at science or perform science tasks is affected by if a student values being good at science and thinks that they could be good at science. Zimmerman, Bandura, and Martinez-Pons (1992) define self-regulated learners as proactively oriented, higher performing than non self-regulated learners, and self-motivationally driven. Although motivation is rooted in cognitive activities, reinforcement encourages motivation (Bandura, 1977), which is an important factor in any educational setting.

Efficacy

Efficacy or self-efficacy is “concerned with people’s beliefs in their capabilities to produce given attainments” (Bandura, 1997, p.307). A higher perceived efficacy in a subject, the more likely a student is to pursue studying that subject in college, choosing an occupation related to that subject, and persisting in that career (Bandura, Barbaranelli, Caprara, & Pastorelli, 1996, 2001; Bandura, 1977, 2006). Strong efficacy beliefs have been linked to more interest in a career path (DiLisi, McMillin, & Virostek, 2011). Perceived efficacy contributes to accomplishments both via motivation and through support of strategic thinking (Caprara, et al., 2008). Believing one can overcome challenges, accomplish goals, or persevere despite challenges can help a person to work through the steps needed to achieve this goal. A high self-efficacy for science skills indicates that science self-efficacy will fully mediate the effects of science experiences on student commitment and performance (Chemers, Zurbriggen, Syed, Goza, & Bearman, 2011).

The ability to perform science skills due to self-efficacy indicates the link between self-efficacy and science identity through performance as indicated by Carlone & Johnson (2007). A perceived self-efficacy in science skills will help strengthen the performance construct of science identity. Several studies have indicated that students with a high sense of academic efficacy show greater persistence, effort, and intrinsic interest in their studies and performance (Schunk, 1984, 1989).

Agency

Agency, the act of doing what one believes they can, is at once the possibility of imagining and asserting a new self in a setting at the same time as it is about using one's identity to imagine a new and different setting (Calabrese Barton & Tan, 2010). “How one learns and what one learns are fundamentally related to the kind of person one wants to become” (National Academy of Science, 2007, p. 201). Students are unlikely to seek out careers in science if they don’t see themselves as a scientist. Agency can also be thought of as the action that leads to identity; the development of skills and practice leading to the development of identity (Bandura et al., 2001; Calabrese Barton & Tan, 2010). For this study, what learning experiences help create science identity is of greater focus than what propels students to act as agents towards science careers. Without believing they can be scientists, students are unlikely to pursue science or STEM related careers.

The focus for this study is based on science identity over self-efficacy, motivation, or agency. The reason for this focus is the notion that self-efficacy, motivation, and agency are all inter-related to identity, but identity is the lasting and sustaining factor (Carlone & Johnson, 2007). Among these factors, “using an identity lens offer the most complete understanding of students’ trajectories in relation to science (alienation or recruitment)” (Krogh & Andersen, 2013, p. 712). Science identity offers an important predictor of participation in and persistence in science careers (Fraser & Ward, 2009). Identification with context relevant identities provides better prediction of academic performance and persistence than racial or ethnic identity (Bonous-Hammarth, 2000; Eccles & Barber, 1999; Osborne & Walker, 2006). Identity development can increase confidence and therefore motivation, often leading to academic success, which creates a continuous feedback loop of success and persistence in science (Graham et al., 2013).

Science Identity and Informal Education

Informal education can offer support and augmentation to a classroom teacher’s curriculum. Informal science education can complement, scaffold, and extend learning opportunities for students, providing a valuable opportunity for students to enrich their science education (National Research Council, 1996). Science centers and similar informal education sites provide students the opportunity to explore and develop their science identity in ways that are hindered in the classroom (Fraser & Ward, 2009). Students may feel bound by how they are perceived by their teachers in their schools and their family at home, at times at odds with how they would like to be perceived (Carlone & Johnson, 2007; Dweck, 1986; Gee, 2001; Hansen, 1999; Taniguchi et al., 2005). Interacting with a new group of adults and curriculum in a novel format can offer students the opportunity to explore new identities previously unavailable to them.

Exposure to science content in a new environment or in a different context can spark interest that was previously lacking (Hansen, 1999). The hands-on and/or interactive nature of many informal education centers often entices students who previously lacked interest in the same topic when read out of books (Fraser & Ward, 2009; Hansen, 1999; Taniguchi et al., 2005). Identifying rock types from the side of a trail, for example, can intrigue students in ways their textbooks do not, offering students an opportunity to engage with science in a new way.

Exposure to different adults' teaching styles and/or enthusiasm towards science can also elicit change in perspective towards science (Carlone & Johnson, 2007). Educators at an informal education center may have a method of explanation or example that provides the missing piece in a students' understanding, allowing a student to grasp a concept that had previously eluded them. The use of informal science centers to augment classroom teaching also provides teachers with an extension to their classroom tools and curriculum, as is expressed by teachers that visit MOSS.

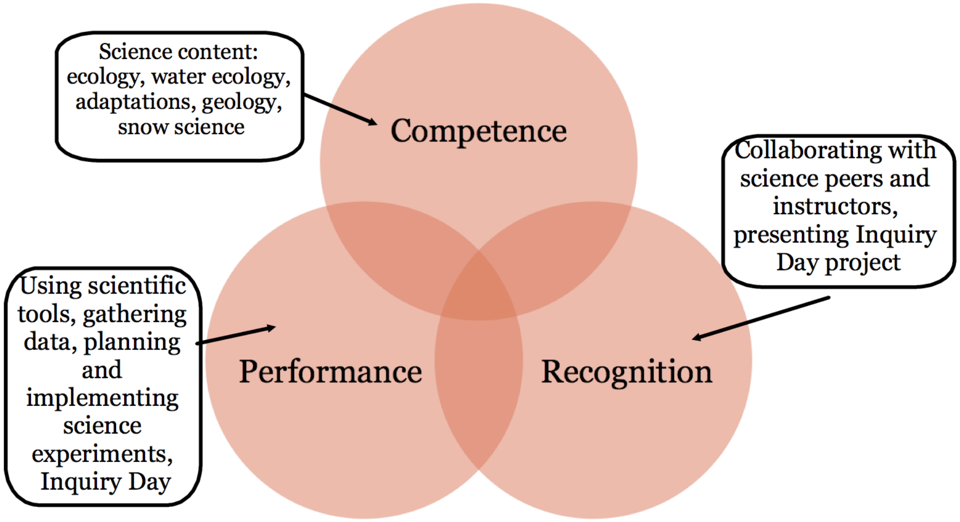
Informal science education centers can help develop science identity, beyond the limitations in the classroom. It is therefore important for these centers to have a way to assess and determine their impact on science identity development.

Currently, there is an absence in the literature how informal education centers can operationalize identity theory into practice to demonstrate the development of science identity for their students (Fraser & Ward, 2009). A better understanding of how students can integrate science into their existing culture, rather than temporarily adopting an identity, may make it possible to create formal and informal science learning environments that are more accessible and meaningful (NAS, 2007).

MOSS and Science Identity

The weekly MOSS program illustrates Carlone and Johnson's (2007) science identity framework. Students are taught about specific science topics and are encouraged and given an opportunity to gain competence in their new skills (using equipment, using science language, performing mini-experiments) during the first part of the week. Towards the end of the week at MOSS, students develop their own science experiment, or research project, from start to finish (creating the question they want to research, conducting it, and drawing conclusions from their results) and then present their experiment to an audience of their peers, teachers, parents and staff at MOSS; supporting students to move from competence to performance to recognition (see Figure 2). Students must recognize themselves as a scientist first and be recognized by others to create their science identity (Carlone & Johnsons, 2007; Herrera et al., 2012).

Figure 2: Science Identity Framework and MOSS Curriculum



Being at MOSS for the week allows students to be both physically and emotionally removed from their normal educational setting, providing several potential benefits to the students. One potential benefit is being removed from the pressures that are often associated with the traditional classroom and the emphasis on achieving performance goals. MOSS puts more of a focus on learning goals, as opposed to performance goals which helps alleviate anxiety about ability levels, allowing students to "focus on progress and mastery through effort" (Dweck, 1986, p. 1041). Another benefit for students is being exposed to a new group of teachers, their field instructors. Teachers can affect students' identity development and performance through the *teacher expectancy effect*, which is the impact of a teachers' impression and view of a student and the resulting impact on students' performance (Dweck, 1986). At MOSS, field instructors know little about their field groups prior to their arrival and therefore provide a clean slate of opportunities for students to excel beyond previous teacher's expectancy effect. Altering the teacher expectancy effect can also result in change in motivation for students towards learning science. Since motivation affects ability to use skills, acquire new ones and transfer new skills to novel situations (Dweck, 1986) students may also see an improvement in science skills from their time at MOSS.

Graham et al. (2013) defines several learning opportunities required for students' persistence in science that are also seen in the structure of MOSS and which help to explain the potential impact of the MOSS program on science identity development. According to Graham et al. (2013), students need to be exposed to the following opportunities to encourage them to continue and stay within science careers: early research experiences, active learning in introductory courses, and membership in STEM learning communities. The MOSS curriculum and focus on inquiry serves as an early research experience where students are allowed to explore and direct their own science experiments throughout the week. Students at MOSS are also exposed to the research being conducted by professors on campus, visiting researchers, and their own graduate students/ field instructors.

The second learning experience required for persistence in STEM careers is exposure to active learning (Graham, 2013). "Active learning includes any activity in which every student must think, create, or solve a problem," (Graham et al, 2013, p. 1456). Active learning is used through the week at MOSS but especially during Inquiry Day, putting the students in charge of their own research. During Inquiry

Day and throughout the week at MOSS, students are thinking through science questions and actively working on how to answer their questions.

The final attribute of the persistence framework, membership in STEM learning communities, is satisfied in the community created at MOSS. From the first day at MOSS students are empowered to think of themselves as being a part of the science community at MOSS. Ashbacher, Li, and Roth (2009) also found that the influence of communities, both at school and out of school, has a strong influence on persistence and science identity. Although this community is ephemeral for MOSS students, it does offer students a glimpse of what it is like to study within a STEM learning community.

Summary

As seen from a review of the literature there is a need for development of a science identity instrument to advise informal education centers and their participants of the benefit of their programing. Limited assessment tools addressing science identity are available that can be adequately implemented in an informal educational center, as current options require lengthy interviews or methods that conflict with informal education centers. The lack of resources and contact time with students presents many hurdles for informal educators. Another significant hurdle for informal education centers is finding and using an evaluation instrument that is reflective of the instructional method used by the center.

It is also seen from the review of the literature that science identity is an important and timely topic that has not been thoroughly researched in methods for assessment of developing science identity. Informal education centers can play an important role in furthering a student’s science identity development and therefore need an appropriate method to assess change in science identity as a result of programing.

Chapter 3: Methods

As indicated in the literature review, there is a need for the development of both a quantitative tool that demonstrates changes in science identity and a quantitative test that demonstrates student benefit from participation in informal educational programs. Limited resources present several challenges for informal education centers that can be mitigated with a quality and concise assessment test. As addressed in the Literature Review chapter, it is important for informal education centers to have an evaluation strategy that mirrors their instructional strategy (NRC, 2009). The methods used in this research aim to create an assessment instrument that is developed with the programing goals in mind, but with a concise tool that is easy to implement and track change in science identity development.

With the need to examine what factors are influencing students choosing STEM related careers, or not choosing them, science identity is a timely and important topic. Informal education centers offer opportunities for students to develop and expand their science identity in ways that may not be possible in the classroom. Use of hands-on, inquiry based teaching, new technology and tools often not available at their schools, and being exposed to different instructors offer students various experiences that can strengthen science identity that is not otherwise available or abundant in their school.

Restatement of Research Questions

To understand the constructs that lead to science identity formation and the impact the MOSS program has on science identity development, the following questions will be explored:

(1) How do students define what it means to be a scientist? What evidence do they look for to define someone who is competent as a scientist, can perform as a scientist, and is recognized as a scientist?

(2) How does the MOSS program impact science identity?

(3) Do changes in scores over time (pre, post, one-month post) for emerging science identify vary by students' gender, field instructor gender, city, or Title 1 status of school?

Design: Overview

The purpose of this research was to create a quantitative instrument to measure emerging science identity of students that participate in MOSS programing. Creation of the test utilizes the lens of Carlone and Johnson's (2007) framework for science identity: competence, performance, and recognition. This instrument will serve as a blueprint for other informal education centers to model after in order to create their own informative assessment tool.

Creating a quantitative assessment tool addressing science identity comes with flaws since the dependence of identity development on others' view of individuals makes operationalizing science identity difficult, since it cannot be "reducible to a set of core defining characteristics" (Carlone et al., 2008, p.2). For this reason a mixed methods approach was used to weave together salient aspects of science identity for students at MOSS and their experiences unique to MOSS. Similar to Krogh and Anderson's (2013) approach, the quantitative tool aims to use experience specific examples to create the assessment tool. However, the hope is that the tool will be flexible enough to use at any informal education center that is similar to the inquiry-based, hands-on, place-based approach used by MOSS.

The employment of a mixed methods approach to create a science identity instrument aims to provide depth from the qualitative data to inform the creation of the quantitative tool. As Creswell (2003) points out, the use of collecting and examining qualitative data in a sequential explanatory strategy provides support to quantitative data. "Qualitative data can help the quantitative side of a study during design by aiding in conceptual development and instrumentation" (Miles, Huberman, & Saldaña, (2014, p.1014). Following Creswell's (2003) Sequential Exploratory Design, data collection moved from the qualitative to the quantitative through collection and analysis of each, followed by a final interpretation and analysis of the final results.

Initially students attending MOSS summer programs in 2014 were interviewed. One program, *Beyond MOSS*, had several middle school age students that have attended MOSS programs before. A second program, *Upward Bound*, brought in thirty high school students. Beyond MOSS and Upward Bound students entered middle and high school, respectively, in the fall 2015. Since these groups are a few years older than the average MOSS attendees, they offered insight and explanation to their experiences when they were in 5th and 6th grade. Being slightly older than the typical MOSS attendees, these middle and high school students were able to offer a depth in their interviews that 5th and 6th graders wouldn't necessarily be able to verbalize. Beyond MOSS is what we call an "open booking" program where students (or their parents) self-select into the program paying a modest fee. Upward Bound is a national program housed through state universities that focuses on rural, low-income, first generation college bound students. The difference in these two programs will provide a broader understanding of what it means to be a science person for students this age then if only one type of group was interviewed. This study used interviews to inform the creation of the quantitative questions as did DeWaters and Powers (2012), and Stern, Powell , and Ardoin (2011) in their research, and suggested by Cresswell (2013). In this case, however, the panel was composed of age experts, representatives from the age group tested (Stern, Powell, & Ardoin, 2011) instead of industry experts.

The interviews took the form of focus groups with groups of four to seven students per group, as suggested by Krueger and Casey (2009). A focus group setting will hopefully allow students to feel comfortable enough to share their opinions. One-on-one interviews often create anxiety for students concerned about providing the "right" answer (Krueger & Casey, 2009). In the focus group setting students are encouraged to share freely allowing them to hear each other's thoughts, sparking ideas and comments that can add to a richer and deeper conversation than a one-on-one interview (Krueger & Casey, 2009).

Both groups of students were asked about when they feel like a science person at home, school, or MOSS. The students were asked about times in their life when they feel competent in science, like they can perform science, and when they feel recognized as a science person (see Appendix A). “Science person” is used here as opposed to “scientists” due to the distinction between “being a scientist” and “doing science,” found by Archer et al. (2010). Archer et al. (2010) found that students associate with enjoying science but not with being a scientist, so “science person” is used to try and create a more neutral term for students. Students were also asked what they think of when they hear “scientist” versus “science person” to back up Archer et al.’s (2010) findings. The middle and high school students both represent two distinct phases in a person’s interest in science and potentially in their science identity development. As seen in the data from the Micron study (2014), students in middle school display less interest in science than they did in fourth grade; this interest in science diminishes further in high school. Interviewing each age group, middle and high school age students, helps to determine what factors are needed in an experience, at school, home or at MOSS, to elicit connection with a science identity.

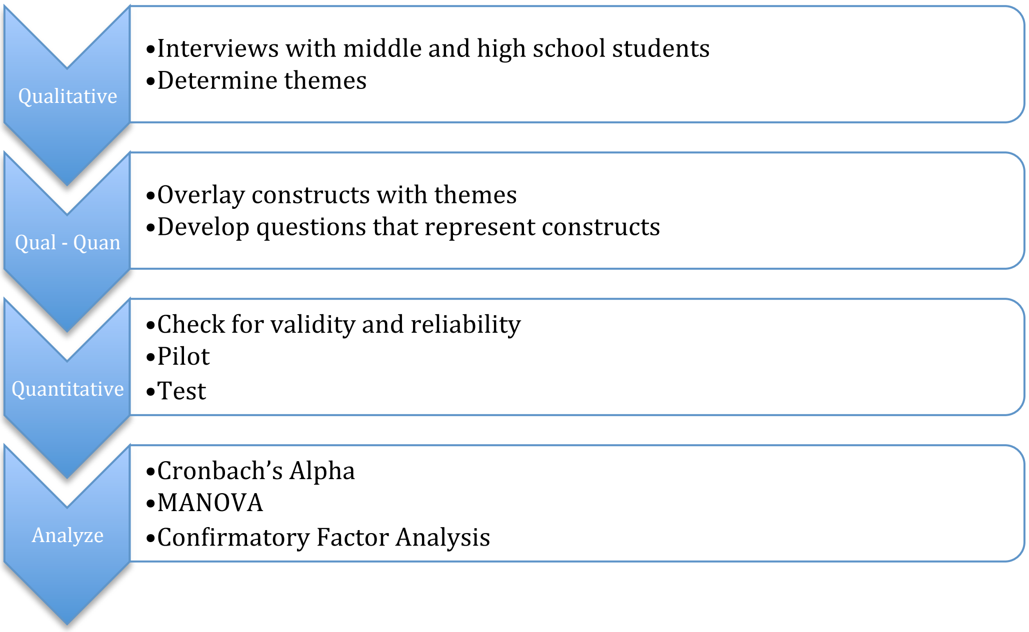
Moving from qualitative to quantitative

The next phase elucidated the three constructs of science identity, competence, performance, and recognition within the MOSS context, using the information gathered from the focus group interviews. The focus group interviews were coded and examined looking for themes that can overlay with the constructs of science identity. Quantitative questions were drafted from the results of the interviews. For example, interview questions asked students to define when they felt recognized as a scientist and those answers were used to create the quantitative questions. If a theme from the focus groups emerges that students feel recognized as a scientist when other's see them collect data, then the following quantitative question represents that theme: I feel like others see me as a scientist when they see me collect data. Questions used a Likert scale ranging from "I strongly agree" to "I strongly disagree."

The following phase verified the quantitative questions created were valid and could produce reliable results. During the first week of MOSS fall programing, think-alouds were performed to validate the questions for 5th and 6th graders. Wording was adjusted per student recommendation to prepare for the quantitative research.

The final phase was to test the quantitative test on the fall population of students at MOSS. Students took a pre-test upon arriving at MOSS, a post-test before they left at the end of the week, and a one-month delayed posttest back at their school. The pretest, posttest, delayed posttest model indicates if change in opinions about science identity persists after returning home from MOSS. The pretest, posttest, delayed posttest model was chosen to look at change over time and change following the end of the program, similar to the model used by Stern et al. (2011); to determine the short-term impacts of a residential program but to also look beyond the immediate impact of the program. Having data collected from three different time points, or "follow-up data, is less commonly reported in the literature" (Stern, 2011, p.110). Stern et al. (2011) however, used a three-month gap in between the posttest and delayed posttest. Personal knowledge of teachers schedule, winter breaks, and lack of financial incentive for completing the delayed posttest were all factors in deciding to use a shorter delay time of just one month. An overview of the methods moving from qualitative to quantitative can be seen in Figure 3.

Figure 3: Methods



Instrument Design: Qualitative

The first phase of this research plan was to interview students during the summer of 2014 about when they feel like a science person (three groups of three to ten students). Since it is difficult to observe change in developing science identity directly this study relies on self-report (Ajzen & Fishbein, 1980) for both the interviews and quantitative tests. The qualitative approach for this research is similar to the creation of grounded theory with the aim being to "generate a general explanation (a theory) of a process, action or interaction shaped by the views of participants" (Creswell, Hanson, Clark Plano, & Morales, 2007, p.248) and to look at the theory relating to the process of science identity (Lictman, 2011). However, new theory is not created in this research, rather the processes are similar, not the outcomes.

The format for the interviews was in a group setting, specifically a focus group, in the MOSS classroom with three to six students at a time. One to two interviews took place per summer program, *Beyond MOSS* (1) and *Upward Bound* (2), for a total of three interviews. Interviews were recorded and later transcribed, with permission from participants, and notes were taken. Questions guided the interview, while allowing for the conversation to flow organically, being largely driven by the students. See Appendix A: Focus Group Interviews for the script and questions used in the interview.

The questions used were chosen to help guide a conversation about being a scientist and times when students felt like scientists. Specifically, the first three questions asked students when they felt like a science person at school, home, and at MOSS, with the hope of finding themes in activities or moments that led to this science feeling. Questions were also used to target the science identity constructs: competence, performance, and recognition (Carlone & Johnson, 2007). For example, "do you feel competent in science or like you can do science well?" and "what makes you feel that way?" were asked to address the construct of competence. Similar questions were asked for performance and recognition. The final question aimed to clarify the word choice between "scientist" and "science person." In other words, did students find a difference between the two? Was it easier to think of oneself as a "science person" versus "scientist"? The concern was that some students might not think of themselves as a scientist, not having the proper, or enough education, in the field and/or a job in the field, but might relate more to thinking of themselves as a science person.

Students were not asked directly if they feel like a scientist, if they feel like the can perform as a scientists, if they feel like they are competent at science, or if they recognize themselves or think they are recognized by others as being a scientists. These direct questions would likely be too strongly stated for students to relate to, resulting in negative answers. However, questions that get at times when they do feel like they are performing science, competent in science, and recognized as a scientist would more likely elicit a genuine and authentic answer, leading more to the underlining subtleties behind each construct.

Instrument Design: Quantitative

After the interviews were coded and analyzed questions were developed for the quantitative test, as "qualitative data can help the quantitative side of a study during design by aiding in conceptual development and instrumentation" (Miles, Huberman, & Saldaña, p. 43, 2014). Since assessment tools require at least four items or questions per construct to accurately determine reliability (Dillman et al., 2009), at least four questions for each science identity construct were created: competence, performance, and recognition. All questions are Likert-scale questions using a scale from strongly agree (5) to strongly disagree (1) or describes me all the time (5) to never describe me (1). Other information collected on the quantitative survey includes: name, school, field instructor, and general demographic information. The first three pieces of information were collected to match the pre, post, and one-month posttests to each other. After tests were linked, the identifying information was replaced with a number.

To promote teacher response for the delayed one-month posttest teachers received several reminders about the posttest and the importance of returning the completed test. Teachers were first informed of the research upon their visit to MOSS. Three weeks following their school's MOSS visit, teachers received an email informing them of the package coming in the mail. The package mailed to teachers included paper copies of the delayed one-month posttest for all students that attended MOSS, a letter of explanation, and a pre-paid envelope for mailing the completed tests back to MOSS. The letter of explanation mailed to teachers can be found in Appendix E. Five-weeks following the school's MOSS visit teachers received an additional email once a week until the one-month posttest was received at MOSS (see Appendix F).

Research Sample

Sampling, as defined by Dillman et al. (2009), should occur throughout the sample frame, the subset of the population that has an opportunity to be sampled, and be performed as randomly as possible. The sampling frame is all students that attend a MOSS four or five-day program in the fall 2014. Approximately 430 students were registered to come to MOSS for a four or five-day program in the fall of 2014. Using Dillman et al.'s (2009) sample size calculation, 307 students would need to be sampled for a population of 427. For this study a 30% attrition rate is assumed due to students not completing or not being able to complete the final post-test. For more information about attrition see the assumption section within this chapter. Assuming a 30% attrition rate brings up the sample size to 399, or 400 students. Being that this number is so close to the population size, all students in the entire population were tested instead of a sample.

Demographics of Sample

All students that attended MOSS for either a four-day or a five-day program were tested. For the most part these were fifth and sixth grade students. For a breakdown of school, location, and grades attending MOSS in the fall of 2014, see Figure 4.

Figure 4: Schools to be sampled Fall 2014

School Name	**City**	**Grade Level Attending**
Montessori Academy	Moscow	6
Moscow Charter	Moscow	6
Riverstone	Boise	4
Rose Hill Montessori	Boise	5 & 6
All Saints	Lewiston	6
St. Mary's Moscow	Moscow	6
Willowcreek	Vale, OR	5 & 6
Longfellow	Boise	6
Whitney	Boise	6
Village Charter	Boise	7
St. Paul's	Nampa	5 & 6
St. Mark's	Boise	5 & 6
St. Mary's Boise	Boise	5 & 6

Demographic information was collected for each student sampled and included: age, grade, gender, race, disability, and if they identity as belonging to a tribe. The demographic questions were in the following format:

Questions about who you are: please answer as honestly as possible

A. How old are you? ________________

B. What grade are you in? ________________

C. What race do you consider yourself?
☐ White / Caucasian
☐ American/Native Indian or Alaskan Native
☐ Asian
☐ Black or African American
☐ Native Hawaiian or other Pacific Islander
☐ Other
☐ Do not want to provide this information

D. Are you Hispanic / Latino? ☐ Yes ☐ No

E. If you belong to an Indian Tribe(s), please list:
____

F. What is your gender?
☐ male ☐ female

G. Disability:
☐ None
☐ Deaf/ Hard of hearing
☐ Mobility / Orthopedic Impaired
☐ Vision Impaired
☐ Other
____

Ethical Considerations

All students surveyed or interviewed completed a consent form, as did their parents. The consent form is approved by the University of Idaho's Institutional Review Board (IRB) in conjunction with all necessary approvals and documentation required by the IRB, which can be found in Appendix G.

Although this research design is intended to have little impact both on instructional time and personal impact to students, there are some ethical considerations to acknowledge. Students may have found the interview questions to be uncomfortable as it might bring up personal struggles with science identity that are related to gender, race or socioeconomic status. Some students may feel uncomfortable sharing their opinions openly with other students around them.

Data Analysis: Quantitative and Qualitative

Validity

To determine the degree that the test is addressing what it intends to evaluate, both the questions individually and the greater objective (Trochim & Donnelly, 2008), validity needs to be evaluated, specifically construct validity. Construct validity addresses the degree to which inferences can be made from the test, in this case, relating to the construct: science identity (Messick, 1990; Trochim & Donnelly, 2008).

To determine the validity of the test, the interview guidelines outlined by Miles, Huberman, and Saldaña's (2014) were followed. In general, the objective is to ensure that the observer accurately represented what students were sharing, using Sadaña's "that's right!" factor (2014), when the audience or interviewees respond positively to the summary of their thoughts. After the interviews were concluded a third party rater was used to code the interviews. The two versions of coding were compared to check for validity.

Validity for quantitative tools can be addressed by using an expert's judgment of relevancy of the questions to the topic or domain (Messick, 1990). Since the concern in the research was for the questions to be understandable and relatable to 5th and 6th graders, the students themselves were used as experts to assess for validity.

Students were also used to test for readability and flow. Dillman et al. (2009) suggest assessment tools should be designed for a fifth grade reading level at the most, which can be determined using the feature within Microsoft Word (2011).

During the trial period four groups of five – eight students per group were asked to participate in a think-aloud when reading the assessment to determine areas of confusion or define any limitations, as suggested by the National Quality Council (2009). Talk-alouds (or think-alouds) are used to determine the quality and clarity of the questions used to test students. Talk-aloud protocol includes asking the participants to "talk-aloud constantly from the time the problem was presented until they had given their final answer" (Kenny, Marks, & Wendt, 2007, p. 22). During this time the researcher is recording the comments, usually with an audio recorder, and only encouraging the participant to continue talking (Young, 2005). The use of a talk-aloud, or think-aloud, is to capture "what is held in the short-term memory" which "results in a sequence of thought that reflect what occurs cognitively during completion of a given activity" (Young, 2005, p.20). The talk-aloud method is useful if the goal is to "capture what the subject is actually doing" (Young, 2005, p.21), the data will shape the beginning phases of understanding behavior or the data will explain unknown behavior. The use of a talk-aloud with assessment questions helped to determine if the questions made sense and/or are appropriate for the MOSS 5th/6th grade population as well as point out any gaps in the development of the constructs.

It is important to note, however that students in 5th and 6th grade often struggle with verbalizing what they are thinking and, therefore, modeling the process of a think-aloud with an example question was necessary. Each question was read aloud to students in their field groups of five to eight students per group. Students were then asked to say what thoughts occurred in their mind when they heard the question. Was any part of it confusing, what was their first thought reaction, where did those thoughts take them? The small group setting allowed students to be more comfortable with this process and to use each other as sounding boards. Students were also encouraged to share their thoughts even if they were different than their peers since there is no correct answer, just their opinions. The think-aloud process utilized students as a review panel to assist in assessing the content validity of the questions and how they are being interpreted.

Reliability

To encourage increased inter-rater reliability, the degree to which different participants give consistent estimates of the same phenomenon, a trial period was utilized (Trochim & Donnelly, 2008). During this time the goal was to determine if the instrument is an adequate fit for determining science identity and if there are any edits that are required. Pilot testing the instrument helped determine if elements were confusing to students or if elements of the instrument produced varied results. This trial period occurred during the first week of MOSS in which two schools came for only three days and occurred in conjunction with the talk-aloud testing (see the above section, validity). Three-day programs are not suitable for assessment due to the lack of contact time, but can be used to test reliability of the instrument.

Internal consistency reliability was also addressed. Internal consistency reliability assesses the consistency of results for items within the test, or, in other words, how different questions assess the same construct (Trochim & Donnelly, 2008). Cronbach's alpha was used to determine internal consistency reliability for the three constructs (Cronk, 2012; Privitera, 2012; Tabachnichk & Fidell, 2001). A Cronbach's alpha of .70 or above indicates a low to high reliability (.70 = low, .80 = moderate, .90 = high).

Analysis – Qualitative

Methods for coding and evaluating the qualitative data included looking for themes and patterns in the responses from students (Creswell, 2013; Gibbs, 2007; Saldaña, 2009). Interviews were reviewed for themes that demonstrate attributes of the constructs of science identity. Interviews were coded both by an impartial third party and myself to check for inter-rater reliability. A process similar to grounded theory research was used, coding in three stages: open, axial, and selective (Gibbs, 2007). Examining the responses and comparing the responses is one aspect of open coding, along with constantly looking for the theoretical issues behind the results (Gibbs, 2007). Axial coding is the process of refining categories and looking for interconnections (Gibbs, 2007). The final stage, selective coding, will determine the "central category that ties all other categories in the theory together" (Gibbs, 2007, p. 50). The central categories were then compared to the three constructs of science identity for similarities and differences. This model was used to guide the analysis of the interviews, but not for the aim of turning this research into grounded theory.

Analysis – Quantitative

The data from the quantitative assessment test was evaluated using repeated measures one-way ANOVA to compare differences in scores from the pretest to the posttest and to the one-month posttest (Orion & Hofstein, 1994; Privitera, 2012). A statistically significant difference from the pretest to the posttest indicates a change in science identity. A p-value of .05 or less indicates a rejection of the null hypothesis, or hypothesis stating there is not a significant difference in scores between the pretest and posttest (Cronk, 2012). SPSS software was used to calculate statistical significance.

A paired t-test or one-way ANOVA was used to look at difference between the pretest and posttest, posttest and one-month posttest, and pretest and one-month posttest individually. Similar to the ANOVA analysis above, a statistically significant difference (p-value of .05 or less) from one test to the comparison test indicates a change in science identity. Another analysis was conducted to compare each construct, competence, performance, and recognition over time for each test (pre, post, one-month post).

A MANOVA was used to compare several of the constructs together with independent variables, this is assuming "the dependent variables (are) related conceptually, and should be correlated with one another at a low to moderate level" (Leech, Barrett, & Morgan, 2011). A MANOVA was used to look for differences in constructs compared to demographic data, for example, do girls show a greater difference in science identity over time than boys? The MANOVA was used to compare changes in science identity over time compared to student gender, field instructor gender, town (location of school), and Title 1 status of school. A statistically significant difference (p-value of .05 or less) from the one test to the comparison test indicates a change in science identity. The variables chosen to compare over time and with each other (gender, field instructor gender, town, Title

1 status) do not represent all the demographic information collected. Comparison of race, tribe, age, or grade level were not made to lack of variability in those categories.

A confirmatory factor analysis was calculated to ensure that the constructs of science identity are distinct from each other, similar to the approach Pugh et al. (2009) used in their study. The confirmatory factor analysis also helps determine the strength of the relationship between the questions and the constructs and the strength of the relationship between each construct. A confirmatory factor analysis allows for the comparison of various models to determine which one is the "best fit" indicated by several statistical parameters, a significant p-value, and high factor loadings between constructs and questions. Finding the best-fit of the constructs within science identity compared to the questions used will explain how well questions define each construct and if any covariance is interfering with how one question relates to a construct.

Limitations

There are many limitations within this design. The research design outlined here will only reflect the impact of one informal education center: MOSS. Although the hope is that the findings in this study can be transferred to other informal education centers. For example, a five-day program cannot be directly compared to a one-hour museum visit.

As mentioned in the Literature Review chapter, creating a quantitative instrument to measure change in science identity comes with noted flaws. Carlone et al. (2008) points out that the dependence of identity development on others' view of individuals makes operationalizing science identity difficult, since it cannot be "reducible to a set of core defining characteristics" (p. 2). Although the use of student interviews to inform the creation of the instrument aims to mitigate the over-generalization of science identity and to focus on aspects that are unique to MOSS and other similar educational centers, there is still the risk of either being too general with the questions or focusing on one narrow aspect of science identity formation as a result of MOSS.

The product suggested in these methods is a quantitative instrument, that at face value is at direct odds with the NRC's (2009) suggestion that standard pre and posttests does not reflect the type of hands-on learning that is associated with informal science learning experiences. Although this is true, the instrument created was from direct input from MOSS students (summer focus group interviews) and is validated by MOSS students (think-alouds). The pre and posttest model is at odds to the type of learning occurring at MOSS, but does reflect MOSS student opinions and is balanced with the greater need of developing an assessment tool that can be easily implemented in a short time period. The need to assess change in science identity development in a concise and timely manner, is at odds to the need to create an instrument that perfectly mirrors the instructional strategies of MOSS. Rather the objective was to try and create an instrument that is reflective of the learning environment, but more importantly addresses the change in science identity development.

Interviewing only the students at MOSS in the summer of 2014 also creates several limitations and assumptions. These students (or their parents) have self-selected to go to a science school in the summer meaning the students are likely already identifying with science and view science positively. This may skew the data to misrepresent those students that are on the opposite end of the science identity spectrum.

Another limitation is geographically related. With the exception of one school, all the students surveyed are Idaho students, so transferability to students in other regions may be limited.

In general, it is assumed that MOSS offers students an opportunity to change their science identity, or encourages further development of their science identity, this is a rather large assumption, which if untrue greatly affects this research. It is also assumed that the three constructs of science identity are embedded within MOSS programing and that my interpretation of how the constructs overlay with MOSS programing is accurate and/or representative of how Carlone and Johnson (2007) intended the constructs to be viewed, in other words, that there is no misinterpretation of the constructs and how the MOSS program represents those constructs.

It was assumed students would be willing to be interviewed and would offer valuable insight to the formation of science identity. It was also assumed themes would emerge from the interviews that would help inform the creation of the quantitative test. There was also an assumption that teachers would allot classroom time for the completion of the delayed one-month posttest and would send these posttests back. There is also an assumption of honesty from student responses.

An assumption of 30% attrition rate is also expressed in this research. It is assumed that about 30% of the students will not complete one of the posttests due to a number of reasons including, but not limited to: going home sick from MOSS, missing school the day the delayed one-month posttest is completed in class, the teacher not allowing time for completion of the one-month posttest, teachers not mailing the completed one-month posttest, said posttests being lost in the mail, etc.

It is assumed this assessment process, the instrument, and the research around the development of it will be useful to other informal education centers. An assumption has been made that the process and test will be transferable and flexible to fit the needs of others. The research conducted here is for a wide audience of informal education centers, which will vary immensely in content, format, and location. Lumping museums, parks, afterschool programs, and residential programs into one category brings many assumptions about content, populations served, geographic locations, and assessment needs. Generalizing for such a vast audience leads to many assumptions and limitations about the program being offered and their assessment needs.

Summary

With the mixed methods approach of utilizing interviews to inform the creation of a quantitative science identity test, the research aimed to assess the impact of the MOSS program on student's science identity formation. Students in the summer programs at MOSS in 2014 were interviewed to determine what salient factors contribute to their science identity formation. The information gathered from the interviews was then overlaid with the constructs from Carlone and

Johnson (2007) for science identity: competence, performance, and recognition. Likert scale questions were created from the analysis and information obtained from the interviews. The test was piloted the first week of MOSS programing to ensure validity, readability, and flow. Teachers and various educators were called upon to test for validity as well. Every student that attended the MOSS program in the fall 2014, about 360 students, took the pretest and posttest while at MOSS, and then the one-month posttest back at their school. Data was analyzed for significant positive changes and relation of factors to influencing science identity.

Chapter 4: Research Findings

A mixed method approach was used to understand if the MOSS program impacted science identity formation for attending students based on the three constructs: competence, performance, and recognition. In the summer 2014 two programs of students were interviewed. These interviews were then coded and used to create a quantitative test using Likert scale questions that were tested in the fall of 2014. A restatement of the research questions that these methods address are:

(1) How do students define what it means to be a scientist?
    What evidence do they look for to define someone who is competent as a scientist, can perform as a scientist, and is recognized as a scientist?
(2) How does the MOSS program impact emerging science identity for students?
(3) Do changes in scores over time (pre, post, one-month post) for emerging science identify vary by students' gender, field instructor gender, city, or Title 1 status of school?

Qualitative Findings

In July 2014 both Beyond MOSS and Upward Bound students were interviewed in a focus group setting. In the first group, Beyond MOSS, six girls volunteered to be in the focus group. The second group, Upward Bound, produced two separate focus groups: one with two boys and three girls and the other with two boys and four girls. A total of seventeen students participated in the three focus groups. Each interview lasted between fifteen and twenty-five minutes. Interviews were recorded and transcribed. Transcribed interviews were read through with the audio to check for accuracy. An additional impartial third party and I coded the interviews to validate themes and account for personal biases. The themes that emerged from the focus groups are listed below each interview question. The interview transcripts from all three interviews can be found in Appendix B. The coding notes and themes developed can be found in Appendix C.

1. Tell me about times when you feel like a science person at school?
    - Experimenting (labs, measuring things, testing)
    - Using trial and error or experimenting
    - Learning about science (reading, assignments, lectures)
2. Tell me about times when you feel like a science person at home?
    - Experimenting (cooking, measuring things, testing pool water
    - Demonstrating new knowledge (helping parents, explaining things to siblings)
3. Tell me about times when you feel like a science person at MOSS?
    - Experimenting (measuring things, testing, using tools)
    - Observing (being in nature, identifying, using five senses)
    - Learning about science (lessons, vocabulary building)
4. Do you feel competent in science or like you can do science well? What makes you feel that way?
    - Sharing (talking to others about science, helping peers)

- Ease (subject comes easily, new information is mastered easily, understand the process/see the connections easily)
- Experiment success (when the lab goes “right”)
- Grades

5. Do you feel like you can perform science tasks and use science skills? For example, can you use the scientific inquiry process, can you measure different variables, like the pH of water? What makes you feel that way?

- Experimenting (testing, measuring, hands-on – especially when it goes “right”)
- Using technology
- Practice (previous experience)
- Grades

6. Do you feel like your peers, teachers or family recognize you as a science person? Do they see you as someone that can do science well or is good at science? What makes you feel that way?

- Grades
- Teacher approval
- Helping (peers, family members)

7. What do you think of when I say “scientist” versus “science person”?

- Scientist = someone with a degree and a job in science
- Science person = hobby, interest in science, anyone

A student perspective of what it means to think of oneself as a scientist was ascertained from three focus group interviews. Students often mentioned the act of doing an experiment, or experiment-like activity (measuring pool chemicals or food for baking) as times when they felt like a scientists. Evidence of feeling like a science person either as a competent scientist, one that can perform as a scientist, or one that is recognized as a scientist, often came in the form of high grades from their science teacher or other students seeking their help. Each focus group discussed the difference of "being a scientist" versus "being a science person." All groups agreed that a scientist was someone who has a degree or job in science, where as a science person could be anyone with an interest in science.

From these results, the above concepts were overlaid with the three constructs, performance, competence, and recognition to create five questions per construct for a total of fifteen questions (see Appendix D for the instrument). Figure 5 shows the overlay of the results and the constructs, where Figure 6 shows the questions developed to reflect the results in relation to the constructs. Questions were created to reflect concepts addressed by students from the focus group meetings in conjunction with the distinguishing attributes of each construct, denoted by Carlone and Johnson (2007). It should be noted that although grades were brought up by students, a question pertaining to grades was not used since the MOSS program does not use grades for the K-12 students. Faculty at MOSS also reviewed the science identity questions for validity in relation to Carlone and Johnson's (2007) constructs: competence, performance, and recognition. Faculty approved the questions as relating to each construct and to science identity overall, based on their understanding of Carlone and Johnson's (2007) research and previous understanding of science identity.

Figure 5: Overlay of results from interview and constructs

Competence		**Performance**		**Recognition**	
Student comments	From Q #	Student comments	From Q #	Student comments	From Q #
Getting good grades	4,5,6	Getting good grades	4,5,6	Getting good grades	4,5,6
Explaining science to others	2,4,6	Explaining science to others	2,4,6	Explaining science to others	2,4,6
Learning about science	1,3	Learning about science	1,3	Teacher approval	6
Doing experiments	1,2,3,4	Doing experiments	1,2,3,4		
Making observations	3	Making observations	3		
Conducting successful experiments	4,5	Conducting successful experiments	4,5		
		Practicing science	5		

Figure 6: Overlay of constructs and test questions

Competence	Performance	Recognition
1. I am good at science	6. I can use science equipment and/or technology to collect data	11. My friends see me as someone that is good at science
2. I know a lot about science	7. I know how to use the scientific method/process	12. When giving a science report, I feel like a scientist
3. I am good at most science experiments	8. I can talk with others about science related topics	13. Others see me as a scientist when I share my observations
4. I understand science topics	9. I can create my own science experiments	14. When I share data I've collected, I feel like a scientist
5. I learn new science topics easily	10. I can use my observations to create a hypothesis	15. I can help others with science related topics

Validity Results/ Think-alouds:

Group think-alouds were conducted with students attending MOSS the first week of fall programing, September 8th-12th, 2014. Four groups were interviewed to see if the instrument's questions were confusing to students. Students read the questions out loud and then responded what they thought the question was asking, if there were any confusing elements of the question, and also offered suggestions for changing the questions. After several sessions, it was clear the word choice of "science person" was troublesome for students. Every group said that the questions should say "scientist" instead of "science person". After asking students if they thought there was a difference between a scientist and a science person, they then understood the word choice, but felt that most students, without the additional explanation, would be confused. Students defined a scientist as a person that has a career in science and/or has gone to college taking science classes. Students defined a science person as someone that does science as a hobby or enjoys it. Students felt other 5th and 6th graders would be bothered by or confused by the word choice of science person. The other question students didn't like was the question "I am good at science experiments." Several groups felt there should be a qualifier, like "some" or "most" before experiments. One group also didn't like the word choice of "conduct" and suggested the question should read: "I can create my own science experiences." The final version of the quantitative questions can be found in Appendix D with the incorporated changes suggested by students above.

Quantitative Response

Students attending fall MOSS residential programming from September through November 2014 took a pre and posttest at MOSS and were mailed a delayed one-month posttest to complete back at their school. Table 7 shows how many students completed the tests for each school. Title 1 schools are defined as schools serving low-income students that require additional financial assistance from the U.S. Department of Education to meet the needs of at-risk and low-income students (http://www.brighthubeducation.com/teaching-methods-tips/11105-basics-of-title-1-funds/).

Figure 7: Schools tested at MOSS Fall 2014

School Name	City	Title 1?	Grade Level Attending	Pre and Post @ MOSS	One-month Post
Montessori Academy	Moscow	No	6	10	7
Moscow Charter	Moscow	Yes	6	19	16
Riverstone	Boise	No	4	24	24
Rose Hill Montessori	Boise	No	5 & 6	9	9
All Saints	Lewiston	No	6	19	16
St. Mary's Moscow	Moscow	No	6	5	6
Willowcreek	Vale, OR	Yes	5 & 6	15	14
Longfellow	Boise	Yes	6	45	44
Whitney	Boise	Yes	6	55	43
Village Charter	Boise	Yes	7	30	22
St. Paul's	Nampa	No	5 & 6	34	28
St. Mark's	Boise	No	5 & 6	41	33
Sacred Heart	Boise	No	6	13	13
St. Mary's Boise	Boise	No	5 & 6	39	30
Total	14 schools 9 Boise area 3 Moscow 2 other	9 No 5 Yes	12 5 &/or 6 1 4 1 7	358	305

Quantitative Analysis

Data from the pre-test, post-test, and one-month post-test was entered into a spreadsheet and then imported into SPSS. Any data set missing a part, for example, a post-test, was removed. Data was checked for outliers or inaccuracies; for example, gender was entered as a “1” for male and a “2” for female students, a number other than 1 or 2 would indicate an inaccuracy and require going back to the test. All student names were replaced with numbers for student confidentiality. After cleaning up the data a total of 305 responses remained.

Overview of Data

Figure 8 shows the descriptive statistics for the main constructs (science identity overall, science performance, science competence, and science recognition) for each time (pre, post, one-month post). Figures 9 and 10 show the mean scores for each test versus the construct. Figure 11 shows an overview of the data for each construct per time including the minimum score, maximum, mean, and standard deviation. Further analysis was conducted on this final set of data.

Figure 8: Descriptive statistics for each construct (science identity overall, science performance, science competence, and science recognition) and test taking time (pre, post, one-month post).

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
SIPRE	305	0	75	50.86	12.618
SIPOST	305	19	75	58.38	11.146
SI1MOPOST	305	18	75	57.08	11.523
SIPRECOMP	305	0	25	17.49	4.079
SIPREPERF	305	0	25	18.01	4.699
SIPRERECOG	305	0	25	15.36	5.403
SIPOSTCOMP	305	8	25	19.89	3.518
SIPOSTPERF	305	6	25	20.90	3.642
SIPOSTRECOG	305	0	25	17.60	5.124
SI1MOPOSTCOMP	305	7	25	19.43	3.867
SI1MOPOSTPERF	305	6	25	20.28	3.849
SI1MOPOSTRECOG	305	5	25	17.37	5.017
Valid N (listwise)	305				

PRE, POST and 1MOPOST = refer to test time, taken at the beginning of the MOSS week (PRE), at the end of the MOSS week (POST), and one-month following the MOSS week (1MOPOST)
SI = Science Identity, all 15 questions
COMP = Competence questions, #1-5
PERF = Performance questions, #6-10
RECOG = Recognition questions, #11-15

Figure 9: Mean science identity score per time

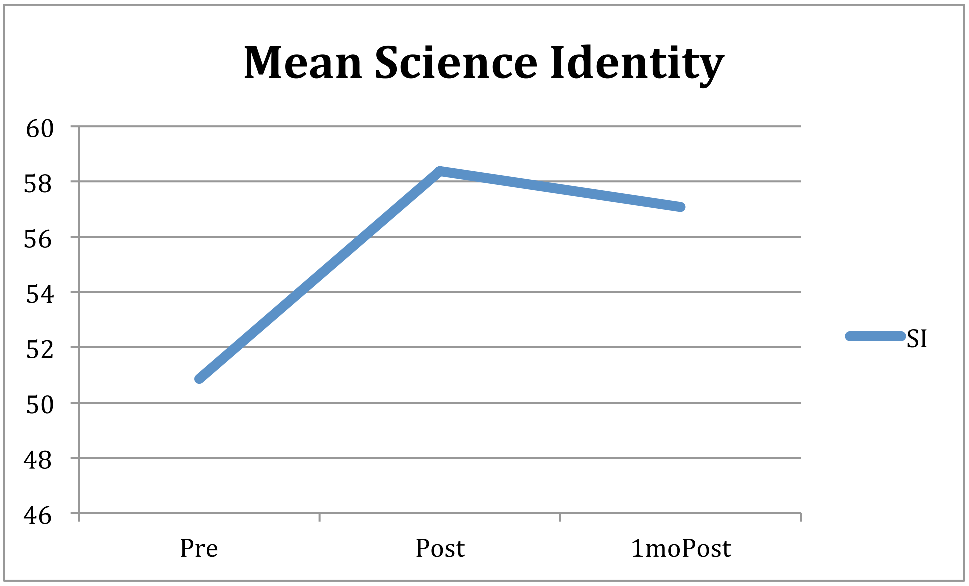


Figure 10: Mean construct per time

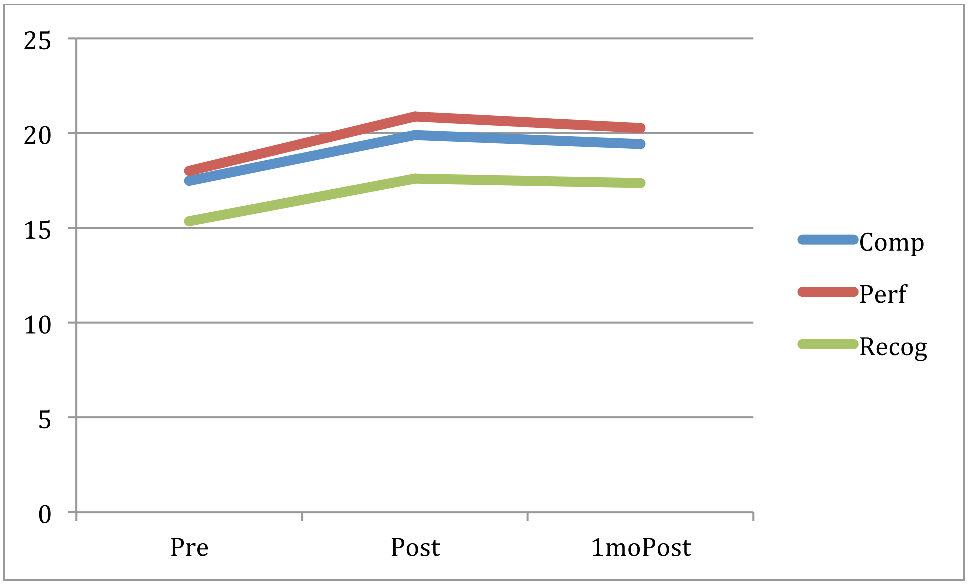
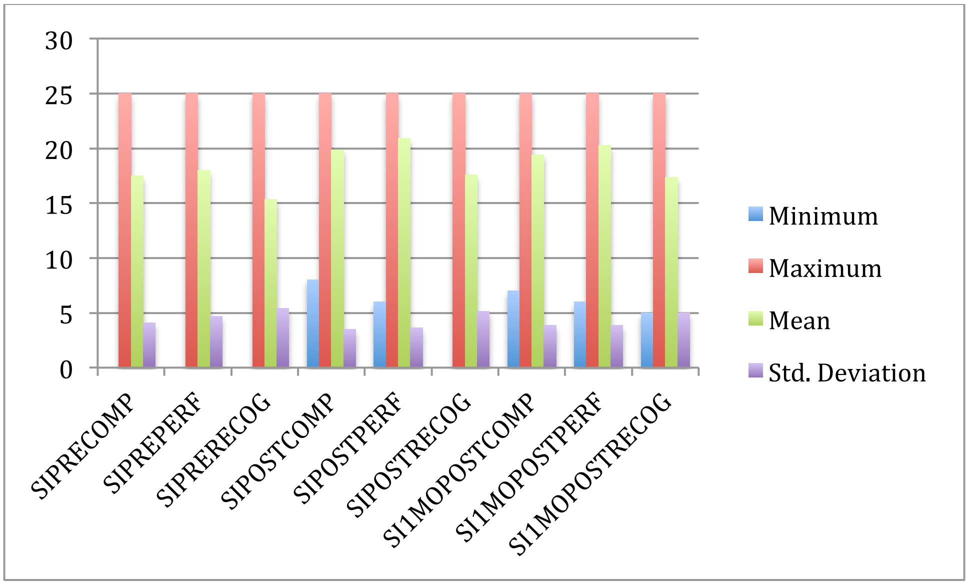


Figure 11: Minimum, maximum, mean, and standard deviation for each construct per time



Reliability Results

Split-half reliability was used to assess internal consistency of the test. A Cronbach's alpha of .89 was found, indicating a high level of reliability of the test for testing science identity overall. This is helpful if isolating the constructs is not informative or an overall change is of more value than change per construct. A further reliability analysis was conducted to verify if the questions created for each construct: competence, performance, and recognition, were indeed interrelated. The following Cronbach's alpha for each construct was calculated: competence – .85, performance – .85, recognition – .88.

Hypothesis #1 Results:

To test the first hypothesis, that the MOSS program increases students perceived science identity, a paired-samples t-test was used. A paired-samples t-test was used to compare the mean science identity pretest score (SIPRE) to the mean posttest score (SIPOST), the mean posttest to the mean one-month posttest score (SI1MOPOST), and the mean pretest to the mean one-month posttest scores. The mean science identity pretest score was 50.86 (*sd* = 12.62). The mean posttest score was 58.38 (*sd* = 11.15). The mean one-month posttest score was 57.08 (*sd* = 11.52). A significant increase from pretest to posttest was found (*t(*305) = -15.15, *p* = 0.00). A significant decrease from posttest to one-month posttest was found (*t(*305) = 2.95, *p* = 0.003). A significant increase from pretest to one-month posttest was found (*t(*305) = -11.27, *p* = 0.00). Data from this first analysis is represented in Figure 12.

Figure 12: Paired sample t test, comparing Science Identity between pre, post, and one-month posttests

Paired Samples Test

		Mean	Std. Dev	SEM	t	df	Sig. (2-tailed)
Pair 1	SIPRE - SIPOST	-7.525	8.67	0.496	-15.157	304	0
Pair 2	SIPOST - SI1MOPOST	1.302	7.708	0.441	2.949	304	0.003
Pair 3	SIPRE - SI1MOPOST	-6.223	9.642	0.552	-11.271	304	0

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	SIPRE & SIPOST	305	.740	.000
Pair 2	SIPOST & SI1MOPOST	305	.769	.000
Pair 3	SIPRE & SI1MOPOST	305	.684	.000

Hypothesis #2 Results:

To test the second hypothesis, if greater improvement was found in the recognition construct, a repeated measures ANOVA was used. A repeated measures one-way ANOVA, or univariate test, comparing time (pre, post, 1mopost) and constructs (science identity as a whole, science competence questions 1-5, science performance questions 6-10, science recognition questions 11-15) indicates a significant difference between time and each construct $p = 0.00$, as indicated from Figure 13. Significant difference between each time and each construct addresses if any one construct is resulting in the overall significance change between tests. A follow up paired-samples t test was used to compare the mean science competence, performance, and recognition pretest score (SIPRECOMP, SIPREPERF, SIPRERECOG) to the mean posttest score (SIPOSTCOMP, SIPOSTPERF, SIPOSTRECOG), the mean posttest to the mean one-month posttest score (SI1MOPOSTCOMP, SI1MOPOSTPERF, SI1MOPOSTRECOG), and the mean pretest to the mean one-month posttest scores. Figure 14 contains the results, indicating a significant difference between each pair (nine total) except the construct recognition between the posttest and one-month posttest ($t(304) = 1.07$, $p = 0.29$). Since these protected t tests were conducted as a result of the significant ANOVA, the Type I error (the probability of rejecting the null hypothesis when it is true) is inflated, meaning a correction for the number of tests needs to be adjusted by dividing .05 by the number of tests to determine significance (Cronk, 2012). Therefore, since .05/9 = 0.006, a p value of .0006 or less is needed to indicate a significant difference between each pair. Figure 15 simplifies the data by showing the pair examined, if there was a significant difference and if the difference was due to an increase or decrease in mean scores.

Figure 13: Repeated measures ANOVA comparing time and construct

Univariate Tests

Source	Measure		Type III Sum of Squares	df	F	Sig.
time	SI	Sphericity Assumed	9865.615	2	130.064	.000
		Greenhouse-Geisser	9865.615	1.877	130.064	.000
		Huynh-Feldt	9865.615	1.889	130.064	.000
		Lower-bound	9865.615	1.000	130.064	.000
	Comp	Sphericity Assumed	986.166	2	95.970	.000
		Greenhouse-Geisser	986.166	1.862	95.970	.000
		Huynh-Feldt	986.166	1.874	95.970	.000
		Lower-bound	986.166	1.000	95.970	.000
	Perf	Sphericity Assumed	1412.859	2	121.658	.000
		Greenhouse-Geisser	1412.859	1.861	121.658	.000
		Huynh-Feldt	1412.859	1.872	121.658	.000
		Lower-bound	1412.859	1.000	121.658	.000
	Recog	Sphericity Assumed	927.045	2	59.037	.000
		Greenhouse-Geisser	927.045	1.951	59.037	.000
		Huynh-Feldt	927.045	1.963	59.037	.000
		Lower-bound	927.045	1.000	59.037	.000

Error(time)	SI	Sphericity Assumed	23059.051	608		
		Greenhouse-Geisser	23059.051	570.711		
		Huynh-Feldt	23059.051	574.134		
		Lower-bound	23059.051	304.000		
	Comp	Sphericity Assumed	3123.834	608		
		Greenhouse-Geisser	3123.834	566.193		
		Huynh-Feldt	3123.834	569.544		
		Lower-bound	3123.834	304.000		
	Perf	Sphericity Assumed	3530.474	608		
		Greenhouse-Geisser	3530.474	565.816		
		Huynh-Feldt	3530.474	569.162		
		Lower-bound	3530.474	304.000		
	Recog	Sphericity Assumed	4773.622	608		
		Greenhouse-Geisser	4773.622	592.963		
		Huynh-Feldt	4773.622	596.742		
		Lower-bound	4773.622	304.000		

Figure 14: Paired samples t test comparing means for each construct: competence, performance, and recognition versus time

Paired Samples Test

		Paired Differences						
					95% Confidence Interval of the Difference			
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	Sig. (2-tailed)
Pair 1	SIPRECOMP - SIPOSTCOMP	-2.397	3.187	.182	-2.756	-2.038	-13.135	.000
Pair 2	SIPOSTCOMP - SI1MOPOSTCOMP	.462	2.814	.161	.145	.779	2.869	.004
Pair 3	SIPRECOMP - SI1MOPOSTCOMP	-1.934	3.571	.204	-2.337	-1.532	-9.460	.000
Pair 4	SIPREPERF - SIPOSTPERF	-2.889	3.583	.205	-3.292	-2.485	-14.080	.000
Pair 5	SIPOSTPERF - SI1MOPOSTPERF	.613	2.910	.167	.285	.941	3.680	.000
Pair 6	SIPREPERF - SI1MOPOSTPERF	-2.275	3.679	.211	-2.690	-1.861	-10.801	.000
Pair 7	SIPRERECOG - SIPOSTRECOG	-2.239	3.938	.225	-2.683	-1.796	-9.932	.000
Pair 8	SIPOSTRECOG - SI1MOPOSTRECOG	.226	3.694	.211	-.190	.642	1.070	.286
Pair 9	SIPRERECOG - SI1MOPOSTRECOG	-2.013	4.238	.243	-2.491	-1.536	-8.296	.000

Figure 14 continue: Paired samples t test comparing means for each construct: competence, performance, and recognition versus time

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	SIPRECOMP & SIPOSTCOMP	305	.657	.000
Pair 2	SIPOSTCOMP & SI1MOPOSTCOMP	305	.713	.000
Pair 3	SIPRECOMP & SI1MOPOSTCOMP	305	.597	.000
Pair 4	SIPREPERF & SIPOSTPERF	305	.658	.000
Pair 5	SIPOSTPERF & SI1MOPOSTPERF	305	.699	.000
Pair 6	SIPREPERF & SI1MOPOSTPERF	305	.646	.000
Pair 7	SIPRERECOG & SIPOSTRECOG	305	.721	.000
Pair 8	SIPOSTRECOG & SI1MOPOSTRECOG	305	.735	.000
Pair 9	SIPRERECOG & SI1MOPOSTRECOG	305	.672	.000

Figure 14: Simplified results from Figure 13, indicating significant difference from time one to time two and significance due to an increase or decrease in mean scores

		Sig?	Increase or decrease?
Pair 1	SIPRECOMP - SIPOSTCOMP	Yes	increase
Pair 2	SIPOSTCOMP - SI1MOPOSTCOMP	Yes	decrease
Pair 3	SIPRECOMP - SI1MOPOSTCOMP	Yes	increase
Pair 4	SIPREPERF - SIPOSTPERF	Yes	increase
Pair 5	SIPOSTPERF - SI1MOPOSTPERF	Yes	decrease
Pair 6	SIPREPERF - SI1MOPOSTPERF	Yes	increase
Pair 7	SIPRERECOG - SIPOSTRECOG	Yes	increase
Pair 8	SIPOSTRECOG - SI1MOPOSTRECOG	No	decrease
Pair 9	SIPRERECOG - SI1MOPOSTRECOG	Yes	increase

Hypothesis #3 Results:

A repeated measures multivariate analysis was conducted to assess if there was a difference between responses in the three tests for the constructs, competence, performance, and recognition due to gender of students (Gender), gender of field instructor (FIgender), school town being either Boise, Moscow, or rural (town), and if the school is a Title1 school (Title1). The repeated measures MANOVA is a five way analysis examining the three constructs (competence, performance, and recognition) compared to the variables of gender, field instructor gender, town, and Title 1 school status. The MANOVA testing addresses the third hypothesis: changes in scores over time (pre, post, one-month post) for emerging science identity will vary by students' gender, city, and Title 1 status of school, but not by field instructor gender.

Statistically significant multivariate effects were found for the main effects on time, F (2,282) = 33.45, $p = .000$ but not for the interaction between time and town, F

(2,282) = 8.97, *p = .465,* nor for the interaction between time and field instructor gender, *F* (2,282) = 1.19, *p = .312*. There is not a statistically significant interaction between time and student gender, *F* (2,282) = .898, *p = .408*. The interaction between time and Title 1 status is barely significant, *F* (2,282) = 3.03, *p = .05.* However, the partial eta squared value of .021 signifies this significance is of a low value. The interaction effects between the various combination of variables (gender, FIgender, town, Title 1 status) and time did not produce statistically significant results expect for the combination of time, town, FIgender, and Title 1 status, *F* (2,282) = 3.22, *p = .041*, with a partial eta squared value of .022*.* Figure 15 displays the results for the MANOVA test comparing change in science identity over time versus student gender, field instructor gender, Title 1 status, and town. Figure 16 summarizes the results from the MANOVA tests, in short, that there is no significant interaction between the main effect and student gender, field instructor gender, town, or Title 1 school status.

Figure 15: MANOVA for change in science identity over time versus town, FI gender, Title 1 status, gender and the interactions between them.

Multivariate Tests[a]

Effect		Value	F	Error df	Sig.	Partial Eta Squared
time	Pillai's Trace	.192	33.457[b]	282.000	.000	.192
	Wilks' Lambda	.808	33.457[b]	282.000	.000	.192
	Hotelling's Trace	.237	33.457[b]	282.000	.000	.192
	Roy's Largest Root	.237	33.457[b]	282.000	.000	.192
time * Town	Pillai's Trace	.013	.898	566.000	.465	.006
	Wilks' Lambda	.987	.897[b]	564.000	.465	.006
	Hotelling's Trace	.013	.897	562.000	.466	.006
	Roy's Largest Root	.013	1.786[c]	283.000	.169	.012
time * FIGENDER	Pillai's Trace	.017	1.198	566.000	.310	.008
	Wilks' Lambda	.983	1.196[b]	564.000	.312	.008
	Hotelling's Trace	.017	1.193	562.000	.313	.008
	Roy's Largest Root	.013	1.857[c]	283.000	.158	.013
time * Title1	Pillai's Trace	.021	3.029[b]	282.000	.050	.021
	Wilks' Lambda	.979	3.029[b]	282.000	.050	.021
	Hotelling's Trace	.021	3.029[b]	282.000	.050	.021
	Roy's Largest Root	.021	3.029[b]	282.000	.050	.021
time * GENDER	Pillai's Trace	.006	.898[b]	282.000	.408	.006
	Wilks' Lambda	.994	.898[b]	282.000	.408	.006
	Hotelling's Trace	.006	.898[b]	282.000	.408	.006
	Roy's Largest Root	.006	.898[b]	282.000	.408	.006
time * Town * FIGENDER	Pillai's Trace	.005	.692[b]	282.000	.501	.005
	Wilks' Lambda	.995	.692[b]	282.000	.501	.005
	Hotelling's Trace	.005	.692[b]	282.000	.501	.005
	Roy's Largest Root	.005	.692[b]	282.000	.501	.005
time * Town * Title1	Pillai's Trace	.015	1.081	566.000	.365	.008
	Wilks' Lambda	.985	1.080[b]	564.000	.366	.008

	Hotelling's Trace	.015	1.079	562.000	.366	.008
	Roy's Largest Root	.014	1.960[c]	283.000	.143	.014
time * Town * GENDER	Pillai's Trace	.019	1.387	566.000	.237	.010
	Wilks' Lambda	.981	1.389[b]	564.000	.236	.010
	Hotelling's Trace	.020	1.391	562.000	.236	.010
	Roy's Largest Root	.020	2.802[c]	283.000	.062	.019
time * FIGENDER * Title1	Pillai's Trace	.008	1.153[b]	282.000	.317	.008
	Wilks' Lambda	.992	1.153[b]	282.000	.317	.008
	Hotelling's Trace	.008	1.153[b]	282.000	.317	.008
	Roy's Largest Root	.008	1.153[b]	282.000	.317	.008
time * FIGENDER * GENDER	Pillai's Trace	.006	.428	566.000	.788	.003
	Wilks' Lambda	.994	.427[b]	564.000	.789	.003
	Hotelling's Trace	.006	.425	562.000	.790	.003
	Roy's Largest Root	.004	.530[c]	283.000	.589	.004
time * Title1 * GENDER	Pillai's Trace	.003	.413[b]	282.000	.662	.003
	Wilks' Lambda	.997	.413[b]	282.000	.662	.003
	Hotelling's Trace	.003	.413[b]	282.000	.662	.003
	Roy's Largest Root	.003	.413[b]	282.000	.662	.003
time * Town * FIGENDER * Title1	Pillai's Trace	.022	3.219[b]	282.000	.041	.022
	Wilks' Lambda	.978	3.219[b]	282.000	.041	.022
	Hotelling's Trace	.023	3.219[b]	282.000	.041	.022
	Roy's Largest Root	.023	3.219[b]	282.000	.041	.022
time * Town * FIGENDER * GENDER	Pillai's Trace	.003	.375[b]	282.000	.687	.003
	Wilks' Lambda	.997	.375[b]	282.000	.687	.003
	Hotelling's Trace	.003	.375[b]	282.000	.687	.003
	Roy's Largest Root	.003	.375[b]	282.000	.687	.003
time * Town * Title1 * GENDER	Pillai's Trace	.013	.944	566.000	.438	.007
	Wilks' Lambda	.987	.944[b]	564.000	.438	.007
	Hotelling's Trace	.013	.944	562.000	.438	.007
	Roy's Largest Root	.013	1.885[c]	283.000	.154	.013

time * FIGENDER * Title1 * GENDER	Pillai's Trace	.004	.580^{b}	282.000	.560	.004
	Wilks' Lambda	.996	.580^{b}	282.000	.560	.004
	Hotelling's Trace	.004	.580^{b}	282.000	.560	.004
	Roy's Largest Root	.004	.580^{b}	282.000	.560	.004
time * Town * FIGENDER * Title1 * GENDER	Pillai's Trace	.005	.697^{b}	282.000	.499	.005
	Wilks' Lambda	.995	.697^{b}	282.000	.499	.005
	Hotelling's Trace	.005	.697^{b}	282.000	.499	.005
	Roy's Largest Root	.005	.697^{b}	282.000	.499	.005

a. Design: Intercept + Town + FIGENDER + Title1 + GENDER + Town * FIGENDER + Town * Title1 + Town * GENDER + FIGENDER * Title1 + FIGENDER * GENDER + Title1 * GENDER + Town * FIGENDER * Title1 + Town * FIGENDER * GENDER + Town * Title1 * GENDER + FIGENDER * Title1 * GENDER + Town * FIGENDER * Title1 * GENDER

Within Subjects Design: time

b. Exact statistic

c. The statistic is an upper bound on F that yields a lower bound on the significance level.

Figure 16: Summary of multivariate tests comparing time and other factors against science identity construct results, using the Wilks' Lamda value

Interaction	Sig
time * Gender	0.408
time * FI Gender	0.312
time * town	0.465
time * Title 1	0.05
time * Town * Figender	0.501
time * Town * Title 1	0.366
time * Town * Gender	0.236
time * FIGender * Title 1	0.317
time * FIGender * Gender	0.789
time * Title 1 * Gender	0.662
time * Town * FIGender * Title 1	0.041
time * Town * FIGender * Gender	0.687
time * Town * Title1 * Gender	0.438
time * FIGender * Title1 * Gender	0.56
time * Town * FIGender * Title1 * Gender	0.499

Goodness of Fit for Instrument Results:

A confirmatory factor analysis was calculated to ensure the constructs of science identity were distinct from each other and if the questions within a construct were related to each other. The hypothesized model is presented in Figure 19 where circles represent latent variables, and rectangles represent measured variables. Lines indicate an implied effect. Questions associated with each construct were grouped: respectively, competence questions 1-5, performance questions 6-10, and recognition questions 11-15. Maximum likelihood estimation was employed to estimate all models.

For reference, a chi square (χ^2) test examines the difference between the estimated variance-covariance matrix and actual variance-covariance matrix (Bollen & Long, 1993; Kline, 2004; Maruyama, 1998). A significant, or small, p value means there is a difference between estimated and actual matrices. A large chi square and small p value need to be further examined by the following indices to determine if the model is a good fit. A comparative fit index (CFI), general standard for good fit (GFI), and adjusted goodness of fit index (AGFI) indicate a good fit for scores of .95 or higher. The standardized root mean squared residual (SRMR) should be .08 or lower and the root mean square error of approximation (RMSEA) should be .06 or lower. The CFI, GFI, and AGFI indicate a goodness of fit, the higher the score the better. Where as the RMSEA and SRMR indicate a badness of fit, the lower the score the better.

The hypothesized model was tested and supported χ^2 (87, N = 304) = 232.55, p = 0.0, comparative fix index (CFI) = .934. Other examinations of indices showed acceptable model fit with GI = .905, AGFI = .869, RMSEA = .07, SRMR = .065, as seen in Figure 18. However, mediation indices suggested freeing the covariance between two terms (e12 and e14). A subsequent model freeing this path was found to have better fit to the constrained models, χ^2 (86, N = 304) = 206.48, p = 0.0, CFI = .945, GFI = .917, AGFI = .884, RMSEA = .068, SRMR = .060, as seen in Figure 19. A chi-square difference test indicated a significant improvement in fit between the independence model and the hypothesized model, $\Delta\chi^2$ (1, N = 304) = 26.07, p = 0.0.

The factor loadings (the numbers in between each question and construct in Figures 19 and 20) for each question associated with each construct (i.e. competence, performance, and recognition) show which questions are better indicators of each construct, denoted by a numbers closer to 1.0. Overall, the factor loadings for recognition were higher than the other two constructs, indicating that the questions associated with recognition are a better fit for that construct than the other two (Figure 19 & 20). The model could be strengthened by reconstructing some of the questions with a lower factor loading for competence and performance, for example, numbers one, three, and eight.

The modification indices for the confirmatory factor analysis were all fairly low, indicating little covariance between the questions. However, questions number 12 and 14 had a high modification indication number of 20.86, about ten points higher than any other combination. After accounting for this covariance in the second model (Figure 20), the goodness of fit scores increased. Question 12 and 14 are as follows: “When giving a science report, I feel like a scientist” and “when I share data I’ve collected, I feel like a scientist”. When students share a science report they are also sharing data they have collected and so the two questions possess similar elements that can overlap or interfere with each other and the degree to which the questions are better indicators of the construct.

Results indicated that the test is a good fit for assessing emerging science identity and the questions associated with each construct are a good fit for assessing the aspects within science identity, as seen in the goodness of fit calculations (CFI and GFI), badness of fit calculations (RMSEA and SRMR), and chi-square significance. The higher the numbers or factor loadings, associated with each arrow in Figures 19 and 20, signify a better indicator of that question and the construct it is linked to. The model becomes a better fit after accounting for the covariance between questions number 12 and 14 (Figure 20). Squaring the factor loading produces the percentage that the variable explains that construct, for example, the factor loading for Science Identity question number 11 is .85, meaning question number 11 explains the variance of recognition 72% of the time. The questions relating to the recognition construct explain the variance 72-100% of the time, 50-100% for the time for competence, and 70-100% of the time for performance.

Figure 17: Confirmatory Factor Analysis before adjusting for covariance

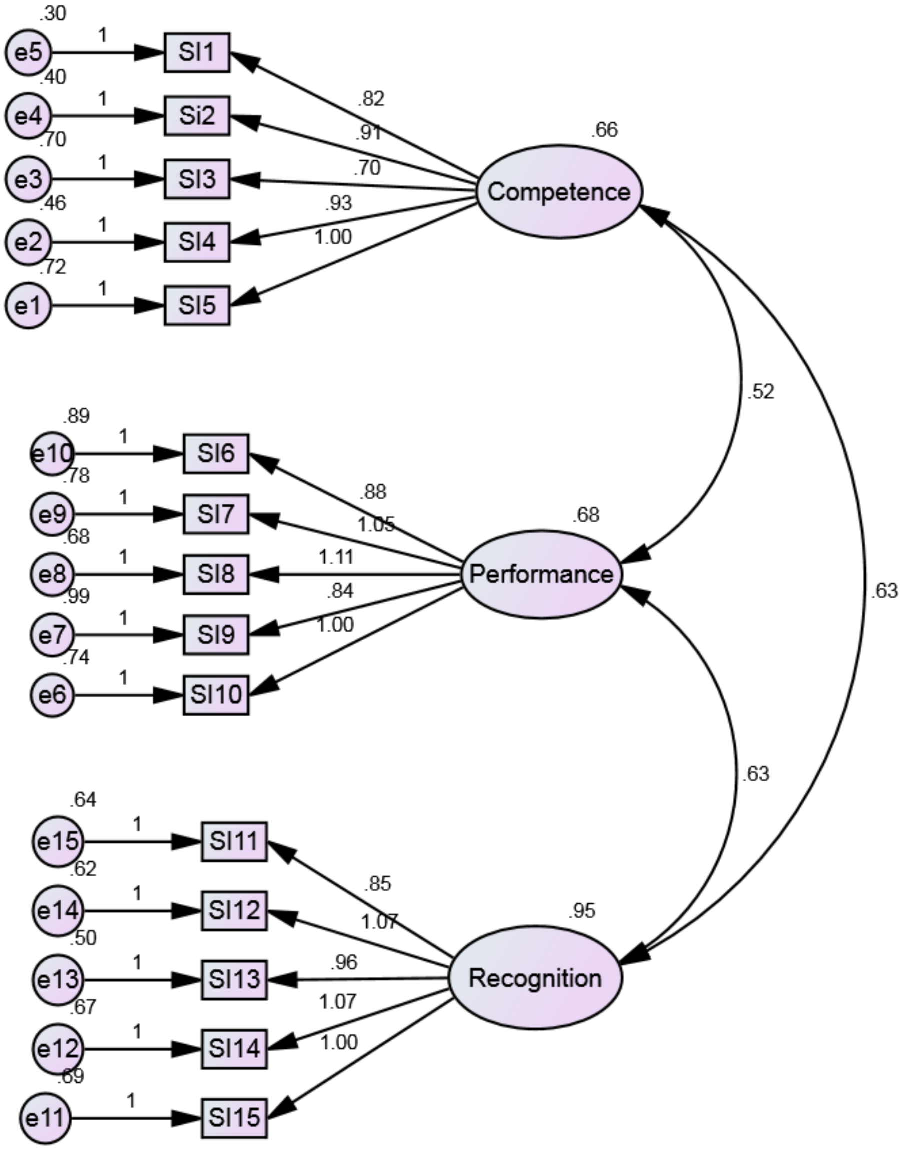
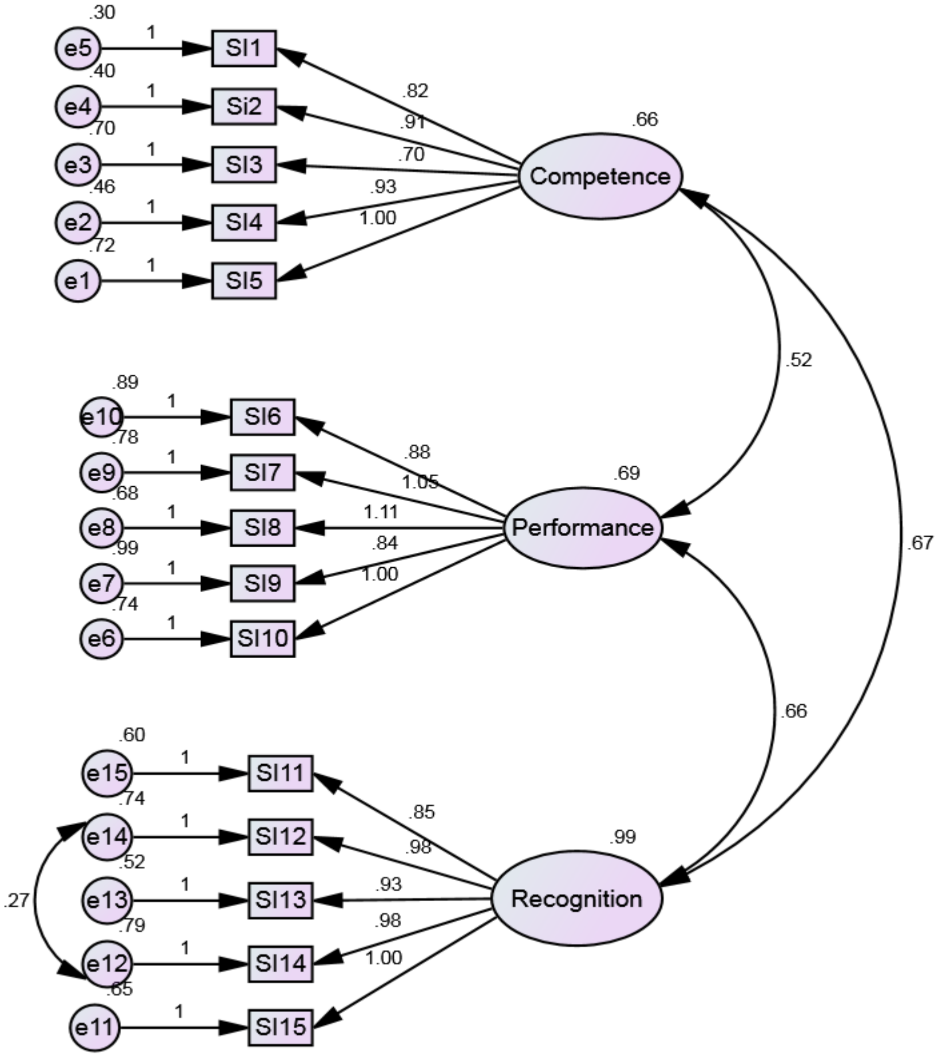


Figure 18: Confirmatory Factor Analysis after adjusting for covariance



Hypothesis Findings - Summarized

The first hypothesis was that the MOSS program would result in an increase in students' perceived science identity, which was supported as seen by the paired-sampled t-test testing. The second hypothesis stated that students would demonstrate greater change in areas of recognition than the other two constructs: competence and performance, although positive change can be seen in all three constructs following the MOSS program. This hypothesis was also supported as seen by the repeated measures ANOVA testing. The final hypothesis predicted that changes in scores over time (pre, post, one-month post) for emerging science identity would vary by students' gender, city, and Title 1 status of school, but not by field instructor gender. The final hypothesis was not supported as there was no statistically significant difference for any of the variables over time as seen from the MANOVA testing.

Summary

From the mixed-method approach, data was collected from three focus groups interviews and 305 student surveys to better understand emerging science identity in relation to competence, performance, and recognition for students attending the MOSS programing. Three groups of middle (1) and high school (2) students were interviewed. Students were asked about times in their daily lives, both at school and at home, when they feel like a scientist and activities that contributed to this notion. From the interviews, a 15-question Likert scale test was created to quantitatively assess students' science identity formation. Four groups of students were interviewed the first week of fall programing at MOSS to check the readability and flow of the test. Every student that attended the fall programing at MOSS in 2014 completed a pre and posttest while at MOSS and most completed a one-month posttest.

Interviews conducted over the summer revealed themes and times when students felt like a scientist. Many students emphasized the value of experiments and technology in their science identity formation. Most students also expressed the importance of grades as a form of recognition for being good at science. In the trial period of the quantitative test, several students expressed the need for the quantitative test wording to be "scientist" versus "science person" to reduce confusion for students.

Figure 9 provides an overview of the results from the pre, post, and one-month posttest, showing an increase in mean test scores from the pre to the post and a slight decrease between the post and one-month posttest. Examination of the mean for the questions related to the constructs: competence, performance, and recognition, demonstrate a similar trend. Reliability results indicate the questions provide reliable results both for all the questions as a whole and for each construct.

Paired-samples t-tests and ANOVA tests comparing means of each test time (pre, post, one-month post) for all the questions and the questions related to each construct indicate a statistically significant difference for each comparison except for the comparison of post recognition questions to one-month post recognition questions. All comparisons between post and one-month posttest means were due to a decrease in mean score, where as the comparison between pre and posttest and pre and one-month posttest was due to an increase in mean score.

There was no significance found in the MANOVA comparing change in test scores over time versus student gender, field instructor gender, town, or status as a Title 1 school. A confirmatory factor analysis indicates that the three constructs, five questions per each construct, are a good model for testing the constructs within science identity and science identity overall.

Chapter 5: Discussion and Implications

Over the summer of 2014, three groups of middle (1) and high school (2) students were interviewed to understand times when they felt like a scientist and contributing factors to their science competence, performance, and recognition. The data from the interviews were coded and compared with an external reviewer for inter-rater reliability. The coding of the interviews then informed the creation of a 15-question five-point Likert scale test ranging from strongly agree to strongly disagree. The first week of fall programing 2014 was spent interviewing students in a think-aloud format to check readability and flow of the test. All students that came to MOSS for the remaining fall program weeks, 358 students, completed a pre and posttest at MOSS. Following the week at MOSS, schools were mailed a one-month posttest to examine resilient impacts on science identity formation one month later. Data collected from pre, post, and one-month posttests were analyzed to understand change and impact.

Review of Findings and Interpretation of Results

Data collected from both the focus groups in the summer and from the students attending the MOSS program in the fall provide insight into understanding pre-adolescent science identity development. Science identity is not an easily quantified distinction, nor is it easily defined by students themselves. There is still much more understanding to develop with emerging science identity for pre-adolescents; examination of the data collected from this research can help continue to build on the literature and current research in science identity to and provide opportunities for continued research in this area.

From the focus group meetings in the summer with the three student groups, several themes became quickly apparent. Students often cited grades as an indicator of their success or status for being known as a scientist or a science person. Students also associated high grades with the idea that they had to get science “right” or perfect each time; failure to complete a lab perfectly meant that they weren’t good at science. It seemed that students felt they couldn’t be intrinsically good at science or that they weren’t able to be in complete control of their status as a scientist. Rather, their teachers and the grades the students received determined being good at science. Students’ science identity seemed to be more determined by grades than attitudes or interest in science; this emphasis placed on grades may indicate that grades have a larger influence in science identity development than engaging science lessons.

Another theme that was apparent from the focus groups was that science to the students was often defined by the use of technology and/or hands-on experimenting. Students often cited labs and experiments as evidence of when they felt like a scientist at home or at school. The act of measuring out and mixing items, such as chemicals to test the water of a pool or ingredients for baking, encouraged them to feel more like a scientist. The use of the scientific method or act of hypothesizing and testing, for example, did not seem to be important activities that helped students to feel like a scientist. The emphasis is placed on action and not thought processes, akin to acting in a play rather than imagining the role.

In beginning of the each focus group interview, students seemed taken aback at the idea that they could perform science, be competent in science, or be recognized as scientists. However, as the interviews progressed and students started to reflect more on times when they felt like they were performing as scientists, for example, they were more able to see how they have taken on the scientist role. This further justifies the need to use questions that get at the constructs without asking directly if students feel like they are competent in science, for example.

During the first focus group meetings it became apparent that students were hampered by their definition of a scientist; they seemed to react negatively to the word choice since it wasn't an option for them to be seen as a scientist. When asked further, all groups agreed that a scientist was someone that has studied science in college or had a job in a science related career. The act of asking them about the distinction between a "science person" and a "scientist" led them further to the conclusion that a scientist is someone who has studied science in college or has a job in science, but this was not something students explained initially.

The final question in the focus group interviews likely led to a biased answer when asking students to define a "scientist" and a "science person" separately, which was made apparent during the think-alouds during the first week of MOSS fall programing. Students that participated in the think-alouds were confused by the use of the term "science person," as it was not something they heard on a daily basis and so preferred "scientist" instead. Although students felt there was a difference between a science person and a scientist when provoked through questioning, they didn't come to that conclusion initially on their own. It had seemed initially that the word choice was important to students and they would be negatively impacted by a strong word choice, such as “scientist,” however, the opposite was true. It seemed from the think-alouds that it was important to stick with words students were familiar with in order to assess their change in science identity formation from their time at MOSS.

The quantitative data and subsequent analysis provided many interesting insights into emerging science identity for MOSS students. The first point of interest comes from the one-way ANOVA and paired-samples t-tests. Comparing the pre, post, and one-month posttest overall scores revealed a statistically significant change between each testing time. More specifically, students increased their overall science identity scores between the pre and posttest, decreased between post and one-month posttest, but with an overall increase compared to the pre and one-month posttest. This suggests that as a result of attending the MOSS program students’ overall science identity increased, however, with some attrition in science identity a month following their time at MOSS. Since the difference between the pre and one-month posttest was statistically significant, the MOSS program did have an overall positive impact on students’ science identity, for at least a month following their visit. The statistically significant difference between the posttest and delayed one-month posttest indicates that the benefit of the MOSS program diminishes after leaving MOSS, likely due to students returning to previous habits and environments that may or may not place an emphasis on science identity growth. An examination of various delayed posttest design, such as a three-month delay, six-month, and one-year will help to determine if and when there is a plateau for this diminishing difference.

The paired-samples t-test comparing the constructs of science identity over time provided a similar pattern of statistically significant increase between pre and posttest, statistically significant decrease between posttest and one-month posttest, but overall statistically significant increase between pretest and posttest. The one exception to this trend was the difference between the posttest and one-month posttest for the recognition construct. There was a decrease between the posttest and one-month posttest for recognition but not a statistically significant decrease. This indicates that students' change in their recognition or sense of being recognized as a scientist did not decline as greatly over time as the other constructs. In other words, the MOSS program had a greater impact in the longevity of if students felt recognized as scientists than for their competence or performance as scientists, which is further backed by the high Pearson correlation score for each recognition pairing (Correlation column in Figure 14).

Recognition can be a challenging construct to address in a classroom setting since grades do play such an important role in recognition; the indication that the MOSS program encourages students to feel recognized as scientists is an important benefit of the MOSS program for students' science identity development. From the data, it is implied that the MOSS program and programs similar to it may be a method for combating the strong influence grades have on science identity development, offering an option for students to foster a science identity for those that may struggle with the subject at school. The lasting impact of recognition over the other constructs is interesting as recognition is the construct the least developed in a classroom setting (Carlone & Johnson, 2007), and therefore the most likely to diminish for students after to returning to their daily routine. The fact that recognition had the least attrition of the three other constructs could be explained by the high need for students to feel recognized or that the emphasis of the MOSS program targeted this construct greater than the others, or did so in more of a meaningful way.

The MANOVA test compared change in results for overall science identity scores and scores for each construct over time compared to student gender, field instructor gender, town of residence, and Title 1 school status proved to yield few statistically significant results. Lack of significance indicates that the factors compared over time (student gender, field instructor gender, town of residence, and Title 1 school status) had no or little impact on change in student identity. It is an important distinction to note that field instructor gender is not influencing students' change in science identity and that student demographics are also largely not influencing change in science identity. One possible implication here is the idea that students have control of their science identity development outside of these factors. It is interesting that the interaction between time, town, field instructor gender, and Title 1 status produced statically significant results, in other words, all factors combined except student gender. More research is needed to understand why this combination produces statistically significant results.

The confirmatory factor analysis examined the relationship between the questions and their associated constructs. The results indicate that the test is a good model, or a plausible model for assessing science identity. It should be noted that this does not mean that this model addresses all salient aspects to determining science identity, only that it is plausible that the quantitative instrument addresses science identity and the three constructs within science identity and that there are three distinct constructs within science identity.

Overall, the data indicates that the MOSS program encourages students to develop a stronger science identity from their time at MOSS. Students demonstrated an increase in overall science identity as well as for how they view their competence, performance, and recognition as scientists. Comparison of scores over time indicate that students do lose some of their self-perceived science identity a month following the MOSS program, but maintain their sense of recognition as a scientist more over time than their sense of competence or performance as a scientist. Demographic factors and gender of field instructors appear to not influence change in science identity. The instrument created for this research appears to be a good fit for testing science identity and the constructs within science identity.

Implications for the Literature

Designing an instrument that can be used for assessment in a variety of informal education settings is challenging (NRC, 2009). The instrument created from this research can provide science centers looking to address change in science identity a tool that can be implemented with little time or funding required (See Appendix D for the instrument). This instrument doesn't require extensive interviews or mixed methods that often deplete resources available at informal education centers

(Campbell & Carson, 2005; Kearney, 2009). Since this tool was designed to address change in science identity and not content, it can be used for a wide variety of science programs. The challenge of finding a concise instrument for assessing the value of an informal education center is mitigated by the instrument created here, therefore avoiding lengthy tests or uninformative, short tests (Bourdeau & Arnold, 2009; Hosty, Arnold, Dalton, Livesay, & Galloway, 2006; Liang et al., 2005; Pugh, Linnenbrink-Garcia, Koskey, Stewart, & Manzey, 2009).

The instrument created and used in this research is relevant for any educator working in a setting that targets the three constructs of science identity (competence, performance, recognition) or targets science identity overall. Both formal and informal educators alike aiming to assess change in science identity development from various learning experiences can use the instrument. The brevity of the instrument, only 15 Likert-scale questions, requires minimal completion time and therefore little time taken away from instructional time.

The instrument created and tested in this research also provides a novel approach to assessing science identity, since most previous assessment has included a qualitative approach (Brown et al., 2005; Calabrese Barton & Tan, 2010; Carlone & Johnson, 2007; Gee, 2001; Herrera, Hurtado, Garcia, & Gasiewski, 2012; Kozoll & Osborne, 2004). The strategy used for creating this science identity instrument, interviews informing the creation of the tool, aimed to address Carlone et al.'s (2008) concerns about the difficulty of operationalizing science identity, since it cannot be "reducible to a set of core defining characteristics" (p. 2). Although there are inevitably other aspects of a students' science identity not addressed in this instrument, the student validation process (focus groups and think-alouds) and goodness of fit tests (confirmatory factor analysis and Chronbach's alpha) justify this tool and its ability to assess change in science identity for MOSS students.

As seen in the literature, identities are being negotiated from moment to moment as students interact with their peers, a topic or challenge, and in their daily lives (Gumperz, 1982; Hymes, 1974; Kozoll & Osborne, 2004). Students' time at MOSS provides a valuable opportunity to re-negotiate their relationship with science. The exposure to a new environment, various technology, and new instructors allows students the opportunity to explore a new connection with science (Calabrese Barton & Tan, 2010; Carlone et al., 2008; Gee, 2001). The opportunity for students to craft a science experiment from start to finish during the MOSS Inquiry Day and to present their findings potentially allows them an opportunity to adjust or redefine their identity through developing their competence, performing as a scientist, and being recognized as a scientist (Carlone & Johnson, 2007).

Having a better understanding of what activities, such as visiting an outdoor school like MOSS, help increase science identity, can help educators determine what learning activities to choose in order to promote STEM education and careers (Graham, Frederick, Byars-Winston, Hunter & Handelsman, 2013; Fraser & Ward, 2009). Although this research does not address what specific aspects of the MOSS program encourage science identity development, it does narrow down that the experiences at MOSS help to build science identity, which is a prominent and important step towards educators understanding what specific learning experiences help foster science identity growth.

Implications for MOSS and Other Programs

The findings in this study imply that the MOSS program has a continued positive impact on students' science identity formation, specifically with the construct of recognition one month following the visit to MOSS. The MOSS program increases the number of students that feel like they are scientists. It is implied that curriculum and focus of the MOSS program (place-based, problem-based, hands-on inquiry) increases science identity, although this relationship does need to be examined further. On a wider scale, this research implies that informal education centers and/or residential programs could serve an important role for supplementing science curriculum in the schools and can serve an important role in developing students' science identity and building their recognition as a scientist. Visitations to museums, outdoor science schools, nature centers and the like could greatly benefit science identity development of students.

Recognition is the one construct that did not decreases significantly from the posttest to the one-moth posttest, unlike performance and competence that did decrease with statistical significance from the posttest to the one-month posttest. Although there was still a significant increase in each construct between the pretest and one-month posttest, the lack of significant decrease for recognition implies that the MOSS program had the greatest impact on the recognition construct for students. The implication here is that the most lasting aspect of the MOSS program for students is the opportunity to be realized, by self and others, as a scientist.

Implications of this research for other educational settings, both formal and informal, are that students need more of an opportunity to feel like and be recognized as being a scientist, as seen in the lasting impact on recognition from the pretest, posttest, and one-month posttest. Students can potentially benefit from experiences at MOSS that focus on recognition of students as scientist by developing their competence and performance of science skills and where they develop and present their own science experiment to help increase their science identity development. Teachers in classrooms can incorporate these practices into their classroom to help facilitate science identity development for their students. Informal education centers can use a similar model to MOSS to help bolster their attendees' science identity development.

The goodness-of-fit analysis implies that the instrument created for this research is a good fit for assessing science identity as defined by the constructs of competence, performance, and recognition, as evidenced by the confirmatory factor analysis (Figure 18). The instrument, therefore, is a valuable tool for other informal education centers aiming to increase science identity with a focus on the three constructs. Informal education centers can use this instrument to determine the change in their students' science identity in an efficient and effective manner. Since validity and reliability testing has already been conducted, the instrument is ready for other educators to use with minimal effort or training required from staff. The instrument can be used in a pre/posttest model in house or with a delayed posttest depending on the need and resources of the informal education center.

Significance

As stated above, the research conducted in this study and the instrument created adds to the existing research on science identity and aids informal education centers in assessing their students' emerging science identity. This research provides significant contributions to the understanding of science identity, the methods for assessing science identity, and the process for creating a meaningful quantitative assessment tool.

It was examined earlier in this chapter the implications this research has on science identity. The significance of these implications is the importance of recognition in science identity formation, as also noted by Carlone and Johnson (2007). The ANOVA and follow up paired-samples t-test comparing time and each construct demonstrate that recognition is the lowest rated of the three constructs, but has the least change from post to one-month posttest. In other words, students rate themselves lower for recognition than the other constructs but benefit from the focus on recognition in the MOSS program the most. It is important for educators to note the current lack of scientist recognition development in students and the need for opportunities that focus on science identity. Without the recognition component of science identity, students that may have high levels of competence and performance will not fully develop their science identity or development will be limited. Recognition of students as scientist by self and others is necessary for the students to develop a science identity and potentially pursue and persist in science or STEM related careers. Incorporation of a focus on fostering recognition of self and others as scientist can help students develop this science identity, potentially resulting in an increase in students entering science related fields post college.

Previously science identity was determined through qualitative measures requiring lengthy interviews and involving small sample sizes. The instrument created in this study allows for changes in science identity to be assessed efficiently and effectively, by any educator, regardless of available funding, or research backgrounds. Being able to assess science identity easily and in a short amount of time provides formal and informal educators the opportunity to attest for the benefit of their curriculum on science identity where previously limited. Educators that lacked the time, resources, or experience in conducting science identity research will no longer be limited or unable to assess change in their students science identity. This makes science identity research accessible to a wider field of researchers and educators than previously. Although some statistical analysis is required to compare pre and posttests, a simplified analysis can be done in Microsoft Excel by comparing change in means for overall test scores. A concise and easily implemented science identity instrument will benefit many educators in describing change in an important and timely topic, such as science identity.

The process used in creating this science identity instrument is, in and of itself, useful to educators looking to describe change in a specific construct in which tools are currently lacking. The methods used here, following Creswell's Sequential Exploratory Design (2003) and Miles, Huberman, and Saldaña's (2014) approach to creating an instrument from qualitative data, provides a streamlined example for other educators to use. Further exemplified in this study is the process of validating and accounting for reliability of a newly created instrument. The process for validating the instrument using Think-alouds is attainable for researchers lacking access to an expert panel or for constructs in which experts on the subject may not currently exist or are limited. Educators and researchers looking to create a novel instrument can also follow the analysis approach used here (ANOVA, MANOVA, paired-samples t-test, confirmatory factor analysis) to explain if their instrument denotes change over time and is a good fit for the constructs targeted. This research and the methods used can serve as a blueprint for other researchers and educators looking to create an instrument to address specific constructs, reducing the time and effort needed to gather information and determine the most appropriate steps needed for their own research.

Future Studies

The results from the science identity instrument indicates that both the instrument is a good fit for determining emerging science identity and that the MOSS program positively impacts development of science identity for attending students. However, follow-up interviews with students would validate the findings. Do students agree with the changes noted between the different tests (pre, post, one-month post)? What is the test not representing or misrepresenting? Are there other factors that need to be explored that may be influencing how students answer the tests? Do results vary on how the questions are organized, for example, if the competence, performance, and recognition questions were interspersed and not listed out in their respective sections would that impact results?

It would also be worth exploring what specific aspects of the MOSS program have led to an increase in science identity and how these aspects can be transferred to any educational setting. It would be valuable to understand what element or elements of the MOSS program result in increase in science identity. Potential influencing elements could be the opportunity to focus on just science for several days, the integration of new technology, the outdoor environment, the young instructors and their enthusiasm, the emphasis placed throughout the week on everyone is a scientist, the Inquiry Project and final day presentation of the project, or the ability to repeatedly practice science skills and students' peers witnessing each other's practice and growth. Knowing what factors lead to an increase in science identity can inform other educators on how best to foster the growth of their students' science identity.

Exploring applicability to other informal educational programs and formal classroom settings would help determine if this instrument is a good fit for general audiences. Ideally educators in any setting could use this instrument to examine students emerging science identity. Having other educators use this instrument in a myriad of demographic and geographic settings backed by follow up interviews will help validate this test as a universally usable tool. For example, if the instrument were tested in a public school, private school, day field trip setting (museum, learning center, zoo), and in a residential informal education center similar to MOSS in each of the major regions of the nation (West, Southwest, Midwest, Northeast, Southeast) there would be enough data to evaluate if the instrument is a universal tool nationwide.

The confirmatory factor analysis indicated a correlational association between science identity constructs based on the factor loadings, but how do the constructs interact or effect each other and what is the nature of these interactions? Is there a causal association between the constructs? Acquiring more data and using a structural equation model would help to further examine these questions as structural equation modeling examines causal associations, a step beyond the correlational associations examined with confirmatory factor analysis.

The study described here only used a one-month delayed posttest. What happens a year after attending the MOSS program? Several years? How lasting are the changes in science identity as a result of the MOSS program? Do these changes impact which courses students enroll in high school, college, and/or career choices? It would be interesting to have a better understanding of the impact of the MOSS program but also the nature of science identity formation and how transitory it may or may not be. Understanding at what point science identity diminishes following a visit to MOSS will help educators know when another science identity rich experience is needed for their students' to maintain and further develop their science identity.

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Appendices

Appendix A: Focus Group Interview Questions

Hello everyone! Thank you for agreeing to be interviewed about your views on MOSS and science. Does anyone mind if I record this conversation? It helps me to recall more accurately what everyone said, since I can only write so fast! Please know that this interview is strictly confidential. There are no wrong or right answers here, just your opinions. Please feel free to share your thoughts honestly; it's ok if you have a different opinion than everyone else here. I have several questions here to guide our conversation, but I'd like for you all to feel free to bring up other things these questions might trigger in your mind. I'd like to hear from everyone equally as much as possible. You don't need to raise your hand to talk, but if I haven't heard from someone in awhile I may direct the conservation over to that person. Does anyone have any questions?

The following questions were used to direct the conversation:

1. Tell me about times when you feel like a science person at school?
2. Tell me about times when you feel like a science person at home?
3. Tell me about times when you feel like a science person at MOSS?
4. Do you feel competent in science or like you can do science well? What makes you feel that way?
5. Do you feel like you can perform science tasks and use science skills? For example, can you use the scientific inquiry process, can you measure different variables, like the pH of water? What makes you feel that way?

6. Do you feel like your peers, teachers or family recognize you as a science person? Do they see you as someone that can do science well or is good at science? What makes you feel that way?

7. What do you think of when I say “scientist” versus “science person”?

Appendix B: Focus Group Interview Notes (interview 1-3)

Interview 1

Interviewer All right. So, tell me about time when you feel like a science person at school.

male child: When we're during science experiments I like to dissect things and when I get to open them up I'm like oooh. When we're during chemical reactions in test tubes and we're just like oooh, I feel like a scientist.

female child: I feel like a scientist when we learn something in science

female child: So like when they give you the goggles and all that, and then you're doing stuff.

female child: I feel like a scientist sometimes after I've learned something, and then I go home and I'm like, "Dad did you know?" He'll be like, "No I didn't." And I'm like, "Yes!"

Interviewer: What about this half of the table? Ladies?

male child: I feel like a scientist whenever I learn new things and can say that stuff to my sister that she doesn't know about so I feel a lot smarter than her.

Interviewer: Is your sister older or younger?

male child: Five years older than me.

Interviewer: Ohhhhh.

female child: Same for me.

Interviewer: So when you get to share something that you learned with somebody else, you feel like a scientist?

male child: Or like doing experiments, like they say.

female child: Probably dissections and chemical reactions.

Interviewer: Cool. It's a similar question, but when do feel like a science person at home? Some of you guys kind of touched upon this maybe when you talk to your sisters and parents.

male child: When I do things perfectly.

female child: When I read about like nature and stuff.

male child: Science worksheet.

Interviewer: Doing homework, science homework?

male child: Also if the science teacher makes you do stuff at home, like a project at home.

male child: Oh, I guess a school project.

female child: Or, if I just like go outside and look at things, then I feel excited.

male child: I kind of like cooking and I didn't know what I was suppose to do, so I just threw all the ingredients into a bowl, and like, what if like the face is baking soda and vinegar. So it blew up in my face, and it was just like, Eric, [crosstalk 00:03:24] stop now. She was like, alright. So I kind of felt like a stupid scientist, but I still felt like a scientist.

Interviewer: Well, all the great scientists that we read about in books did things like that at some point. They had things blow up in the their face and that's how they figured out later what works and what doesn't work.

male child: I blow up stuff on my face on purpose. I love getting dirty.

Interviewer: What are other things at home that make you guys feel like a scientist?

female child: I do lots of experiments, like random experiments.

male child: Like giving medicine to ... Like when you're like ... You need the right amount of medicine or something.

Interviewer: Oh the little measuring things?

male child: Yeah.

female child: Well I go outside and I'm Like I'm outside and looking up.

female child: When sit at home I make ice cream in a bag, and then I'm like yes! I'm a scientist! I have no idea why it works. I know the salt makes the ice cream cold, but I don't know why, when you shake it, it turns into ice cream.

male child: Does the ice go with the salt? Or with the other stuff?

female child: No uh-

female child: I feel like we're getting off topic.

Interviewer: A little bit.

female child: The salt goes with the ice, and then the little bag has like the cream, the vanilla and the sugar in it.

female child: OK, thank you.

Interviewer: Yeah, otherwise it would be salty ice cream and that would be gross. Tell me about times this week at Moss when you feel like a science person.

male child: [crosstalk 00:05:01] how old the tree was.

male child: And we did the water testing with the devices.

male child: When we go to measure stuff out and we were like 15 centimeters or 50 centimeters, they were like [inaudible 00:05:16].

male child: Yes.

female child: I felt like a sucky scientist. We did the egg drop.

female child: They all...

female child: We still felt like a scientist, we just totally failed.

female child: It's OK we broke ours before the actual thing. We broke scrambled mafia.

Interviewer: What are other times at Moss you guys felt like a science person?

female child: Exploring.

Interviewer: Exploring?

female child: Or hiking.

male child: I felt like an outdoorsman when we were like hiking and stuff.

male child: When we were doing the water testing and tree coring, I felt like a scientist.

male child: Whenever we were like hiking down in back, they wouldn't be just like, it wouldn't be just like hike there, they would sometimes go, "Oh, look at this plant. This is really rare, it's called dah-dah-dah-dah."

Interviewer: It made you feel like a science person then?

male child: Yes.

female child: I felt like a science person when we were like spruce or spikey and like watchamacallit ...

male child: Spikey spruce friendly fir.

male child: Friendly fir, yes.

male child: I like how it was all like, "Ohhh, now I'm going to be hiking through the woods ... " [inaudible 00:06:29] and my dad will be like, "How do you know that?" And I'm like, "Because I do."

Interviewer: This is maybe more of a personal opinion question. Do you feel confident in science or you can do science well? What makes you feel that way?

female child: I think I do because it interests me. I find a lot of logic in it.

male child: I think I'm not as good at science because, sometimes you know how to do it, but it just doesn't click together. I don’t know how, but it just doesn't.

male child: Science interests me, but it's a maybe on me, because science interests me sometimes, but other times it is kind of boring to me because we've gone over all of that stuff. Then we get to do new stuff, which that interests me.

female child: I think so all the time because science is my favorite subject. Excitement.

female child: I think it's fun like all the time, like when we have an hour conversation about it [crosstalk 00:07:41] ...

male child: I think that science is fun, but I don't think I am necessarily super good at it.

Interviewer: What makes you feel like you're not good at it?

male child: My grades.

Interviewer: Okay, grades aside. Are there times where you think, "Maybe I am good at this?"

male child: Well when I'm doing an experiment and I just can't figure it out, or I keep putting in the wrong things, or I keep messing up.

female child: That's never happened to me because I'm perfect.

Interviewer: So it sounds like there is maybe the thought, and you guys have all said something like, we failed on this, like the notion that if your experiment doesn't go the way you want it to go, then you think that you're bad at science?

male child: No.

female child: No.

[crosstalk 00:08:30]

female child: ... constantly messed up and figured out something new. It's not really bad ... [crosstalk 00:08:36]

Interviewer: Right, right. So for those of you who do feel like you're good at science, what are some other things that make you feel that way? That make you feel like you're good at science.

male child: Get intrigued by it, I guess. It's kind of easy for me, but fun at the same time.

male child: When you get your project done first and it's an A+ project.

male child: I really like science in school because all the other subjects, mostly, you just kind of sit there and they give you a worksheet, but then in science you actually get to go and dissect stuff and do experiments instead of just doing another worksheet.

Interviewer: So the hands on part?

male child: That’s why I'm also bad at science because during science experiments, if you don't put in the right amount of stuff, because you have to convert some stuff ... I suck at that. But then the good part of it is, all the science that I like, is that it's fun and it's fun to mess up sometimes because you might create something new.

male child: I like how you learn from your mistakes. You always mess up and have it blow up in your face, but then you kind of learn from that and then make it better.

Interviewer: Okay, next question. Do you guys feel like you can perform science tasks and use science skills? For example, can you use the scientific inquiry process, measure different variables like ph of water? What makes you feel like you can perform science skills?

male child: Technology.

Interviewer: Technology helps you feel like you can do the skills?

male child: Because my teacher has taught me.

female child: Have you seen all of those videos of people doing random stuff so easy, but if I tried it it would be like ... [inaudible 00:10:35] but actually read the instructions and tried it, I'd be like, "Hmmm..."

male child: Look at that.

female child: I think technology has helped scientists throughout the years discover new things to measure with things, so I think technology also helps with a bunch of things.

Interviewer: What are some other things that make you feel like you can perform science?

female child: When an experiment goes right.

Interviewer: When an experiment goes right?

male child: Yeah, when an experiment goes right.

male child: Like when you know the questioning. You're not even thinking about it and you're just like "Boom, done."

male child: That's never happened to me, I don't think.

female child: Yeah, I'm never like, "Boom, done." I'm like, "There's something missing here."

female child: I'm like, "It cannot be this easy."

female child: Yeah.

Interviewer: What about just basic skills? Like science skills, like doing the inquiry process, which is ...

male child: I don't know what the inquiry process is, so I think that says a lot.

Interviewer: Ohhhhh. That's what you're going to be doing today, so that's the create a question, form a hypothesis, design experiment ...

male child: Ohhhhhh.

male child: That's it?

Interviewer: Yeah, same name different, or different name, same thing. Yeah.

male child: I think it's pretty easy, like when ...

female child: We've done it a lot at school. [crosstalk 00:11:51]

male child: Our teacher always asks us questions about things and then he goes into the scientific method without us knowing it because we have to ask a question, then we have to prove [inaudible 00:12:03] ...

Interviewer: Okay, so this is the last question. Do you feel like your peers ... Do you guys know what peers are?

male child: Yes.

female child: Yes.

Interviewer: That's each other, right? Maybe your peers back at school or here, but do you feel like your peers, your teachers, or your family recognize you as a science person? So do they see you as somebody that can do science well or is good at science?

female child: Yes.

male child: Yeah.

female child: Yeses and nos?

male child: Of course my parents would say yes because they love me.

male child: Not my teachers. My parents say they do, but I'm not sure. I don't know about my peers.

female child: People at school are always just like, because I usually get straight A's, they're just like, "You're really good at science." [crosstalk 00:12:48]

male child: ... like me too.

Interviewer: Other people are saying you're really good at it because of your grades?

male child: Yeah. Sometimes in school it's mostly based off grades if you're good at it or not ...

Interviewer: Right.

female child: When I help with the [inaudible 00:13:00] they're like, "You're the best at science," and I'm like, "I know you're just saying that so I can help you some more, but ..."

Interviewer: So I hear 2 different things. One, your grades tells you if other people, like other people know what your grade is and then they see you as being a science person, but then also, if you can help them is the other thing where you get recognized as being a science person by your peers?

female child: Yes, or like when you have a science partner and they don't know what to do and you know what to do and they tell you that you're really good at science.

Interviewer: Mhmm (affirmative).

female child: "Oh my gosh, I'm so lucky I have you as a partner."

Interviewer: You guys get that a lot, huh?

female child: [crosstalk 00:13:34] like me and other people who are good at science and make us do all the work and stuff because they don't even care to know what to do.

Interviewer: What about your family or your teachers? How do they make you feel like you are or are not a science person?

male child: Well, my teacher makes me feel good because he knows I'm good at science and tries to push me harder sometimes. It's fun.

Interviewer: Mhmm (affirmative).

Interviewer: I have a different question that I threw in there. What ... I'm just trying to think about the way I want to say it. When I ask you ... If I were to ask you, "Do you feel like a scientist?" versus "Do you feel like a science person?", do you feel like there's a difference between those 2 different terms?

male child: Yeah.

female child: Yes.

Interviewer: Explain to me what you think the difference is.

male child: Scientists is like kind of professional. He's like famous and he ...

male child: Well not always ...

male child: He does work to people or something.

male child: I think science person is someone that's good at science.

female child: I think science people are people who might do science as a hobby instead of a scientist who does it for their job.

male child: Yeah and scientists go to school and want to get a degree on it to do it for their lifetime.

female child: I think a science person is just someone who likes to do science, it doesn't necessarily mean they're good at it, but they like to do it. I think a scientist might be someone who thinks they might want to do it for a living or does experiments on their own or something like that. Or are really curious about that kind of stuff.

Interviewer: Mhmm (affirmative), cool.

Is there anything else you guys want to share about how you feel about when you feel like a science person?

male child: I think when I feel like a science person, I get really into the zone because I want to make sure that I do things right, and if I mess up, I mean I don't care if I mess up, and if I do then I just want to re-go back in my steps to see what I did mess up. If I found it, then I'd be like I need to do that and convert that. It's actually pretty fun to [inaudible 00:18:04] because it's interesting. You get to learn a lot of new things.

Interviewer: Cool, alright.

Interview 2

Speaker 1: OK, alright. So the first question is tell me about times when you feel like a science person at school? So at your normal school.

Speaker 2: When we do labs and our procedures and stuff.

Speaker 3: Yeah, mostly during science class or anatomy classes.

Speaker 4: Yeah, and leading my group in labs.

Speaker 1: And what do you mean by leading?

Speaker 4: Like actually knowing the information and being able to teach them so we can do the project right.

Speaker 3: And when we do the scientific method (laughing).

Speaker 2: Yeah.

Speaker 1: And what about the scientific method makes you feel like a science person? Because you know scientists do that, or...

Speaker 3: Yeah, because I know scientists do that, and the hypothesis and all that stuff.

Speaker 2: And, like, using the procedure to finally show your data, and then you can, kind of feel like you achieve something. That's like the last part, because you get to see the data that you did.

Speaker 1: Cool. Alright, so, kind of similar question. But tell me about times when you feel like a science person at home. And do you ever feel like a science person at home?

Speaker 2: [The closest I've seen 01:24] would be like fertilizers, we test the soil and the, that's like the only time.

Speaker 1: So is it like the act of measuring things and mixing things that makes you feel like a science person at home.

Speaker 2: Mm-hmm (affirmative). Mixing, measuring, testing.

Speaker 3: Oh, when we're testing the pH level in the water for the pools...

Speaker 1: Mm-hmm (affirmative).

Speaker 3: ...or the hot tubs.

Speaker 4: For me it'd be no, because [I'd only be 01:58] with my little sister, and she hasn't learned to do that yet, so I can't really help her on anything.

Speaker 1: Mm-hmm (affirmative). You guys also "no"s feeling like a science person at home?

Speaker 5: I don't think I feel like a science person at home.

Speaker 1: That's OK, nothing wrong about...Alright, so I know you guys have only been at [Moss 02:22] for a couple days, but are there are any times when here at [Moss 02:25] you feel like a science person?

Speaker 2: Mm-hmm (affirmative).

Speaker 1: And when are those times, what are you guys doing when you feel like a science person?

Speaker 2: When we use the lab quest. [cross talk 02:40]

Speaker 1: Those little computers where you plug the probes in.

Speaker 3: And, like, that little computer.

Speaker 4: Yeah, when we're testing all those. I've done that before, and being able to apply it again is kind of nice. Like the milk, the materials that it helps to do it again.

Speaker 3: And that was probably my first time testing, like, for turbidity and all those other ones.

Speaker 1: What about other people that said yes for feeling like a science person at Moss? Are there other times you can think of?

Speaker 5: [inaudible 03:31] talking about doing ecosystem [inaudible 3:34].

Speaker 1: Talking about ecosystems?

Speaker 5: When we were down there, putting all the, that stuff in the water.

Speaker 3: Oh, OK, I was like "when did we do that?"

Speaker 6: Not in the lake water of course.

Speaker 4: [inaudible 03:48] water, it was clean after, I promise.

Speaker 1: Any other times while you were here? Any other things?

Speaker 4: No, it's only been a couple days.

Speaker 6: Didn't really thing that we would use, kind of like mapping. I don't know, I feel like science-y when we do the multi-speck with Dirk.

Speaker 1: Mm-hmm (affirmative).

Speaker 6: [cross talk 04:11] Because me and Blake got something out of, straight out of, near our hometown.

Speaker 1: Oh, nice. OK, so, do you guys individually, not as a collective whole, feel competent in science, or, like, you can do science well? And then what makes you feel that way?

Speaker 4: I think anytime we do an outside experiment, or really anything hands-on where I'm not having to read all the time, is like, yeah, I feel like I'm really, really good, and, like, also able to teach it as well. But when we're, like, inside, I feel like I just stay behind, so I don't have to, yeah.

Speaker 3: It's much better when it's hands-on.

Speaker 1: Hands-on?

Speaker 3: Mm-hmm (affirmative).

Speaker 6: I feel yes because I'm able to professionally do the work.

Speaker 1: Mm-hmm (affirmative).

Speaker 6: Not just in the school setting, but also professional, such using Lab Quests. They do come in handy. This is just adding on to this a little bit more knowledge that I have of certain [pros 05:27], and I think that it betters the unit, makes me more, kind of, competent in science. So I don't look kind of dumb.

Speaker 1: OK, so adding on to what you already know, that helps you feel competent in it?

Speaker 1: Mm-hmm (affirmative).

Speaker 6: That's what helps me.

Speaker 1: Nice. Do you have something that you were thinking when you said "yes" you feel like you can do science?

Speaker 2: Because what they just said, that that's also.

Speaker 1: Mm-hmm (affirmative).

Speaker 2: And, that's it.

Speaker 1: And do you feel like you can do science? And it's OK if the answer's no, too.

Speaker 5: I think it's when I know what we're starting.

Speaker 1: Mm-hmm (affirmative).

Speaker 5: When I already know what I’m doing

Speaker 1: So it's already maybe a little bit familiar?

Speaker 5: Mm-hmm (affirmative).

Speaker 1: Alright, so do you guys feel like you can perform science tasks, oh, did you have something to add on? Oh, sorry. Do you feel like you can perform science tasks and use science skills? For example, can you use the scientific inquiry process, measure different variables? And you guys already mentioned some, like pH of water. And then what makes you feel that way?

Yeah, no, that's OK, and I can say it again. Basically, do you feel like you can, the confidence is like knowing how to do it, but then performance is actually being able to do it. Do you feel like you're able to perform these science tasks?

Speaker 6: Yeah, I believe I can, and I can. Going back to what I said earlier, like, [inaudible 07:15] working in a professional state, and it being actually technology that you use, I thought that was awesome. And me personally, I don't know about them, I feel proficient in it, being able to test and understand what criteria they need for it

Speaker 1: Great. Any other thoughts?

Speaker 5: I think I [cross talk 07:41]

Speaker 1: What would you need to be able to say, "Yes! I've got it." You said possibly.

Speaker 5: I feel we would need a little help in understanding what perfect science is, and it’s not my greatest strength. Like, once we learned doing things, then I'll be able to do it

Speaker 1: So, like a little bit of help from, like, your teachers, and maybe like other students...

Speaker 5: [cross talk 08:14] I'm on the right track.

Speaker 1: Mm-hmm, mm-hmm (affirmative).

Speaker 3: Yeah, I have to pretty much get, not really every step, but I have to go in-depth with like every single, like, small task because I need description...

Speaker 3: Mm-hmm (affirmative).

Speaker 1: Nice. Alright, so last one. Do you feel like your peers, so other students, teachers, or family members recognize you as a science person?

Speaker 3: No.

Speaker 1: Is it no? For those who say yes, and those you say no, like, tell me why. What makes you think that they don't see you as a science person? Or as a science person?

Speaker 3: I don't think my mom really knows about the science field, that's why. Or my dad. Whenever it, like, it has do with, like, the pool or the hot tub, like, they'll go ask me, like, "Oh, figure this out." But, I don't think they really think about it that way.

Speaker 1: OK, so it sounds like maybe they do a little bit, because they're asking for your help, but they don't, like, formalize that thought is kind of what you're saying?

Speaker 3: Mm-hmm (affirmative).

Speaker 1: OK.

Speaker 2: With me, it's, my family, the ones I work with too, who are pretty much my family. They trust me in science, and they know if I don't know it, I will try to find it out. It can be anywhere from fertilizers to water waste management. That's kind of the simple ways update that I help.

Speaker 1: And what do you think got you to that point, where they know that you'll, if you don't know the answer, you'll look it up?

Speaker 2: Trial and error, because we, farming is a developing work, it's never the same. No 2 fields are the same. You have to, kind of, wrap the blanket around a certain baby, you could say. So, I guess that I just work it out, and slowly they trusted me with bigger stuff, like, what do we put in the soil, how do we trust the soil's going to be good, stuff like that.

Speaker 1: Mm-hmm (affirmative).

Speaker 2: Of course I do talk with experts about those.

Speaker 1: What else for those "yes"es and "no"s? What makes you think your family...

Speaker 5: I think at school once my teachers see that I'm getting what we’re learning.

Speaker 1: Mm-hmm (affirmative). You guys have any other thoughts?

Speaker 4: I don't know, my dad when he knew I was coming here, was like, "Why are you going to a science school? It's not really what you're going into." I was like, "I wanted the experience." They don't really think of me as a person that is, not that I'm not interested in it, but they just think that, you know, if that's not what I'm going to go into, why go?

Speaker 1: Mm-hmm (affirmative). One last question that I want to add on. If I were to ask you if you felt like a scientist, do you feel like that's a different question than if you feel like a science person?

Speaker 6: Yeah.

Speaker 1: What do you think? There's a lot of research that's been done on this, and on just how kids feel that they're a scientist, but I'm what trying to introduce is that word is maybe confusing. So I'm curious what you guys think when you hear the 2 different phrases?

Speaker 6: I feel like a scientist, you got to go 4 years, and then you got to get a doctorate, and then just being a science-y kind of person is just having knowledge of the sciences. A lot of people are like that, and I just wonder if I'm not a scientist.

Speaker 5: I agree with him (laughing).

Speaker 3: I don't think of it that way. I don't think a scientist is a person that has to go out to college. I mean, yeah, they have to go college, but I don't think of it that way. I think of a science person, or a scientist as someone that is so interested in something, they're going to research it whether they went to school or not. A science person can be, you know, if a little kid wants to, "Oh, I want to be a scientist," or they want to be a science person. You know, I just think that a little differently.

Speaker 1: Mm-hmm (affirmative).

Speaker 4: I think that anyone can be a science person, but if you really, really want it, then you'll be a scientist.

Interview 3

Interviewer: The first question is, tell me about times when you feel like a science person at school ... At your home school, not here.

Female Student: Definitely when we get to do science experiments.

Male Student: Yeah when we do labs.

Female Student: Which actually is not often.

Male Student: We get to dissect frogs and everything like that

Interviewer: Yeah. What about the science experiments and labs makes you feel like a science person?

Female Student: In 8th grade the labs were really fun because this is more like we mix things, it was kind of like we had to have actual test tubes and stuff I guess so that's what I thought was really fun. I don't know it was actually interesting.

Male Student: And how you actually record the information.

Female Student: You actually do, learn how to identify chemicals and stuff.

Female Student: Yeah core results, I guess.

Interviewer: Cool. What about, tell me about times when you feel like a science person at home? Or do you?

Female Student: Probably when I make measurements because sat my house I have to measure certain chemicals for like house cleaner or whatever for my mom because her skin is so sensitive that she can't touch it without the gloves. Probably also when I'm giving my dog a bath because sometimes I need a lot and holding him down, probably, really challenging.

Male Student: I would say when I am cooking food because if you get bored with the food you're always making you make some random stuff and see if it tastes good. Put different seasons in and sometimes it turns out really good, sometimes you just throw it away [crosstalk 00:02:00]. I do that all the time with eggs.

Female Student: Also helping out in the yard. Sometimes we do some pH levels so we have to measure that sometimes. Other times I like reading a bunch of books on how to keep your garden healthy and stuff, experiment with different stuff you can put in the ground. Apparently coffee grounds really help plants.

Male Student: It kind of feels like it all the time because at our house we have gardens, we do a bunch of stuff with our grass, weeding, and we have somebody actually come over and show us the chemicals that he does and puts it all in there. We have to pool and hot tub which we do ourselves so we have to test it once a week at least. Also, the pool, because we have a saltwater pool.

Interviewer: Oh yeah.

Male Student: We have to put a certain amount of salt and a certain amount of chlorine that will go with the salt.

Interviewer: Mmhmm (affirmative)

Male Student: And cooking.

Interviewer: Right. I know you guys have only been here a few days but tell me about times you feel like a science person here at MOSS.

Male Student: Every day.

Interviewer: Every day.

Male Student: Writing, recording stuff

Male Student: All of the time.

Female Student: Identifying plants and we're testing the stuff in the water

Female Student: Especially when we're talking we're saying turbidity and stuff and then there were random people and I felt kind of cool because we were saying those big words.

Male Student: Even when we're playing games they somehow interacted, at least at the end, it always kind of goes with it, or just because we're maybe in nature I guess.

Interviewer: So using some tools and terms and even the games make you feel like a science person here at MOSS?

Male Student: Yeah. Or just looking around.

Interviewer: Making observations?

Male Student: Yeah. Sitting, staring ...

Male Student: Yeah, they made us sit in the woods one of these times and hear everything around and just record it

Female Student: Using your senses to really get what's going on around you.

Female Student: Particularly the hearing though.

Female Student: Yeah.

Interviewer: Cool. Do you guys feel confident in science, like you can do science?

Male Student: Yeah.

Female Student: Yeah.

Male Student: I love science, it's my favorite thing in school. I am very open minded so I get all of it pretty much and then I can also find ... There's a lot of loopholes in science.

Female Student: Yes there are.

Male Student: Like, a lot. I just kind of experiment on my own those loopholes, trying to think of it how they say it and then kind of find loopholes and see the different aspects that could coincide with that and go along with it.

Cut out some ranting about being re-taught things…

Male Student: It's really easy for me to ... Science is really easy if I can do hands-on types of things but just listening to it in a classroom.

Female Student: Reading a book you don't actually go and learn it, you're just kind of getting it put into your head. [crosstalk 00:07:13]

Interviewer: The second part to that question is do you feel like you can do science and what makes you feel that way? You were starting to go there, the hands on stuff makes you feel like you can do it?

Male Student: Yeah because a lot of kids with the books, they won't even read it, they'll just skim through it. The teachers will say, "Don't skim through it," or someone will. It will take hours if you don't skim through it.

Interviewer: What are some other things that make you guys feel like you can do science, or if you feel like you can't do science, what are the things that make you feel like you can't do science?

Female Student: Probably sometimes we'll bring in professions like geologists and such like that, they'll bring in those kind of people. When I feel like I'm working besides someone whose a professional, not just a teacher who took a course and learned it in college, but someone who actually went out and experienced something. Them sharing that and then sort of transitioning it into what they're teaching us, giving us an example, I feel like that actually makes me feel as if I have more options on what I can do and it makes me feel like I can do it and makes it feel like it's possible.

Female Student: I've noticed in some classes where it is just textbook, a lot of times it's harder to just retain that stuff, but when we actually do the hands on stuff ... In one of our biology classes we actually got to work with parts of the anatomy like the bones, organs, dissecting things. I retained so much of that and I still remember a greater majority of it than just the normal textbook stuff. Hands-on stuff just clicks better with a lot more people.

Cut out more ranting about past teachers….

Female Student: Yeah. That's a really good example of a teacher who is stubborn and who is, I would say narrow minded on what they want to teach their kids because there are some people who can remember text, there are some people who ... Everyone, I think, if they have a little bit of hands on, they can remember a lot better.

Interviewer: Right. The next question is do you feel like you can perform science tasks and use science skills? For example, the scientific inquiry process, and can you measure different variables like pH of water, and what makes you feel like you can perform science skills?

Female Student: I've had experience having doing those a bit in school and out of school. The interactions I still remember, also just numbering ...

Female Student: I think having a team of other people, not just yourself, kind of takes the stress off of it. I had a teacher and we did a standing water assessment. It was one of the ponds that's near OHS, we did a standing water assessment which is pretty much all the assessments into one. My team still got done 15 minutes early because it was so stress free. Everyone did what they were supposed to do. Interaction is a big part of it.

Interviewer: Yeah. What else do you think helps you guys feel like you can perform science skills?

Male Student: I don't know why but science is one of the only things I can remember. I guess it's just because the math ... I was in geometry and I can't remember anything from algebra at all. Next year I have to go into algebra 2 so it's going to be weird because I can't remember half of the stuff we did in algebra. Science, I guess, is easier to remember and doing labs and all that instead of just writing formulas and everything all the time. It does have it's math with it, but everything has math in it.

Male Student: Yeah. I think I'm different from that because science, I am not good at science but I am really good at math. When I have formulas with science it makes it 10x easier for me just because I know what I am doing, I am not one of those creativity people. I hate creativity, I really do. I am not one of those people like that, I’m not creative. I am just more a person that would go textbook style. If you give me a formula, give me a problem and I would probably be able to do it if you just give me a problem and say, "Use your creative mind," I will just skip it because I can't do it.

Interviewer: Then in the context of science do you feel like if you know the process of it you feel like you can do it?

Male Student: Yeah if they show me how to do it hands on, but if they just tell me, I just kind of space out because it just gets boring.

Female Student: Part of it is we get it proven to us through text when we read the text books and then we do it ourselves so it's confidence that I can do it and that we can do it ourselves.

Interviewer: So textbooks serve a purpose.

Female Student: Yeah.

Female Student: Confirming it can do it, it’s possible, it’s in a book

Interviewer: Sure.

Female Student: Then [inaudible 00:15:20] and then you get to do it [crosstalk 00:15:24] you're using multiple parts of memory process use so it works better.

Cut out more ranting about teachers…

Interviewer: For sure. Do you guys feel like your peers, your teachers, your families recognize you as a science person and if so what makes you feel recognized? What do they do? What do you hear/see/feel?

Female Student: My dad ... I told him I want to be a marine biologist so he went on the internet and actually he's the one that found me the college I want to go to now ... The top four marine biologists have gone there. He did his research because I told him what I wanted to be so he was like, "Okay, let's do this ..." I produced where I wanted to go originally but it changed when he produced the statistics. It's cooperation, them helping you. My mom, as I said before, has me do measurements, and I think that's very helpful.

Male Student: I feel like my family does because they'll ask me a bunch of stuff. They know I've gone through stuff like this and a bunch of other stuff so they'll ask me if I know what certain plants are or if they can make something out of different things safely or something. Them asking questions, I guess.

Interviewer: What about some other things that people do that make you feel like a science person or not a science person?

Female Student: They don't look at us like we're scientists but they look at us like we're students and that we're learning about these things and they trust the fact that we know it, but they don't think we're experts obviously. I think my parents voice that our educations was so much [inaudible 00:19:08] theirs and we'll know so much more about so many different things than they every will. In that way they respect that but they don't think that we're genius's because there are a lot of things we don't know.

Female Student: Yeah.

Interviewer: They trust that you're moving along the process but not at the end.

Male Student: One thing I really don't like is when people underestimate me or something like that. I will tell them what I believe and then they will be like, "No, that's wrong." It makes me mad and I will be like, "Okay, you can look it up."

Interviewer: Right.

Male Student: If you don't trust me, don't ask me, just look it up if you're going to just diss me.

Interviewer: What about your peers? What do they do that makes you feel like you're a science person or not a science person?

Female Student: They sometimes come and ask for help [crosstalk 00:20:01]

Male Student: Copy off me ... [crosstalk 00:20:06]

Female Student: The teachers, if they know you're potential, like in one of my science classes I was put in charge and I think that demonstration of trust that I can get it done, I think that factored in with me. I've always loved science so that made me want more and more and more of it, want to get teachers to trust me.

Male Student: Labs, if people ask me, they've wanted me in their lab with them, that just kind of made me feel like I knew what I was doing, which usually I did or other times I'd be like, "Okay I want this person," because I know they know what they're talking about.

Female Student: Probably helping people out when we've had labs and stuff in science, when people asked me for help that made me feel like a scientist but it's not like I knew what I was doing, sort of.

Interviewer: That actually leads to a question that I don't have in here that I'm going to throw in, if I were to ask you do you feel like a science person or do you feel like a scientist? Do you think they're the same? Do you think they're different? Why?

Female Student: Kind of different.

Male Student: I would say they're different.

Interviewer: Than what?

Female Student: A science person ... Anyone could do something scientific and do it for their own interest but I think a scientist, on the other hand, is one that goes out there and actually gathers information, gets it together, and creates a process ... Brings it all together to make this one thing for a specific purpose with all this information and probably so they could publish it, I don't know, I would say more in depth.

Male Student: Yesterday we were listening to a story and reading a story and this I would consider a science person, the kid went out ... He didn't know what he was doing, he didn't write like a scientist or adult, he just went out and did what he wanted to do and his own research, and went out and sat out, watched birds and nature and stuff but he wasn't doing it for a specific person, it was just [inaudible 00:22:24].

Female Student: Scientists starts out of a science person [crosstalk 00:22:29] stepping stone.

Male Student: I am still below science person.

Female Student: I think they're different because a scientist, they go in depth, it's not like they get pretty crazy about what they believe in, I think it takes a certain strength to take what you think that you know and set it aside and relearn ... I think a science person doesn't really have that strength, they just go out there, observe, take notes, come back in. A scientist will go to Costa Rica and stay there for several months and then come back with hard evidence that say [inaudible 00:23:22] is changing. They can have hard evidence that that's happening through going out there with a thermometer and staying out there for 12 hours. That's way more than a science person would ever do.

Interviewer: Right.

Female Student: Also, I think a science person, I don't know if it's just depending on your personality, but a science person would just be doing it for their own peace of mind. I do it.

Female Student: A science person I was thinking was just someone who loves science.

Female Student: Exactly.

Female Student: Scientists I was thinking more of someone who has ...

Male Student: Does it as a job.

Female Student: Exactly, it's their job and they went to school [inaudible 00:23:59]

Male Student: And they've got hobbies and then work.

Female Student: I believe a scientist is still a science person and they like science [crosstalk 00:24:04]

Male Student: That's pretty much the perfect combination, science and work ...

Female Student: Why do something that you don't love? Sometimes if you're in a hard situation you'll do it, but, if you don't do something that you love it's not going to last. If you do something you enjoy, it will make a career and last forever.

Interviewer: Thank you guys, that's all my questions, thank you so much for letting me interview you. Let me stop this ...

Appendix C: Focus Group Coding Notes and Themes

Science at school

Coder 1: experiments, labs (stereotypical), scientific method (trial and error)

Coder 2: science activities (measuring, testing, using equipment), stereotypical science oriented activities, reading about science (HW), nature, learning about science, being outside, experimenting (trial and error)

Science at home

Coder 1: cooking (experimenting), measuring things (experimenting), testing (experimenting)

Coder 2: measuring testing, science homework, experimenting, knowing & demonstrating new knowledge

Science at MOSS

Coder 1: using tools, making observations, identification, using terms (learning)

Coder 2: being outside (nature), measuring/testing (experimenting), lessons/teaching (learning)

Competence Q

Coder 1: grades, doing the experiment “right”, easy, understand the process, hands-on, adding to what they already know, working with professionals

Coder 2: personal interest (comes easy, people seeking their help), learning new information (and master), talking to others about science (using terms, sharing), learning from mistakes, active learning (hands-on, labs, testing, measuring), perfectionism - subtheme

Performance Q

Coder 1: experiment goes “right”, it comes easily, being able to use the technology, assistance, previous experience, interaction with others (feedback)

Coder 2: technology, testing/measuring, experimenting (when it goes right – not science when it goes wrong) - perfectionism

Recognition Q

Coder 1: grades, peers saying they are good at it, others asking for help, parents asking for help

Coder 2: grades, teacher approval, knowing what to do (procedures), social recognition, family support.

Not getting any other feedback about being a science person, not being acknowledged anywhere else than at school

Science person: hobby, enjoys it, anyone can be a science person Coder 2: agrees

Scientist: professional, degree Coder 2: agrees

The act of asking the question caused them to separate

I feel like a science person when I use measurement tools at MOSS

I feel like a science person when I identify trees

I feel like a science person when I use my five senses to make observations

I feel like a science person when I use science terms like pH.

First Draft of Questions from themes:

Competence

I feel like I know a lot about science

I can learn from science experiments

I feel like I can learn a new science topic easily

I understand science related vocabulary words

I can design a scientific procedure to answer a question

Performance

I can use science equipment to collect data

I feel like a science person when I use technology

I know how to use the scientific method/process

I can talk with others about science related topics

I feel like a science person when I use my five senses to make observations

I understand how to identify trees

Recognition

My friends see me as someone that is good at science

My parents see me as someone that is good at science

My teacher seem me as someone that is good at science

Other people ask me for help with science related questions

I see myself as a science person

Appendix D: Quantitative Pre/Post Test

Survey of MOSS Program Participants

Your Name: ___________________________

Your School: __________________________

Your Field Instructor's Name:_________________

The information that we gather will be used to help us to understand some of the things that students are learning in our program. We are very interested in YOUR OPINION about things – don't feel like you have to answer in a way that will please your field instructor, your teacher, or any of the MOSS staff.

DIRECTIONS FOR THE SURVEY:
Science Identity Questions: Please read each statement carefully and complete it as honestly as possible. You can indicate your answer by circling the number that corresponds to your answer.

1. I am good at science	Strongly Agree 5 4 3 2 1 Strongly Disagree
2. I know a lot about science	Strongly Agree 5 4 3 2 1 Strongly Disagree
3. I am good at most science experiments	Strongly Agree 5 4 3 2 1 Strongly Disagree
4. I understand science topics	Strongly Agree 5 4 3 2 1 Strongly Disagree
5. I learn new science topics easily	Strongly Agree 5 4 3 2 1 Strongly Disagree
6. I can use science equipment and/or technology to collect data	Strongly Agree 5 4 3 2 1 Strongly Disagree
7. I know how to use the scientific method/process	Strongly Agree 5 4 3 2 1 Strongly Disagree
8. I can talk with others about science related topics	Strongly Agree 5 4 3 2 1 Strongly Disagree

9. I can create my own science experiments	Strongly Agree 5 4 3 2 1 Strongly Disagree
10. I can use my observations to create a hypothesis	Strongly Agree 5 4 3 2 1 Strongly Disagree
11. My friends see me as someone that is good at science	Strongly Agree 5 4 3 2 1 Strongly Disagree
12. When giving a science report, I feel like a scientist	Strongly Agree 5 4 3 2 1 Strongly Disagree
13. Others see me as a scientist when I share my observations	Strongly Agree 5 4 3 2 1 Strongly Disagree
14. When I share data I've collected, I feel like a scientist	Strongly Agree 5 4 3 2 1 Strongly Disagree
15. I can help others with science related topics	Strongly Agree 5 4 3 2 1 Strongly Disagree

Questions about who you are: please answer as honestly as possible

A. How old are you? ________________

B. What grade are you in? _______________

C. What race do you consider yourself?
☐ White / Caucasian
☐ American/Native Indian or Alaskan Native
☐ Asian
☐ Black or African American
☐ Native Hawaiian or other Pacific Islander
☐ Other
☐ Do not want to provide this information

D. Are you Hispanic / Latino? ☐ Yes ☐ No

E. If you belong to an Indian Tribe(s), please list: ______________________________

F. What is your gender?
☐ male ☐ female

Appendix E: Letter to teachers in mailed package

Dear MOSS Teacher(s)

We hope you enjoyed your time at MOSS this fall! At MOSS we are invested in your students' science education and committed to offering the best programming possible. In order to determine if we are meeting our objectives and your needs we have students complete a pre and post program survey while at MOSS to assess change in their understanding of science topics and opinions of their place in science. Currently we are concerned with the concept of science identity: in particular, we want to understand if they feel someone like them could be a scientist, which hopefully leads to further interest, appreciation of and understanding of science. This fall we want to understand how students respond to our questions a month after returning from MOSS.

This is where I need your help! Included is a the one-month post test for the students that came to MOSS. Can you please have each student that attended MOSS complete this test/survey? I've also included a pre-paid envelope so you can easily mail them back to us at MOSS.

This one-month posttest is a critical part of our assessment at MOSS that helps us to answer the question of how the MOSS experience impacts your students. This data helps to inform schools the benefit of coming to MOSS, helps our staff write and report to grants and/or donors, and helps shape our curriculum and programing. We greatly appreciate your help in our research endeavors.

If you have any questions, concerns or comments or would like the results from this research, please don't hesitate to contact me. I look forward to receiving your students' one-month posttests soon!

Thank you,

Jenny Schon

Program Coordinator

McCall Outdoor Science School

PO Box 1025

McCall, ID 83638

208-310-7082

jschon@uidaho.edu

Appendix F: Letter to teacher one week following due date for delayed 1-month posttest

Good morning Mr./Mrs. X -

I hope you are having a lovely fall and the school year is still going smoothly following your time here at MOSS! I wanted to check in with you about the MOSS 1-month post surveys. Hopefully you've received them in the mail, if not please let me know and I'll send some new ones out right away. If you get a chance, please have your students fill them out this week and return them to me here at MOSS. This data is an important part of our assessment of our program, both in how we are doing and how we can improve what we do. We also use this data to report to grants and donors, so this data can help us to secure more funding - which means both a more affordable program and more cool science tools for students to use!

If you have any questions or comments, please let me know how I can help. Otherwise, I hope to see those surveys soon. Thanks Mr./Mrs. X!

Jenny Schon
Program Coordinator
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Appendix G: Institutional Review Board Approval

University of Idaho

August 5, 2014

Office of Research Assurances (ORA)

Institutional Review Board (IRB)

875 Perimeter Drive, MS 3010 Moscow ID 83844-3010

Phone: 208-885-6162

Fax: 208-885-5752

irb@uidaho.edu

To:	Karla Eitel Bradley
Cc:	Sheralynn Bauder, Jennifer Schon
From:	IRB, University of Idaho Institutional Review Board
Subject:	Exempt Certification for IRB project number 13-214
Determination:	August 5, 2014

Certified as Exempt under category 1 at 45 CFR 46.101(b)(1)

IRB project number 13-214: Evaluating Learning at the McCall Outdoor Science School

The modification to the protocol has been determined to retain the exempt certification. This study may be conducted according to the protocol described in the Application without further review by the IRB. As specific instruments are developed, each should be forwarded to the ORA, in order to allow the IRB to maintain current records. Every effort should be made to ensure that the project is conducted in a manner consistent with the three fundamental principles identified in the Belmont Report: respect for persons; beneficence; and justice.

It is important to note that certification of exemption is NOT approval by the IRB. Do not include the statement that the UI IRB has reviewed and approved the study for human subject participation. Remove all statements of IRB Approval and IRB contact information from study materials that will be disseminated to participants. Instead please indicate, "The University of Idaho Institutional Review Board has Certified this project as Exempt."

Certification of exemption is not to be construed as authorization to recruit participants or conduct research in schools or other institutions, including on Native Reserved lands or within Native Institutions, which have their own policies that require approvals before Human Subjects Research Projects can begin. This authorization must be obtained from the appropriate Tribal Government (or equivalent) and/or Institutional Administration. This may include independent review by a tribal or institutional IRB or equivalent. It is the investigator's responsibility to obtain all such necessary approvals and provide copies of these approvals to ORA, in order to allow the IRB to maintain current records.

This certification is valid only for the study protocol as it was submitted to the ORA. Studies certified as Exempt are not subject to continuing review (this Certification does not expire). If any changes are made to the study protocol, you must submit the changes to the ORA for determination that the study remains Exempt before implementing the changes. The IRB Modification Request Form is available online at: http://www.uidaho.edu/ora/committees/irb/irbforms

University of Idaho Institutional Review Board: IRB00000843, FWA00005639