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Astronomy Week: An Investigation Of The Implementation And Identity Formation Of Participants

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ASTRONOMY WEEK: AN INVESTIGATION OF THE IMPLEMENTATION AND IDENTITY FORMATION OF PARTICIPANTS

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ABSTRACT

Our society has a great need for Science, Technology, Engineering, and Mathematics (STEM) professionals and educational institutions are currently having difficulty keeping up with society's demand (Carnevale, 2011). Outreach efforts are a key strategy to encouraging young people to pursue STEM careers and evaluation methods need to be used to ensure that this outreach is efficient and effective in helping young students see themselves as a prospective STEM professionals (Moskal, 2011).

The purpose of this dissertation study was to investigate the implementation of an Astronomy Week supported by the Center for Mathematics and Science Education (CMSE) and its impact on student identity formation. Three classrooms implemented the CMSE Astronomy Week curriculum and accepted a visit from the Starlab mobile planetarium. Data consisted of field notes from classroom observations, interviews with students and teachers, the Draw a Scientist Test (DAST), and surveys from both teachers and students.

Results provide evidence that this outreach effort was a significant science event that helped change the stereotypical beliefs about scientists, especially in minority students. Drawings of scientists and written responses provided valuable insight into participants' identity formation and desires to pursue a career in science. Results also provide suggestions for improving the programmatic and curricular aspects of the outreach program. Teacher interviews and questionnaire responses were particularly valuable in the development of suggestions for improving the program.

DEDICATION

This work is dedicated to my eternal companion, Gina. Thank you for your support throughout this process. It is an honor to be a part of your life.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I: INTRODUCTION

All people start life with universal interests that tend to narrow with age and experience (Fredricks & Eccles, 2002). New experiences cause a child to cast away interests or potential career choices that do not align with his or her emerging identity. One can think of the narrowing of interests as the process by which a child forms an identity (Fredricks & Eccles, 2002). Educators can provide a safe environment for children in which to try on different interests so that the child can determine which interests most align with his or her emerging identity.

The National Science Education Standards (NSES) (National Research Council, 1996) stresses the importance of the process of doing science when stating the following:

> The Standards call for more than "science as a process," in which students learn such skills as observing, inferring, and experimenting. Inquiry is central to science learning. When engaging in inquiry, students describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge, and communicate their ideas to others. They identify their assumptions, use critical and logical thinking, and consider alternative explanations. In this way, students actively develop their understanding of science by combining scientific knowledge with reasoning and thinking skills. (p. 2)

A child can be given the opportunity to experience the process of scientific inquiry that leads to findings of scientists of the past in a way that is engaging both physically and mentally. A good science lesson can be a significant event in the life of a child that leads him to accept the possibility of becoming a scientist or at least not exclude science from their narrowing set of interests.

More recently, the National Research Council suggests that children need to be engaged in a full range of scientific practices and engineering design in order to learn science (National Research Council, 2011). This range of practices include modeling, explaining, and investigating the world. Children engage in scientific practices when they investigate the world, develop an argument to communicate to others, value feedback from peers, and review and refine their findings. The National Frameworks suggest that these practices have too often been "underemphasized in the context of science education" (National Research Council, 2011, p. 44)

In a report released about the United States' workforce authors state that since the United States' advantage in the marketplace and in science and technology has begun to erode, corrective action is needed to ensure future competitiveness in the global economy (Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science, 2007). The suggested action plan in this report calls for changes in classroom practices to increase the number of scientists and engineers in our workforce. If the number of scientists is to increase, then educators must focus on helping students find the role of a scientist that fits comfortably with their respective emerging identities. Educators can help students by teaching that any role is available and by providing opportunities for students to try different roles in a safe environment.

Americans tend to believe that academic abilities and therefore, essential pieces of identities, are attributes with which a person is born (Wood, 2000). When students are taught that academic abilities are malleable and can be formed with personal effort, work, and practice, their joy in learning increases along with academic performance (Aronson, Fried, & Good, 2002).

Therefore, it is important that educators help children understand that they can choose any career path which allows them to fulfill personal aspirations.

A person's identity is formed by his or her perception of where they belong, meaning that a person will choose a career path if that path provides the person with a feeling of community (Cook, Church, Ajanaku, & Shadish, 1996). Feelings of community may develop from common language and skill sets that are a direct consequence of active participation (Larson, 2000). A child will tend to keep a career within their narrowing set of possible identities if that career path gives them a feeling of community. Alternatively, a child may discard a career path, even one that fits his or her identity, if the career path causes isolation from a community or criticism from peers. Educators have a responsibility to provide a safe environment for each child to discover his or her own emerging identity without which, the child may discard a potential life path that leads to self-actualization.

Purpose of the Study

The Center for Mathematics and Science Education (CMSE) at the University of Mississippi helps schools provide opportunities for students to experience astronomy through hands-on activities and immersive technology. Through the CMSE Astronomy Week outreach program, middle school students across northern Mississippi engage in scientific practices similar to real astronomers of the past and modern day. The purpose of this study was to examine qualitatively how effectively and/or ineffectively the CMSE Astronomy Week curriculum is implemented in North Mississippi middle schools and evaluate the curriculum's impact on student identity formation. This study interviewed teachers concerning their efforts to use the curriculum in the classroom and includes interviews with students about their experiences using the curriculum. The Draw a Scientist Test (DAST) was administered to students before and after curriculum implementation (Chambers, 1983). Also, a follow-up survey to the DAST was administered. The follow-up survey asked students to describe their scientist and provide a reason for drawing the scientist of a particular race and gender, similar to work done by Sumrall (1995). The study looked for patterns and themes within the qualitative data and changes in frequency of self-identifying markers between pre and post tests.

Research Questions and Hypothesis

The following research questions were used to guide the study:

1. What impact, if any, does the CMSE Astronomy Week have on student identity formation?
2. What programmatic factors influence the effective and/or ineffective implementation of the CMSE Astronomy Week?
3. What curriculum aspects influence the effective and/or ineffective implementation of the CMSE Astronomy Week?

Significance of the Study

This study can help guide future research in the attempt to increase the number of STEM (Science, Technology, Engineering and Mathematics) workers and in the attempt to help form science related identities in children. The United States is facing a major shortage of workers in the fields of science, technology, engineering and mathematics (STEM) and it would be beneficial if educators enabled students to develop an identity and choose a career that meets the demands of society (Carnevale, 2011). Increasing the number of people in the STEM workforce is also a matter of equity. Students interested in the STEM fields may experience adversity with stereotypes which may affect decisions about entering those fields (Claude M. Steele, 1997). If a child avoids a career path because of the effects of stereotyping, bullying, or ostracization from a community, then a disservice has been done to that child. Every child should feel safe to choose a line of study that aligns with his or her emerging identity.

Sumrall (1995) suggests that "...teachers need to find ways in which African-American and female students can see themselves as successful scientists..." and that this can be done by "...ensuring that students are immersed in activities in which they envision themselves as a scientist" (p. 89). The CMSE Astronomy Week curriculum, that was implemented in this study is designed so that students build and use tools that real astronomers use and are introduced to African-American and female scientists. Students are trying on the identity of an astronomer through hands-on activities and immersion in the environment of the planetarium as well as being introduced to role models of different races and genders. This study evaluated the impact of the curriculum on student identity formation and determined if it sufficiently helped students of all ethnicities see themselves as scientists.

Limitations

The curriculum used in this significant science event incorporates the use of an inflatable planetarium, the cost of which may be prohibitive in the scalability of the project. The study was conducted in middle schools in Northern Mississippi which have no planetarium resources. In areas where planetariums are readily available, the significance of bringing a planetarium to a school may be diminished. This study did not utilize a coding method to identity individual students and thus, pre and post tests were not linked and a quantitative determination of significant changes in occurrences of self-similar images could not be determined.

Delimitations

Only middle schools in Northern Mississippi that volunteered for the project were included in the study. Increase in content knowledge was not considered. The curriculum only involved approximately four hours of classroom instruction and a visit from the planetarium and a set of hands-on activities. While this significant science event was intended to encourage students to pursue STEM, it took place over just a one week period. The curriculum was only part of what should be a long-term, sustained effort between schools and universities.

Conclusion

Children begin to develop identities as they gain experience and discard possible identities that do not align with whom they want to become. Teachers have a responsibility to facilitate identity formation for students, which in an unsafe environment, may cause students to discard career options, resulting an inequitable distribution of careers. This study uses teacher interviews, student interviews, and the DAST survey to analyze the effectiveness of the implementation of the CMSE Astronomy Week curriculum and its impact on student identity formation. Results from this research can guide future efforts to help students form science identities and increase the number of people entering the STEM workforce.

CHAPTER II: REVIEW OF LITERATURE

Introduction

There is a national effort to increase the number of people working in the fields of science, technology, engineering, and mathematics (STEM). If this effort is to be successful then it is necessary to take into consideration effective methods for guiding a person through the pipeline that results in a career in science. This review of literature is focused on topics related to the need in STEM fields and ways to fill the need in STEM fields, including a targeted method of engaging students in a way that helps them develop an identity as a scientist.

Need for STEM Education

Recently, the Center for Education and the Workforce brought to light issues about the STEM workforce and discussed issues we may be facing in the near future (Carnevale, 2011). The report warns that we are in the middle of a chronic STEM workforce shortage. Between 2012 and 2018, the United States economy will have a shortage of approximately 2,400,000 jobs in STEM areas and projections show that the United States is on track to produce fewer than half of those jobs. The report states:

> We find that the diversion of STEM talent-which ultimately results in its overall scarcity-owes to the transferability of some STEM competencies into other academic disciplines or the diversion of STEM students into other careers that satisfy alternative personal and work interests and values. In the education system, for example, STEM-related curricula in math and science can lead to a variety of occupations ranging from architecture to business and finance to medicine. What's more, some of these occupations pay better

> wages than STEM, increasing incentives for some STEM students and workers to leave the field.
>
> We conclude that our education system is not producing enough STEM-capable students to keep up with demand both in traditional STEM occupations and other sectors across the economy that demand similar competencies. (p.10)

This shortage of STEM-capable workers is a growing national problem and all signs point towards the educational system as the way to fix it.

A report released about the workforce in the United States by the Committee on Prospering in the Global Economy in the 21st Century's report, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* (2007) states that the United States' advantage in the marketplace and in science and technology has begun to erode and corrective action is needed to ensure future competitiveness in the global economy. The suggested action plan in this report calls for vast changes in classroom practices and greater efforts to increase the number of scientists and engineers in the workforce.

Many researchers use the term "pipeline" to describe the path people take to reach a STEM career (Astin, 1992; Ma, 2011; Maltese & Tai, 2011; Starobin & Laanan, 2008; Telli, Brok, & Cakiroglu, 2010). The main idea behind this pipeline metaphor is that, in order for someone to enter a STEM career, they must study that field in college, which means that they must be interested in majoring in that field. Somewhere in the course of an individual’s life, they must enter the pipeline that leads them to a STEM career and they must stay in that pipeline. If a person strays from the STEM career path, it could be said that the pipeline is leaking. One study which showed success in keeping this pipeline from leaking, found success when students in the STEM pipeline had a clear path to a higher degree and when junior colleges made partnerships with major universities and funding organizations such as the National Science Foundation (Starobin & Laanan, 2008). That is, students need to be able to see the end result of their educational efforts and they need to be able to see the steps they are to take to get to their career and see the rewards that are awaiting at the completion of their schooling. An example of how to make the pathway clear for students interested in STEM careers is to use media presentations that teach and inform individuals about educational pathways and careers after education. This can be done with partnerships that give support to students while in school or recruiting efforts made between institutions. These partnerships have been a key to the successful development of services and programs that bring people into the STEM fields.

Race and Gender Issues in STEM.

Gender and race both play a role in educational outcomes of students on the path to a STEM career (Mau, 2003). All aspects of a person's life constitute that person's identity. Race and gender both play a role in identity formation. Whether race and gender are viewed separately or individually is a matter of discussion in some research but nevertheless, race and gender are important factors in STEM career attainment (Riegle-Crumb & King, 2010).

Scores from the National Assessment of Education Progress (NAEP) have shown that the achievement gap between White and African-American students has narrowed between 1980 and 2000 but White students still score significantly higher than African-American students (Campbell, 2000). It also shows that the gap between White and Hispanic students has remained relatively consistent over those twenty years. This shows that progress has been made in the United States educational system with regards to equity among races. More progress is needed, especially in helping Hispanic students receive the same educational opportunities as other Americans.

Even though all people have potential to enter a STEM career, boys and girls hold different competence beliefs even at early ages. Boys hold higher competence beliefs than girls in the field of mathematics while girls hold higher competence beliefs than boys in language and art (Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002).These competence beliefs are related to societal and cultural stereotypes as well as small changes in interest were associated with the threat associated with these stereotypes. Also, in the past women may have faced more difficulties in successfully completing a STEM degree than men did. In the 1990's, women were more likely to not complete a STEM degree than men because women are more likely to leave the STEM pipeline at every possible junction (Seymour & Hewitt, 1997). But over the past decade, progress has been made in narrowing gender differences in the STEM pipeline. More recent research shows that there is no significant gender differences in STEM persistence to degree completion once a person has matriculated into college (Chen, National Center for Education Statistics., & Institute of Education Sciences (U.S.), 2009; Xie & Shauman, 2003). The author suggests that this major improvement may be associated with the reduction of gender stereotypes in professional careers.

National data show that there are roughly equal percentages between the amount of White, Hispanic, African-American students who graduate from college and those who obtain a degree in STEM (Tyson, 2007). This means that for minority students who graduate are just as likely to gain a STEM degree as non-minority students. When accounting for differences in preparation, white males hold little or no advantage in STEM fields (Riegle-Crumb & King, 2010). This research shows that when accounting for preparation, African-American females are more likely to declare a STEM major than white females. Also, African-American and Hispanic men who enter college are as likely as their White male peers to enter STEM majors but that disparities may still exist before college matriculation. The disparity comes from the attrition rate of underrepresented groups. Underrepresented groups are more likely to leave the STEM field than majority groups (Bonous-Harnmarth, 2000). This suggests that while it is important to continue monitoring equity in college, if representation in STEM courses is to be more equitable among ethnicity and gender, efforts should be aimed toward keeping underrepresented students in college and providing better preparation before college.

Identity Issues in STEM.

A person's self-concept is a major factor that can be used to predict if that person will follow a career path that leads to a STEM career (Krogh & Andersen, 2013). Researchers observed a group of students as they experienced the last years of upper secondary school and through a university mentorship program in Denmark. Using repeated interviews, questionnaires and observations throughout the process the researchers were able to compile these narratives and develop an understanding of the students' educational identity. A set of frameworks were formed that enabled the researchers to reasonably predict if a student would stay on a secured path to enter a science field. This framework uses identity process orientations, personal values, subject self-concepts, and subject interests to make this prediction on secured paths into science fields and careers.

In his paper *AThreat in the Air: How Stereotypes Shape Intellectual Identity and Performance,* Claude M Steele (1997) describes stereotype threat and its effect on academic identification when he says:

> ...this analysis assumes that sustained school achievement depends, most centrally, on identifying with school, that is, forming a relationship between oneself and the domains of schooling such that one's self-regard significantly depends on achievement in those

> domains. Extrinsic rewards such as better career outcomes, personal security, parental exhortation, and so on, can also motivate school achievement. But it is presumed that sustaining motivation through the ebb and flow of these other rewards requires school identification. ...another threat to their identification, more subtle perhaps [than structural and cultural threats] but nevertheless profound: that of stereotype threat. I define it as follows: the event of a negative stereotype about a group to which one belongs becoming self-relevant, usually as a plausible interpretation for something one is doing, for an experience one is having, or for a situation one is in, that has relevance to one's self-definition. ...the possibility of conforming to the stereotype or of being treated and judged in terms of it, becomes self-threatening. It means that one could be limited or diminished in a domain that is self-definitional. For students from groups in which abilities are negatively stereotyped in all or some school domains, this threat may be keenly felt, felt enough, I argue, to become a further barrier to their identification with the domain. (p.616-617)

This landmark description of stereotype threat and its effect on student intellectual identity laid the foundation for researchers to look for ways to minimize threatening stereotypes as a way to open the pathway to STEM careers.

In a recent study a group of thirty young children from varying socio-economic backgrounds were interviewed and asked to draw scientists (Buldu, 2006). The interviews and images were laden with indicators that the children held both stereotypical and non-stereotypical perceptions of scientists. The research suggests that students in the middle school ages begin to develop stereotypes that this level of stereotype differs with levels of socio-economic status.

Stereotypes that take hold in the middle school years of a person's life may persist into adulthood (Song & Kim, 1999). Researchers in Korea used both quantitative and qualitative data from over one thousand students and found that stereotypes were not attributed so much to the cognitive ability of the person but the affective and ethical characteristics of the person. These characteristics and therefore the stereotypes can persist through adulthood if there is no intervention.

Females may feel that their identity as female is not compatible with the identity of a scientist and may play a role in an individual's decision to leave a STEM field (Wyer, 2003). In a study that compared common ways to encourage students to persist in their degree, the study suggests that an individual's gender may be more important in explaining why that individual leaves a STEM field than in explaining why others stay.

Filling the Need for STEM

It is interesting to note that the recent STEM workforce study (Carnevale, 2011) showed that a narrow set of interests and values have much to do with STEM career choices, because for several years we have been seeing the rise of programs and schools that try to cultivate interest in STEM fields. The United States has seen the establishment of schools that focus on math and science and colleges that try to recruit students into STEM pathways through outreach programs. The United States has seen a slew of innovative lessons and demonstrations that strive to increase interest in STEM.

In many states there are specialized schools that focus on areas of STEM. Mississippi has a residential high school specifically tailored to students who are academically gifted in math and science. Students get to live on campus and return home to their families on weekends and holidays. The development of these specialized schools has been an effort to fill the STEM pipeline by giving young people a challenging atmosphere and the resources to pursue advanced studies. Subotnik suggests that, while there is not any research of scholarly quality that indicates that these specialized schools are having an impact on the STEM pipeline, it is intuitive that there must be some positive effect (Subotnik, Tai, Rickoff, & Almarode, 2010). He suggests that, in order to say that these schools are having an impact, a study needs to be launched that explores the educational paths of the students. This study should be designed to follow the students of these specialized schools to see their final career choices and the multidimensional factors that help or hinder their progress to a STEM career.

Often colleges and universities reach out to K-12 schools and provide resources and opportunities for teachers and students. Moskal (2011) showed that outreach from universities can help support the K-12 classroom but these outreach programs are often heavily reliant on the availability of external funding. Moskal's research was centered around a ten-day professional development workshop that helped teachers gain better content understandings that they could bring back to their classrooms. The program also provided support for the teachers during the school year as well as tutoring assistance for struggling students. It was shown that the program was successful in helping students perform better on standardized tests which is one possible indicator of success in a STEM pathway. With funding as an issue, it is expedient to show that current funds are being spent to meet the goals that have been set. Programs that are developed to deal with the STEM workforce shortage should be targeted towards students whose personal work values and interests align with that of the STEM workforce. Focusing funding efforts towards specific student profiles could stretch current funds and improve results in filling the STEM pipeline with students who will remain in the program. This could be an argument for continued funding while programs that show little results are likely to be defunded and discontinued.

Innovative lessons and demonstrations in schools are a small part of the experiences that help students decide to enter the demanding fields of STEM. In a study about using demonstrations in a physics classroom, researchers found that demonstrations lead to an increase in student participation and questions in class (Buncick, Betts, & Horgan, 2001). In another study it was shown that interactive lessons, including physics demonstrations, helped improve students' attitudes about science but it is not sufficient to do the job alone (Moll, 2009). Demonstrations and discrepant events are just two of the tools used to help boost interest in STEM.

Students do not always have access to information on STEM careers through their school counseling . Using social media outlets, researchers surveyed high school students from around the United States and discovered that interest in environment and natural resource issues were high but interest in those related careers was low (Hager, Straka, & Irwin, 2007). The study suggests that marketing techniques can be used to attract students to professions where there is a lack of information readily available to students.

Engaging Students.

Engaging students in science is key to guiding them into the pipeline that leads to careers in science. The ideas of motivation, interest and identity are deeply rooted in the assumption that a person can work to become the type of person they hope to be. This assumption is the main focus of theoretical frameworks around identity formation including taking on the identity of a scientist. While the research discussing engagement in science is vast and complex, the focus of this literature review follows the framework provided by Wigfield and Eccles (2002).

Wigfield and Eccles help define engagement in science by describing three main core components: a student's belief about their ability to do science, motivation to do science, and identity as a doer of science. These three core components are essential for a person to continue to choose to travel down the pipeline towards a career in science. Even if a person believes they have the ability to do science, they need the motivation to participate. This motivation may be hindered if they feel ridiculed or stereotyped because of their participation in science. Each of these core components are discussed in detail in this literature review.

Belief in ability to do science.

A student's belief about their own ability to do science impacts that student's engagement in science. Students will exert minimal effort in their academic work if they do not believe that they have the capacity to find success (Atkinson, 1964). Students must set aside preconceived ideas about their capabilities in order to engage in a science lesson both physically and mentally. Unfortunately, Americans tend to have a belief that their academic abilities are something with which they are born with and over which they have no control (Wood, 2000). This is the tendency to say that "I'm not a math/science person". The desire to label one's science abilities negatively, hinders his or her engagement in science.

One study reported that, when students were led to understand that their cognitive abilities were dependant on personal effort, work and practice, they found academic studies to be more joyful (Aronson et al., 2002). They were more likely to be engaged in their studies and make better grades. A child is not simply born with all the capabilities that he or she will possess for the rest of their lives; they have the ability to mold their identity according to their desires. Each person has control over their own abilities, and the knowledge of that control enables them to become the individual they aspire to be.

Desire and interest to do science.

A student's desire and interest to do science impacts that student's engagement in science. Some people see value in doing a task that is difficult and find joy in striving to improve their abilities. This is a type of motivation that comes from within but can be fostered with the right educational practices. The desire to do science is linked to a person’s intrinsic motivation or locus of control. In a study involving a program called concept-oriented reading instruction (CORI), it was shown that intrinsic motivation or the desire to work on and see value in difficult tasks was increased by providing students with support for academic success (Guthrie, Wigfield, Barbosa, & Perencevich, 2004).

Children are born with universal interests that tends to narrow as they get older. (Damon, 1998; Fredricks & Eccles, 2002). As one experiences new discoveries he or she turns away from interests that do not align with his or her emerging identity. Students in the middle grades may be most vulnerable for discarding interests. In the study done by Fredricks and Eccles (2002) it was discovered that the valuing of mathematics declined most during the high school years, leading to the belief that the middle school years are key to developing an identity of being a doer of mathematics. This means that intervention efforts that aim to guide the identity formation of children or the career paths of children, should be targeted toward middle school or below.

Developing an identity as a scientist.

A student's developing identity impacts that student's engagement in science. Holland (1998) gives a description of identity in the book, *Identity and Agency in Cultural Worlds*, when stating:

> Identity is a concept that figuratively combines the intimate or personal world with the collective space of cultural forms and social relations. . . . Identities are lived in and through activity and so must be conceptualized as they develop in social practice. . . .

> Identities are a key means through which people care about and care for what is going on around them. They are important bases from which people create new activities, new worlds, and new ways of being. (p. 5)

Understanding the formation of identities is important if educators wish to help guide children into specific careers. There is a notable initial assumption made in some identity formation research. "Research on identity and learning in specific domains builds on the premise that how one learns and what one learns are fundamentally related to the kind of person one wants to become" (Duschl et al., 2007, p. 201).

Suggestions for helping to guide a child in the process of developing an identity include giving challenging lessons over remediation, affirming acceptance into a domain group, valuing multiple perspectives, and providing role models (Claude M. Steele, 1997). The author suggests that schools would be wise to implement these suggestions and notes that simple items such as providing role models is overlooked in the design of education. These interventions seem to be focused on giving students resources and support without categorizing or grouping the students based on ability.

The level of school work that is challenging may vary for children at various skill levels but all students can and need to be challenged. The successful completion of a challenging lesson can help a child grow in skill and confidence. Challenging course work is significantly linked to attainment of college degrees (Adelman, 2006; Tyson, 2007). While advanced mathematics and science classes may be considered challenging, it should be noted that there may be significant selection bias when samples are taken from these advanced courses. Students who are already interested in STEM careers are more likely to enroll in these advanced classes (Federman, 2007). Determining whether students choose a class based on their interest or student interests are developed based on classroom experiences may be difficult to state. It is difficult to identify which is the cause of the other because a person's identity is continually developing and changing. In either case, teachers can at least provide those challenging experiences for students.

A teacher can help students find an identity by affirming that students belong within a domain such as telling a child that they have the potential to be a good engineer or scientist. Participation in organizations such as sports, clubs, and teams leads to the development of new language that is unique to that organization and shows within the organization (Larson, 2000). This may be related to the feeling of community during participation in the organizations. A feeling of community may help a child not feel threatened by stereotypes placed on them by their peers or family.

For efforts to increase our STEM workforce, schools could increase the number of available STEM related teams and clubs. Many organizations have engineering competitions, math competitions, and other outreach efforts to assist schools in this area. In a study done by Welch and Huffman (2011) students participating in a robotics program "adopted the term "geek" to represent a position of status and honor, of which they strive to be a part" (p. 422). Not only did students in the program find acceptance within a team, they redefined a stereotype from what would be considered threatening to something that is honored and valued.

Identity as a Scientist

Forming an identity as a scientist is key to being engaged in science, as mentioned above. In the section below, I reference research and intervention efforts that have been published in relation to this goal. I first cite research about locus of control and how it can help one interpret identity formation and then I describe some intervention efforts that have been utilized to affect identity. The intervention efforts mentioned include role models and challenging lessons in both the general STEM fields and some Astronomy specific efforts. I end this section by referencing articles and research related to a test to measure stereotypes in science.

Locus of Control.

The concept of Locus of Control (LOC) was first introduce by Rotter (1966) in his landmark paper *Generalized expectancies for internal versus external control of reinforcement*. LOC is a concept that measures a person's belief that consequences are a result of one's own action. LOC is a measurable belief system where individuals can score in a continuum ranging from internal to external. Internal LOC, or the belief that one's actions directly relate to consequences, has been linked to both procrastination and test anxiety (Carden, Bryant, & Moss, 2004).

People often site indicators for an external LOC, such as luck, chance events, and fate, when describing factors that determine a career path even when much personal effort is involved in developing that career (Bright, Pryor, Chan, & Rijanto, 2009; Hirschi, 2010). Finding a career that fits within one's identity is a journey that relies on understanding one's identity or having self concept. Self concept has been positively and significantly correlated to internal LOC (Yong, 1994).

A recent study performed with nursing students showed that minorities and women are more likely to attribute low achievement to external forces that are out of their control (A. M. Wood, Saylor, & Cohen, 2009). Mirowsky and Ross (2003) suggests that there are societal reasons for minorities and females to feel a lack of control in their lives and career paths. In truth, much of the research on LOC has been an attempt to overcome social injustices (Fredstrom, Adams, & Gilman, 2011; Rahim & Psenicka, 1996; Solomon, Mikulincer, & Avitzur, 1988; Steese et al., 2006). Intervention efforts have shown that LOC can shift from external to internal. One example of this is by providing support such as a protégé or mentor Wang, Tomlinson, and Noe (2010) were able to help participants shift their LOC toward the internal side of the spectrum.

In an investigation of student persistence in STEM career aspirations, researchers found self-concept, parental involvement, socioeconomic status, and academic achievement are indicators of a student's persistence in pursuing a STEM career (Mau, 2003). The author collected data on a sample of 8th graders who indicated in the 8th grade that they were interested in STEM careers and persisted in those aspirations for six years. Mau concluded that self-efficacy expectiations which lead to career interests and career goals are affected by contextual support when stating:

> ... if people perceive their efforts to be impeded by adverse environmental factors, such as inadequate support systems or an intimidating environment, their aspirations are less likely to be translated into goals and, thus, less likely for those goals to be translated into action. (p. 240)

Productive Participation.

Research in engaging students has lead researchers to pursue classrooms where students are productively participating in the subject material being taught (Engle & Conant, 2002). Engle and Conant argue in their article *Guiding Principles for Fostering Productive Disciplinary Engagement: Explaining an Emergent Argument in a Community of Learners Classroom*, that:

> ...productive disciplinary engagement can be fostered by designing learning environments that support (a) problematizing subject matter, (b) giving students authority to address

> such problems, (c) holding students accountable to others and to shared disciplinary norms, and (d) providing students with relevant resources. (p. 399)

The article describes a case study in which students use argumentation to immerse themselves in deep scientific practice and content. The students debate over the classification of an orca as to whether it is a whale or a dolphin and investigate biological attributes and classifications deeply as a result. Many other efforts have been made to encourage productive participation in the classroom. Below, I give STEM related examples below and specific examples for Astronomy related material as well.

STEM efforts.

In an effort to study the efficacy of a STEM intervention program, Leung, Stewart, Smith, Roberts, and Dees (2012) examined whether student improved interests in science, knowledge, skills, and awareness of science through the Geosciences in Middle School (GIMS) program. The GIMS was a career oriented program that consisted of both science and career activities. They met on Saturdays throughout the year and performed geological field studies and met with career counselors to discuss future goals and career paths. Data were collected on student's self-reported interests, knowledge, skills, and awareness of science and science careers along with other data. The study concluded that the GIMS career intervention program enhanced students' interests, knowledge, and skill in science, and science careers. The program used open communication with students about careers and career goals with the result of having young students who are aware of their career possibilities and who have a clear understanding of the path that they will need to take in order to enter that profession.

Astronomy specific efforts.

The field of Astronomy can be a challenging topic to learn about in school because it can be difficult for students to grasp the vastness of space and the inner workings of matter being held together in gravitational fields. Research has shown that even students who have advanced to college have major misconceptions about basic topics in Astronomy (Trumper, 2001).

Early work in Astronomy education shows that images can help with student comprehension of topics in Astronomy (Pena & Gil Quilez, 2001). With recent technological advances, teachers of Astronomy have been able to advance from still images to video guided tours to augmented reality programs that give the user the ability to explore space at their own pace. Research with desktop virtual realities has shown that student understanding of Earth's motion and Astronomy related material can be improved with these digital resources (Chen, Yang, Shen, & Jeng, 2007).

So, at what age is it appropriate for students to begin learning about the size and nature of the Universe? The imagery and digital resources mentioned above are tools to help students develop a mental model of our solar system and universe. Taylor (2003) suggests that middle school students may be capable of building mental models in astronomy. Middle school students may be up to the task of learning about astronomy but often teachers have a low opinion in the capabilities of students of that age. Miranda (2010) showed that teachers viewed their students as lacking in the prerequisite knowledge and skills needed to be successful in an Astronomy class and often compensated by deemphasizing related academic skills, omitting advanced topics, and decreasing the depth of material taught. In a later study it was shown that partnering teachers with an astronomer was beneficial to student motivation and made the subject material more relevant to students (Miranda, 2012).

The Houston Museum of Natural Science collaborated with researchers at Rice University to perform outreach using a portable theater (Sumners, Reiff, & Weber, 2008). The theater was used to teach student about basic Earth Science topics in a wide range of grades. The theater used short videos in an immersive environment that utilized multiple modes for learning, such as: hearing, seeing, discussion, and immersion. After following this program for five years, the researchers showed that the participants gained a significant short-term increase in knowledge in basic Earth Science.

In a study that examined the change in students' understanding of apparent celestial motion, the use of an immersive environment was shown to improve knowledge about celestial motion (Plummer, 2009). First, several groups of young elementary students were interviewed and their understandings about apparent celestial motion were assessed. Then, the students attended a planetarium program. The post-interviews showed a significant increase in knowledge when compared to the pre-interview. This study suggests that even at a very young age, students are capable of learning about celestial systems and models that describe them. It also suggests that immersive environments such as a planetarium hold value in education.

Teachers and adults often have major misconceptions about astronomical concepts. In a study of adult college students in a preservice teacher program, fifty participants were assessed on their understandings of lunar phases and none of the preservice teachers understood the cause of lunar phases (Bell & Trundle, 2008). The preservice teachers explored lunar phases using computer simulations and after the instruction most of the participants were able to demonstrate a scientific understanding of the cause of moon phases and were able to draw a model to explain their newly found understanding. This research suggests that computer simulations can be effectively used to explore our physical world and that inquiry learning in astronomy is possible when environments are simulated.

Role Models.

Providing a role model for a student can give that student someone with whom to identify and help the student to visualize what career expectations exist for someone who follows the same career path as the role model. "People from the stereotype-threatened group who have been successful in the domain carry the message that stereotype threat is not an insurmountable barrier. . ." (Claude M. Steele, 1997, p. 625). A role model of the same race or gender may help establish a feeling that the student can succeed. STEM role models may include practitioners from STEM fields such as scientists, engineers, or other researchers. Providing an engineering role model for a child that aspires to be an engineer gives that child a resource to whom they can direct questions and glean guidance. Research shows that career aspirations are strongly related to career expectations and that a person's identity is formed by his or her perception of where they belong (Cook et al., 1996).

DAST.

Since the introduction of the Draw a Scientist Test (DAST) by Chambers (1983), the DAST has been a widely used test to explore the stereotypes held against scientists (Brechet, 2013; Cheryan, Plaut, Handron, & Hudson, 2013; Finson, 2002; Maoldomhnaigh & Hunt, 1988; Mason, Kahle, & Gardner, 1991; Subramaniam, Esprívalo Harrell, & Wojnowski, 2013; Symington & Spurling, 1990; Thomas, Henley, & Snell, 2006). Many years of research show us that young students often have stereotypic images of scientists and recent research has begun to shift the discussion of stereotypes to include mythical scientists (Allchin, 2003). The mythical scientist discussed by Allchin is a super-moral scientific hero which, can mislead students in their understanding of how science derives its authority.

A recent study with Native American students showed that once initial perceptions of scientists are identified, researchers and teachers can provide significant experiences to overcome stereotypes (Laubach, Crofford, & Marek, 2012). These significant experiences may come in a variety of packages such as large informal educational experiences (Leach, 2012) or simple teacher discourse that introduces students to authentic science activities (Hsu & Roth, 2009).

Young children can distinguish between science that is learned in school and the perceived dangerous and lonely work of a "real" scientist (Zhai, Jocz, & Tan, 2013). While this perception of the stereotypic scientist is found early in children, middle school students have been found to have no perception of engineers (Fralick, Kearn, Thompson, & Lyons, 2009). This lack of perception in one of the STEM professions lead the researchers to call for more outreach in the STEM fields in order to develop perceptions that encourage students to pursue STEM careers.

CHAPTER III: METHODOLOGY

Introduction

The CMSE Astronomy Week is an attempt to bring minds-on/hands-on activities and innovative experiences to northern Mississippi. The curriculum included approximately four hours of planned class activities and an additional, immersive experience in a mobile planetarium (see Appendix F). The lessons were designed to allow students to try on the identity of an astronomer by experiencing discoveries similar to famous astronomers of the past and by utilizing scientific practices. *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* defines scientific practices as: "...the major practices that scientists employ as they investigate and build models and theories about the world" (National Research Council, 2011, p. 30). During the lessons students built a telescope, investigated the retrograde motion of planets, built a model of the solar system, and planed a mission to Mars.

In the first lesson, students used PVC pipe and an assortment of lenses to create telescopes. Each group of students got a telescope and a set of eight exchangeable lenses. Different combinations of lenses can be used to create a Galilean telescope or a Keplerian telescope while some combinations fail to produce a focused image. Students investigated which combination of different types of lenses will cause a magnification and a focused image, and will use their telescopes to read an eye chart from across the room. After finding which combination of lenses worked the best, students were able to take the telescopes home. Just as Galileo and Kepler used telescopes to make detailed observations of the night sky, students used the telescope they built to look at the night sky. Students were asked to reflect on their experiences looking at the night sky with their telescope.

In the second lesson, students used a computer simulation to view changes in the night sky over a long period of time and make a model to describe observed phenomenon. Using *Stellarium,* a computer program that simulates the night sky, students watched the movement of Mars against the background stars over the course of a simulated year. They observed the peculiar retrograde motion of Mars against the background stars and had a chance to make conjectures about their observations. They then drew a model of the phenomena similar to the model first drawn by Copernicus in his book *The Revolution of Heavenly Bodies* where the Sun was the center of our system. Just as Copernicus first described the rotation of planets around the Sun, students wrote a proclamation to the world describing their findings. This lesson was designed to allow students to make the same discovery that Copernicus made and then relate this discovery to the world. Students used their observations to make models and communicate their findings to others.

In the third lesson, students made a model of the solar system. Astronomers design models to try to make sense of the universe. Students used actual distances of planets from the Sun to make a scale model of our solar system and tried to make sense of the size of our celestial world. Using common objects such as a ball, coffee beans, peppercorns, and pins, students paced out the relative distance each planet is from the Sun. Alternatively, when circumstances prevented this activity from being completed in the classroom, students used Google Earth to draw a map of their solar system over a map of their local area. In his lesson, students modeled astronomical phenomena to make sense of data that was provided to them. The lesson used reflective questions to invite students to describe how models can be used by real scientists.

In the fourth activity, students planed a mission to Mars while taking into account the advantages and disadvantages of different capabilities of equipment. Students used the standalone version of *the Marsbound! A Mission to the Red Planet* lesson developed by the Mars Education Program Jet Propulsion Laboratory at Arizona State University (Watt, 2003). This lesson allowed students to set goals for a trip to Mars and use a point system to calculate fuel and resources needed as well as cost. This simulation allowed students to experience the real planning process that scientists use when planning a trip to another planet, including random events that help or hinder the expedition. The lesson included reflection questions that ask students to describe the goals and important points of their mission and to develop an argument to support NASA's space program. This lesson was intended to engage students in active problem solving and to give students the opportunity to experience the role of a scientist in space exploration today.

The final day of the CMSE Astronomy Week featured a visit from the STARLAB mobile planetarium. Groups of approximately twenty students at a time entered the planetarium and experience an immersive lesson that lasted approximately thirty minutes. While in the planetarium, students tracked the position of the sunrise, sunset, and length of time the Sun was visible during different seasons. The declination of the Sun will also be tracked over the course of a year to form an analemma and it was discussed how an analemma could be used to describe the seasons. Students also viewed the night sky and looked at common constellations and stars. They learned how to find Polaris and discussed how it is used in navigation. The immersive experience of the planetarium allowed students to clearly view celestial events in a controlled and exciting atmosphere. This activity was planned to be the climax in the significant science event of the CMSE Astronomy Week.

The purpose of this study was to examine qualitatively how the CMSE Astronomy Week curriculum was implemented in North Mississippi middle schools and also assess the curriculum's impact on student identity formation. This chapter first presents the research questions. Then, details regarding the design of the study are provided including a description of the population and sample, data collection procedures, and data analysis procedures.

Research Questions

The study sought to answer the following research questions.

1. What impact, if any, does the CMSE Astronomy Week have on student identity formation?
2. What programmatic factors influence the effective and/or ineffective implementation of the CMSE Astronomy Week?
3. What curriculum aspects influence the effective and/or ineffective implementation of the CMSE Astronomy Week?

Patton and Patton (2002) encourages qualitative research to be adaptable during the process of study so that emerging themes and ideas may be explored. It is the nature of qualitative study to explore new topics and follow emerging themes as they arise, as problems within these new topics have not been identified yet. With this in mind, the research questions above were guiding ideas that are subject to change within the emerging design.

Design

In using a qualitative approach, the implementation of the curriculum and its impact on identity formation was evaluated. It was qualitative in nature because of the small number of participants and the exploration of participant experiences. A portion of the data helped give added meaning to student identity formation by measuring instances where students identify themselves as a scientist. Qualitative data was gathered using face-to-face interviews with students and teachers, classroom observations, drawings from the DAST, and written questionnaires for both teachers and students.

Sample

The sample included three middle school classrooms in northern Mississippi. To obtain a sample, the researcher distributed a Call for Participants (see Appendix A) through the Mississippi Science Teachers Association (MSTA) list-serve and the Science Spots list-serve through the Mississippi Department of Education. Interested parties were directed to contact the Center for Mathematics and Science Education via email or telephone. Staff at CMSE helped interested parties to schedule materials to be delivered to their school and also scheduled a visit from the mobile planetarium. During the scheduling process, applicants were encouraged to volunteer to participate in the research project. While the nature of this recruitment process is convenience sampling, random assignment was used to isolate the three schools from the willing participants. Each of the teachers from the chosen classes were interviewed along with three students from each of the classes for a total of three teachers and nine students. In addition, all students in each of the three classes were given the DAST and accompanying survey as a pre-test and post-test.

In order to encourage participation in the program, the lessons were chosen based on the 2010 Mississippi Science Framework (2008). Since the targeted population was middle schools, the frameworks for grades 5-8 guided the focus of the subject matter for the lessons and activities. The intention was to not only provide a rich experience for the students but to also to help teachers cover the astronomy related material expected from the frameworks. The lesson titles with the corresponding connection to the framework are given in Table 1.

Table 1
Lesson Connections with 2010 Mississippi Science Framework

Lesson Title	Framework Objective	Description of Objective
Exploring Telescopes	7th grade 4f	Distinguish the structure and movements of objects in the solar system- Contributions of Copernicus, Galileo, and Kepler in describing the solar system
Exploring Planetary Motion	7th grade 4f	Distinguish the structure and movements of objects in the solar system- Contributions of Copernicus, Galileo, and Kepler in describing the solar system
	6th grade 4f	Differentiate between objects in the universe (e.g., stars, moon, solar systems, asteroids, galaxies)
Solar System Model	5th grade 4f	Compare and contrast the physical characteristics of the planets (e.g., mass, surface gravity, distance from the sun, surface characteristics, moons)
Marsbound!	7th grade 4e	Research and develop a logical argument to support the funding of NASA's Space Programs
Planetarium Star Show	8th grade 4e	Explain how the tilt of Earth's axis and the position of the Earth in relation to the sun determine climatic zones, seasons, and length of the days.

Qualitative Data Collection

The Interview Protocol (see Appendix B) was used to guide interviews with teachers and students. The Interview Protocol used broad questions concerning the curriculum to give participants an opportunity to share experiences related to the curriculum. The focus of discussion with teachers was guided towards the curriculum and implementation efforts. The focus for student interviews was guided towards experiences and the formation of an identity as a scientist.

The Observation Tool (see Appendix C) was used during classroom observations. The first page of the tool was used to give a detailed description of the classroom including layout and student grouping. The second page was used for notes on the observed lesson and specific items about curriculum fidelity. The intent of this observation was to assess the implementation of the curriculum in as much as it provided a significant science event that allowed students to try on the identity of a scientist and to assess the safety of the environment in which students were trying on this identity. The Observation Tool provided relevant data towards this intent.

The survey for teachers solicited information about the curriculum that may not have been recorded in the interviews. Teachers were asked to discuss strengths and weaknesses of the curriculum and give suggestions about how the curriculum could be improved. The teacher survey provided valuable feedback on how to further increase the effectiveness of the curriculum and to increase the ease of implementation.

The researcher was a key instrument in the collection of data because the researcher's perspective determined which data are relevant enough to be recorded. The researcher was a doctoral candidate in the field of education with an emphasis in secondary science. The researcher served as a developer of the curriculum being implemented. Degrees earned include Master of Education and Bachelor of Arts in physics. The researcher has taught high school and college level sciences. He holds biases that have developed over years of learning, teaching, and researching. One bias is that the researcher believes it is challenging for teachers to provide significant science events where students take on the role of a scientist and that often teachers revert to a more lecture-based teaching method for the sake of simplicity. Another bias that the researcher holds is the belief that it is challenging to provide a safe environment where students can participate without social consequences or stereotyping from peers and even adults. These biases and experiences create a lens through which the data being gathered was viewed.

A questionnaire (see Appendix E) was administered along with the DAST in both the pre and post tests. The questionnaire asked students to identify their own gender and race as well as the gender and race of the drawn scientist. The questionnaire also asked if students would like to become a scientist. It also allowed participants to identify the drawn scientist. The DAST and the questionnaire were given before the implementation of the curriculum as a pre-test and approximately one week after the curriculum as a post-test. The post-test questionnaire had an additional two questions. The first additional question asked students if they changed the race or gender from their first drawing and if so why did they do so. The second question asked students to indicate whether the astronomy lessons instilled a desire to learn more about astronomy. Both the pre-test and the post-test were implemented by the researcher with assistance from the classroom teacher.

Qualitative Data Analysis

The interviews with teachers and students were transcribed and coded along with the completed observation tools and teacher questionnaires. The interview transcripts, teacher questionnaires, and observation tools were analyzed and reviewed for themes and patterns. Some possible patterns that emerged are difficulties with understanding curriculum, shortage of resources, insufficient facilities, and time constraints.

The researcher examined the results of the DAST to see how many participants drew a scientist that has the same gender and/or race as themselves. The researcher tallied the occurrences of matched drawn scientist ethnicity with student ethnicity and the occurrences of matched drawn scientist gender with student gender. The frequency of these identifying markers between pre and post tests were compared qualitatively.

Conclusion

This curriculum aimed to provide a significant science event where students could try on the identity of an astronomer to see if that profession fits with their emerging identity. Interviews, observations, and drawings allowed the researcher to assess the impact of the curriculum on student identity formation. Data collected was analyzed qualitatively in attempt to get a rich description of the problem. The experiences and biases of the researcher acted as a lens that governed how the data was collected and interpreted.

CHAPTER IV: DATA ANALYSIS

Introduction

In an attempt to answer the research questions I used a variety of techniques to gather data. I used Nvivo to organize and code the data so that a clear picture of events and themes could be determined. This chapter describes the prevalent themes uncovered through each of the data gathering techniques with the specific research questions being addressed individually.

Students in each of the classrooms observed, completed aDraw a Scientist Test (DAST) and the accompanying questionnaire. Students were asked to draw a scientist and to be as detailed as possible on their drawings. After drawing their scientist the students answered a questionnaire about the drawn scientist and themselves. The purpose of this questionnaire was to acquire a count of students who drew a scientist that is similar to themselves. Because previous research shows that students tend to draw white, male, chemists, I took special notice of African-American students who drew African-American scientists and female students who drew female scientists. The post-test survey contained additional questions to ask students why they may have changed their drawings after experiencing the CMSE Astronomy Week. The DAST and accompanying questionnaire are tools I have used to help judge the effects of the curriculum on student identity formation.

I attended and observed each of the lessons as they were taught in the classroom and use the Observation Tool to record events within the classroom. The Observation Tool was used as a way to record notable events and possible fidelity issues with the curriculum implementation.

In each of the classrooms, the teacher chose three students to be interviewed. I asked students about their experiences with the Astronomy Week and about their desire to be an astronomer when they grow up. The interviews were a valuable resource for insight into the identity formation of the students. In the following pages I refer to the students by pseudonyms to protect their identity. I have used student responses to qualitatively investigate the program's effect on student identity formation.

The teachers were each interviewed after all the lessons were implemented. The teacher interviews were a valuable resource used to answer the research questions because the teachers were very candid about the positive and negative aspects of the Astronomy Week. Teachers were questioned about their experiences with the CMSE Astronomy Week. They shared positive experiences, frustrations, and ideas for making the program more classroom friendly. I used the teachers' responses to help answer the research questions and to inform the program administration.

In addition to the interviews, each teacher filled out a questionnaire to help identify programmatic and curriculum aspects involving the implementation of the Astronomy Week. This questionnaire specifically targets each of the lessons and asks for feedback from the teacher that can be used to help improve the CMSE Astronomy Week. The questionnaire allowed teachers to organize and collect their thoughts about each lesson and the program as a whole.

Research Question 1

This section addresses the research question, "What impact, if any, does the CMSE Astronomy Week have on student identity formation?" I have organized the data by giving a numerical overview from the DAST questionnaire followed by student work and student interviews.

Numerical overview of the DAST questionnaire.

After completing the Draw a Scientist Test, students were asked questions about themselves and the scientist that they drew. Student responses were tallied and are given in Table 2.

Table 2

A numerical description of student responses

	Pre-test	Post-test
Number of Students	53 (19 are African-American) (20 are female)	65 (22 are African-American) (30 are female)
Student drew a scientist with the same gender and ethnicity as themselves	35 (66.0%)	41 (63.1%)
African-American Student drew an African-American Scientist	13 (68.4%)	16 (72.7%)
Female student drew a female scientist	10 (50.0%)	18 (60.0%)
Student indicated that they would like to be a scientist	18 (33.96%)	24 (36.92%)
Number of students that drew an astronomer or astronaut	1 (1.8%)	5 (7.7%)

Fifty-three students participated the pre-test and sixty-five students participated in the post-test. The number of students differed from pre-test to post-test because of several reasons, ranging from absences to school functions. The most notable cause for this difference was a basketball game that removed some of the female participants from the pre-test. While this difference is notable and rather large for the sample size, I kept the scheduled time for the pre-test as to not ruin the sequence of scheduled activities planned in the classroom.

On the questionnaire after the DAST students were asked to identify the race and gender of the scientist that they drew as well as their own race and gender. In the pre-test 35 students drew a scientist that had both the same race and gender as themselves. Meaning that 66.0% of students drew a scientist that resembles themselves. In the post-test forty-one students did the same. While this was an increase in number it was not an increase in the percentage because the number of students in the post-test was higher than in the pre-test. Only 63.1% of students drew a scientist that resembles themselves.

When accounting for only the African-American students I found thirteen students drew a self-similar scientist during the pre-test, which was 68.4% of the African-American students in the study. After the lessons and the introduction of the students to two different African-American scientists, I found sixteen African-American students who drew an African-American Scientist, meaning that 72.7% of African-American students drew African-American scientists. This increase of over 4 percent suggests that African-American students were more likely to draw self-similar scientists after the CMSE Astronomy Week. Similarly, in the pre-test I found 50% of female students drew female scientists. Whereas, being introduce to two different female scientists during the lessons, I found 60% of female students drew female scientists.

As part of the pre-test and post-test questionnaire, participants were asked if they would like to be a scientist. There was an increase in both number and average here as well. The number of students having a desire to be a scientist rose from eighteen to twenty-four during the study. I saw an increase from 33.96% to 36.92% of the class desiring to be a scientist. Also, in the pre-test there was only one participant in the study that drew a scientist that had any resemblance to an astronomer or astronaut. After the curriculum implementation the number of students who drew astronauts or astronomers increased to five.

In summary, I observed an overall increase in the number of students who have a desire to be a scientist as a result of the CMSE Astronomy Week. There was an increase in the number of young women and African-American participants who drew self-similar scientists before the astronomy week and afterwards.

Selections from student work and interviews.

Many of the participants used the opportunity to draw a scientist to show themselves doing science. Figure 1 is a sample of a student drawing and his response to why he drew his scientist to be a particular race and gender.

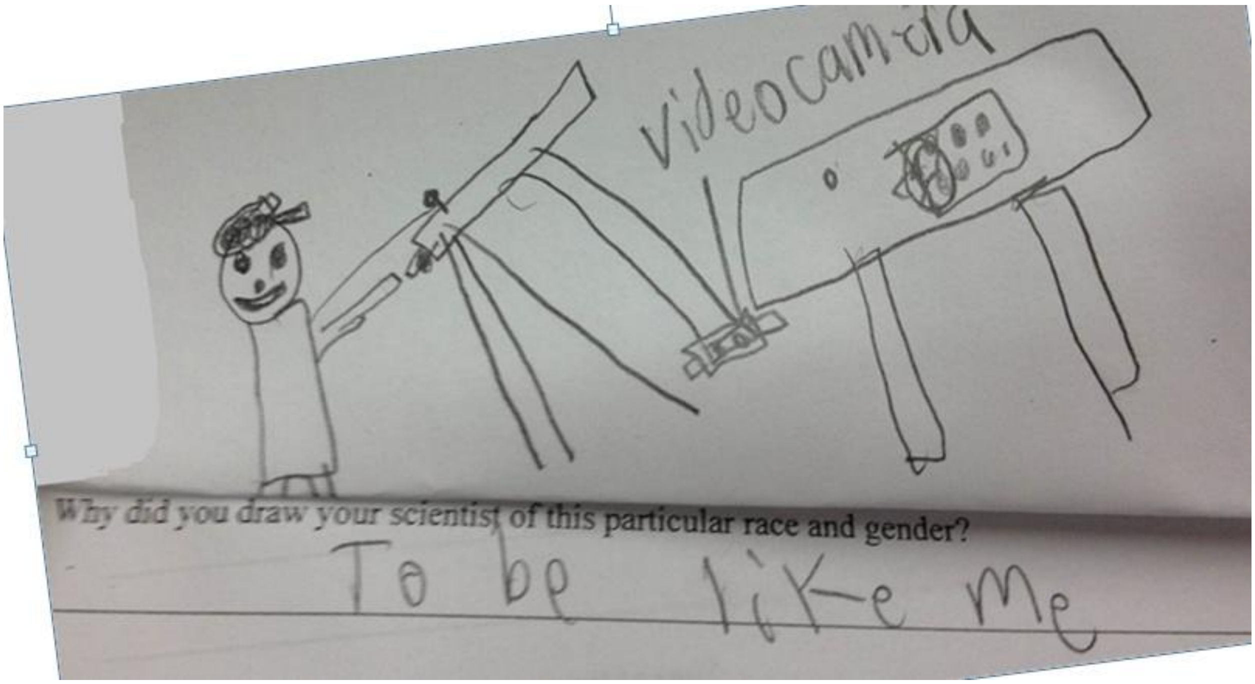

Figure 1:Student drawing

This student drew himself with a telescope and an attached camera to view the stars. He stated that he drew his scientist to be like himself. On the questionnaire each of the students were asked why they drew their scientist a particular race and gender. One students replied that "I drew it as a female because I'm a female and I'm African-American." These samples are evidence that students can use the DAST to project their own identity. Many of the female students drew female scientists. Figure 2 shows a sample of female scientists that were drawn by female students.

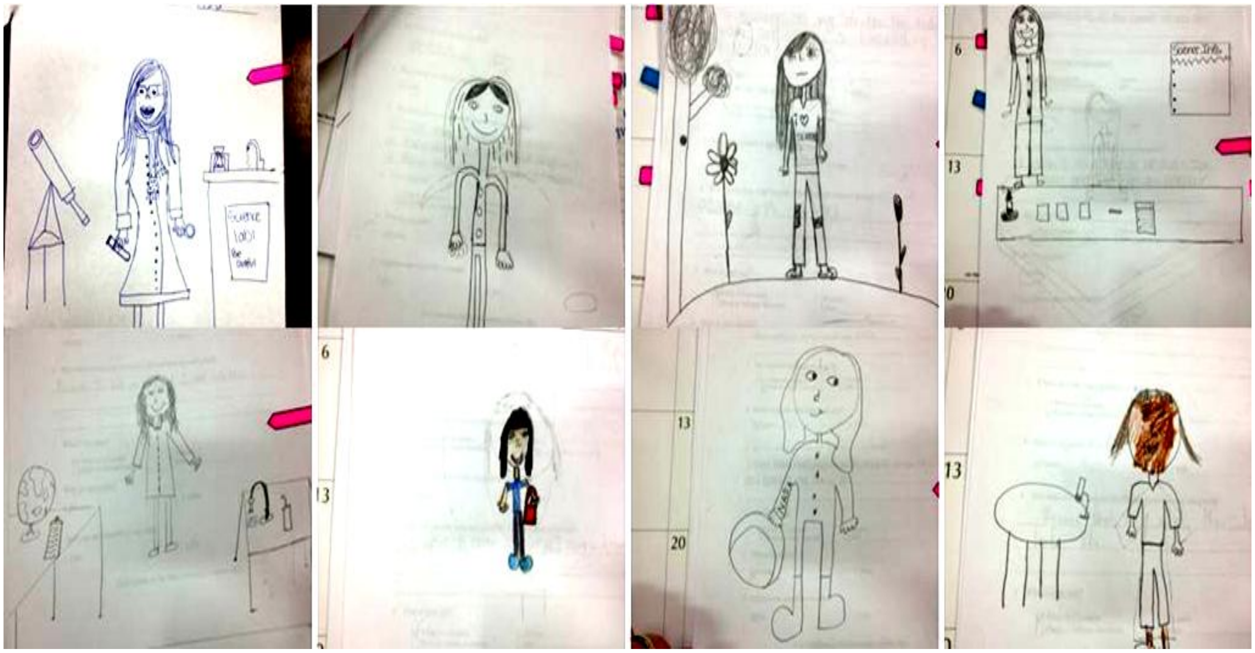

Figure 2: Student drawings of female scientists

In several of the images one can see that the female scientists are surrounded by science equipment that might be found in a chemistry lab while others are placed amongst plants or a telescope. Two of the drawings within the figure are representations of Mae Jemison who was introduced to the students as part of the Astronomy Week. Being introduced to a diverse group of scientists helped the students see that anyone can be a scientist. Figure 3 is a sample from a young man who drew an African-American scientist.

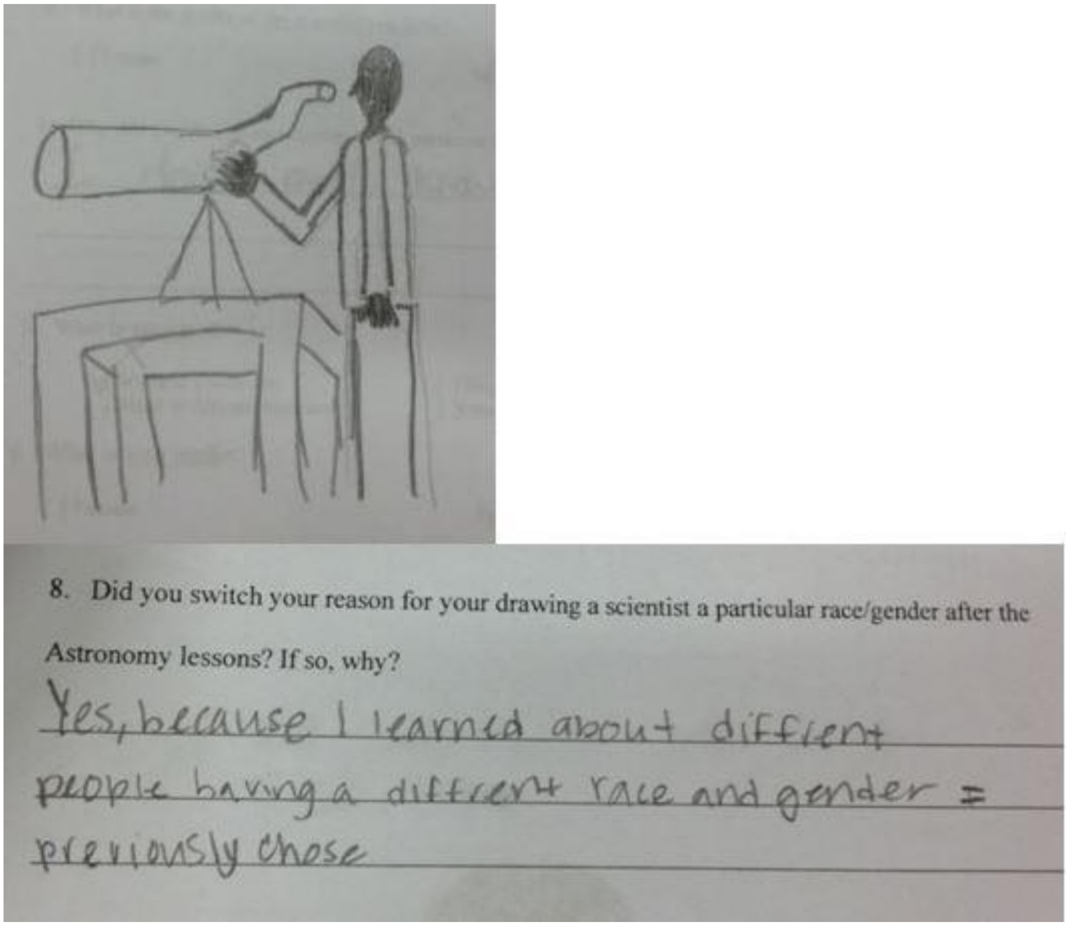

Figure 3:A student drawing of an African-American scientist with their reasoning for changing the race and gender of their drawn scientist

The student states that their reason for drawing a scientist as an African-American male is because they "... learned about different people having a different race and gender..." While the lesson did not emphasize the many ethnicities of the world, it did introduce students to scientists with varying ethnicities including African-American. The young man in this example decided that he could draw a scientist that looked like himself because he learned that there are African-American scientists. The introduction of diverse role models into the curriculum gave students a way to visualize themselves as a scientist. The students showed evidence of changing their belief about what a scientist can look like and therefore changing their belief about who can be a scientist.

Although I saw evidence of dispelled stereotypes, I also saw strong evidence that stereotypes persist. There were many drawings of the stereotypical white, male, scientist with indicators that made them look crazy or dangerous. Figure 4 is a sample of student responses that show the persistence of stereotypes.

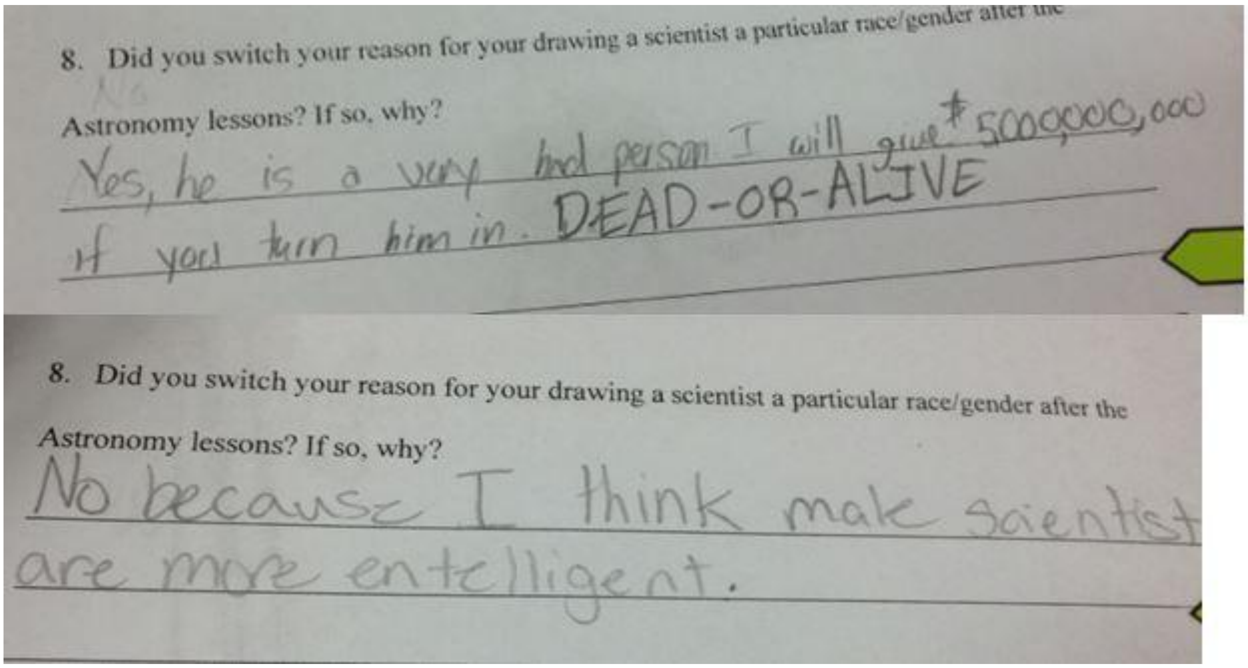

Figure 4:Student responses that include stereotypes about scientists

The belief that scientists are crazy or dangerous is a stereotype. The first student in Figure 4 offers a reward for the capture or killing of a scientist who is a "very bad person". The second student made a point to stress that male scientists are more intelligent than female scientists. These stereotypes were prevalent in the drawings and the student responses. Many of the statements made by students in regards to the stereotypic scientists were made with a measure of levity. But ultimately, even the light-hearted jokes stress a stereotype that may cause unease with becoming a scientist.

During the interviews I found that students were often open to the idea of being a scientist. I sat down with a young man and during the interview gave me some insight into his ideas of science.

> Interviewer: Would you like to be an astronomer when you grow up?
>
> Student C2: (Nods head)
>
> Interviewer: You would? Why?
>
> Student C2: Because you would get to explore a lot and you get to learn while you explore.

The student held the belief that astronomers explore new places. He seemed to imply that astronomers have the opportunity to work in a field where new material keeps the job interesting and exciting.

During the interviews one young lady expressed her desire to follow the career path of a scientist.

> Student F2: I have been thinking about it. I want to do something with science... because I want to be a marine biologist or an astronomer.
>
> Interviewer: A marine biologist or an astronomer. What draws you to those fields?
>
> Student F2: I have always loved the ocean and I have had such curiosity for it because I have only been once. I have always loved sharks. My mom thought I was crazy though... and like I said before, I love space. It is really cool out there.

This student is realizing that a career in science is compatible with her natural curiosity about the world. She has made a decision to follow a career path that will allow her to do things that she finds interesting and enjoyable.

I asked a young man about his experiences with the CMSE Astronomy Week and he seemed to just ramble off topics that were discussed in school.

Student F3: Well, I like the part where we made the rocket ships and how I learned about the two records that were made when they would jump from the space shuttles and how we also learned about the planets and how far apart they really are from each other... and about the black holes up in the planetarium... and how the sun sets different ways from the different seasons of the year... and how the north star can be seen from the north pole... and how you can see constellations in different months and different seasons.

Interviewer: Wow! You have learned a lot from this. Would you recommend the astronomy week to other students your age?

Student F3: Yes sir.

Interviewer: Why? What would you tell them?

Student F3: I would tell them how amazing it is to see how the planets are aligned towards the sun and how they move around each other and how they rotate and how they make a revolution around the sun and about constellations that be in different seasons and months... and how it was a record how two men were able to go up into the Troposphere and make a record about the highest jump.

Interviewer: Alright. Would you like to be an astronomer?

Student F3: Yes.

Interviewer: You would? Why?

Student F3: Because it is amazing to me how all these things are going on in space.

The young man expressed a great deal of excitement about science but there was not much direction in his thoughts or his career path. He mentions a record jump from the Troposphere which was not something that was discussed during the Astronomy Week but he does mention several topics that were included in the Astronomy Week. He mentions making a model of the solar system and even tries to convey the reason we have different seasons here on Earth. I realized that he had a great enthusiasm for science but had not found how he could be a part of the scientific community. I decided to ask him about the possibility of space travel.

Student F3: People are trying to go to Mars and find life there.

Interviewer: Would you go to Mars if you had a chance to go there?

Student F3: Yes.

The young man expressed his knowledge about the current explorations on Mars and expressed a desire to be a part of the process of discovery.

Student M3 was a young man in the seventh grade. I asked him if he would recommend the Astronomy Week to other students his age.

Student M3: Yes sir.

Interviewer: Why?

Student M3: So they could learn more about space and how it works and stuff. And how it is just a big black void that is filled with stars and planets and other galaxies.

Interviewer: Are there any of the lessons that stuck out to you?

Student M3: The one with the planetarium.

The young man remembered his visit inside the planetarium and had a desire for other children his age to experience it. When asked if he would like to be an astronomer when he grows up he answered affirmatively and shared his understanding of what it is like to be an astronomer.

Student M3: Because space fascinates me. Space is like an adventure through an unknown area.

He identified the career of an astronomer as a way that he could satisfy his desire for adventure. He saw astronomy as a way to explore and find new adventures.

Student M2 was a seventh grade female. When asked if she wanted to be an astronomer when she grew up, she indicated that she did not.

> Student M2: Some things, I'd like... but it has not really come to me that I'd like to be an astronomer.
>
> Interviewer: So you enjoyed the lesson but you don't necessarily want to be an astronomer?
>
> Student M2: Yeah.
>
> Interviewer: Would you be interested in a career in science in general?
>
> Student M2: If I can get that way. In science, if I am able to understand it as I get older.

Her experiences had lead her to believe that she was not very good at science and that she should not pursue a career in science. When asked about her experience with the planetarium she expressed enjoyment over the activity.

> Student M2: It was pretty cool. I liked how it looked so real. He was able to go through a day and show us where the Sun and the moon was. He showed us the Milky Way which was pretty cool. I didn't think it looked like that at all. And some of the star names... you know the star names...
>
> Interviewer: The constellations?
>
> Student M2: Yeah, the constellations. All the shapes that they came out to be was pretty cool.

Even though she had decided against being an astronomer or any other kind of scientist she still expressed her enjoyment of the planetarium experience. This may not have given her the experience where she identified with being a scientist but it did give her an experience where she tested the identity of scientist and did not get repulsed by the idea. While nothing in the Astronomy Week instilled in her a desire to become a scientist, she at least did not express any feelings of contempt toward science as a result of the experience.

In both the sample work and the interviews, several students showed signs of developing an identity of a scientist. African-American students were more likely to draw a black scientist after the Astronomy Week. Female students were more likely to draw a female scientist after the Astronomy week. Several students expressed interest in becoming an astronomer even if their understanding of what an astronomer does was not clearly understood. Even the students who did not express any interest in astronomy after the Astronomy Week, expressed enjoyment in the lessons and activities.

Research Question 2

This section addresses the research question regarding programmatic factors that influenced the effective and/or ineffective implementation of the CMSE Astronomy Week. As part of the CMSE Astronomy Week, schools receive a set of materials to be used in the classroom. These materials came in a large, heavy box. Because I had a vested interest in the schools participating in the Astronomy Week, I personally delivered the materials to the classrooms two weeks before the teachers began using the curriculum. The efficient delivery of the materials would be problematic for schools that are some distance from the university. The size and weight would make the shipping cost prohibitive. Without my personal intervention, the teachers would have had to travel to the University to gather the materials themselves.

These materials that were delivered were intended for the teacher to use in the classroom but in each of the schools there were multiple classrooms that wanted to participate in the

Astronomy Week. I found that teachers were sharing the materials with other faculty members and allowing students from multiple grades and classrooms to use the curriculum. While this was easily accomplished with the digital materials, the physical materials were in short demand. Teachers staggered the lessons so that other classes would have access to the materials.

I found that two of the three teachers in the study had insufficient technical equipment in their classrooms to implement the curriculum. The lessons included a slide of pictures, a video in mp4 format, and a free computer program called Stellarium, used to simulate the night sky. Teacher M and Teacher F had difficulty playing the videos on the school computers because the computers were outdated. Teacher F brought her own personal computer to the school during the Astronomy Week and used it to overcome technical issues with the equipment belonging to the school. When Teacher M used the school's computer, the Stellarium program lagged and affected the viewing experience. Also, when Teacher M tried to use the school's computer to view the videos, the videos had no sound. After a few failed attempts she decided to skip the video about Ronald McNair. Not wanting the students to miss out on being introduced to this great role-model, I offered the use of my personal computer which I had brought with me that day. Eventually, each of the teachers were able to overcome the obstacles but inadequate technology in the classroom remains a factor in the successful implementation of the CMSE Astronomy Week.

Running the planetarium was a strenuous task. On the day of the planetarium visit, each of the teachers invited their faculty peers to bring their classes through the planetarium as well. This meant that the staff for the planetarium presented a show every thirty to forty-five minutes for seven hours with no breaks. The presenter sits on the floor with a computer to operate the planetarium. I chose the option of sitting on a small stool for comfort but that option comes with the drawback of having the projector shine in my eyes. After presenting lessons for approximately four hours, I alternated with another CMSE employee. By the end of the day, my eyes were slightly strained and my legs were stiff from sitting on the floor. The stresses of presenting to multiple groups is a factor in the successful implementation of the program.

Research Question 3

This section addresses the research question, "What curriculum aspects influenced the effective and/or ineffective implementation of the CMSE Astronomy Week?" I give a description of the implementation of each of the lessons along with supporting information from the teacher questionnaires and other data collection instruments.

The curriculum involved four lessons that the teachers were to implement during the Astronomy Week. Each of the lessons can be done in a typical fifty minute class period and teachers were able to teach each of the four lessons within their class periods. The timing of the lessons was appropriate but, there were several factors that hindered the successful implementation of the lessons.

Lesson 1.

The first lesson was not implemented well in any of the classrooms I observed. There were technical issues with the telescopes. Teachers faced difficulty in sending the telescopes home with students. Vague instructions left the teachers feeling frustrated and confused. These factors made the telescope lesson the least favorite among the participants

This lesson involved the students making a telescope out of PVC pipes and fittings with lenses that fit into each end of the pipe to act as an eyepiece and an objective. It was intended that a lens would be placed on one end of the pipe and a threaded pipe connector would screw onto the pipe to fasten the lens securely. While this worked well with two of the lenses, six of the lenses were too thick and would not allow the threading to catch. I observed students showing signs of frustration while trying to look through an eyepiece that would not stay attached to their telescope. Students would spend effort trying to keep the lenses in place and forget to extend the telescope to bring an image into focus.

Each classroom was given enough materials to make fifteen telescopes. While this was plenty to complete the activity in class, each of the students were supposed to take a telescope home to view the stars and planets on their own. Teacher C was the only teacher that was able to send the telescopes home with students. She had one group that finished the telescope in class and they took turns taking the telescope home. This group was unique in that no other group in the study was able to both finish the telescope in class and take the telescope home.

On the teacher questionnaires, teachers stated that the main weakness of the Build a Telescope lesson was the lack of instructions or a guide for the teachers and students. Teacher M requested a step-by-step activity to help students understand the purpose of the lesson. Teacher F stated that the lesson needed some background information about different telescopes and lenses so that she could have something to reference when students had questions. The teacher responses showed that that this lesson needed more development along with compatible lenses and supporting materials.

Lesson 2.

The second lesson was implemented in each of the classrooms with a few difficulties. Each of the teachers were able to use Stellarium to show the retrograde motion of Mars after some practice at home, but the program has many more capabilities. Teacher F asked for more instructions on the program so that she could use it to teach other topics in astronomy.

Teacher C's 5th grade students had few issues but Teacher M's 7th grade students complained that the lesson was too advanced for them. Teacher C easily projected the program on a large screen in the classroom and her 5th grade students were able to use the student activity sheet to graphically show the retrograde motion of Mars. Because of an outdated computer, Teacher M experienced a lag in the program. The movement did not look smooth and the video was projected onto a tiny section of the whiteboard at the front of the room.

Lesson 3.

The third lesson had students pace out the radial distance from a Sun that is the size of a bowling ball. On this scale, Neptune is the size of a coffee bean and has a radial distance of over seven hundred yards from the Bowling ball. Each of the classes were able to implement this lesson with only minor difficulties.

In her responses to the questionnaire, Teacher C stated that her students were amazed at the distance between the planets. Her students were unable to pace the distance all the way out to Neptune because of the limited size of the school grounds but they were able to make it Saturn. Teacher C stopped the students at Saturn and asked the students how many steps they thought it would be to the next two planets. After hearing the students hypothesize about the distances, she told them the real values before heading back to the classroom.

Both Teacher F and Teacher M implemented scale model lesson to the point of pacing out the distance to Mars and then discussing the distances out to other planets. Teacher F asked her students if they could change the scale to make the model fit on the school grounds. One student replied that if the model were any bigger, the planets would be too small to see.

None of the teachers used Google Earth to pace out the scale model. I asked Teacher M if she would be able to use Google Earth if the lesson was on a rainy day and she was hesitant but open to the idea.

> Interviewer: Would you consider using Google Earth to put it on a map?
>
> Teacher M: I thought about it but I was kind of leery of it. I would need to practice with it a little bit more...finding the time to train and get familiar with the program. If I could, I would have thought about doing that with them. Maybe that would give them another little visual with the model.

While this option was not used in any of the classrooms, the teachers were no more hesitant to use Google Earth than they were to implement the lesson as planned.

Overall, the Solar System Model was the favorite among the teachers in this study. It was easy to implement, the materials were provided, and the directions were thorough and easy to follow. The teachers expressed interest in adding this lesson to their yearly curriculum and they even commented on the fact that it would be easy for students to make the materials when this lesson is given to classes in the future.

Lesson 4.

The fourth lesson was eventually implemented well within each of the classrooms but initially, each of the teachers felt some hesitancy about trying this lesson. This lesson has student plan a mission to Mars. Using a set of cards which gave a cost and description of a variety of equipment, students picked the equipment that they would need to take on their spaceship.

This lesson is intended to be part of a lengthy curriculum that has students submit their designs to space travel experts for grading. For the CMSE Astronomy Week, students only completed the stand alone activity. While the complete curriculum for this lesson is very detailed, the stand alone activity did not have a lengthy set of instructions for the teachers. The teachers had to review the entire curriculum to complete this activity. Two of the teachers even called me the night before the lesson to make sure that they were going to give the lesson the way it was intended. The teachers felt that the lesson was intimidating and were not sure how to present it to the class.

Part of this intimidating feeling came from a lack of instructions. Teachers needed to give the students a budget and since they had never done the activity, they were not sure how much it would cost to put a rover on Mars or put a satellite in orbit around Mars. They were also not sure how to present the goals of the trip to Mars. When the teachers called me, I suggested that the class have a common goal of putting a rover on Mars and I suggested a budget. I also asked that the teachers should try completing the activity themselves before presenting it to their students.

With a common class goal and suggested budget, the teachers implemented the lesson in their classrooms. After giving the lesson with the class I observed, the teachers became more open to using the lesson with other classes.

> Teacher F: I was real nervous building the rocket or spacecraft to Mars. I started out only doing it with the 5th period class but I went back and did it with my other classes and I actually got a grip of it and understood it a little more myself. They actually loved it and we had a competition and the winner got a prize. They actually had fun with it.
>
> Interviewer: So, after you did it a few times it became easier to do?
>
> Teacher F: Yes. Yes. For me especially because I understood it a little bit more. We were only doing that one little section of it so I had to go back and fully understand the first part and how to look at the power, look at the rocket boosters, and look at what you need

to compares. Whereas, the other one it kind of said: "Have the competition" without a lot of the information that I felt was missing for that. But overall, it was good.

Each of the teachers had similar experiences to Teacher F. Once they implemented the lesson once and knew the appropriate budget, they felt comfortable giving the lesson to all of their classes. They each also expressed frustration with the extra material that they read in order to understand the stand-alone activity.

Videos and Stories.

Each of the teachers were able to show and discuss the videos and stories that accompanied the activities. The teachers expressed that the videos worked great in the sense that they provided role models for the students but lacked a connection to the activities.

Interviewer: What about the stories and the videos that we watched?

Teacher F: I got feedback on that a lot. Most of them said that it was interesting but they did not see a connection. They thought: "Why are we watching this when it doesn't have anything to do with the lesson?" Because it didn't lead into anything that you would talk about on some other things. We do some a lot of articles and stuff in here and usually it has some tie into what we talk about. That may be the connection that they are used to and so, they didn't see a connection at all. Even with the telescope, you could do something with the history to tie into the lesson. They enjoyed it. They saw different things but then they were like: "whatever".

The lack of connection between the videos and stories made a fragmented theme within the curriculum. Students noticed the fragmentation and voiced their concerns to the teachers.

Planetarium.

The planetarium provided a realistic view of the sky and allowed students to be immersed in astronomy. The planetarium visit was implemented into the Astronomy Week with the only curricular issue was the presentation varying with different presenters. As a result of the planetarium show is not a recorded presentation, the show varied with the person delivering the lesson. After presenting multiple sessions, I felt weary and some of my enthusiasm began to waver. The weariness and the varying personalities of the presenters lead to a lesson that was slightly different in each class. These variations appeared to be minor, as the material covered in each presentation was consistent.

Conclusion

In conclusion, there were both major and minor curricular issues during the CMSE Astronomy Week. Teachers became frustrated with the lack of detailed instruction and from the lack of training before implementation. The videos and stories that were intended to emphasize diversity within science careers did not connect well with the lessons. The schools faced issues with limited space and technology requirements. The teachers used diverse methods to overcome the curricular issues and were able to implement the curriculum successfully.

Chapter Summary

In reference to my first research question, I noticed indicators that point to an impact on student identity formation as a result of the CMSE Astronomy Week. More African-American students drew an African-American scientist at the end of the CMSE Astronomy week than before it. More female students drew a female scientist at the end of the CMSE Astronomy week than before it. There was an increase in the number of students who drew astronomers or astronauts and some of the participants expressed interest in becoming an astronomer. Many of the students who expressed that they did not want to be astronomers, did indicate that they enjoyed the CMSE Astronomy week and would recommend it to a friend. These observations indicate that there was an impact on the identity formation of the participants.

In reference to my second research question, there was evidence of several factors that influenced the implementation of the CMSE Astronomy Week. The delivery method for curricular materials that was utilized was successful but inefficient. Teachers faced issues with having old and outdated computers and equipment. The long hours in the planetarium were strenuous on both the body and the eyes of the staff. While these factors did not cripple the project, they did require extraordinary effort from the staff and myself.

In reference to my third research question, there were many curriculum aspects that influenced the implementation of the CMSE Astronomy Week. The first lesson lacked adequate teacher instructions and functioning materials. The second lesson was implemented effectively in each of the classrooms but teachers asked for more guidance on using the Stellarium program. The third lesson was the favorite lesson among the participants of this study but faced issues with limited space on school property. One teacher overcame her lack of space by using Google Earth to place a model of the solar system on a map. The fourth lesson was implemented effectively but each of the teachers felt some hesitancy in presenting the lesson but this hesitancy was dispelled after their first time presenting. The supplementary videos and stories that introduced students to scientists of varying races and gender were easily presented but both teachers and student felt that they did not connect well with the lessons. While some of the materials lacked rigor, the teachers and students showed excitement and appreciation for the experience of the CMSE Astronomy Week and were interested in sharing the experience with their peers.

CHAPTER V: SUMMARY AND FUTURE WORK

Introduction

The CMSE Astronomy Week acts as an agent of change in the positive direction for STEM careers in Mississippi. There is evidence that the program helps students include science as a possibility for a career path. They even broadened their view of scientists to include astronomy related professions. The positive outcomes call for a continued effort to reach students in Mississippi and help them find a STEM career. The implementation of the program and its curriculum was not perfect but steps can be made to improve the program and help ensure its success. It is my desire to see the results of this study used to help improve the CMSE Astronomy Week program so that the program can continue to enrich the lives of students in Mississippi and be successful in developing students' interest in STEM professions.

Summary of Findings

Research question 1.

In relation to my first research question, there is evidence that the CMSE Astronomy Week had an impact on student identity formation. Students were introduced to a diverse set of scientists and as a result, more African-American students drew African-American scientists and more female students drew female scientists. One student even indicated that being introduced to the diverse scientists in the lessons, caused them to draw a scientist that was similar to themselves. While there was some progress shown in the dispelling of stereotypes, many indicators of stereotypes remained. This is important to note because while there was progress made, the short intervention should be only a portion of long-term attempts to help students follow a STEM career.

Students were introduced to a diverse set of astronomy related professionals as suggested by Claude M Steele (1997). This gave them the chance to see and hear about a real person working in a profession that they may very well one day serve in. Being introduced to female and minority scientists allowed female and minority students to gain a role model in the STEM profession. While there was an increase in the number of female students who drew female scientists, this may be misleading by the change in the number of female students from pre to post-tests. There were more female students in the post-test because of a female sporting event that took place on the pre-test date.

Of all the students participating in the study, only one student drew an astronomer or space related scientist during the pre-test. The lack of representation of astronomy in student drawings raises the question of whether students see astronomy as a credible scientific field or as a common scientific profession. Students may not even be aware that the field of astronomy exists. A total of five students drew a space related scientist in the post-test. This shows that exposure to astronomers helps students recognize astronomers as scientists and as part of the scientific community. Future efforts to lure students into STEM careers can be assisted by introducing students to professionals who can act as role models for the students.

The data show that stereotypes for scientists still persist after the CMSE Astronomy Week. I got the impression that the stereotypes of scientists being crazy or dangerous was often a student's attempt at being humorous, while the stereotypes of scientists being predominately white males was a more serious extension of who the students believed could be a scientist. It is important to remember that even stereotypes that seem benign may cause a threat to students who are thinking of entering a STEM profession (Claude M Steele, 1997). The art provided by the students was both insightful and attention grabbing as it affirmed the image that many children have in their mind of a person in the field of science. While both stereotypes persisted throughout the study, the increase in the diversity of drawn scientists shows that student perceptions of scientists were altered in a positive way. This will hopefully, lead to a greater desire to enter into a science profession. With continued education that includes fun, scientific activities that involve hands on experiences and advanced teaching tools, these students can have a clear view of a career path that leads to a STEM profession.

Research question 2.

In reference to my second research question, there was evidence of several factors that influenced the implementation of the CMSE Astronomy Week. The delivery method for curricular materials that was utilized was successful but inefficient. Teachers faced issues with having old and outdated computers and equipment. The long hours in the planetarium were strenuous on both the body and the eyes of the staff. While these factors did not cripple the project, they did require extraordinary effort from the staff and myself.

When schools reserve the materials for the CMSE Astronomy Week and request a visit from the planetarium, an efficient method of delivery is needed for the curricular materials. The large, heavy box containing the materials could be transported to varying campuses via the University shuttle system. This way, teachers could pick up the materials at the university campus that is closest to them. Another option is to have the materials delivered by carrier. While this would be the easiest method, it would be costly and affect the sustainability of the program. The idea of teachers picking up their own material and transferring it to their classroom or school gym can be overwhelming. This could greatly affect the number of teachers willing to participate in future CMSE programs. The current method of personal delivery to the school is effective but not feasible for the program as it becomes larger in scale.

Outdated equipment was a concern in the schools that participated in the study. It is not in the best interest of the program to start supplying schools with standard computer equipment that should be in every classroom. However, personnel at the CMSE can ensure that the media files associated with the curriculum are uncorrupted and in an easily accessible format. Future program personnel should work to minimize technical issues that can lead to frustration in the classroom. The simplification of media files is a way that the curriculum can be made more accessible to teachers.

Training for teachers would also be beneficial. If teachers were given instruction in a summer workshop or training session then they would be better equipped to overcome challenges in implementing the lessons. This training would also alleviate concerns teachers may have about the lessons because it would give them a chance to practice the lessons with assistance from other professional educators. Teachers that participate in a summer training session could have first priority in reserving the materials and planetarium. With future plans to scale up the program to accommodate more schools in the area, reserving the materials in advance will help the program reach as many schools as possible while maximizing its effectiveness.

An adequate number of staff are needed to reduce the stress on presenter inside the planetarium. The long hours and awkward sitting positions becoming draining and irritating, making the quality of the presentation suffer. Having staff that can take shifts in the planetarium can reduce the eye strain and stiff muscles that come with presenting in the mobile planetarium over long periods of time. Eye strain could also be reduced if the projector was elevated a few inches so that it does not shine in the eyes of the presenter. It is important to note that these minor physical stresses are not prohibitive and are quite minor in comparison to the prohibitive travel requirements associated with going to a full-sized planetarium.

The recommendations provided are given with the intent of the program being scaled up and becoming sustainable over long periods of time. Financial concerns for sustainability also need to be addressed. I believe that with the implementation of the recommendations from this study, the CMSE Astronomy Week will be a quality experience that schools would be willing to pay for. The cost of travel expenses and staff salaries could be covered by a small fee from participating schools. Future personnel should analyze the cost of maintaining the program and consider charging a fee to ensure that the CMSE Astronomy Week has a long, sustainable future in Mississippi.

Research question 3.

In reference to my third research question, there were many curriculum aspects that influenced the implementation of the CMSE Astronomy Week. The first lesson was impaired by lack of teacher directive and functional materials. The first lesson sessions became exasperating at times and led the teachers to feel discouraged. This lesson could easily be revised and improved by ensuring that the materials are functional. Following the revisions, a peer review process should be utilized to ensure that the lesson holds to professional standards.

The second lesson was presented effectively in each of the classrooms but teachers asked for more direction when it came to using the Stellarium program. This lesson gave each class a chance to perceive the universe from the comfort of their classroom. The simplicity of this program made it effortless to use in the classroom as a small planetarium. Again, some training on the use of the program was requested by the teachers.

The third lesson was the preferred lesson amid the members of this study but faced issues with inadequate space on school property. One teacher overcame her lack of space by using Google Earth to place a model of the solar system on a map. She was able to overcome her lack of space effectively by using the resources she had available.

The fourth lesson was implemented as planned but each of the teachers felt some reluctance in presenting the lesson. This hesitancy was dispelled after their initial experience with the lesson. The teachers presented the stand alone activity and expressed frustration with the lack of instructions specifically for the stand alone activity. This peer reviewed lesson is of high quality and appropriate for the CMSE Astronomy Week. Teachers could be better equipped to present the stand alone activity if they were trained prior to implementing the lesson in their classroom.

The accompanying videos and stories that introduced students to scientists of varying races and gender were easily presented but participants felt that the videos did not have any coherence with the lessons. My recommendation is to create an entire new lesson or find a peer reviewed lesson already in existence that is devoted to introducing students to multicultural scientists. Introducing the students to multicultural scientists influenced the identity formation of minority students but I feel like this lesson could be better presented as a completely separate lesson that is specifically designed to provide role models for minority students.

Table 3

Suggestions to Improve the CMSE Astronomy Week
• Shuttle the materials to University satellite campuses to avoid shipping and to ease travel burden • Hold a summer workshop to train teachers on implementing the curriculum • Ensure the planetarium is staffed by at least two people when visiting schools • Charge schools a field trip fee to pay for travel and expenses for the planetarium • Revise Lesson 1 and assess it via a peer review process • Create or include a separate lesson to introduce students to ethnically diverse scientist

Future work.

It is my hope that the CMSE Astronomy Week becomes a model for STEM outreach in Mississippi. I want to see students being introduced to STEM careers from an early age and see students guided toward careers that can fit within their own personal identity and fill the need we have for STEM careers. In order for my desires to come to fruition, the CMSE Astronomy Week must become sustainable and be effective in its mission to bring astronomy to students in Mississippi. I believe that my suggestions are a first step to ensuring the successful continuance of the program but more work is needed.

More research is needed to show the long term effect this outreach effort on student career paths. After changes are made in the curriculum, it should be studied again to ensure that the lessons are accomplishing the goals of the program. Future work could take a different approach to working with schools, with more emphasis on scaling up the program to serve more people.

As the program grows and the curriculum is improved, it will be possible to study student identity formation with more participants and with fewer curricular deficiencies. Future research could provide a better understanding of student identity formation by testing the significance of change in the number of self-similar images and thus providing a quantitative understanding of how identity is changing in students. Rich data could be gathered by having students also write a story about their drawn scientists while also making a connection to the language arts common core standards (Initiative, 2010). Stories about the scientist could also help identify who the scientist is supposed to be. If the student is drawing a picture of a close relative or friend, then the picture drawn may not be related to the identity formation of the individual.

This future research could act as a scientific basis to obtain funding and continue the services that the CMSE Astronomy Week is bringing to schools in the area.

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APPENDIX A: CALL FOR PARTICIPANTS

Call for Participants:

The Center for Mathematics and Science Education (CMSE) at the University of Mississippi is requesting participants for the CMSE Astronomy Week. This free program consists of a week's worth of teaching materials delivered to participating schools followed by a visit from a traveling exhibition that includes hands-on activities and a mobile planetarium. Participating schools are asked to implement approximately four hours of astronomy curriculum materials and afterwards, the CMSE will bring the traveling exhibition. The traveling planetarium will accommodate approximately 30 students at a time and allows the students to be immersed in a star show that captivates and inspires. **PLEASE SCHEDULE A VISIT TO YOUR SCHOOL by** contacting CMSE at umcmse@olemiss.edu or by calling 662-915-6621.

This outreach program is a service brought to you by the Center for Mathematics and Science Education at the University of Mississippi. Participants are asked to volunteer in a research study that will help guide future outreach efforts. When scheduling a visit, please feel free to volunteer in this research study. More details can be found at http://cmse.olemiss.edu.

APPENDIX B: INTERVIEW PROTOCOL

Interview Protocol

Date: Time: Place:

Interviewer: Carl Dewitt

Interviewee(s):

Standard Procedures:

The participant(s) will be interviewed for approximately thirty minutes at a mutually agreed upon location. An audio recorder will be used turned on during as the interview begins. The interviewer will use the following prompts and open-ended questions to guide the interview. There will be flexibility to allow the interviewer to ask additional questions that arise during the interview. Once the interview has been concluded, the audio recorder will be turned off. A debrief with the participant will occur and the participant will be thanked for their participation.

Teacher Interview Prompts:

1. Tell me about your classroom experiences with the CMSE Astronomy Week curriculum.
2. Were students given the opportunity to become an astronomer for the week? Provide examples from your classroom.
3. Were there any factors that influenced the implementation of the curriculum?

Student Interview Prompts:

1. Tell me about your classroom experiences with the CMSE Astronomy Week.
2. Would you recommend the Astronomy Week with its classroom activities and the planetarium visit to other children your age? Why?

3. Would you like to be an astronomer? Why or why not?

Thank-you statement:

Thank you for sharing for your participation with this outreach program and research study. Do you have any questions for me?

APPENDIX C: OBSERVATON TOOL

Observation Tool

Classroom Description:

Layout and Student Grouping:

Observation Tool (page 2)

Lesson being observed:

Observations:

Possible Fidelity Issues:

APPENDIX D: DRAW A SCIENTIST TEST

Instructions: Draw a Scientist

APPENDIX E: STUDENT QUESTIONNAIRE

Student Questionnaire

1. Describe the scientist that you drew.

____

____

____

____

2. What is the race of the scientist you drew?

[ ] White or Caucasian [ ] Hispanic
[ ] Black or African-American [ ]Other:___________________________

3. What is the gender of the scientist you drew?

[ ] Female [ ] Male

4. Why did you draw your scientist of this particular race and gender?

____

____

____

5. What is your race?

[ ] White or Caucasian [ ] Hispanic
[ ] Black or African-American [ ]Other:___________________________

6. What is your gender?

[ ] Female [ ] Male

7. Could you see yourself as a scientist?

[ ] Yes [ ] No

(Last Questions for Post-Astronomy Lessons only)

8. Did you switch your reason for your drawing a scientist a particular race/gender after the Astronomy lessons? If so, why?

____

____

____

____

9. As a result of the Astronomy Week lessons, do you want to pursue Astronomy in the future?

[ ] Yes, I want to learn more about astronomy because of the Astronomy Week

[ ] No, I do not want to learn more about astronomy because of the Astronomy Week

Please explain:

____

____

____

____

10. Is there anything else you want to say?

____

____

____

____

APPENDIX F: TEACHER QUESTIONNAIRE

Teacher Questionnaire

Answer the following questions honestly. Please be as detailed as possible. Use the back or extra paper if necessary.

1. What are the strengths of the CMSE Astronomy Week Curriculum in general?

2. What are the weaknesses of the CMSE Astronomy Week Curriculum in general?

3. What are the strengths and weaknesses of the Build a Telescope lesson? Did the students actually use the telescopes to look at the night sky?

4. What are the strengths and weaknesses of the Retrograde Motion lesson?

5. What are the strengths and weaknesses of the Solar System model lesson? Were you able to do the entire walk or did you make other accomidations?

6. What are the strengths and weaknesses of the Marsbound lesson? Were students able to make it Mars?

7. What are the strengths and weaknesses of the planetarium experience?

8. In what way could the CMSE Astronomy Week Curriculum be improved?

9. Would you recommend the CMSE Astronomy Week to other teachers? Why?

VITA

Carl Dewitt

Education

University of Mississippi
Masters in Education (2010)
Areas of Concentration: Secondary Education, Physics

University of Mississippi
B.A. Physics (2008)
Areas of Concentration: Physics, Mathematics, Education
Minor: Mathematics
Sigma Pi Sigma Honors

Itawamba Community College
Associates of Arts, (2006)
Phi Theta Kappa Honors

Professional Experience

University of Mississippi (8/09-Present)
Graduate Student, Fellow for Center for Mathematics and Science Education

Northwest Community College (8/11-Present)
Physical Science Teacher

Oxford City Schools (8/08-5/09)
Physical/Earth Science Teacher, 9-12

Awards and Honors

- Awarded Graduate Fellowship 2012-2013
- Awarded Graduate Fellowship 2011-2012
- Awarded Graduate Fellowship 2010-2011
- Awarded Graduate Fellowship 2009-2010
- Awarded Mississippi Space Grant Scholarship 2008 and 2009
- Sigma Pi Sigma physics honor society 2008

- Phi Kappa Phi honor society 2008
- Awarded Phi Theta Kappa Scholarship 2006-2008
- Awarded Lucky Day Scholarship 2006-8
- Phi Theta Kappa honor society 2006

Professional Memberships

- Mississippi Science Teachers Association 2007-present
- National Science Teachers Association 2009-present
- American Association of Physics Teachers 2009-present
- Society for Information Technology and Teacher Education 2011-present
- Mississippi Association of Physicists 2012-present