ABSTRACT

KIER, MEREDITH WEAVER. Examining the Effects of a STEM Career Video Intervention on the Interests and STEM Professional Identities of Rural, Minority Middle School Students. (Under the direction of Margaret R. Blanchard).

National efforts to interest students in STEM careers are intensifying around the globe, due to a shortage of professionals to fill the growing demands in these fields. Although some US studies find high interest in STEM in K-12 students, longitudinal studies show a decline in interest following middle school. Many students, particularly females and minorities, feel that they do not fit the image of a STEM professional. Little is known about perceptions held by students in rural areas, who have limited access to diverse STEM careers. This dissertation study employed an in school STEM career video intervention with eighty-five rural, minority, eighth grade students in a high poverty district in the southeastern US. Research questions explore students’ STEM career interests before and after the STEM career video intervention, and analyze how students in this population negotiate a potential identity in STEM. Applying aspects of Lent, Brown, & Hackett’s social cognitive career theory (SCCT), students’ exploration sheets and video planning sheets were coded to understand positive or negative contributors to STEM career interests. Students’ initial explorations were limited to careers to which they had been previously exposed at home or in class, and were influenced by their personal dispositions. Over the course of the intervention, increased knowledge of careers increased the diversity of careers selected, attention to educational level, and the influence of more sophisticated career outcomes on interest. Students selected careers based on personal interests and outcome expectations, but were
able to identify how their academic strengths, dispositions, and family support systems related to their career goals. Post survey analyses found the presence of role models and high self-efficacy were new predictors of interest. Study results imply that similar interventions can help students gain more sophisticated understandings of careers, can motivate students without external rewards, and that with extensive exposure to new careers, students will begin to consider their own skill set when trying on careers. Case studies of four highlighted issues of race, access to resources, hands-on experiences and course access, teachers’ perceptions of them, and parental support among others that impact their STEM experiences and negotiations of a STEM self.
Examining the Effects of a STEM Career Video Intervention on the Interests and STEM Professional Identities of Rural, Minority Middle School Students

by
Meredith Weaver Kier

A dissertation submitted to the Graduate Faculty of North Carolina State University in partial fulfillment of the requirements for the degree of Doctor of Philosophy

Science Education

Raleigh, North Carolina

2013

APPROVED BY:

Margaret Blanchard
Committee Chair

Glenda Carter
Committee Member

Sarah Carrier
Committee Member

Heidi Carlone
Committee Member

Miriam Ferzli
Committee Member
DEDICATION

This dissertation is dedicated to my husband Nick. I thank him for letting me bounce ideas off of him, for proofreading my writing, for encouraging me when I was not sure of myself and for being such a great father to our one year old daughter, Olivia. I could not have made it through this without you.
BIOGRAPHY

Meredith Weaver Kier was born in 1983 in Suffolk, Virginia. Her parents Keith and Susan Weaver raised her and younger sister Emily in the very rural town of Carrsville, Virginia. Living in the boonies created a lifelong love for nature, animals, and outdoor sports. Many days were spent riding bikes down desolate back roads, running around with the family dogs outside and hitting tennis balls on the roof. Meredith’s father owned a small family construction business, and mother worked as a high school math teacher for 18 years. When Meredith entered high school, they decided to make a career change to become owners of a childcare business in Suffolk, VA. They now own two childcare centers and preschools in Suffolk and Smithfield, Virginia.

Meredith attended Nansemond Suffolk Academy in Suffolk Virginia from kindergarten to the twelfth grade. She excelled in her science classes and realized that she had a passion for the life sciences when she stayed after her AP Biology class to continue dissecting a pregnant cat. Meredith also enjoyed team sports, playing basketball and soccer throughout high school. She was involved in many clubs, including holding office in the National Honor Society. Meredith attended James Madison University for her undergraduate B.S. degree in Biology as well as her Master's Degree in the Art of Teaching. Throughout college, she worked as a server at an Italian Restaurant and was actively involved in Campus Assault Response (CARE).

She took her first job at Falls Church High School, in Falls Church, Virginia as an ESL Biology Teacher. Having limited experiences with students who spoke languages other than English, she worked diligently to understand the different cultures of her classroom and
to form a trusting connection with her students. She became passionate about helping ESL students understand the language of Biology and taking part in new lab experiences that they never knew before. She moved to Raleigh, NC after her first year of teaching and taught at Wakefield High School in Raleigh, NC. She was recognized by her colleagues as being able to connect with lower level students and ‘break down’ the subject of Biology to help students excel. During her second year of teaching at Wakefield, she began attending North Carolina State University part-time. The following year, Meredith became a full-time student and graduate assistant to Dr. Meg Blanchard on her STEM Career Awareness Grant.

Meredith is married to her husband Nick, who is a high school social studies teacher at Wakefield High School. Nick and Meredith welcomed their daughter Olivia to the world in April of 2012. Nick, Meredith, Olivia and 4 year old retriever Cooley reside in Northeastern Raleigh, NC.
ACKNOWLEDGMENTS

I want to express my gratitude for the support given to me throughout this process by my advisor, colleagues, study participants, family and friends.

Thank you to my advisory committee chair, Dr. Meg Blanchard. I truly appreciate your feedback on everything that I ever wrote in graduate school and your guidance throughout the process of this dissertation. You have provided me with opportunities to work on your grant with the wonderful teachers in North Eastern North Carolina, to meet and work with people across the country in our field and to experience different facets of research and teaching. It has truly been a pleasure to learn from someone who cares so much about their research and their students.

Thank you to my committee members. Dr. Glenda Carter, I appreciate your thoughtful questions and your push to help me explain my thoughts more articulately. Dr. Sarah Carrier, thank you for your thorough feedback on my writing and our conversations about research. Dr. Heidi Carlone, thank you for mentoring me in Colorado, pushing me to write good research questions and helping me to better understand student identity. Dr. Miriam Ferzli, thank you for your feedback and support. I would also like to thank my Master’s advisor Dr. David Slykhuis. Your enthusiasm in my first methods course made me realize that I wanted to do what you do. Thank you for your recommendations and support for the past 7 years. Also thank you to Dell Tolin and Jennifer Albert. Dell, thank you for consulting with me about statistics, and for explaining the implications of my analyses. Jen, thank you for being a sounding board, a great coworker, a good working mother mentor, and a friend throughout this process. I am so grateful to Cicelia Aguilar and her students who
allowed me into her classroom each week for an entire semester. Cicelia, I am truly inspired by your commitment to your students, your eagerness to try new things in your classroom, and your love of science education.

Thank you to my parents Keith and Susan Weaver who modeled how to work hard for your dreams. Thank you both for listening to me through the good and the bad days and pushing me not to give up. You have both supported me in my decisions and pushed me to step outside of my comfort zone to take chances and find happiness. Also, thank you to my mother-in-law Laurin Kier for your love and support.

I cannot fully express my love and gratitude to my husband, Nick Kier, for sticking by my side through the ups and downs of graduate school. I know you didn’t really care about the literature reviews and drafts of articles that you read, but it means so much to me that you offered your feedback. I could not ask for a more kind, loving and supportive partner to be by my side. I love you.

Finally, thank you to my sweet daughter Olivia. I always tried to write while you slept. Exhaustion was forgotten when you smiled at me and reached for me to hug you. You make this world a better place. Take chances, and go after what you want. I love you to the moon and back.
# TABLE OF CONTENTS

LIST OF TABLES ......................................................................................................................... xii

LIST OF FIGURES ......................................................................................................................... xiv

CHAPTER ONE: INTRODUCTION .............................................................................................. 1

Interest in STEM Careers ........................................................................................................ 2

Students’ Perceptions of STEM Careers and Professionals ................................................... 3

Strategies Encouraging STEM Interest in Rural Schools ..................................................... 4

Theoretical and Conceptual Frameworks ................................................................................. 5

  Social Cognitive Career Theory ......................................................................................... 5
  STEM Identity ...................................................................................................................... 7
  Possible Selves’ Theory ...................................................................................................... 9

Research Questions ................................................................................................................ 10

Summary ................................................................................................................................ 11

CHAPTER TWO: REVIEW OF THE LITERATURE ..................................................................... 14

The Need for STEM Professionals ........................................................................................ 15

  Definition of STEM and the STEM Workforce ............................................................... 15
  STEM Education ............................................................................................................... 17
  Development of STEM Career Interest .......................................................................... 17
  Students’ Perceptions of STEM Careers and Professionals ......................................... 20
  Recommended Strategies to Increase Interest in STEM ................................................ 22

Theoretical Frameworks ....................................................................................................... 24

  The Social Cognitive Career Theory ............................................................................. 25
  Science Identities .......................................................................................................... 33

Summary ................................................................................................................................ 38

CHAPTER THREE: METHODOLOGY .................................................................................... 40

Research Questions .............................................................................................................. 40

Setting .................................................................................................................................. 41
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>42</td>
</tr>
<tr>
<td>Context of Overall Project</td>
<td>43</td>
</tr>
<tr>
<td>Project Design</td>
<td>46</td>
</tr>
<tr>
<td>Data Sources and Analysis</td>
<td>52</td>
</tr>
<tr>
<td>Pre survey/Post survey</td>
<td>52</td>
</tr>
<tr>
<td>Student Career Video Exploration Sheets</td>
<td>55</td>
</tr>
<tr>
<td>STEM Career Identity Protocol</td>
<td>61</td>
</tr>
<tr>
<td>STEM Career Planning Guides</td>
<td>61</td>
</tr>
<tr>
<td>STEM Career Script</td>
<td>63</td>
</tr>
<tr>
<td>STEM Career Video</td>
<td>63</td>
</tr>
<tr>
<td>STEM Career Identity Interview</td>
<td>64</td>
</tr>
<tr>
<td>Significance of Study</td>
<td>65</td>
</tr>
<tr>
<td>CHAPTER FOUR: HOW DOES A STEM CAREER VIDEO INTERVENTION INFLUENCE THE STEM CAREER INTERESTS OF RURAL, MINORITY MIDDLE SCHOOL STUDENTS?</td>
<td>66</td>
</tr>
<tr>
<td>Abstract</td>
<td>66</td>
</tr>
<tr>
<td>Introduction</td>
<td>67</td>
</tr>
<tr>
<td>Literature Review</td>
<td>69</td>
</tr>
<tr>
<td>STEM Education</td>
<td>69</td>
</tr>
<tr>
<td>The Development of Student Interest in STEM</td>
<td>70</td>
</tr>
<tr>
<td>Students’ Perceptions of STEM Careers</td>
<td>73</td>
</tr>
<tr>
<td>Strategies that Encourage Interest and Goals in STEM</td>
<td>74</td>
</tr>
<tr>
<td>Theoretical Framework</td>
<td>76</td>
</tr>
<tr>
<td>SCCT Application at the Middle School Level</td>
<td>80</td>
</tr>
<tr>
<td>Research Questions</td>
<td>83</td>
</tr>
<tr>
<td>Methods</td>
<td>83</td>
</tr>
<tr>
<td>Setting</td>
<td>83</td>
</tr>
<tr>
<td>Participants</td>
<td>85</td>
</tr>
<tr>
<td>Context of Overall Project</td>
<td>86</td>
</tr>
<tr>
<td>Project Design</td>
<td>87</td>
</tr>
</tbody>
</table>
Data Sources and Analysis...........................................................................................................94

Pre survey/Post survey ................................................................................................................95
Student Career Video Exploration Sheets ..................................................................................97
STEM Career Video Planning Guides .........................................................................................103
Findings......................................................................................................................................105

Initial Interest in STEM Classes and Careers........................................................................105
Summary of Students’ Initial Interests in STEM Careers .............................................................111
Career Video Planning Guides .....................................................................................................114
Summary of Students’ Explanations of STEM Career Interests ..................................................116
Effects of a STEM career intervention on student interest ............................................................117
Student’s Planning Sheets and Video Selections .......................................................................125
STEM Career Videos ..................................................................................................................127
Quantitative changes in SCCT factors .......................................................................................128
Student Engagement and Motivation over Time .......................................................................133

Summary of Changes in Students’ STEM Interests ...................................................................135
Discussion...................................................................................................................................136

Students’ Initial Interest in STEM...............................................................................................136
Students’ Explanations of their Interests and Influences to Pursue a Career in STEM ............138
How STEM Career Interests Changed throughout a Video Intervention ....................................142

CONCLUSIONS AND IMPLICATIONS.........................................................................................147

CHAPTER FIVE: HOW DO FOUR RURAL MIDDLE SCHOOL STUDENTS EXPLAIN THEIR STEM INTERESTS AND STEM IDENTITIES WHEN EXPLORING AND CREATING A STEM CAREER VIDEO? .................................................................150

Abstract......................................................................................................................................150
Introduction.................................................................................................................................151

Literature Review........................................................................................................................154

The Development of STEM Career Interest................................................................................154
Perceptions of STEM Professionals and Careers .......................................................................156
Suggested Strategies to Increase Interest and Awareness in STEM ............................................157
Social Cognitive Career Theory in the Context of STEM..............................................................159
Discussion........................................................................................................................................219
Students’ Changes in STEM Interest through a Video Intervention .................................................220
How Students’ Negotiated STEM Career Identities .................................................................225
Students’ Conceptions of their ‘Possible Selves’ ...........................................................................228
STEM Identities ..........................................................................................................................230
Conclusions and Implications ........................................................................................................236
CHAPTER SIX: CONCLUSIONS .......................................................................................................239
Summary of Conclusions .................................................................................................................240
Implications .....................................................................................................................................241
The Utility of the SCCT in Understanding Student Interest .............................................................245
Assessing the use of the STEM Career Interest Survey .................................................................246
Examining the use of a STEM Identities Framework and Possible Selves ......................................247
REFERENCES .....................................................................................................................................249
Appendix A: STEM Career Interest Survey (STEM-CIS) ...............................................................265
Appendix B: STEM Career Video Exploration Sheet .....................................................................267
Appendix C: STEM Career Video Planning Sheet .........................................................................269
Appendix D: STEM Career Identity Student Interview Protocol ..................................................272
LIST OF TABLES

Table 3.1 Demographics of Washington Middle School ......................................................... 41
Table 3.2 Student participant demographics ...................................................................... 43
Table 3.3 Timeline of STEM career video intervention ......................................................... 51
Table 4.1 Demographics of Washington Middle School ........................................................ 84
Table 4.2 Student participant demographics ...................................................................... 85
Table 4.3 Timeline of STEM career video intervention ......................................................... 93
Table 4.4 Pre survey summary of best fit models for interest in science, mathematics, and technology .................................................................................................................. 106
Table 4.5 Careers selected by students during the first career exploration ......................... 109
Table 4.6 Calculated percentage of positive and negative SCCT factors recorded on students’ exploration sheets during each exploration (rounded to nearest whole percent) .............. 124
Table 4.7 Students STEM Career Videos ........................................................................... 127
Table 4.8 Multiple regression summary of best model fits for interest in pre survey and post survey ...................................................................................................................... 131
Table 4.9 STEM careers stated by students after intervention ............................................. 134
Table 5.1 Demographics of Washington Middle School students ........................................ 170
Table 5.2 Summary of Darius’ career selections and SCCT influences .............................. 184
Table 5.3 Summary of Elle’s career selections and SCCT influences ................................. 192
Table 5.4 Summary of Mariah’s career selections and SCCT influences ......................... 203
Table 5.5 Summary of Theresa’s career selections and SCCT influences ......................... 211
Table 5.6 Comparison of students’ STEM professional identity based on the model by Carlone and Johnson (2007)
LIST OF FIGURES

Figure 1.1 The socio-cognitive career theory. Lent, Brown, & Hackett, 1994 .......................7
Figure 1.2 Model of Science Identity. Based on Carlone & Johnson, 2006............................8
Figure 2.1 The socio-cognitive career theory. Lent, Brown, & Hackett, 1994 .....................27
Figure 2.2 Model of Science Identity. Based on Carlone & Johnson, 2006.........................34
Figure 4.1 The socio-cognitive career theory. Lent, Brown, & Hackett, 1994. ....................76
Figure 4.2 STEM career poster featuring QR® codes of video and fact sheet....................90
Figure 4.3 Students’ descriptions of career factors during class discussion.......................121
Figure 5.1 The socio-cognitive career theory. Lent, Brown, & Hackett, 1994....................164
Figure 5.2 Predicted Model of Rural Middle School Students Predicted STEM Identity.....166
Figure 5.3 Participants’ changes in STEM interest based on pre and post
STEM-CIS surveys ..............................................................................................................218
Figure 5.4 STEM career identity model for four, rural, middle school students ..................236
CHAPTER ONE: INTRODUCTION

In a time of economic recovery, leaders in the United States must continue to identify ways to keep the country scientifically and technologically competitive with other nations in the world (Lohr, 2009). Political agendas offer promise of innovation with ‘green initiatives’ that would increase solar, wind, and bio-fuel industries allowing products to be marketed to nations around the world (National Science Board, 2010). These new industries are expected to generate about 2.7 million new jobs in science and technological services by 2018, thereby increasing the demand for qualified workers (U.S. Bureau of Labor Statistics, 2010). Those who are trained are predominately white and Asian males (National Center for Educational Statistics; NCES, 2010), limiting the diverse thought processes and considerations of women and minorities.

To address needs in STEM, especially those of underrepresented individuals, educational researchers suggest concentrated efforts to recruit these individuals in STEM, helping them see how their strengths, interests, and dispositions can align with professionals who work in STEM fields (Tan & Calabrese Barton, 2006). National organizations recommend that K-12 educations focus on fostering students’ interest in these fields at the middle school level (American College Testing; ACT, 2011). Studies suggest that middle school students who engage in career explorations focusing on mathematics and science have the opportunity to develop their interests and self-efficacy in these fields before college (Subotnik, Edminston, & Rayhack, 2007). This is important because student interest in these subject areas, particularly in females, declines by the time they reach high school (VanLeuvan, 2004; Wells, Sanchez & Atwell, 2007).
Interest in STEM Careers

One plausible reason that students in high school and college do not see themselves in STEM careers is because of a perception that these careers are too difficult and require too much education (American Association of State Colleges and Universities, 2005; Drew, 2010). Cole, Ray, & Zanetis (2011) suggest that when students show interest in a career path, it is important to provide them with information that allows them to envision a future in the career, including daily responsibilities and salary. Studies that have examined influences on STEM interest in high school and undergraduate students find that personal interest is most important aspect when choosing a major; however many do not realize that they are personally interested until they explore their career options (Beggs, Banthum, & Taylor, 2008; Hall, Dickerson, Batts, Kauffmann, & Bosse, 2011).

At the high school level, student self-efficacy in a subject is the main reason for interest and intent to pursue careers (Tang, Pan, & Newmeyer, 2008). When selecting a college major, Betz & Voyten (2012) found low self-efficacy to be the most influential in career indecision, whereas outcome expectations were the best indicator of intention to explore careers. Self-efficacy beliefs form as early as elementary school; an early study found that females reported low confidence in their mathematics abilities and felt inferior to males, despite their actual performance on assignments (Wigfield, Eccles, & Yoon, 1997). Few research studies have investigated important influences on STEM career interest for middle school students, compared to those at the secondary and post-secondary level (Usher, 2009). Kitts (2009) found that middle school and high school students are interested in science but have a lesser desire to become a scientist. These interests have been found to
differ by gender. When examining what questions high school and middle school students ask in an *Ask a Scientist* website, males were more likely to ask questions about the physical sciences and females were more inclined to ask about the biological sciences (Baram-Tsabari, Sethi, Bry, & Yarden, 2009; Baram-Tsabari & Yarden, 2007, 2008). When Brotman and Moore (2008) interviewed 8th grade males and females, they found that females reported fewer informal experiences than males.

Positive learning experiences in science and mathematics have been found to build self-efficacy and increase interest in those subjects (Griffith, 2010; Lent, Brown, & Hackett, 1994). One study of preservice math and science teachers asked what they believed influenced secondary students’ interest in their subject areas. They named teachers’ and family members’ attitudes toward math and science, teachers’ abilities to relate math and science to real-world contexts and place emphasis on applying the material rather than memorization, and a school’s philosophy on the coverage of content versus learning content (Ellsworth and Buss, 2010).

**Students’ Perceptions of STEM Careers and Professionals**

Research has connected declining interests in STEM fields to the perceptions that students hold of STEM professionals. For example, Kitts (2009) found that middle and high school students are interested in STEM but cannot see themselves in STEM careers. One study found that many high school students perceive these careers as isolated, not creative and less people oriented than other professionals in the liberal arts (Masknik, Valenti, Cox, & Osman, 2010). Also, many studies have found misconceptions in K-12 students’ beliefs
about STEM professionals, such as drawing and describing scientists as white males who work long hours in a lab doing research, engineers as male mechanics who fix cars, and those who work in technology careers being nerdy, uncreative, and sitting at a computer every day (Bouchey & Harter, 2005; Capobianco, Diefes-Dux, Mena, & Weller, 2011; Fralick, Kearn, Thompson, Thompson, & Lyons, 2009; Thomas & Allen, 2006).

**Strategies Encouraging STEM Interest in Rural Schools**

Lent, Brown & Hackett (1994) posed that positive learning experiences and support from family, teachers, peers and role models mediate interest in careers. Specifically, interventions that have included role models as a means of increasing students’ engagement, interest, and perceptions of STEM have been found very effective (Ashby Plant, Baylor, Doerr, & Rosenberg-Kima, 2009; Stout, Dasgupta, Hunsinger, & McManus, 2011; Zeldin, Britner & Parajes, 2008). This has also been found to be the case with females and underrepresented minority students majoring and participating in STEM (Fries-Britt, & Holmes, 2012; Griffith, 2010), for whom positive learning experiences and strong role models outweighed negative stereotypes, leading them to persist in STEM. These support systems and role models may be more difficult to find in areas of high poverty and/or lack of access to high technology careers (Avery, 2013). For example, finding STEM role models for students living in rural areas can often be a difficult task (Horn, 2011), because many rural communities are surrounded by local family-owned businesses and farming limiting exposure to diverse career choices (Griffin, Hutchins, & Meece, 2011).
Some researchers have found value in having students play games that allow them to make choices (e.g. Life© and Monopoly©) that allows them act out professional roles with their peers (Bergen & Fromberg, 2009; Singer and Singer 2006). In science education literature, role play and peer video documentaries have been found a promising means to help middle school students relate to science and to connect them to a professional community while also increasing classroom engagement, motivation, and sense of ownership (Furman & Calabrese Barton, 2006; O’Neill & Calabrese Barton, 2005).

**Theoretical and Conceptual Frameworks**

**Social Cognitive Career Theory**

Lent, Brown and Hackett’s (1994; 2000) social cognitive career theory (SCCT) is based on Bandura’s (1986) social cognitive theory of learning. Bandura explains that people exhibit two loci of control over their own actions: internal and external. Internal refers to how individuals control their own actions; external is how they negotiate societal interactions and influences. According to Bandura, the most influential personal control over action is self-efficacy, an individual’s belief that they are capable of mastering events within their lives. For example, a student with high science self-efficacy may believe that she is able to earn a good grade in her science class.

Bandura (1986) identifies sources within an individual’s life, such as successful mastery experiences, vicarious learning experiences, verbal influences, and varying emotional and physiological states as driving an individual’s self-efficacy beliefs. From these experiences, individuals form perceptions of their abilities to achieve personal goals. These goals are constantly adjusted or reformed through experiences and reflections upon
these experiences. If a student has a science teacher who does not call on him in class, or has low expectations for his success in the course, this could negatively impact his self-efficacy in that subject. Bandura also points out that self-efficacy beliefs and personal goals correspond to an individual’s anticipated outcomes when considering a particular activity. For example, if an individual perceives tasks within a particular activity to be easy, such as completing a laboratory investigation, then they are likely to anticipate a successful outcome when participating in the activity.

Researchers who have utilized the SCCT with middle school students have found that self-efficacy, a belief in being able to complete a future task (e.g. balance a chemical equation) can be built through successful mastery experiences, seeing others master tasks similar to those that the learner is asked to do, social persuasion, and feelings of positive emotions during learning (Britner & Pajares, 2006). The SCCT framework also incorporates personal factors such as ethnicity, gender and contextual factors (supportive structures and barriers) to help explain influences on students’ perceptions of careers. One example is a study showing that undergraduate minority science and engineering majors attribute their successes to previous science experiences, family support, teacher encouragement, perseverance and supportive communities (Russell & Atwater, 2005).
Figure 1.1. The socio-cognitive career theory. (This figure is adapted from Lent, Brown, and Hackett, 1994.)

STEM Identity

While multiple influences on career interest and choice are highlighted by the SCCT, yet other researchers focus on the notion of identity. Witz (2000) suggests that identity theory allows a better understanding of the difficulties that many students have when participating and making meaning of the world of science. Carlone and Johnson (2007) assert, “Cultivating short-term knowledge and interest are not enough to develop sustained interest in science; we need to look beyond achievement and interest to understand how and why some students persist in and others opt out of science.

Identity explains how an individual participates in the world, and how others view that participation (Brickhouse, Lowery & Shultz, 2000). Carlone and Johnson (2007)
highlight this social construct within science as an interaction between science competence, science performance and science recognition. They characterize a student with a strong science identity as an individual who understands the nature of science, is capable of taking part in the social and procedural norms of science, and most importantly, one who recognizes himself/herself as a scientist, and is also recognized by others. The predicted model of rural middle school student STEM identity is adapted from Carlone & Johnson’s (2007) work as a starting point to interpret the STEM career identities of the rural, middle school students in this study (see Figure 1.2).

Figure 1.2. Model of science identity. (This figure is adapted from Carlone & Johnson, 2007).
Possible Selves’ Theory

To better understand how students develop a STEM career identity while exploring and creating STEM career videos, this study implores the conceptual framework of “possible selves” (Markus & Nurius, 1986). The idea of possible selves invokes the consideration of what someone believes that they might become, what they want to become and what they fear becoming. When exploring the personal selves of students, Oyserman & Fryberg (2006) suggest having them share past and present experiences, social roles, and group memberships and to explain how these experiences and roles define who they were, who they are, and who they will become. Several studies have utilized possible selves theory as a means to explore the identity of preservice teachers, as well as to explore the identities of students negotiating possible selves through extracurricular activities (Hamman, Gosselin, Romano, & Bunuan, 2010; Slay & Smith, 2011; Stevenson & Clegg, 2011). These studies provide implication that engaging students in questions aligned with possible selves’ theory elicits thoughts about the future and provides identity-relevant information and motivation to pursue future goals.

This framework has been used to explore the possible selves of underrepresented minorities in STEM, and how students in middle and high school negotiate possible selves within the discipline while participating in science games, engaging in mathematics content, and taking part in STEM enrichment programs (Beier, Miller, & Wang, 2012; Harper, 2010; Varelas, Martin, & Kane, 2012).
**Research Questions**

This study explores the STEM career interests of rural, minority middle school students. Given that little research has examined the effects of a long-term classroom STEM career intervention on the interest, this study asks,

1. What are the initial STEM career interests of rural, minority middle school students?
2. How do students explain their interests and influences to pursue a career in STEM?
3. In what ways do students’ interests change with a video intervention?
4. How do four rural middle school students explain the social cognitive career influences that guide them in exploring and creating STEM career videos?
5. What role do gender, race, ethnicity, and rural location play in these students’ STEM career identities?
Summary

Chapter One presented statistics from the workforce and within STEM education documenting the necessity to meet the growing demand for STEM professionals. Teachers of students who are marginalized in STEM (females, African Americans, Hispanics, and Native Americans) are charged with generating interest in STEM subjects and careers to enhance the US workforce, develop innovations that will keep the US competitive in a global market, and benefit STEM fields through the perspectives from all social and ethnic groups.

National organizations and researchers in STEM education suggest that teachers introduce career discussions, role models and career-related activities during late elementary school and middle school level, while students are forming concepts of their possible selves. Few studies have examined how students from younger age groups develop interest in and understanding of STEM careers, and even fewer have studied how this interest develops in students from rural communities.

The socio-cognitive career theory and identity theory are promising frameworks to guide how to better understand these students’ STEM career interests and learn how they come to identify with STEM careers. Through this dissertation study, these frameworks can potentially shed light on how race, gender, and locational identity (living in a rural community) plays a role in developing interests in STEM careers. Little research to date has examined rural, minority middle school students. The theoretical frameworks of the social cognitive career theory and identity theory, guided by the conceptual framework of possible
selves’ theory will provide insight into how students’ personal inputs and background affect interest and identity.

Chapter Two is a review of the literature which describes the need for STEM educators, and shows a decline of student interest in STEM by the time they reach high school. It highlights research showing the inaccurate perceptions of STEM careers and professionals that many students hold, which lead them to not being able to imagine themselves within these careers. Chapter Two also includes studies that provide implications for best-practice strategies that increase the interest and the ability to identify with STEM.

Two theoretical frameworks, the Social Cognitive Career Theory (Lent, Brown, & Hackett, 1994) and STEM identity (based on a science identity model posed by Carlone & Johnson, 2007) are described, as well as the conceptual framework of Possible Selves Theory (Markus & Nurius, 1986).

In Chapter Three, Methods, describes the setting for the study, the participants, and the context of the overall project in which this study is situated. The design for the video intervention, data sources, and analyses are described.

The findings are described in two chapters, Chapter Four and Chapter Five. These chapters are written to be journal ready, and as such both include an abstract, literature review, theoretical frameworks, methods, findings, discussion, conclusions and implications.

In Chapter Four, all of the students who participated in the video intervention are included in the analyses. Changes in students’ STEM career interest are analyzed using quantitative data (the STEM Career Interest Survey; STEM-CIS, Kier, Blanchard, Osborne, & Albert, in
review) and qualitative data (students’ STEM career exploration sheets, STEM career planning sheets, scripts, videos, interviews, and field notes).

Chapter Five focuses on four students from the intervention who created the broadest range of videos and who represented a diverse group of students in race/ethnicity, and career interests (3 females, 1 male; 2 African American, 1 White, 1 Native American). Their changes in STEM career interest and how they express their STEM identity are described in detail.

Chapter Six is the conclusions chapter, which summarizes the main findings of the study. In this chapter, the utility of the theoretical frameworks are examined, as well as how they potentially complement one another in gaining meaning from the STEM career interest of rural middle school students and how they identify with STEM subjects and careers.
CHAPTER TWO: REVIEW OF THE LITERATURE

There is an overarching national concern in the US about the insufficient numbers of professionals in science, technology, engineering and math (STEM), especially those needed to fill the number of jobs that will be created by green initiatives and other future jobs in STEM fields (Stine & Mathews, 2009). Given that females and minorities are greatly underrepresented in these fields, the potential exists to devise strategies to recruit talented and diverse individuals, particularly from these pools, to fill these STEM positions (Hill, Corbett, & St. Rose, 2010; National Science Board; NSB, 2010; National Science Foundation; NSF, 2009.) Educators at the K-12 level have the most contact with students in school settings, and therefore seem ideally suited to inform and interest students in STEM before they reach college (President’s Council of Advisers on Science and Technology, 2010).

There are challenges for teachers in promoting STEM to students. Many students struggle to identify with scientists and STEM careers, and in fact, many teachers know little about STEM careers or how to develop STEM identity and interests (Fralick et al., 2008; Masnick et al., 2010). Researchers recommend interventions that increase students’ awareness and provide accurate perceptions of what it means to be in STEM professions to begin prior to high school; during late elementary school and middle school is considered the age when students are most likely to consider a career in STEM (ACT, 2011; Scott and Martin, 2012). Some of the strategies that have been recommended that increase students’ STEM interest are providing diverse role models, involving students in the process of science, and using video recording as a means for students to explain and reflect their own
accounts of the natural world (Buck, Clark., Leslie-Pelicky, Lu , & Cerda-Lizarraga 2008; Martin, 2011; O’Neill & Calabrese Barton, 2005; Sathertwait, 2010).

### The Need for STEM Professionals

**Definition of STEM and the STEM Workforce**

Beede et al., 2010 defines STEM professions as “professional and technical support occupations in the fields of computer science and mathematics, engineering, life and physical sciences” (p. 2). US Labor statistics predict that by 2018, approximately 2.7 million new jobs will be generated in science and technological services, which fall within the realm of STEM professions (Bureau of Labor Statistics, 2010). Within these fields, the largest portion of these jobs are in computer and mathematics fields (47%), followed by engineering and surveying jobs (33%), physical and life sciences (12%) and STEM management positions (8%). Nationally, it is believed that the professionals within these fields will develop innovations that will keep our country technologically and economically competitive with the rest of the world (Department of Labor; DOL, 2010).

Beede et al. (2010) provide a demographic perspective of the United States, predicting that that there will be a 25% increase in the U.S. population in the bracket of 16 years and older (“civilians”) and an 8.2% increase in the civilian labor force between 2008 and 2018. Employing these adult workers will require the creation of thousands of new jobs. STEM-related industries are expected to play a crucial role in providing jobs for workers over the next decade, as proposed green innovations will require many skilled workers from diverse educational backgrounds (DOL, 2007). Labor statistics also indicate that by 2018,
the U.S. workforce will experience some demographic changes. It is anticipated that within the workforce, European Americans/whites will decrease by 2%, African Americans will increase by 0.6%, Asians will increase by 0.9% and the Hispanic workforce will increase by 3.3% (U.S. Bureau of Labor Statistics, 2010).

The Bureau of Labor Statistics (2008) reports that the current demographics of the civilian labor force are similar between women and men (47% female and 53% males). Statistics on racial proportions show the labor force consists of 68% white, 14% Hispanic, 12% African American, and 5% Asian. However, the demographic representation of the labor force is not represented in STEM; 72% of STEM positions are held by non-Hispanic white individuals, and the rest are occupied by Asians (14%), African Americans (6%), and Hispanics (6%) (US Census Bureau, 2009; US DOC, 2010). The National Science Foundation (NSF) expresses concern that those in STEM fields do not reflect the makeup of our population. From an equity stance, it is recommended that government agencies, schools, and private businesses make a concerted effort to recruit more individuals into these careers and to devise ways to encourage underrepresented individuals to enter these STEM areas. This concern is reflected in a 2008 NSF report highlighting the importance of diversity in STEM fields:

Framings of sustainability and potential responses are strongly related to worldviews, ways of knowing, and socio-cultural and historical contexts, so diversity is not only important for obvious equity reasons, but also to help ensure a sufficiently rich array of problem framings and identification and elucidation of diverse sensibilities about the environment, technology, justice, and sustainability. (4)
**STEM Education**

NCES (2011) reports that of the 1.6 million students who achieve a first time bachelor’s degree, only 16% major in a STEM related field and the greatest percentage of students receive a degree in business. Asians are awarded 31% of the STEM undergraduate degrees, African Americans earn 15% and Hispanics receive 12% (Cataldi et al. 2011). Given that Asians make up only 5% of the civilian labor force, and African Americans make up 12%, this highlights a large disparity between the percentages of Asians that are pursuing careers in STEM versus African American students. The National Science Foundation has reported that reasons for the disparities of underrepresented students in STEM fields may include a lack of quality preparation in mathematics and science in K-12 educational systems, lack of access to money and technology, lack of minority role models, and lack of guidance from family members who are affiliated with STEM careers (National Academy of Sciences, Global Affairs, & Institute Of Medicine, 2011).

**Development of STEM Career Interest**

The career literature has identified student influences on developing career interest and provided suggestions for furthering this interest. Cole Ray, & Zanetis (2011) suggest that when students show interest in a career path, it is important to provide them with information that allows them to envision a future in the career, including daily responsibilities and salary. Studies that have examined influences on STEM interest in high school and undergraduate students find that personal interest is most important to students when choosing a major; however, many students do not realize that they are personally
interested until they explore their career options (Beggs, Banthum, & Taylor, 2008; Hall et al., 2011). At the high school level, students reported self-efficacy as the predominant reason for interest and intent to pursue careers (Tang, Pan, & Newmeyer, 2008). When selecting a major, Betz & Voyten (2012) found that positive outcome expectations were the best indicator of intention to explore careers, but low self-efficacy often causes students to not pursue these interests.

Few research studies have investigated important influences on STEM career interest for middle school students, compared to the secondary and post-secondary level (Usher, 2009). Like other studies, Burke & Mattis (2008) found that females in high school have little knowledge of what an engineer does on a daily basis or how they could relate to an engineer. Millward et al. (2006) suggest presenting information on the balance of work, a social life, and home life. Studies show that this knowledge can be gained by more interactions with female professionals in technology and engineering, helping them to better see themselves in STEM careers (Koch et al. 2010).

In the previously mentioned survey study by Kitts, students averaged a high interest in science (7.0 out of 10.0) but a low desire to be a scientist themselves (3.0 out of 10.0) (Kitts, 2009). Studies have shown that STEM interests do in fact differ by gender, as well as the influences that encourage males and females to persist in STEM. Studies by Baram-Tsabari and colleagues examine gender differences between high school students and adults who were are asked to spontaneously ask questions on an Ask a Scientist website (Baram-Tsabari 2007, 2008; Baram-Tsabari, Sethi, Bry, & Yarden, 2009). The researchers classified these students’ questions as their personal interests and found that males were more likely to
ask questions about the physical sciences and females were more inclined to ask about the biological sciences (Baram-Tsabari & Yarden, 2007, 2008; Baram-Tsabari, Sethi Bry, & Yarden, 2009). Brotman and Moore (2008) reported that based on interview responses of eighth grade boys and girls in science classes, females had less informal experiences with science. They recommend that K-12 teachers find ways to connect females with outside science experiences and apply the physical sciences to real-world scenarios.

Lent, Brown, & Hackett (1994) pose that people who have positive learning experiences will have higher self-efficacy; beliefs that they can be successful in a class or career. This confidence encourages interest in tasks, courses and careers, and may even cause one to create related goals. Zeldin, Britner, and Pajares (2008) analyzed the self-efficacy beliefs of men and women in STEM careers, finding that men chose to enter STEM careers because of past mastery experiences, whereas women remembered positive social experiences and role models who encouraged them to enter careers. In the context of STEM classes, students develop early self-efficacy beliefs that are influenced by not only mastery experiences but by vicarious experiences, social influences, and psychological factors (Bandura, 1986). For example, one study finds that elementary school females believe that they are inferior to males in math related tasks, despite their similar performance on assignments and tests (Eccles, 1987; 1994). Usher’s work (2009) contributes to understanding the possible reasons for this discrepancy. When interviewing students with high and low self-efficacy in math, she found that students with high self-efficacy mentioned teachers who structured assignments that allowed them to be successful at different points during the class and had parents that reinforced their confidence in math. Those with low
self-efficacy named few experiences of mastery in math, becoming increasingly frustrated with their low grades in math at an early age. These views are consistent with findings by Ellsworth and Buss (2010), who asked preservice math and science teachers to reflect upon their past and present reasons for being interested or disinterested in math. Five themes were found in preservice teachers’ autobiographies: the effect of good and bad teachers, the impact of family members’ attitudes toward math and science, the connection between math and science to real-world contexts, the school’s approach to understanding the material rather than covering a massive amount of content, and the emphasis on memorization rather than building and applying concepts.

**Students’ Perceptions of STEM Careers and Professionals**

One barrier that may be standing in the way of students’ STEM career interest is the inaccurate perceptions that many students hold of STEM careers and STEM career professionals (Masknik, Valenti, Cox & Osman, 2010). By having students draw scientists and engineers, researchers elicit the views of STEM professionals held by children and adolescents (Bouchey & Harter, 2005; Capobianco et al., 2011; Fralick et al., 2009; Thomas & Allen, 2006). Capobianco and colleagues (2011) found that four hundred students in grades 1-5 in suburban, urban, and rural schools all drew and described engineers as mostly men, who fixed cars and electronics or assumed duties similar to a construction worker.

These views continue into middle school. Fralick et al. (2009) analyzed 1600 minority middle school students’ drawings of scientists and engineers. Fifty percent of students drew male engineers, 13% drew females, and 37% could not be identified as one
gender. Only 5% of students drew engineers with brown skin, the rest being colorless or shaded peach. Students drew engineers fixing things (e.g. working on car), and working outdoors. When students were asked to draw scientists, they drew white males in lab coats, who were doing experiments in a lab (Fralick et al., 2008). Similarly, negative perceptions extend to information technology (IT) careers; one study found that college students chose not to major in IT because they perceived it to be boring, lacking creativity, and enduring long hours in front of a computer doing technical work (Thomas & Allen, 2006). Another study found that women believed IT careers to be better for men, because the long hours were not conducive to being a mother (Trauth, Quesenberry and Huang (2008).

In contrast, (Kitts, 2009) surveyed 2500 suburban and urban high middle and high school students to find that positive attitudes, accurate perceptions, and high interests in science and scientists. Using a ten item Likert-scale survey (ranging from strongly disagree at 1 to strongly agree at 10) examining students’ perceptions of cultural stereotypes, opportunities, interest in science, teacher bias, role models in science, and competency in science, no significant differences were found between males and females. Students showed accurate perceptions of scientists, averaging approximately a 3.0/10.0 (showing disagreement) on the statements such as scientists are men, scientists are atheist, and scientists work in a lab. Students averaged a 4.0/10.0 on the statement that science was too difficult (slightly disagree) and a 6.0 that science careers involve a lot of math (somewhat agree).
Recommended Strategies to Increase Interest in STEM

Research shows that students in middle school are highly influenced by the career messages that peers, family, and teachers relay (Ferry et al., 2000). By the age of thirteen, most students have made decisions about what they do not want to do in a future career, a decision that influences their career goals into high school and college (Extraordinary Women Engineers Project, 2007, http://www.engineeryourlife.org/). Unfortunately, these decisions often translate into a sharp decline in interest of females in science by the time they reach high school (VanLeuven, 2004). Many organizations suggest that teachers should begin discussing STEM career opportunities with students during late elementary school and middle school (ACT, 2011; Skamp, 2007). Two promising ways to encourage STEM career interest is discussed below, role models and video technology.

Role models. The Regional Science Resource Center (RSRC) at the University of Massachusetts bases their mission and resources on addressing the barriers minority students face to STEM fields because they do not have role models in these professions who are similar to them ethnically. The RSRC proposed three goals to address the lack of relevant role models that include: have middle school students meet diverse role models and learn about their job descriptions; have students and parents hear positive messages associated with STEM fields and learn about the paths to diverse careers, together; and develop networks of low-income families to share understandings of STEM career choices.

Certainly, one way to create more accurate perceptions in the middle school classroom is to introduce female and minority students to similar-looking professionals in STEM. In one, Buck et al., (2008) investigated the cognitive processes that eighth grade
females use when identifying science role models. The researchers studied 13 eighth grade females who participated in classes visited by scientist graduate students once a week, conducting interviews with the students before and after their experience with these role models. Their study found that students initially viewed family members as role models and could not identify scientists as role models because they saw scientists as men without families, mean, or geeky. After students’ experience with young female scientists, they changed their perceptions of scientists as role models; the students reported that they felt an emotional connection to the visiting scientists who were fashionable and social (Buck et al., 2008). This study implies that diverse role models can connect students to the field of science, give students a more accurate understanding of the nature of real scientists, and a vision of scientists that they can identify with and perhaps emulate. Buck et al. (2008) suggest that it is possible to make great strides with students to connect to STEM careers, given mentoring and role models with whom the students can identify.

**Videos in STEM.** Video technology is another promising avenue for helping students to find their own voice in STEM careers. For example, Furman and Calabrese Barton (2006) followed two seventh grade males Anthony and William in a low-income urban setting, as they worked together to create a video documentary on science in an after-school program. Over a three-year period, the researchers taught Anthony and William to use video technology to make mini-documentaries in their technology classes. Past studies have found that technology enhances motivation and interest, gives students a sense of ownership in what they are learning, allows students to communicate on their own terms, and connects their personal interests with the subject of science (O’Neill & Calabrese Barton,
In the creation of a video documentary about animals, Anthony was able to show his gregarious nature and leadership skills, narrating footage of a local zoo. William, on the other hand, was able to express his science identity by acting as a reporter who interviewed others to obtain information. He directed questions to Anthony and also interviewed his teacher to include in their video. Unlike Anthony, William was able to negotiate a science identity behind the camera, and used a producer/director role to show knowledge of both science and technology. This study shows how video technology in science can allow students to meld their own interests into the discipline and express their science identities.

The benefits of connecting videos to STEM engagement have also been seen in a recent study. Wyss, Heulskamp, & Seibert (2012) created a classroom environment that allowed students to create their own video interviews with STEM professionals. When researchers piloted a Likert-type survey measuring interest and attitudes to becoming STEM professionals, they found that students increased their interest in STEM-related goals after recording and watching STEM interviews.

**Theoretical Frameworks**

This study utilized two theoretical frameworks to gain an understanding of how students become interested in STEM careers and how they can better identify with scientists and STEM professionals: Lent, Brown and Hackett’s (1994; 2000) Social Cognitive Career Theory (SCCT), and a socio-cultural framework developed by Carlone & Johnson (2007) that describes science identities of underrepresented women in science.
The Social Cognitive Career Theory

Lent, Brown and Hackett’s (1994; 2000) social cognitive career theory (SCCT) is based on Bandura’s (1986) social cognitive theory of learning. In Bandura’s theory, individuals exhibit two loci of control over their own actions, internal and external. Internal refers to how individuals control their own actions; external is how they negotiate societal interactions and influences. According to Bandura, the most influential personal control over action is self-efficacy, an individual’s belief that they are capable of mastering events within their lives. For example, a student may believe that she is able to earn a good grade in her science class.

Bandura identifies sources within an individual’s life, such as successful mastery experiences, vicarious learning experiences, verbal influences, and varying emotional and physiological states as driving an individual’s self-efficacy beliefs. From these experiences, individuals form perceptions of their abilities to achieve personal goals. If a student has a science teacher who does not call on him in class, or has low expectations for his success in the course, this could negatively impact his self-efficacy. Bandura also points out that self-efficacy beliefs and personal goals correspond to an individual’s anticipated outcomes when considering a particular activity. For example, if an individual perceives tasks within a particular activity to be easy, such as completing a laboratory investigation, then they are likely to anticipate a successful outcome when participating in the activity. Zeldin, Britner, & Pajares, (2007) examined these sources of self-efficacy among male and female STEM professionals. Personal narratives showed that men’s self-efficacy was primarily influenced by mastery experience, whereas female STEM professional were primarily influenced by
social persuasion and vicarious experiences. The findings imply that females need supportive relationships in STEM professions, to succeed in a male-dominated workforce. Lent, Brown and Hackett (1994) combine Bandura’s relationship between self-efficacy, outcome expectations, interests and goals with the concepts of contextual factors, personal inputs and an individual’s background and context to explain how individuals make career-related decisions (see Figure 2.1). In their model, personal inputs are socially constructed factors, such as gender, background, race and socio-economic status, and intrapersonal factors such as personality that contribute to one’s feelings of high or low self-efficacy. Contextual supports and barriers are external factors of individuals, which either facilitate or impede high self-efficacy or setting academic or career goals.

The academic and career interest model by Lent, Brown and Hackett (1994) proposes eleven hypotheses regarding the cognitive factors of career choice.

1) Interest is dependent on an individual’s self-efficacy beliefs and outcome expectations;
2) Career/academic ability is related to interest and mediated by self-efficacy;
3) Self-efficacy affects goals and actions;
4) Outcome expectations affect goals and actions;
5) Individuals will create goals that relate to their academic/career interests;
6) Individuals will choose to pursue goals if they are committed to them;
7) Interests indirectly affect pursuit of goals;
8) Self-efficacy beliefs influence academic/career performance; outcome expectations indirectly influence performance through their impact on goals;
9) Ability will affect performance through its influence on self-efficacy beliefs;
10) Self-efficacy beliefs are developed through mastery learning experiences, seeing others successfully perform tasks, social persuasion and emotional reactions to educational/career related activities;
11) Outcome expectations are developed from mastery and vicarious learning experience; and
12) Outcome expectations are affected by self-efficacy beliefs and experiences of success and failures.

*Figure 2.1.* The socio-cognitive career theory. (This framework is adapted from Lent, Brown, & Hackett, 1994).
A number of early studies have applied the SCCT and the researchers’ hypotheses to predict and explain mathematics and science choices at the college level (Hackett, 1985; Nauta, & Epperson, 2003; Schaefers, Epperson, & Nauta, 1997), finding that self-efficacy and outcome expectations have direct and indirect effects on interests and goal choice. In a later study, Ferry, Fouad, and Smith (2000) identified these factors to be important, as well. In their study of 791 predominately white undergraduate psychology majors, they found that parental encouragement has a direct effect on learning outcomes and learning expectancies in mathematics and science. Age and gender are additional personal inputs that directly affected learning experiences, and indirectly affected self-efficacy.

In a more recent study, Lent (2005) surveyed approximately 500 students in two historically black colleges and universities (HBCU) and one predominantly white college to better understand differences in career choice and interest based on gender and race. Surveys were given to all students taking an introductory engineering course to measure self-efficacy, engineering outcome expectations, technical interests, social supports and barriers, and major choice goals. Finding no significant difference between gender in the study, African American students at HBCUs had higher reported self-efficacies, outcome expectations, interests, and contextual supports. The author suggested that the findings may be attributed to the HBCUs having stronger mentoring programs than the predominately white college, providing students with connections to role models that support student self-efficacy. Similar results were found in a larger study by Lent, Lopez, Lopez, & Sheu (2008) when they examined 21 HBCUs and 12 predominately white colleges. The researchers recommend this research design in a variety of contexts to better understand how contextual supports
influence interest and goal setting. They encourage future researchers to operationalize these contextual factors (e.g. personal attitudes, parents’ educational attainment, parental support) and personal inputs (e.g. race, gender, ethnicity, disabilities) so as to better understand their role in different populations.

For example, Flores and O’Brien (2002) operationalized SCCT constructs to explore the career interests of Mexican-American high school females. Specifically, researchers looked at how background contextual factors including acculturation level, feminist attitudes, mother’s educational attainment and job, and parental support affect student’s self-efficacy and interest to pursue non-traditional/male dominant careers (e.g. STEM careers). Before analyzing contextual factors, they found that non-traditional career self-efficacy (i.e. the belief that one can take part in a male-dominated career) predicted interests in these careers. Parental support and perceived barriers directly predicted career choice. No relationship was found between non-traditional career self-efficacy and acculturation level, feminist attitudes, and mother’s educational attainment and career choice. The researchers also found that career interests did not predict career goals. However, the study supported propositions made by Lent, Brown, & Hackett (1994), finding that females with high non-traditional career self-efficacy showed high interest in more non-traditional jobs and low-interest in traditional female-dominated careers. The study also found that parental support predicted both career choice and aspirations and that occupational barriers predicted career choice.

Gushue (2006) explored the relationship between ethnic identity, career interest, self-efficacy, and outcome expectations in a study of 128 Latino high school students. The researcher defined ethnic identity as the feeling of connectedness to one’s ethnicity,
including a feeling of membership and pride. Students were asked to complete surveys measuring how well they identified to their own ethnicities and other ethnicities, their self-efficacy in career decisions, their outcome expectations, and a demographic survey to find relationships between the variables of interest. This study found that ethnic identity had a strong direct relationship to career self-efficacy (i.e. students’ beliefs in their abilities to make career-related choices and decisions). For example, students’ identification with their ethnic group directly influenced their self-efficacy to engage in career exploration. Additionally, these students who showed strong ethnic ties and high career self-efficacy also believed that would be successful in their career endeavors (positive outcome expectations).

Researchers suggest that inputs such as race and gender can affect the learning opportunities that are afforded to students, thereby affecting their self-efficacy beliefs and outcome expectations.

Compared to the studies on general career interest, and ones on the math and science interests of high school and college students, less research has explored how the SCCT explains the mathematics and science career interests of ethnically diverse middle school minority students. In an early study by Fouad & Smith (1996), they used the SCCT framework to explore how self-efficacy, outcome expectations, interests, and personal inputs affected the math and science goals of 380 ethnically diverse seventh and eighth grade students from a predominately low socio-economic school. They found that eighth graders had less interest in these subjects than seventh graders. Males showed less interest in mathematics and science than females, but had higher outcome expectations. Researchers found that positive in-school and out-of-school experiences with science were high indicators
of interest in these fields, suggesting that the males had more of these experiences with science. Self-efficacy had a direct effect on outcome expectations, an indirect effect on personal goals, and a significant effect on interest and students’ intentions to pursue goals in math and science. Thus, this model was shown to effectively predict mathematics and science interest within this diverse population of 8th grade students; furthermore, it shows potential in supporting students’ career goals through contextual supports, such as more contact with positive out-of-school science experiences.

Navarro, Flores and Worthington (2007) conducted a study that looked specifically at how personal inputs and contextual factors affect the interests and goal choices of 409 Mexican-American middle school students to pursue science and mathematics. Using hierarchical linear modeling, researchers examined how a broad range of factors explained the career goals of these students. They examined: gender, generational status, personal association with Mexican or Anglo cultures (based on language and ethnicity), social class (based on parents’ highest level of educational attainment), access to technology in the home, number of people living in the home, perceived support of family, friends and teachers, past mathematics and science accomplishments, self-efficacy, outcome expectations, interests, and goals. Findings showed no differences in students’ goal intentions, by gender. Higher social class had a small direct effect on mathematics and science performance, and indirectly affected higher self-efficacy in math and science. This study shows that careful selection of personal factors and background/contextual factors can be beneficial in explaining the variance in math and science goal intentions for middle school populations.
In a recent longitudinal study (Rowan-Kenyon, Swan, & Creager, 2012) on 67 fifth, seventh, and ninth grade school students, researchers qualitatively investigated how students’ perceptions of support and engagement in math class and math activities influences math interest. These students were sampled from a school district consisting of approximately 50% African American students, 50% white students and 50% being eligible for free or reduced lunch. Three parents and eight teachers also participated in focus groups to provide researchers with more insight into the students’ engagement, interests, and goals. Students were asked what they liked about math, what types of activities they enjoyed the most and how others expected them to do in math.

Students in fifth and seventh grade reported that their parents had high expectations of them in math, helping them with their homework and preparing them for tests. Fifth grade males and females and seventh grade females stated that their parents gave them rewards/money for doing well in math but very few said that they were motivated to do well in math simply because they were interested. Students at all age levels said that they most enjoyed activities where they worked with others and created products. Fifth and seventh grade students admitted being frustrated by other peers who distracted them in math class because of their disruptive behavior. The researchers suggest that math teachers provide meaningful hands-on and collaborative learning experiences to engage students in class. They emphasize the importance of teachers and parents supporting students in late elementary school to encourage intrinsic motivation in math class at an early age, facilitating the desire to take part in math outside of school.
In summary, the SCCT provides a means to predict how self-efficacy, outcome expectations, personal inputs, and contextual supports and barriers affect the academic and career-related interests of many populations within different contexts. Within the body of literature surrounding the utilization of SCCT, few studies have been conducted with middle school students, particularly ethnically diverse, rural middle school students. Findings from these studies suggest future research that operationalizes the aspects of the SCCT to better understand the relationship between cognitive and external factors of the model.

**Science Identities**

As the social-cognitive career theory shows promise in examining STEM interest, identity research provides a means to investigate how students perceive themselves while participating in STEM and how they believe that they are perceived by others (Carlone & Johnson, 2007). Research suggests that identity theory is a promising lens with which to study students who are underrepresented in science because it allows students to voice their experiences in the classroom, immerse themselves in the culture of science and express aspects of science with which they connect (Carlone & Johnson, 2007; Cobb, 2004). Brickhouse and Potter (2001) believe that identity theory helps researchers to understand how an individual’s past experiences affect their present lives and the perception of their potential future. This framework has been useful in understanding identity conflict, particularly with minority students. For example, Russell and Atwater (2005) found that African American college students at a predominately white institutions conveyed previous
experiences of feeling isolated by their peer group as a result of striving for success in school.

Similarly, Carlone and Johnson (2007) used the identity framework to analyze how students incorporate gender, ethnicity, and race into their experience to negotiate either positive or negative science identities. Based on previous literature on females attitudes and experiences in science, they propose a model (see Figure 2.2) to explain how undergraduate and professional women of color form identities in science.

![Components of a Science Identity](image)

*Figure 2.2. Model of Science Identity.* (This framework is based on Carlone & Johnson 2007).
Their model incorporates ideas from Maxwell (2005), describing identity as interrelated components of competence, performance and recognition. According to Carlone and Johnson (2007), a student with a strong science identity understands the content of science, feels capable of performing scientific practices, and recognizes herself as a scientific person and who also perceives others (e.g. peers, family, and teachers) to recognize her accordingly.

In their study, they interviewed four Latina, four African Americans, three Native Americans, and three Asian women and analyzed themes of their past and present experiences in science, ways in which they negotiated perceived masculine norms in science, and pathway to persisting as a scientist. Interview analyses yielded three types of scientists - the research scientist, the altruistic scientist, and the disrupted scientist. They described the ‘research scientists’ to be individuals who identified themselves as scientists, identified with the community of science, expressed their love for science as a way of knowing, and enjoyed taking part in the processes of science. All of these women stated that they felt recognized and received praise by others within the community. ‘Altruistic scientists’ were identified as individuals who connected with science by desiring to take care of others. The felt supported by family and people in their local community, but not so much by other scientists. A few women were characterized as ‘disrupted scientists’ because they expressed negative science identities, providing instances where they were overlooked or marginalized as science students.

All of the women in Carlone and Johnson’s (2007) study depended on how others recognized them in science, including science communities, teachers, family and themselves.
as being significant in this recognition. This finding provides implications to K-12 science teachers that it is important to include all students in science, provide them with mastery learning experiences, and offer positive feedback to encourage the development of positive science identities.

In a different context, Tan & Calabrese Barton (2008) conducted ethnographies on two middle school Latina females in a low income urban school, seeking to understand their ‘science identities-in-practice’. The term “identities in practice” is used rather than “identities” because Tan and Calabrese Barton propose that the environment of the science classroom is highly influential in shaping the experiences and identities of students. They observed two Latinas, through their sixth grade year, taking careful field notes, video recording them in science lessons and interviewing them to understand how the girls participated in science.

Their study found that although the girls came from different backgrounds and had very different personalities, the teacher was integral in facilitating positive science identities-in-practice. For example, he incorporated students’ cultural experience in classroom activities, and allowed students time to share their out-of-school experiences with science. He provided rules and social norms that allowed both females to grow and thrive in their science communities. Both students showed agency in the classrooms with their identities-in-practice, one showing a caring and supporting identity to others in the class while the other showing an identity that ensured her participation in science. The authors suggest that allowing students to author new identities in the science classroom will encourage interest and likely persistence in the field.
More recently, Archer, Osborne, Dillon, Willis, & Wong, (2010) used the identity lens to better understand the interests and aspirations of middle school students in science. Six focus group interviews were conducted with 42 ten-year-old students from four London schools in neighborhoods with diverse socio-economic, racial and ethnic backgrounds, asking them about their experiences in science and feelings about becoming a scientist. They found that middle school students associated doing science with danger, explosions, fun and excitement. Several females viewed science as being too dangerous for them. Many students implied that ‘doing science’ was not allowed in their schools because it was too dangerous, suggesting a dissonance between science done by real scientists and what students take part in at school. Males in particular talked about practicing science outside of the classroom, mixing various household chemicals and exploding bottles. Students from predominately middle class backgrounds talked about more formal science experiences such as reading and using their own microscopes at home than students from schools characterized by lower SES. Many students discussed not enjoying science because their teachers were boring and that science is too difficult.

Several studies have examined how students from an urban setting have created science identities, but little is known about how students from a rural setting create science career identities. The available literature on rural high school students document that rural students lack access to diverse career opportunities, are hesitant to stray from traditional family-centered jobs, and do not have high priorities on obtaining higher degrees in school (Fowler, 2010; Jacobs, Finken, Griffin, & Wright, 1998). In a study by Gilbert and Yerrick (2001), researchers examined the key components of lower track classrooms in a rural
context by conducting focus groups with six African American students, one white student and one Cuban student. These students reported that they desired to take lower track science classes because their friends took these classes, good grades were easier to obtain than more higher-level classes, and because they were planning on going into alternative careers that would not require much post-secondary education. African Americans within these lower track classes identified their African American peers that took honors level classes as trying to “act white.” They believed that in their lower-track science classes, their teachers perceived them as not smart and often talked to them in a condescending manner. These research findings parallel others that suggest students often feel the need to change their identity to succeed in science (Fordham, 1997) and that rural communities may not place emphasis on higher education, deterring motivation in science by students (Corbett, 2007).

Summary

More professionals are needed to fill STEM positions in the United States, and political agendas place the onus on K-12 educators to encourage students’ interest in STEM prior to choosing a major in college. It is likely that students’ decline in interest from middle to high school is partly because students cannot see themselves in these professions. Research suggests that students hold perceptions of STEM professionals that do not match the actuality of the environments, responsibilities, and types of people in STEM. Studies that have applied the socio-cognitive career theory to show interest in career exploration, STEM courses, and STEM careers suggest that general interest, self-efficacy, and outcome expectancies guide future interest and the development of goals. This predictive framework
has been used in a variety of contexts and populations, but research suggests that the indirect influences of interest, including personal dispositions, background, and contextual supports and barriers ought to be further explored to operationalize the SCCT framework for different populations. Studying students’ identity in STEM, based on a previously developed model of science identities, is likely to further elicit students’ indirect influences on interest and how they pertain to their future goals in STEM. This study uses recent findings and implications from STEM education and career literature to examine how rural, minority middle school students demonstrate interest and form identities in STEM careers.
CHAPTER THREE: METHODOLOGY

This study is a two-phase, embedded, mixed-methods study (Greene, Caracelli, & Graham, 1989) designed to investigate interest and identity in STEM careers among four classes of ethnically diverse, rural eighth grade students. The two phases included an exploration phase and a creation phase; students explored STEM career videos and then they created them. Qualitative data including written artifacts, interviews, and field notes were used to corroborate and triangulate quantitative data obtained from a pre/post Likert-type survey. The research questions guiding this study were:

Research Questions

1. What are the initial STEM career interests of rural, minority middle school students?

2. How do students explain their interests and influences to pursue a career in STEM?

3. In what ways do students’ interests change with a video intervention?

4. How do four rural middle school students explain the social cognitive career influences that guide them in exploring and creating STEM career videos?

5. What role do gender, race, ethnicity, and rural location play in these students’ STEM career identities?
Setting

This study took place at Washington Middle School (pseudonym: WMS), a school in a rural county in the southeastern United States. This county is predominantly agricultural, with cotton, tobacco, and soybean fields along country roads. Small, family-run businesses can be found in tiny towns (e.g. population 20,081 in the nearest town) within this district, many of which are struggling through economic decline, with the unemployment rate 13.1% at the time of this study (US DOL, 2012). According to the WMS website, the largest employers in the county are the school system, the prison, and the county government. There are 13 small industrial companies employing about 1000 people. The poverty rate is approximately 27%, approximately 67.5% of the population graduate with a high school degree, and 11.6% have some form of post-secondary education.

Washington Middle school is the only middle school within the county (444 sq. miles), and serves students in grades 6-8. The demographics of the school are found in Table 3.1. (www.greatschools.org).

Table 3.1

Demographics of Washington Middle School; 2011-2012

<table>
<thead>
<tr>
<th>Washington Middle School</th>
<th>450</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Students in the School</td>
<td></td>
</tr>
<tr>
<td>Student Ethnicity</td>
<td></td>
</tr>
<tr>
<td>71% African American</td>
<td></td>
</tr>
<tr>
<td>18% White</td>
<td></td>
</tr>
<tr>
<td>6% American Indian</td>
<td></td>
</tr>
<tr>
<td>5% Hispanic</td>
<td></td>
</tr>
<tr>
<td>1% Pacific Islander</td>
<td></td>
</tr>
</tbody>
</table>
Table 3.1 Continued

<table>
<thead>
<tr>
<th>Students on free or reduced lunch</th>
<th>76.6%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students who passed the state test in mathematics</td>
<td>69% Sixth Graders</td>
</tr>
<tr>
<td></td>
<td>70% Seventh Graders</td>
</tr>
<tr>
<td></td>
<td>79% Eighth Graders</td>
</tr>
<tr>
<td>Students who passed the state test in science</td>
<td>No Science Test in Sixth Grade</td>
</tr>
<tr>
<td></td>
<td>No Science Test in Seventh Grade</td>
</tr>
<tr>
<td></td>
<td>70% Eighth Graders</td>
</tr>
</tbody>
</table>


Participants

This study was implemented in Ms. Cruz’s classroom. Ms. Cruz (pseudonym) is originally from the Philippines, coming to the US in 2006. Ms. Cruz could not afford college and found that if she chose to be a science teacher, she would receive a full scholarship to pursue her degree. She completed her degree in science education and took a few credits towards a Master’s degree in Educational Administration but chose to go into the classroom instead of completing it. She has taught for 15 years in the science classroom, and has been at WMS for 6 years. She is well-known by her colleagues and students as an outstanding science teacher, and strives to bring more STEM initiatives to her school.

Ms. Cruz’s four eighth grade science classes took part in this study every Wednesday for eleven weeks. Demographics for her students and the participants in this study are summarized in Table 3.2. WMS was an ideal school for the implementation of this dissertation study because every Wednesday, thirty minutes of each period was designated as remediation time. In past years, many teachers found that students were not using this time to ask questions about their homework, or get extra help with their difficult classes.
Table 3.2

Student participant demographics

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Participants</td>
<td>85 eighth grade students</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td></td>
<td>42% Males</td>
</tr>
<tr>
<td></td>
<td>43% Females</td>
</tr>
<tr>
<td>Race</td>
<td></td>
</tr>
<tr>
<td></td>
<td>59% African American</td>
</tr>
<tr>
<td></td>
<td>13% Non-Hispanic White</td>
</tr>
<tr>
<td></td>
<td>8% American Indian/Alaska Native</td>
</tr>
<tr>
<td></td>
<td>4% Hispanic</td>
</tr>
<tr>
<td></td>
<td>1% Asian</td>
</tr>
<tr>
<td>Percent on free or reduced lunch</td>
<td>77%</td>
</tr>
</tbody>
</table>

Note: School provided the teacher with data on the % of students on free or reduced lunch.

Therefore, teachers regularly needed to plan extra activities for this time, such as giving students assignments to practice reading, writing, and math. Ms. Cruz believed that this project would not only connect her content to STEM careers, but would also allow her students to engage with a new instructional technology (iPod Touch®), practice their writing skills, and think more about their career goals.

Context of Overall Project

This research is part of larger three-year National Science Foundation (NSF) ITEST grant serving five rural school districts. The focus of the grant is to increase the awareness of, interest in, preparation for, and intention of middle school students to continue in STEM courses, major in STEM, and possibly pursue science, technology, engineering, and mathematics (STEM) careers through the use of instructional technologies. One of the districts serves as a comparison district.
As part of the grant, approximately 12 teachers within each of the four intervention schools (45 teachers total) received one week each summer of extensive technology-enhanced professional development, modeled in pedagogically appropriate ways consistent with technological pedagogical content knowledge (TPACK) (Koehler & Mishra, 2008) and reform-based practices (National Research Council, NRC, 2000). Teachers also received ongoing support throughout the year, through synchronous, online Collaborate sessions each semester (3) and from two coach teachers at each school. During this professional development, teacher participants were provided with a stem career awareness wiki for each school that a small team of project researchers developed. The researcher for this study helped to facilitate the summer workshops and helped to develop many of the professional development resources, and thus was personally familiar with all of the teachers in the project.

**Wikis.** The four school Wikis host a bank of STEM career short videos with short descriptions. For example, the biomedical engineer link contains the description: *Designs tiny particles to take medicine to specific parts in the body.* When students click on the link with the name and picture of the biomedical engineer, they are taken to a wiki page that features that STEM career video. This video bank features STEM career professionals who are female and/or minority and from diverse educational backgrounds. Two independent coders ranked the videos for quality based on characteristics such as action, scene changes, transitions and multiple perspectives of a career, consistent with recommendations in the video and technology literature, selecting only the best videos for use on the wiki (e.g. Pace
All chosen career videos were matched to state content objectives in fifth, sixth, seventh and eighth grade science and mathematics curricula.

Also on each wiki video page is a fact sheet. These fact sheets correspond to the career featured in the video and include information on the job’s educational requirements, salary range, daily tasks/activities, and outside interests that someone may have that would lead them to this career. The fact sheets are based on data obtained from the National Center of O*Net Development (http://www.onetonline.org/) and were modified to be middle school appropriate and to fit on one attractively designed page.

Additionally, each wiki video page contains an example of a corresponding career script. This script contains blanks for students to fill in information about themselves so that they can film and star in their own STEM career video in which they are acting as though they already are employed as a professional in the featured career. During the first year of the summer workshop, teachers learned about characteristics of high quality videos and how to help students create their own career videos by creating their own using the iPod Touch®, fact sheets, and career scripts. Many teachers showed an interest in integrating these career videos into their curriculum.

During the second summer workshop (summer, 2012), the researcher for this study approached Ms. Cruz, an eighth grade science teacher from one of the four middle schools taking part in the grant, WMS, and asked her if she would like to take part in a dissertation study that implemented these career videos in a unique way with her students. She eagerly agreed to invite her students to participate in this study during her remediation period during the Fall 2012 semester.
Project Design

Students took part in the intervention every Wednesday for 11 weeks during the fall, 2012 semester, for 45-60 minutes. On the first Wednesday of the school year, the researcher introduced the project to Ms. Cruz’s eighth grade students. She explained that the purpose of the study was to better understand their interest in science, technology, engineering, and math (called STEM) careers and how they identified with STEM career professionals. The students were asked to name jobs they knew of in science, technology, engineering and math. The researcher explained that they had the option of exploring a new STEM career each week, watching a video, and eventually creating their own STEM career video. Prior to formally being introduced to any careers, students used the iPod Touch® to take the STEM Career Interest Survey (STEM-CIS) to measure their initial interest in science, math, and technology (Kier, Blanchard, Osborne, & Albert, in review).

The next Wednesday (Week 2) every student was given an iPod Touch®. Each student scanned a single QR code which was linked to the URL (uniform resource locator) on the school Wiki, which listed 70 career videos and brief descriptions of each one (http://stemcareerawareness.wikispaces.com is the main site). Students were asked to choose one career from the list that most interested them, watch the video, read the associated fact sheet, and complete a career exploration sheet (Appendix B). Among the careers listed were: aeronautical engineer, mechanical engineer, nurse, doctor, dental hygienist, forester, architect, actuary, marine biologist, and radiologic technicians.

The following Wednesday (Week 3), the primary researcher changed all of the video links on the wiki into QR codes that could be scanned by the iPod Touch® and linked to a
website. She organized the career QR codes by the educational requirements to hold the job and placed them around the walls of Ms. Cruz’s classroom. Categories included: requires 2 years of technical training/Associates Degree; requires 4 years of college/Bachelor’s Degree; and, requires more than 4 years/graduate school. Within each category of educational requirements, the researcher developed subcategories with student-friendly titles, such as: careers using lots of technology, careers using lots of math, careers that test new products and foods before people use them, careers that create new products, careers where you work outside, careers that allow you to travel, careers that let you solve problems, careers that help other people, and careers that work with living things. Students explored these careers in pairs and noted on their career exploration sheets which of the partners had selected the career video to watch.

Students took part in a similar exploration the following week (Week 4) with the addition of three new careers that students had requested to learn more about during Week 3. These new careers included dolphin trainer, graphics designer, and speech therapist, increasing the number of career videos and related fact sheets to 73. The careers were organized in the same manner as Week 3, with posters hung around the room and organized by the level of education required for the job and job titles with student-friendly names.

During Week 5 (Exploration 4), the researcher added more careers for students to explore based on students’ expressed interests, increasing the number of career videos to 79. These career videos included sports analytic software, marine biologist, operations technician, water safety specialist, flash animator and large animal veterinarian. Additionally, all of the QR codes were reorganized on large posters based on the STEM
discipline to which the career is primarily related. However, because most STEM careers overlap in these disciplines (i.e. almost every career uses math) most careers were duplicated on separate posters for science, technology, engineering, and math.

In Week 6, students were again asked to explore a STEM career (Exploration 5) and complete an exploration sheet. Before the students began exploring, however, the researcher facilitated a class discussion asking students to brainstorm considerations for why they would go into a career, as a way to stimulate students to broaden the way they were thinking about careers and to potentially include other important considerations. This elicited students’ responses about ties to their family, feelings toward their hometown, costs of living in large cities and rural towns, and the importance of being happy in your job and enjoying your co-workers. All student responses were recorded by the researcher on the whiteboard in the front of the room. Students were asked to keep these ideas in mind when filling out their last exploration sheet. Additionally, the students were asked to choose a career that they could not see themselves in and write a reflection why they chose this career at the end of their exploration sheet. The purpose of this was to help students to become more aware of additional potentially important considerations regarding career choice. This was considered students’ 6th exploration of STEM careers.

During weeks 6-9, students worked in pairs to plan their own career video. Students worked in a large media center so that they could film their videos in different locations. The researcher provided students with a large box containing many outfits and props including lab coats, various business labels, hats, tools, medical supplies, toy windmills, calculators, magnifying glasses, stuffed animals, plants, a compass, maps, and human dolls. Students
used a planning guide (Appendix D) to guide and document their decisions about where the
career video would be filmed, what props they needed and how the career would be acted
out. When students completed their scripts, they used different locations around the school
to film their career videos with the iPod Touch®. Some students filmed multiple videos and
some asked to re-film their video after watching their own from the Ipod Touch®.

After students finished filming, they uploaded their videos onto a computer hard
drive. The researcher compiled the videos, edited them with transitions, and added
background music. She held a STEM career movie premier in with each class in the school
auditorium so that students could watch the movies created by their peers on Week 10.
Following the premier, students took the STEM career interest survey (post survey) during
the same class period.

Throughout the project, the primary researcher observed students, talked with them as
they worked, and recorded field notes. She also asked students to clarify some of their
answers to exploration sheets; for example, some students would provide very brief
responses such as it’s a good salary, and they would be asked to explain what this meant
(member checking; Creswell, 2012). During the project, Ms. Cruz identified students who
she thought would be eager to share their perspective on STEM and their career goals to take
part in a STEM career identity interview (Appendix D). She chose students who she believed
would represent the academic range of her classes, and who could provide different
experiences of family dynamics, school experiences, and afterschool interests. She identified
a Native American female, a Native American male, a Hispanic female, two African
American females, and three African American males. Three students directly asked the
researcher if they could take part in an interview with her; a multiracial female, a white female, and an African American female student. While the primary researcher conducted these interviews, Mrs. Cruz facilitated the career exploration activity for that day. The timeline for this project is summarized in Table 3.3.
### Table 3.3

**Timeline of STEM career video intervention**

<table>
<thead>
<tr>
<th>Dates</th>
<th>Classroom Activities</th>
<th>Data Collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>August 29</td>
<td>Researcher introduced herself to students and explained the project to the class; students took STEM-CIS survey.</td>
<td>Pre STEM-CIS</td>
</tr>
<tr>
<td>September 5</td>
<td><em>Exploration 1</em>&lt;br&gt;Students selected their favorite career within the bank.</td>
<td>Exploration sheet</td>
</tr>
<tr>
<td>September 12</td>
<td><em>Exploration 2</em>&lt;br&gt;Students selected career of interest. QR codes were organized by level of education.</td>
<td>Exploration sheet</td>
</tr>
<tr>
<td>September 19</td>
<td><em>Exploration 3</em>&lt;br&gt;Students selected career of interest. QR codes were organized by level of education.</td>
<td>Exploration sheet</td>
</tr>
<tr>
<td>September 26</td>
<td><em>Exploration 4</em>&lt;br&gt;All QR codes were organized by level of education.&lt;br&gt;Students selected career of interest.</td>
<td>Exploration sheet</td>
</tr>
<tr>
<td>October 3</td>
<td><em>Exploration 5</em>&lt;br&gt;Class career discussion. All QR codes were organized by level STEM discipline. Students selected career of interest.</td>
<td>Exploration sheet</td>
</tr>
<tr>
<td>October 10</td>
<td><em>Exploration 6</em>&lt;br&gt;Students selected a career in which they were not interested</td>
<td>Written reflection on Exploration 6</td>
</tr>
<tr>
<td>October 17</td>
<td>Planning for video creation</td>
<td>Planning sheet</td>
</tr>
<tr>
<td>October 24</td>
<td>Filming Day 1</td>
<td></td>
</tr>
<tr>
<td>November 7</td>
<td>Filming Day 2</td>
<td></td>
</tr>
<tr>
<td>November 14</td>
<td>STEM Movie Premier Day</td>
<td>Post STEM-CIS</td>
</tr>
</tbody>
</table>
Data Sources and Analysis

Green et al. (1989) present five purposes for mixed methods research including triangulation, complementarity, development, initiation and expansion. The purpose of this mixed methods study is to provide complementary data sources to enhance the understanding of STEM career interest with rural, ethnically diverse students and to triangulate findings with quantitative data analyses. It is hoped that our understandings gained from quantitative indicators of interest and intent to pursue STEM career goals will be enriched through qualitative analysis of STEM exploration sheets, STEM career video planning guides, video scripts, interviews, and secondary audio-recorded data.

Data analysis occurred in two sequential phases with quantitative data analysis preceding qualitative data collection and analysis (Creswell & Plano Clark, 2011). The initial data set obtained from the STEM Career Interest Survey (STEM-CIS) was used to analyze student initial interest factors and change over time. The qualitative data was coded and analyzed to provide further insight into quantitative findings (Creswell & Plano Clark, 2011). These sources included STEM career exploration sheets, nine student interviews, students’ STEM career planning guides, and student STEM career video scripts. Secondary data sources, including member checking, observations, and field notes further enhanced data interpretations.

Pre survey/Post survey

The STEM-Career Interest Survey (STEM-CIS; Kier, Blanchard, Osborne, & Albert, in review; Appendix A) version used for this study consists of thirty-three items with eleven
questions pertaining to science, math and technology. Each question is a five point Likert-scale, 1-5; with 1 corresponding to strongly disagree and 5 corresponding to strongly agree. An engineering scale has been developed; however, it was piloted for validation after this study occurred (to see more about the development of the survey see Kier et al., 2013, in review). Within each subscale, there are questions that address the factors of the social cognitive career theory (SCCT; Lent, Brown, & Hackett, 1994); specifically, two questions on self-efficacy, two on personal goals, two on outcome expectations, two measuring interest, two measuring contextual supports, and one measuring a positive personal input. These aspects of the SCCT were operationalized and appropriately worded for middle school students. For example, the questions measuring science self-efficacy state: I am able to get a good grade in my science class, and I am able to complete my science homework.

**Validation.** This version of the instrument was piloted and validated in an ethnically diverse middle school in North Carolina with approximately 609 students. Cronbach’s alphas were estimated for each subscale. The Cronbach’s alpha for the science scale was $\alpha = 0.80$, math scale was $\alpha = 0.86$, and for the technology scale was $\alpha = 0.86$. Each scale was then subjected to confirmatory factor analysis and each version of the scale was acceptable for use without the others (e.g. science alone) or all three of the scales together.

**Implementation and Analyses.** This STEM-CIS (science, mathematics, and technology subscales) survey was given to the students in each remediation period before the project began; students scanned a QR code with an iPod Touch®, linking them directly to the online survey. Seventy-four students took the pre survey. Basic descriptive analyses were performed on the initial data, including means and standard deviations. Following the
project, the STEM-CIS was administered again to all of the students. A total of 64 students had complete data for the pre survey and post survey. One-way ANOVA was used to determine significant differences between males and females in their overall score on the STEM-CIS, their individual scores in science, math, and technology, and SCCT factor scores (i.e.- self-efficacy, outcome expectations, interests, etc.). Repeated ANOVA measures were used to determine how the students changed after the intervention.

Multiple regression modeling allows for analyzing which factor or combination of factors predicts a dependent variable (Draper & Smith, 1981). There are six items within the STEM-CIS that measure interest. Two in each subject area measure career interest and class interest, respectively; science interest (S#8, S#9), math interest (M#18, M#19) and technology interest (T#29; T#30; see Appendix A for statement numbers on STEM-CIS). Six step-wise multiple regressions were run on these six interest items to determine which SCCT factors (self-efficacy, outcome expectations, contextual supports, and personal disposition) are significant predictors. Two goal-related items within each subscale were not calculated in the multiple regression model, because interest influences the formation of goals (Lent, Brown, & Hackett, 1994) and this analysis looked at which variables were best predicting student interest. A correlational analysis was performed on the post survey items to see which SCCT factors were related to students’ goals.

Interest in science careers (S#7; see Appendix A for items on STEM-CIS for science, mathematics, and technology subscales) was entered as the first dependent variable to find a best fit model. Independent variables were entered; these included, science-self-efficacy (S#1, S #2), science outcome expectations (S#5; S#6), science contextual supports (S#9,
S#11), and personal disposition to talk to scientists (S#10). These same independent variables were entered to measure interest in science class (S#8). Similar regressions were computed for the dependent variables of interest in math careers and math class (M#18 and M#19), and for interest in using technology in class and using technology in careers (T#29 and T#30). Regression modeling was computed for interest in both the pre survey and the post survey.

**Student Career Video Exploration Sheets**

Once a week for five weeks (approximately half of a class period; 45 minutes), students used a career video exploration sheet (Appendix B) to document which video that they were watching, what they learned about the careers, why they selected this career, aspects that they liked/disliked about the career and if they could ever see themselves in this career. In all, there were 200 exploration sheets collected, approximately 4 per student pair. In some instances, both students were interested in the career and supplied reasons together. In other instances, one student selected the career, and the other student would write down the other student’s responses to the exploration sheets as if one was interviewing the other. In either case, each week that students turned in an exploration sheet, each student’s name, career selection, and percentage completion/accuracy of the exploration sheet was documented by the researcher.

Because these explorations were completed in pairs, sometimes both students were interested in the same career, and sometimes only one student of their pair was documented. If both students were interested, their career selections and their completion/accuracy
percentage were documented for both students. If only one student was interested from the pair, only this student’s career selection and completion/accuracy was noted. There were three factual questions on each exploration sheet, specific to the career video watched and related fact sheet: *What are the responsibilities of someone in this profession? How much money does a professional in this career earn? And, how much education does someone need to go into this career?* The intention was to gain an understanding of how closely the student had investigated the career; therefore, these questions were scored based on the level of completion/accuracy.

When scoring the sheets, the researcher assigned students’ responses into 3 categories based on completion and/or accuracy of their open-ended responses. Students received 33% if they provided a response that was only assumed based on the title of the video (e.g. “video game designers make video games”); responses received 66% if they were accurate, but with little detail (e.g. “Veterinarians check for symptoms of illness in pets”; and 100% was assigned to responses that showed a detailed understanding to these questions about the career (e.g. “[Fashion designers] direct and coordinate workers involved in drawing and cutting patterns and constructing samples of finished garments; design specific fabrics that block UV rays; develop new cosmetic formulas select materials and product on techniques to be used for products”).

For the salary information, a score of 100% was assigned to correct responses and 0% was assigned to an incorrect response not seen in the video or on a fact sheet. Similarly, 100% was given to students who listed the degree one must obtain to enter a career and 0% was given to an incorrect degree listed. For the job responsibilities, salary information, and
educational requirements, averages were calculated for the total number of students/student pairs that provided responses for each of these. For example, if 60 students/student pairs provided a response to the salary and 72 documented educational requirements, the salary average was calculated based on dividing the total points by 60 students, and the educational requirements was calculated by dividing the total points by 72 students. Students, who left questions unanswered, did not get calculated as inaccurate but did get calculated as incomplete.

Non-factual questions on the exploration sheet included: Why did you choose the career? Are you comfortable with the job duties, salary, and level of education? Provide three reasons why you like this career, Provide three reasons why you do not like this career, and, Could you see yourself in this career? These questions were assigned a priori codes (Creswell, 2012) based on factors in the SCCT (e.g. self-efficacy, outcome expectations, goal) then given a descriptive code (Saldana, 2009) to operationalize the SCCT factor to reflect middle school wording of responses. For example, if a student wrote, I want to be a plastic surgeon, because they make a lot of money, the associated code was outcome expectations: make a lot of money. Another example is, I want to be a video game designer because I am good at technology. The associated code assigned by the researcher was self-efficacy: good at technology.

Every SCCT factor was characterized as either corresponding positively or negatively to a career, and was categorized by the factor of the SCCT to which it corresponded (e.g. contextual support/barrier, personal input, learning experience). For example, I can’t go into this career because my parents would not approve, was considered a negative contextual
support, or a barrier. An example of a negatively coded personal input could be, *I don’t want to be in this career because I am not a social person.* This student’s stated personal disposition (not being social) was expressed by the student as unfavorable to pursuing the particular future career. For this age-level, phrases were coded as *goals* when they denoted future plans/desires, such as, *I have always wanted to be,* or *I would really like to be* [insert career professional]. Goals were not classified as positive or negative, rather in alignment or not in alignment with expectations of the career being explored (e.g. *I would rather go into the military*). Alternatively, many students identified that they had different goals than the career being explored or that they did not have a desire to go into the career after exploration. These responses were coded as *alternative goals.* Learning experiences are also an important factor in the SCCT. When students mentioned positive things about the STEM career video, such as *I loved how the video showed how they used technology to make different types of fabric,* a code of *positive learning experience: STEM career video* was applied. Alternatively, if students said *the video didn’t show me enough about the career,* this was labeled as a negative learning experience.

**Operational definitions of SCCT factors.** The following list summarizes the definitions of SCCT factors based on the statements of the participants in this study.

- Self-efficacy- confidence in subjects and/or activities related to the job
- Outcome expectations- an effect of pursuing a career that they are exploring
- Interest- likes or dislikes of the career
- Learning experiences- mastery, vicarious, or social experiences that affect self-efficacy and interest in careers.
• Goals- future career plans

• Personal Dispositions- the tendency to act in a specific way that affects participating in a career

• Contextual Influences- afforances or limitations affecting pursuit of a career

**Coder reliability.** The primary researcher and another coder, with knowledge of the SCCT framework and the literature base utilizing the framework, developed a standard protocol that operationalized the factors for coding. This was first done by selecting initial examples within all of the exploration sheets that were representative of the favorable and unfavorable versions of the SCCT factors (i.e. positive/negative self-efficacy about activities in the career, positive and negative outcome expectations of pursuing a particular career, related interests and unrelated/disinterest to pursue a given career/other goals, etc.). When some of the student responses did not fit with other examples that we found for each factor, we created a list of working definitions that could aid in classifying student responses. This often depended on the way that the student phrased their response. For example, a reason one student may like a job as a pediatrician is because they *like to help people.* This was coded as an *interest* in the process of a career. However, if another student said that they liked the pediatrician job because they *will get to help people,* this was coded as an outcome expectation of the career, an expected belief about the outcome of performing a certain job. To assess reliability, the coders independently coded and negotiated all of the students’ first and fifth exploration sheets. On the first exploration sheet that was coded together, 330 codes were assigned, and the two coders agreed on 94% of the codes. On the second sheet
coded together (Exploration 5) 215 codes were assigned, 10 codes were disagreed upon for a 95% inter-rater reliability (Creswell, 2003). All disagreed upon codes were discussed until 100% agreement was reached between the coders on student responses in relation to SCCT factors (Patton, 2002). Given the high level inter-rater reliability, the primary researcher determined that coding the other sheets did not require dual coders, and she completed the rest of the coding herself. For each student, percentages were calculated for the factors specified by the students. For example, if a student’s exploration sheet was coded with 2 positive interest codes, 1 negative interest code, 1 positive contextual support code, and 1 negative personal input code, this was considered a total of 5 codes; 40% positive interest, 20% negative interest, 20% positive contextual support, and 20% negative personal input (a personal input that they consider not conducive to be in a career. For example, *I am not creative enough to be a graphic designer* is a negative personal input.)

The coding of the students’ exploration sheets each week allowed a way to track any changes in the way students were thinking about factors related to careers and to chart them in relation to the SCCT over time. Additionally, the frequencies of SCCT factors recorded by students were calculated for each exploration and each student. For example, here is the coding for a student exploring a geology career: the student explained that he liked the geologist because he liked earth science (code: *interest in subject*) and liked working alone (code: *positive outcome*), but did not like it because he didn’t think that geologists made enough money (code: *negative outcome*) and he was not patient enough (code: *unfavorable personal input*) to study rocks for long periods of time. Therefore, the student documented three positive aspects present in the SCCT; interest, outcome and personal input, and one
negative aspect of the SCCT (outcome). These counts served as a way to gain a better understanding of what was important to students when engaging in career explorations.

**STEM Career Identity Protocol**

The investigator interviewed eight students throughout the intervention, while the classroom teacher facilitated the STEM career explorations and video planning with the rest of the class. These students were purposefully chosen to represent the demographics of the classroom and a range of feelings toward STEM careers. The interview protocol asks about students’ experiences in school and out of school related to STEM, how they feel about their science and math classes, and their feelings toward engineering. The protocol also asks students questions about how they feel about being a male or female in society, and how they feel that their gender, race, and location affect their future career choices. These interviews were open coded and organized into themes related to how they view themselves in STEM and how they feel that others see them as a member of STEM.

**STEM Career Planning Guides**

Students received one video planning guide per group of two or three students, after five exploration sheets were completed (Appendix C). Students were told to respond individually on the same sheet, and write their initials beside their own responses. For example, one student’s strengths may be in history, and the other student’s may be in science, these students would list both strengths and initial, Student 1 and Student 2. Fourteen video planning sheets were completed and turned in to the researcher and Ms. Cruz. For this study, only three questions regarding interest and influences of interest were analyzed according to
the SCCT. The video planning guide asked students to write about themselves prior to thinking about the video, and students were also verbally coached to include things about themselves when they wrote their script and filmed their STEM career video. The planning guide questions asked about students’ favorite classes, their strengths in classes, their afterschool activities, and how these personal characteristics could benefit them in a STEM field. Students were asked to explain their responsibilities as a STEM professional, their educational path, their starting salary, how long they have been working in the field, and how much they make, to date. They were also asked to describe their job environment, including the physical location of their job, what people wore to work, if they saw their coworkers outside of work, and what someone would find when entering in their workplace. Then students also listed what they would need to videotape their STEM career videos, including costumes and props.

All careers that were chosen to be featured in students’ videos were documented. Only questions on the video planning sheet that addressed why students “went into the career” were coded.

These included:

- I decided to go into this career because (3-5 reasons):
- Why do you think that you will be good in this job?
- What will your parents say when you tell them that you got this job?

Each response was assigned an a priori code related to aspects of the social cognitive career theory, including self-efficacy, outcome expectations, interest, personal inputs, background/context of the job, and contextual supports and barriers. The planning guides
were then assigned a descriptive code to operationalize the SCCT aspect for this population. For example, if someone reported that they were really good with technology, which helped them to do fast calculations in their mind, this would be coded as, *self-efficacy: technology and doing quick mental calculations*. These codes were organized by SCCT aspect and common themes were found that were representative of students’ responses.

Planning sheets were also used to analyze students STEM career identity, using the conceptual framework of *Possible Selves Theory* (Markus & Nurius, 1986). These planning sheets contributed to the understanding of students’ past and present experiences, social roles including gender roles, racial and ethnic roles, and group memberships, including their friends, family, and rural school and community.

**STEM Career Script**

Students were given the option of writing a script to be used when videotaping their STEM career. They were given no time limit on their production but told to include what they wrote on their planning guides in a creative way when creating their video. This included their interests in school and out of school, showing how they led them to the career that they chose, and a line by line account of what each student in the video would be saying. These scripts were compared to the planning sheet and the video to see how students incorporated themselves into a STEM career professional.

**STEM Career Video**

Students used an iPod Touch® to film themselves in STEM career videos. Using the video camera on the iPod Touch® allowed them to easily delete portions that they did not
wish to use. When the students were finished recording, they uploaded their videos on the researcher’s computer. These videos were descriptively analyzed by the types of careers portrayed in the video, the students that were in the video and the format in which it was filmed.

**STEM Career Identity Interview**

The primary investigator interviewed nine students throughout the intervention, while the classroom teacher facilitated the STEM career explorations and video planning with the rest of the class. These students were purposefully chosen to represent the demographics of the classroom and articulated positive and negative influences to pursuing a career in STEM. Several studies have utilized possible-selves theory as a means to explore the identity of preservice teachers, as well as to explore the identities of students negotiating possible selves through extracurricular activities (Hamman, Gosselin, Romano, & Bunuan, 2010; Slay & Smith, 2011; Stevenson & Clegg, 2011.) This conceptual framework guided the analyses of how these four students’ negotiated their STEM career identity. When exploring the personal selves of students, Oyserman & Fryberg (2006) suggest having them share past and present experiences, social roles, and group memberships and explain how these experiences and roles define who they were, who they are, and who they will become.

The interview asked about students’ experiences in school and out of school related to STEM, how they feel about their science and math classes, and their feelings toward engineering. The protocol also asks students about their perceptions of being a male or female in society, and how they feel that their gender, race, and rural community affect their
future career choices. These interviews were open coded and organized into themes related to how they view themselves in STEM and how they feel that others see them as a member of STEM.

**Significance of Study**

This study proposes an intervention that addresses the calls in the literature to give rural students exposure to diverse STEM careers, and a methodological approach to understanding how they explore and respond to these careers. Although studies suggest that students have external or psychological barriers to seeing themselves in STEM, few studies have analyzed how middle school students consider STEM career options. This study follows an eleven week intervention, with adjustments made to enhance the potential impact of the experience, such as providing students with age-appropriate descriptions of careers and educational requirements prior them selecting careers to explore. Hopefully, what is learned will provide implications as to what is important to this population of students regarding STEM interest, identifying with STEM careers. By having students create STEM career videos, conclusions may be drawn to how these students interpret the responsibilities of a career and how they place themselves in a given STEM career. Interview analysis likely will provide more insight to how students’ experiences, the culture of middle school, and the culture of a rural community may shape students’ possible identity in STEM.
CHAPTER FOUR: HOW DOES A STEM CAREER VIDEO INTERVENTION INFLUENCE THE STEM CAREER INTERESTS OF RURAL, MINORITY MIDDLE SCHOOL STUDENTS?

Abstract

National initiatives across the globe encourage more students to pursue professions in science, technology, engineering, and mathematics (STEM) fields. Educational organizations in the United States (US) have responded by encouraging teachers to introduce late elementary and middle school students to STEM careers and engage them in career discussions before they form long term career goals. However, the literature suggests that many students have had limited exposure to STEM careers, particularly students in rural communities. To address this need, this study engaged 75 8th grade students, who are in underrepresented groups in STEM fields, in a STEM career intervention. Students were predominately African American (71%) in a rural, high poverty district (80% free-or-reduced lunch) in the southeastern US. Students took part in an intervention for eleven consecutive Wednesdays for 45-60 minutes, during which time they explored STEM career videos featuring primarily minority STEM professionals; they then planned and created an original video script and produced a STEM career video. None of the students’ activities were graded. Research questions guiding this study are: What are students’ initial STEM career interests? How do students explain what influences their career interests? And, in what ways do students’ interests change with a video intervention? Applying aspects of Lent, Brown, & Hackett’s social cognitive career theory (SCCT), students’ exploration sheets and video planning sheets were coded and analyzed for patterns, as were student responses on the pre and post STEM Career Interest Survey (STEM-CIS). This study found that most students
initially selected a career to explore that was based on their current recreational interests. Throughout the intervention, interest guided career exploration and was influenced by the knowledge students had or gained of outcome expectations in the career (e.g. salary, education requirements, impacts that the career can make on others). Students’ written descriptions of why they selected careers to explore and creation of STEM career videos demonstrate their engagement in learning about future career options. Findings suggest that a STEM career video intervention can help students to gain more sophisticated understandings of careers, that viewing STEM videos featuring minority STEM professionals can motivate students without external rewards, and that with more extensive exposure, students will begin to consider their own skill set when trying on careers.

Introduction

In a time of economic recovery, leaders in the United States have increased the number of solar, wind, and bio-fuel industries to keep the country scientifically and technologically competitive with other nations in the world (Lohr, 2009; National Science Board, 2010). These new industries have increased the demand for qualified workers, yet there are not enough individuals trained in science, technology, mathematics, and/or engineering (STEM) to fill these positions (Cataldi et al., 2011; U.S. Bureau of Labor Statistics, 2010). Those who are trained are predominately white and Asian males (NCES, 2010), limiting the inclusion of diverse thought processes and considerations of women and minorities. To remedy this, a concentrated effort is needed to recruit underrepresented individuals to STEM, by helping them see how their strengths, interests, and dispositions can
align with professionals who work in STEM field (Tan & Calabrese Barton, 2006). National organizations recommend that K-12 educations focus on fostering students’ interest in these fields (ACT, 2011).

Research has shown that students may be interested in related subjects (Kitts, 2009), but frequently have difficulty seeing themselves in a STEM career because of the nature of the job. They perceive STEM jobs to be isolated, uncreative and less people oriented than professions in the liberal arts (Masknik, Valenti, Cox, & Osman, 2010). Several studies find that K-12 students have inaccurate views of STEM professionals, drawing and describing scientists as white males who work long hours in a lab doing research, engineers as male mechanics who fix cars, and those who work in technology careers being nerdy, not creative, and sitting at a computer every day (Bouchey & Harter, 2005; Capobianco, Diefes-Dux, Mena, & Weller, 2011; Fralick, Kearn, Thompson, Thompson, & Lyons, 2009; Thomas & Allen, 2006).

Additionally, surveys and focus groups found that students in high school and college view STEM careers to be too difficult and to require too much education (American Association of State Colleges and Universities, 2005; Drew, 2010). These self-efficacy beliefs form as early as elementary school. Wigfield, Eccles, and Yoon (1997) found that females report low confidence in their mathematics abilities and feel inferior to males, despite their actual performance on assignments. Van Leuvan (2004) found that female interest in science sharply decreases in the transition from middle school to high school. Horn (2011) reported a decrease in STEM interest with both males and females as they increased in grade level.
Lent, Brown, & Hackett (1994) posed that positive learning experiences and support from family, teachers, peers and role models mediate interest in careers. Interventions that include role models as a means of increasing students’ engagement, interest, and perceptions of STEM have been found very effective (Ashby Plant, Baylor, Doerr, & Rosenberg-Kima, 2009; Stout, Dasgupta, Hunsinger, & McManus, 2011; Zeldin, Britner, & Parajes, 2008). Finding similar role models for students living in rural areas can often be a difficult task (Horn, 2011), because many rural communities are surrounded by local family-owned businesses and farming, and not high tech careers (Griffin, Hutchins, & Meece, 2011).

Research suggests that it is valuable to have students play games (e.g. Life© and Monopoly©) that allow them to act out professional roles with their peers (Bergen & Fromberg, 2009; Singer and Singer 2006). In the science education literature, role play and peer video documentaries been found to be promising activities to help middle school students relate to science and to connect them to a professional community, while also increasing classroom engagement, motivation, and sense of ownership (Furman & Calabrese Barton, 2006; O’Neill & Calabrese Barton, 2005). These activities may also encourage the awareness of and interest in STEM careers for rural students who have limited exposure to local role model professionals in these fields.

**Literature Review**

**STEM Education**

A report from the National Center for Educational Statistics (Cataldi et al., 2011) reports that of the 1,600,000 of students who achieve a first time bachelor’s degree, only 16%
major in a STEM related field. From this small percentage, only 26% of women in the US work in STEM careers. Also, African American and Hispanics combined only hold 27% of bachelor’s degrees were earned in STEM. In addition to the previously identified factors, living in a rural location may negatively impact recruitment of minorities to STEM fields. Mahaffey (2012) reports that 20% of the nation’s public schools are in a rural area (one in five students), and within that group, 40% live in poverty and 25% are non-white. Some studies have investigated how rural students feel about their opportunities. Corbett (2007) found that high school students in rural populations associate prosperity with urban locations, seeing their rural setting as a place where success cannot be obtained. An ethnographic study (Gilbert & Yerrick, 2001) in a rural high school found that students had negative science identities because of the low expectations and negative culture of their school. These studies suggest that educators in rural settings need to provide students with experiences and local opportunities, to help them to become more aware of the numerous options in STEM and to improve their self-efficacy in STEM subjects.

**The Development of Student Interest in STEM**

Career literature has identified influences on students developing career interests and provided suggestions for furthering these interests. Cole Ray, & Zanetis (2011) suggest that when students show interest in a career path, it is important to provide them with information that allows them to envision a future in the career, including daily responsibilities and salary. Studies that have examined influences on STEM interests of high school and undergraduate students find that personal interest is most important to students when choosing a major;
however, many do not realize that they are personally interested until they explore their
career options (Beggs, Banthum, & Taylor, 2008; Hall et al., 2011). At the high school level,
students reported self-efficacy as the ultimate reason for interest and intent to pursue careers
(Tang, Pan, & Newmeyer, 2008). When selecting a major, Betz & Voyten, (2012) found
self-efficacy as most influential in career indecision, whereas outcome expectations were the
best indicators of intention to explore careers.

Few research studies have investigated important influences on STEM career interest
for middle school students, compared to the secondary and post-secondary level (Usher,
2009). Similar to other studies, Burke & Mattis (2008) found that high school females have
little knowledge of what an engineer does on a daily basis or how they could relate to an
engineer. Studies show that this knowledge can be gained by more exposure to professionals
in technology and engineering, which ultimately increases female interest in those STEM
careers (Koch et al., 2010).

In the previously mentioned survey study by Kitts, students averaged a high interest
in science (7.0/10) but low desire to be a scientist themselves (Kitts, 2009). Studies have
shown that STEM interests do in fact differ by gender, with males more interested in the
physical sciences and females more interested in the biological sciences (Baram-Tsabari
2007, 2008; Baram-Tsabari, Sethi, Bry, & Yarden, 2009). Zeldin, Britner, and Pajares
(2008) analyzed the self-efficacy beliefs of men and women in STEM careers, finding that
men chose to enter STEM careers because of past mastery experiences, whereas women
remembered positive social experiences and role models that encouraged them to enter
careers. A national survey of eighth grade students found females that females reported
fewer informal experiences with science than males, and suggested that K-12 teachers find ways to connect females with outside science experiences and to apply the physical sciences to real-world scenarios (Brotman & Moore, 2008).

Lent, Brown, & Hackett (1994) pose that people who have positive learning experiences will have higher self-efficacy and beliefs that they can be successful in a class or career. This confidence encourages interest in tasks, courses and careers, and may even cause one to set related goals. In the context of STEM classes, students develop early self-efficacy beliefs that are influenced not only by mastery experiences but by vicarious experiences, social influences, and psychological factors (Bandura, 1986). For example, studies by Eccles (1987, 1994) found that elementary school females believe that they are inferior to males in math related tasks, despite their similar performance on assignments and tests.

Usher (2009) interviewed students with high and low self-efficacy in math and found that students with high self-efficacy mentioned teachers who structured assignments that allowed them to be successful, and had parents who reinforced their confidence in math. Those with low self-efficacy named few experiences of mastery in math, becoming increasingly frustrated with their low grades in math at an early age. Five themes were found in autobiographies written by preservice teachers about their previous experiences in math and science including: 1) the effect of good and bad teachers, 2) the impact of family members’ attitudes toward math and science, 3) the connection between math and science to real-world contexts, 4) the school’s approach to understanding the material rather than
covering a massive amount of content, and 5) the emphasis on memorization rather than building and applying concepts.

**Students’ Perceptions of STEM Careers**

Many students hold inaccurate views of STEM careers and STEM career professionals, deterring their willingness to become interested in STEM (Masknik, Valenti, Cox, & Osman, 2010). By having students draw scientists and engineers, findings elicit perceptions of STEM professionals (Bouchey & Harter, 2005; Capobianco et al., 2011; Fralick, et al, 2009; Thomas & Allen, 2006). In a study by Capobianco and colleagues, four hundred students in grades 1-5 from different neighborhoods (i.e. suburban, urban, community) drew and described engineers as mostly men, who fixed things similar to a mechanic. Common conceptions included engineers being a mechanic or someone who works on cars, fixes or builds things, works on electronics, or someone who designs.

These views continue into middle school. Fralick et al. (2009) analyzed 1600 minority middle school students’ drawings of scientists and engineers. Fifty percent of students drew male engineers, 13% drew females, and 37% could not be identified as one gender. Only 5% of students drew engineers with brown skin, the rest being colorless or shaded peach. Students drew engineers fixing things (e.g. working on car), and working outdoors. When students were asked to draw scientists, they drew white males in lab coats, who were doing experiments in a lab (Fralick et al., 2008). Similarly, negative perceptions extend to information technology (IT) careers; one study found that college students chose not to major in IT because they perceived it to be boring, lacking creativity, and enduring long hours in front of a computer doing technical work (Thomas & Allen, 2006). Another
study found that women believed IT careers to be better for men, because the long hours were not conducive to being a mother (Trauth, Quesenberry and Huang, 2008).

**Strategies that Encourage Interest and Goals in STEM**

Many organizations suggest that teachers begin discussing STEM career opportunities with students in late elementary school and early middle school (ACT, 2011; Skamp, 2007). By the age of thirteen, most students have made decisions about what they do not want to do in a future career, a decision that influences their career goals into high school and college (Extraordinary Women Engineers Project, 2007, http://www.engineeryourlife.org/). Unfortunately, these decisions often translate into a sharp decline in females’ interest in science by the time they reach high school (VanLeuven, 2004).

**Role models.** The Regional Science Resource Center (RSRC) at the University of Massachusetts bases their mission and resources on addressing the barriers minority students face to STEM fields because they do not have role models in these professions who are similar to them ethnically. The RSRC proposed three goals to address the lack of relevant role models that include: have middle school students meet diverse role models and learn about their job descriptions; have students and parents hear positive messages associated with STEM fields and learn about the paths to diverse careers, together; and develop networks of low-income families to share understandings of STEM career choices.

Certainly, one way to create more accurate perceptions in the middle school classroom is to introduce female and minority students to similar-looking professionals in STEM. In one study, Buck et al. (2008) investigated the cognitive processes that eighth
grade females use when identifying science role models. The researchers studied 13 eighth grade females who participated in classes visited by scientist graduate students once a week, conducting interviews with the students before and after their experience with these role models. Their study found that students initially viewed family members as role models and could not identify scientists as role models because they saw scientists as men without families, mean, or geeky. After students’ experience with young female scientists, they changed their perceptions of scientists as role models; the students reported that they felt an emotional connection to the visiting scientists who were fashionable and social (Buck et al., 2008).

This study implies that diverse role models can connect students to the field of science, give students a more accurate understanding of the nature of real scientists, and a vision of scientists that they can identify with and perhaps emulate. Buck et al. (2008) suggest that it is possible to make great strides with students to connect to STEM careers, given mentoring and role models with whom the students can identify.

**Videos in STEM.** Video technology is another promising avenue for helping students to find their own voice in STEM careers. For example, Furman and Calabrese Barton (2006) followed two seventh grade males Anthony and William in a low-income urban setting, as they worked together to create a video documentary on science in an after-school program. Over a three-year period, the researchers taught Anthony and William to use video technology to make mini-documentaries in their technology classes. Past studies have found that technology enhances motivation and interest, gives students a sense of ownership in what they are learning, allows students to communicate on their own terms, and
connects their personal interests with the subject of science (O’Neill & Calabrese Barton, 2005; Furman & Calabrese Barton, 2006). In the creation of a video documentary about animals, Anthony was able to show his gregarious nature and leadership skills, narrating footage of a local zoo. William, on the other hand, was able to express his science identity by acting as a reporter who interviewed others to obtain information. He directed questions to Anthony and also interviewed his teacher to include in their video. Unlike Anthony, William was able to negotiate a science identity behind the camera, and used a producer/director role to show knowledge of both science and technology. This study shows how video technology in science can allow students to meld their own interests into the discipline and express their science identities.

The benefits of connecting videos to STEM engagement have also been seen in a recent study. Wyss, Heulskamp, & Seibert (2012) created a classroom environment that allowed students to create their own video interviews with STEM professionals. When researchers piloted a Likert-type survey measuring interest and attitudes to becoming STEM professionals, they found that students increased their interest in STEM-related goals after recording and watching STEM interviews.

**Theoretical Framework**

Lent, Brown and Hackett’s (1994; 2000) social cognitive career theory (SCCT) is based on Bandura’s (1986) social cognitive theory of learning. In Bandura’s theory, individuals exhibit two loci of control over their own actions: internal and external. Internal refers to how individuals control their own actions; external is how they negotiate societal
interactions and influences. According to Bandura, the most influential personal control over action is self-efficacy, an individual’s belief that they are capable of mastering events within their lives. For example, a student with high science self-efficacy may believe that she is able to earn a good grade in her science class. Self-efficacy is involved in setting personal goals, analyzing decisions and making commitments.

Bandura identifies sources within an individual’s life, such as successful mastery experiences, vicarious learning experiences, verbal influences, and varying emotional and physiological states as driving an individual’s self-efficacy beliefs. From these experiences, individuals form perceptions of their abilities to achieve personal goals. These goals are constantly adjusted or reformed through experiences and reflections upon these experiences. If a student has a science teacher who does not call on him in class, or has low expectations for his success in the course, this could negatively impact his self-efficacy in that subject. Bandura also points out that self-efficacy beliefs and personal goals correspond to an individual’s anticipated outcomes when considering a particular activity. For example, if an individual perceives tasks within a particular activity to be easy, such as completing a laboratory investigation, then they are likely to anticipate a successful outcome when participating in the activity.

Lent, Brown and Hackett (1994) take Bandura’s described relationship between cognitive factors such as self-efficacy, outcome expectations, interest, and goals and external factors such as support structures and barriers, personal inputs and background to explain how individuals make career-related decisions (see Figure 4.1). In Lent, Brown, and Hackett’s social cognitive career theory (SCCT) model, personal inputs are socially
constructed factors such as gender, background, race and socio-economic status and intrapersonal factors such as personality that contribute to one’s feelings of high or low self-efficacy. Contextual supports and barriers are external factors or individuals that either facilitate or impede high self-efficacy or setting academic or career goals.

Figure 4.1. The socio-cognitive career theory. (This figure is based on Lent, Brown, & Hackett 1994).
Application of SCCT to predict science and mathematics interests

A number of early studies applied the SCCT and the researchers’ hypotheses to predict and explain choices of mathematics and science courses at the college level (Hackett, 1985; Nauta & Epperson, 2003; Schaefers, Epperson, & Nauta, 1997), finding that self-efficacy and outcome expectations have direct and indirect effects on interests and goal choice. Ferry, Fouad, and Smith (2000) also identified self-efficacy and outcome expectations as important factors. In a study of 791 predominately white undergraduate psychology majors, they found that parental encouragement has direct effects on learning outcomes and learning expectancies in mathematics and science. Age and gender are additional personal inputs that have direct effects on learning experiences, and can indirectly affect self-efficacy.

In a more recent study, Lent (2005) surveyed approximately 500 students in two historically African American colleges and universities (HBCU) (one public and one private), and one predominantly white college to better understand differences in career choice and interest based on gender and race. The students at all three colleges were first and second year engineering majors; eighty-seven percent of the students from HBCUs were self-identified African American, and 13% of the students identified themselves as white, mixed-race, Native American, Hispanic, and Asian. The participants in the predominately white university had a high proportion (63%) of white students and Asian American students (22%). All students in the HBCUs had higher reported self-efficacies, outcome expectations, interests, supports and goals compared to participants at predominately white universities, with no notable differences by gender. The author suggests that the findings could be related
to the fact that HBCUs universities have stronger mentoring programs and provide connections to diverse role models, likely causing the higher feelings of self-efficacy with these students.

Lent’s (2005) findings support the notion that self-efficacy predicts interest and goals, and that contextual supports have a strong indirect effect on students’ interests, goals and persistence in mathematics and science. Similar results were found in a larger study by Lent, Lopez, Lopez, & Sheu (2008) when they expanded their sample size to 21 HBCUs and 12 predominately white colleges.

Zeldin, Britner, & Pajares (2007) examined sources of self-efficacy among male and female STEM professionals. Personal narratives showed that the men’s’ self-efficacy was primarily influenced by mastery experience, whereas the female STEM professionals were primarily influenced by social persuasion and vicarious experiences. The findings imply that females need supportive relationships in STEM professions, to succeed in a male-dominated workforce.

**SCCT Application at the Middle School Level**

Compared to the studies on general career interest, and ones on the math and science interests of high school and college students, less research has explored how the SCCT explains the mathematics and science career interests of ethnically diverse middle school minority students. In an early study by Fouad & Smith (1996), they used the SCCT framework to explore how self-efficacy, outcome expectations, interests, and personal inputs affected the math and science goals of 380 ethnically diverse seventh and eighth grade
students from a predominately low socio-economic school. They found that eighth graders had less interest in these subjects than seventh graders. Males showed less interest in mathematics and science than females, but had higher outcome expectations. Researchers found that positive in-school and out-of-school experiences with science were high indicators of interest in these fields, suggesting that the males had more of these experiences with science. Self-efficacy had a direct effect on outcome expectations, an indirect effect on personal goals, and a significant effect on interest and students’ intentions to pursue goals in math and science. Thus, this model was shown to effectively predict mathematics and science interest within this diverse population of 8th grade students; furthermore, it shows potential in supporting students’ career goals through contextual supports, such as more contact with positive out-of-school science experiences.

Navarro, Flores and Worthington (2007) conducted a study that looked specifically at how personal inputs and contextual factors affect the interests and goal choices of 409 Mexican-American middle school students to pursue science and mathematics. Using hierarchical linear modeling, researchers examined how a broad range of factors explained the career goals of these students. They examined: gender, generational status, personal association with Mexican or Anglo cultures (based on language and ethnicity), social class (based on parents’ highest level of educational attainment), access to technology in the home, number of people living in the home, perceived support of family, friends and teachers, past mathematics and science accomplishments, self-efficacy, outcome expectations, interests, and goals. Findings showed no differences in students’ goal intentions, by gender. Higher social class had a small direct effect on mathematics and science performance, and indirectly
affected higher self-efficacy in math and science. This study shows that careful selection of personal factors and background/contextual factors can be beneficial in explaining the variance in math and science goal intentions for middle school populations.

In a recent longitudinal study (Rowan-Kenyon, Swan, & Creager, 2012) on 67 fifth, seventh, and ninth grade school students, researchers qualitatively investigated how students’ perceptions of support and engagement in math class and math activities influences math interest. These students were sampled from a school district consisting of approximately 50% African American students, 50% white students and 50% being eligible for free or reduced lunch. Three parents and eight teachers also participated in focus groups to provide researchers with more insight into the students’ engagement, interests, and goals. Students were asked what they liked about math, what types of activities they enjoyed the most and how others expected them to do in math.

Students in fifth and seventh grade reported that their parents had high expectations of them in math, helping them with their homework and preparing them for tests. Fifth grade males and females and seventh grade females stated that their parents gave them rewards/money for doing well in math but very few said that they were motivated to do well in math simply because they were interested. Students at all age levels said that they most enjoyed activities where they worked with others and created products. Fifth and seventh grade students admitted being frustrated by other peers who distracted them in math class because of their disruptive behavior. The researchers suggest that math teachers provide meaningful hands-on and collaborative learning experiences in an orderly environment to engage students in class. They emphasize the importance of teachers and parents supporting
students in late elementary school to encourage intrinsic motivation in math class at an early age, facilitating the desire to take part in math outside of school.

In summary, the SCCT provides a means to predict how self-efficacy, outcome expectations, personal inputs, and contextual supports and barriers affect the academic and career-related interests of many populations within different contexts. Within the body of literature surrounding the utilization of SCCT, few studies have been conducted with middle school students, particularly ethnically diverse, rural middle school students. Findings from these studies suggest future research that operationalizes the aspects of the SCCT to better understand the relationship between cognitive and external factors of the model.

**Research Questions**

This study explores the STEM career interests of rural, minority middle school students. Given that little research has examined the STEM career interests of middle school students, and none have investigated a STEM intervention on STEM interest with similar students, this study asks,

1. What are students’ initial STEM career interests?
2. How do students explain what influences their career interests?
3. In what ways do students’ interests change with a video intervention?

**Methods**

**Setting**

This study took place at Washington Middle School (pseudonym; WMS) in a rural county in the southeastern United States. The county is predominantly agricultural, with
cotton, tobacco, and soybean fields along country roads. Small, family-run businesses can be found in tiny towns (e.g. population 20,081 in nearest town) within this district, many of which are struggling through economic decline, with the unemployment rate 13.1% at the time of this study (US DOL, 2012). According to the WMS website, the largest employers in the county are the school system, the prison, and the county government. There are 13 small industrial companies employing about 1000 people in total. The poverty rate is approximately 27% (WMS website). Approximately 67.5% of the population graduate with a high school degree and 11.6% having some form of post-secondary education (WMS website). WMS is the only middle school within the county (444 sq. miles) and serves students in grades 6-8. The demographics of the school are found in Table 4.1.

(www.greatschools.org).

Table 4.1

Demographics of Washington Middle School; 2011-2012

<table>
<thead>
<tr>
<th>Washington Middle School</th>
<th>450</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Students in the School</td>
<td>450</td>
</tr>
<tr>
<td>Student Ethnicity</td>
<td></td>
</tr>
<tr>
<td>71% African American</td>
<td></td>
</tr>
<tr>
<td>18% White</td>
<td></td>
</tr>
<tr>
<td>6% American Indian</td>
<td></td>
</tr>
<tr>
<td>5% Hispanic</td>
<td></td>
</tr>
<tr>
<td>1% Pacific Islander</td>
<td></td>
</tr>
<tr>
<td>Students on free or reduced Lunch</td>
<td>76.6%</td>
</tr>
<tr>
<td>Students who passed the state test in mathematics</td>
<td>69% Sixth Graders</td>
</tr>
<tr>
<td>70% Seventh Graders</td>
<td></td>
</tr>
<tr>
<td>79% Eighth Graders</td>
<td></td>
</tr>
<tr>
<td>Students who passed the state test in science</td>
<td>No Science Test in Sixth Grade</td>
</tr>
<tr>
<td>No Science Test in Seventh Grade</td>
<td>70% Eighth Graders</td>
</tr>
</tbody>
</table>

Participants

The study was implemented in Mrs. Cruz’s classroom. Mrs. Cruz is originally from the Philippines, and came to the US in 2006. Ms. Cruz could not afford college but found that if she chose to be a science teacher, she could get a full scholarship to pursue her degree. She has taught for 15 years in the science classroom, and has been at Washington Middle School for 6 years. She is well-known by her colleagues and students as an outstanding science teacher who is always striving to bring more STEM initiatives into the school.

Ms. Cruz’s four eighth grade science classes took part in this study for 11 Wednesdays during Fall 2012. Demographics for her students and the participants in this study are summarized in Table 4.2. WMS incorporated time for student remediation on Wednesdays, after each class; this allowed time for students to participate in the project between forty-five and sixty minutes each week.

Table 4.2

Student participant demographics

<table>
<thead>
<tr>
<th>Number of Participants</th>
<th>85 eighth grade students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>42% Males</td>
</tr>
<tr>
<td></td>
<td>43% Females</td>
</tr>
<tr>
<td>Race</td>
<td>59% African American</td>
</tr>
<tr>
<td></td>
<td>13% Non-Hispanic White</td>
</tr>
<tr>
<td></td>
<td>8% American Indian/Alaska Native</td>
</tr>
<tr>
<td></td>
<td>4% Hispanic</td>
</tr>
<tr>
<td></td>
<td>1% Asian</td>
</tr>
<tr>
<td>Percent on free-or-reduced lunch</td>
<td>77%</td>
</tr>
</tbody>
</table>

Note: School provided the teacher with data on the % of students on free-or-reduced lunch
**Context of Overall Project**

This research is part of larger three-year NSF ITEST grant serving five rural school districts. The focus of the grant is to increase the awareness of, interest in, preparation for, and intention of middle school students to continue in STEM courses, major in STEM, and possibly pursue science, technology, engineering, and mathematics (STEM) careers. One of the districts serves as a comparison district.

Ms. Cruz was a participant in this project, who received one week each summer of extensive technology-enhanced professional development, modeled in pedagogically appropriate ways consistent with technological pedagogical content knowledge (TPACK) (Koehler & Mishra 2008) and reform-based practices (National Research Council, NRC, 2000). She received ongoing support throughout the year, through synchronous, online Collaborate sessions each semester and the school was provided with a stem career awareness wiki developed by project researchers. The researcher of this study helped to facilitate the summer workshops and helped to develop many of the professional development resources, and thus was personally acquainted with all of the teachers in the project. During the second summer of professional development, the primary researcher asked Ms. Cruz if she would allow her students to participate in activities to explore and create STEM career videos. Ms. Cruz eagerly agreed to take part in the study.

**Wikis.** The school Wiki hosts a bank of short, STEM career videos labeled with short descriptions, consistent with recommendations in the video and technology literature (e.g. Pace & Jones, 2009). For example, the *biomedical engineer* link contains the description: *Designs tiny particles to take medicine to specific parts in the body.* When
students click on the link with the name and picture of the biomedical engineer, they are taken to a wiki page that features that STEM career video. All career videos were matched to state content objectives in fifth, sixth, seventh and eighth grade science and mathematics curricula.

Also on each wiki video page is a fact sheet. These fact sheets correspond to the career featured in the video and include information on the job’s educational requirements, salary range, daily tasks/activities, and outside interests that someone may have that would lead them to this career. The fact sheets were developed based on data obtained from the National Center of O*Net Development (http://www.onetonline.org/) and were modified to be middle school appropriate and fit on one page.

Additionally, each wiki video page contains an example of a corresponding career script. This script contains blanks for students to fill in information about themselves so that they can film and star in their own STEM career video, as though they already are employed as a professional in the featured career. During the first year of the summer workshop, teachers learned about characteristics of high quality videos and how to help students create their own career videos using an iPod Touch ®, fact sheets, and career scripts.

Project Design

Students took part in the intervention every Wednesday for 11 weeks during the fall, 2012 semester. On the first Wednesday of the school year, the researcher introduced the project to Ms. Cruz’s eighth grade students. She explained that the purpose of the study was to better understand their interest in science, technology, engineering, and math (called
STEM) careers and how they identified with STEM career professionals. The students were asked to name jobs they knew of in science, technology, engineering and math. The researcher explained that they had the option of exploring a new STEM career each week by watching a video, and eventually creating their own STEM career video. Prior to being introduced to any careers, students used the iPod Touch® to take the STEM Career Interest Survey to measure their initial interest in science, math, and technology (Kier, Blanchard, Osborne, & Albert, in review) and each class generated names of all of the STEM careers known to them.

On Wednesday (Week 2) every student was given an iPod Touch®, allowing them to access seventy career videos and brief descriptions of each one (http://stemcareerawareness.wikispaces.com). Students were asked to choose one career from the list that most interested them, watch the video, read the associated fact sheet, and complete a career exploration sheet (Appendix B). Among the careers listed were: aeronautical engineer, mechanical engineer, nurse, doctor, dental hygienist, forester, architect, actuary, marine biologist, and radiologic technicians.

Observations of this exploration suggested that the students were choosing careers with which they were familiar or had previously experienced in class. To encourage the students to explore a greater range of STEM careers the following Wednesday (Week 3), the primary researcher changed all of the video links on the wiki into QR codes that could be scanned by the iPod Touch® and linked to a website. She organized the careers by the educational requirements to hold the job. Categories included: requires 2 years of technical training/Associates Degree; requires 4 years of college/Bachelor’s Degree; and, requires
more than 4 years/graduate school. Within each category of educational requirements, the researcher developed subcategories with student-friendly titles, such as: careers using lots of technology, careers using lots of math, careers that test new products and foods before people use them, careers that create new products, careers where you work outside, careers that allow you to travel, careers that let you solve problems, careers that help other people, and careers that work with living things. Students explored these careers in pairs and noted on their career exploration sheets which of the partners had selected the career video to watch.

Students took part in a similar exploration the following week (Week 4) with the additional career options of dolphin trainer, graphics designer and a speech therapist, which had been suggested by the students during Week 3. The careers were organized in the same manner as Week 3 with posters hung around the room and organized by the level of education required for the job and subtitles with student-friendly titles.

During Week 5, the researcher added more student requested careers: sports analytic software developer, marine biologist, operations technician, water safety specialist, flash animator and large animal veterinarian. Additionally, all of the QR codes were reorganized on large posters based on the STEM discipline to which the career is primarily related (see Figure 4.2).
However, because most STEM careers overlap in these disciplines (i.e. almost every career uses math) most careers were duplicated on separate posters for science, technology, engineering, and math.

In Week 6, students were again asked to explore a STEM career and complete an exploration sheet. Before the students began exploring, the researcher facilitated a class discussion asking students to brainstorm considerations for why they would go into a career, as a way to stimulate students to broaden the way they were thinking about careers. This elicited students’ responses about ties to their family, feelings toward their hometown, cost of living in large cities and rural towns, the importance of being happy in your job and enjoying your co-workers. All student responses were recorded by the researcher on the whiteboard in
the front of the room. Students were asked to keep these ideas in mind when filling out their last exploration sheet. Additionally, the students were asked to choose a career that they could never see themselves in and write a reflection about this at the end of their exploration sheet. The researcher thought doing this might help students to become more aware of potentially important considerations regarding career choice.

During weeks 6-9, students worked in pairs to plan their own career video. The researcher provided students with a large box containing many outfits and props including lab coats, various business labels, hats, tools, medical supplies, toy windmills, calculators, magnifying glasses, stuffed animals, plants, a compass, maps, and human dolls. Students used a planning guide (Appendix C) to stimulate and document their decisions about where the career video would be filmed, what props they needed and how the career would be acted out. They were given the option of using Cue Prompter, an online site that allows users to type in/paste in a script, and have it roll across a screen like a newscaster’s prompt. When students completed their scripts, they used different locations around the school to film their career videos with the iPod Touch®. Some students filmed multiple videos and some asked to re-film their video after watching their own from the iPod Touch®.

After students finished filming, they uploaded their videos onto a computer hard drive. The researcher compiled the videos, edited them with transitions, and added background music. She held a STEM career movie premier in each class so that students could watch the movies created by their peers on Week 11. Following the premier, students took the STEM career interest survey (post survey) during the same class period.
Throughout the project, the researcher observed students, talked with them as they worked, and recorded field notes. She also asked students to clarify some of their answers to exploration sheets; for example, some students would provide very brief responses such as *it’s a good salary*, and they would be asked to explain what this meant (member checking; Creswell, 2012).
Table 4.3

*Timeline of STEM career video intervention*

<table>
<thead>
<tr>
<th>Dates</th>
<th>Classroom Activities</th>
<th>Data Collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>August 29</td>
<td>Researcher introduced herself to students and explained the project to the class; students took STEM-CIS survey.</td>
<td>Pre STEM-CIS</td>
</tr>
<tr>
<td>September 5</td>
<td><em>Exploration 1</em> Students selected their favorite career within the bank.</td>
<td>Exploration sheet</td>
</tr>
<tr>
<td>September 12</td>
<td><em>Exploration 2</em> Students selected career of interest. QR codes were organized by level of education.</td>
<td>Exploration sheet</td>
</tr>
<tr>
<td>September 19</td>
<td><em>Exploration 3</em> Students selected career of interest. QR codes were organized by level of education.</td>
<td>Exploration sheet</td>
</tr>
<tr>
<td>September 26</td>
<td><em>Exploration 4</em> All QR codes were organized by level of education. Students selected career of interest.</td>
<td>Exploration sheet</td>
</tr>
<tr>
<td>October 3</td>
<td><em>Exploration 5</em> Class career discussion. All QR codes were organized by level STEM discipline. Students selected career of interest.</td>
<td>Exploration sheet</td>
</tr>
<tr>
<td>October 10</td>
<td><em>Exploration 6</em> Students selected a career in which they were not interested</td>
<td>Written reflection on Exploration 6.</td>
</tr>
<tr>
<td>October 17</td>
<td>Planning for video creation</td>
<td>Planning sheet</td>
</tr>
<tr>
<td>October 24</td>
<td>Planning for video creation</td>
<td>Planning sheet</td>
</tr>
<tr>
<td>November 7</td>
<td>Filming Day 1</td>
<td></td>
</tr>
<tr>
<td>November 14</td>
<td>Filming Day 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>STEM Movie Premier Day</td>
<td>Post STEM-CIS</td>
</tr>
</tbody>
</table>
Data Sources and Analysis

Greene, Caracelli, and Graham (1989) present five purposes for mixed methods research including triangulation, complementarity, development, initiation and expansion. The purpose of this mixed methods study is to provide complementary data sources to enhance the understanding of STEM career exploration with rural, ethnically diverse students and to triangulate findings with quantitative data analyses. It is hoped that understandings gained from quantitative indicators on the STEM-CIS (of interest in STEM subjects and intent to pursue STEM career goals) will be enriched through qualitative analyses of students’ STEM career exploration sheets, students’ STEM career video planning guides, and observations and field notes made prior to the intervention, during the STEM movie premier, and after the intervention.

Data analysis occurred in two sequential phases with quantitative data analysis preceding qualitative data collection and analysis (Creswell & Plano Clark, 2011). The pre STEM-CIS was used to analyze student initial interest factors, and with the post survey, the ability to measure and changes over time. The qualitative data was coded and analyzed to provide further insight into quantitative findings (Creswell & Plano Clark, 2011). These sources included STEM career exploration sheets (200, approximately 3 per student pair), 14 planning guides, and 20 STEM career videos. Secondary data, including member checking, observations, and field notes further corroborated the data analyses.
Pre survey/Post survey

The STEM-Career Interest Survey (STEM-CIS; Kier, Blanchard, Osborne & Albert, in review; Appendix A) version used for this study consists of thirty-three items with eleven questions pertaining to science, math and technology. Each item uses a five point Likert-scale, 1-5; 1 corresponding to strongly disagree and 5 corresponding to strongly agree. An engineering scale has been developed; however, it was piloted for validation after this study occurred (to see more about the development of the survey see Kier, Blanchard, Osborne, & Albert, in review). Within each subscale, there are questions that address the factors of the social cognitive career theory (Lent, Brown, & Hackett, 1994); specifically, two questions on self-efficacy, two on personal goals, two on outcome expectations, two measuring interest, two measuring a contextual supports, and one measuring a positive personal input. These aspects of the SCCT were operationalized and appropriately worded for middle school students. For example, the questions measuring science self-efficacy state: *I am able to get a good grade in my science class, and I am able to complete my science homework.*

Validation. This version of the instrument was piloted and validated in an ethnically diverse middle school in North Carolina with approximately 609 students. Cronbach’s alphas were estimated for each subscale. The Cronbach’s alpha for the science scale was $\alpha = 0.80$, math scale was $\alpha = 0.86$, and for the technology scale was $\alpha = 0.86$. Each scale was then subjected to confirmatory factor analysis and each version of the scale was acceptable for use without the others (e.g. science alone) or all three of the scales together.
Implementation and analyses. This STEM-CIS (science, technology, and mathematics subscales) survey was given to the students in each remediation period before the project began; students scanned a QR code with an iPod Touch®, linking them directly to the online survey. Seventy-four students took the pre survey. Basic descriptive analyses were performed on the initial data, including means, and standard deviations. Following the project, the STEM-CIS was administered again to all of the students. A total of 64 students had complete data for the pre survey and post survey. One-way ANOVA was used to determine significant differences between males and females in their overall score on the STEM-CIS, their individual scores in science, math, and technology, and SCCT factor scores (i.e. self-efficacy, outcome expectations, interests, etc.) between science, technology and math (Kirk, 1995). Repeated ANOVA measures were used to determine how the students changed after the intervention.

Multiple regression modeling allows for analyzing which factor or combination of factors predicts a dependent variable (Draper & Smith, 1981). There are six items within the STEM-CIS that measure interest. Two in each subject area measure career interest and class interest respectively; science interest (S#8, S#9), math interest (M#18, M#19) and technology interest (T#29; T#30; see Appendix A for statement numbers on STEM-CIS). Six step-wise multiple regressions were run on these six interest items to determine which SCCT factors (self-efficacy, outcome expectations, contextual supports, and personal disposition) are significant predictors. The two items within each subscale related to goals were not calculated in the multiple regression model, because interest predicts goals, and this analysis looked at which variables were best predicting student interest. A correlational analysis was
performed on the post survey items to see which SCCT factors were related to students’
goals.

Interest in science careers (S#7; see Appendix A for items on STEM-CIS for science,
mathematics, and technology subscales) was entered as the first dependent variable to find a
best fit model. Independent variables were entered; these included, science-self-efficacy
(S#1, S #2), science outcome expectations (S#5; S#6), science contextual supports (S#9,
S#11), and personal disposition to talk to scientists (S#10). These same independent
variables were entered to measure interest in science class (S#8). Similar regressions were
computed for the dependent variables of interest in math careers and math class (M#18 and
M#19), and for interest in using technology and class and using technology in careers (T#29
and T#30). Regression modeling was computed for interest in both the pre survey and the
post survey.

**Student Career Video Exploration Sheets**

Once a week for five weeks (approximately half of a class period; 45 minutes),
students used a career video exploration sheet (Appendix B) to document which video that
they were watching, what they learned about the careers, why they selected this career,
aspects that they liked/disliked about the career and if they could ever see themselves in this
career. In all, there were 200 exploration sheets collected, approximately 4 per student pair.
In some instances, both students were interested in the career and supplied reasons together.
In other instances, one student selected the career, and the other student would write down
the students’ responses to the exploration sheets as if one was interviewing the other. In
either case, each week that students turned in an exploration sheet, each student’s name, career selection, and percentage completion/accuracy of the exploration sheet was documented by the researcher. Because these explorations were completed in pairs, sometimes both students were interested in the same career, and sometimes only one student of their pair was documented. If both students were interested, their career selections and their completion/accuracy was percentage was documented for both students. If only one student was interested from the pair, only this student’s career selection and completion/accuracy was noted. There were three factual questions on each exploration sheet, specific to the career video watched and related fact sheet: What are the responsibilities of someone in this profession? How much money does a professional in this career earn? And, how much education does someone need to go into this career? The intention was to gain an understanding of how closely the student had investigated the career; therefore, these questions were scored based on the level of completion/accuracy.

When scoring the sheets, the researcher assigned students’ responses into 3 categories based on completion and/or accuracy of their open-ended responses. Students received 33% if they provided a response that was only assumed based on the title of the video (e.g. “video game designers make video games”); responses received 66% if they were accurate, but with little detail (e.g. “Veterinarians check for symptoms of illness in pets”); and 100% was assigned to responses that showed a detailed understanding to these questions about the career (e.g. “[Fashion designers] direct and coordinate workers involved in drawing and cutting patterns and constructing samples of finished garments; design specific fabrics that
block UV rays; develop new cosmetic formulas select materials and product on techniques to be used for products.”

For the salary information, a score of 100% was assigned to correct responses and 0% was assigned to an incorrect response not seen in the video or on a fact sheet. Similarly, 100% was given to students who listed the degree one must obtain to enter a career and 0% was given to an incorrect degree listed. For the job responsibilities, salary information, and educational requirements, averages were calculated for the total number of students/student pairs that provided responses for each of these. For example, if 60 students/student pairs provided a response to the salary and 72 documented educational requirements, the salary average was calculated based on dividing the total points by 60 students, and the educational requirements was calculated by dividing the total points by 72 students. Students, who left questions unanswered, did not get calculated as inaccurate but did get calculated as incomplete.

Additional questions on the exploration sheet included, Why did you choose the career? Are you comfortable with the job duties, salary, and level of education? Provide three reasons why you like this career, Provide three reasons why you do not like this career, and, Could you see yourself in this career? These questions were assigned a priori codes (Creswell, 2007) based on factors in the SCCT (e.g. self-efficacy, outcome expectations, goal) then given a descriptive code (Saldana, 2009) to operationalize the SCCT factor to reflect middle school wording of responses. For example, if a student wrote, I want to be a plastic surgeon, because they make a lot of money, the associated code was outcome expectations: make a lot of money. Another example is, I want to be a video game designer
because I am good at technology. The associated code assigned by the researcher was self-efficacy: good at technology.

Every SCCT factor was characterized as either corresponding positively or negatively to a career, and was categorized by the factor of the SCCT to which it corresponded (e.g. contextual support/barrier, personal input, learning experience). For example, I can’t go into this career because my parents would not approve, was considered a negative contextual support, or a barrier. An example of a negatively coded personal input could be I don’t want to be in this career because I am not a social person. This student’s stated personal disposition (not being social) was expressed by the student as unfavorable to pursuing the particular future career. For this age-level, phrases were coded as goals when they denoted future plans/desires, such as, I have always wanted to be, or I would really like to be [insert career professional]. Goals were not classified as positive or negative, rather in alignment or not in alignment with expectations of the career being explored (e.g. I would rather go into the military). Alternatively, many students identified that they had different goals than the career being explored or that they did not have a desire to go into the career after exploration. These responses were coded as alternative goals. Learning experiences are also an important factor in the SCCT. When students mentioned positive things about the STEM career video, such as I loved how the video showed how they used technology to make different types of fabric, a code of positive learning experience: STEM career video was applied. Alternatively, if students said the video didn’t show me enough about the career, this was labeled as a negative learning experience.
**Operational definitions of SCCT factors.** The following list summarizes the definitions of SCCT factors based on the statements of the participants in this study.

- Self-efficacy- confidence in subjects and/or activities related to the job
- Outcome expectations- an effect of pursuing a career that they are exploring
- Interest- likes or dislikes of the career
- Learning experiences- mastery, vicarious, or social experiences that affect self-efficacy and interest in careers.
- Goals- future career plans
- Personal Dispositions- the tendency to act in a specific way that affects participating in a career
- Contextual Influences- affordances or limitations affecting pursuit of a career

**Coder reliability.** The primary researcher and another coder, with knowledge of the SCCT framework and the literature base utilizing the framework, developed a standard protocol that operationalized the factors for coding. This was first done by selecting initial examples within all of the exploration sheets that were representative of the favorable and unfavorable versions of the SCCT factors (i.e. positive/negative self-efficacy about activities in the career, positive and negative outcome expectations of pursing a particular career, related interests and unrelated/disinterest to pursue a given career /other goals, etc.). When some of the student responses did not fit with other examples that we found for each factor, we created a list of working definitions that could aid in classifying student responses. This often depended on the way that the student phrased their response. For example, a reason one
student may like a job as a pediatrician is because they *like to help people.* This was coded as an *interest* in the process of a career. However, if another student said that they liked the pediatrician job because they *will get to help people;* this was coded as an outcome expectation of the career, an expected belief about the outcome of performing a certain job.

To assess reliability, the coders independently coded and negotiated all of the students’ first and fifth exploration sheets. On the first exploration sheet that was coded together, 330 codes were assigned, and the two coders agreed on 94% of the codes. On the second sheet coded together (Exploration 5) 215 codes were assigned, 10 codes were disagreed upon for a 95% inter-rater reliability (Creswell, 2003). All disagreed upon codes were discussed until 100% agreement was reached between the coders on student responses in relation to SCCT factors (Patton, 2002). Given the high level inter-rater reliability, the primary researcher determined that coding the other sheets did not require dual coders, and she completed the rest of the coding herself. For each student, percentages were calculated for the factors specified by the students. For example, if a student’s exploration sheet was coded with 2 positive interest codes, 1 negative interest code, 1 positive contextual support code, and 1 negative personal input code, this was considered a total of 5 codes; 40% positive interest, 20% negative interest, 20% positive contextual support, and 20% negative personal input (a personal input that they consider not conducive to be in a career). For example, *I am not creative enough to be a graphic designer* is a negative personal input. The coding of the students’ exploration sheets each week allowed a way to track any changes in the way students were thinking about factors related to careers and to chart them in relation to the SCCT over time.
Additionally, the frequencies of SCCT factors recorded by students were calculated for each exploration and each student. For example, here is the coding for a student exploring a geology career: the student explained that he liked the geologist because he liked earth science (code: *interest in subject*) and liked working alone (code: *positive outcome*), but did not like it because he didn’t think that geologists made enough money (code: *negative outcome*) and he was not patient enough (code: *unfavorable personal input*) to study rocks for long periods of time. Therefore, the student documented three positive aspects present in the SCCT; interest, outcome and personal input, and one negative aspect of the SCCT (outcome). These counts served as a way to gain a better understanding of what was important to students when engaging in career explorations.

**STEM Career Video Planning Guides**

Students received one video planning guide per group of two or three students, after five exploration sheets were completed (Appendix C). Students were told to respond individually on the same sheet, and write their initials beside their own responses. For example, one student’s strength may be in history, and the other students may be in science, these students would list both strengths and initial, *Student 1* and *Student 2*. Twenty career videos were created. Several groups of students with similar professions joined together to create a videos. The video planning guide asked students to write about themselves prior to thinking about the video, and students were also verbally coached to include things about themselves when they wrote their script and filmed their STEM career video. The planning guide questions asked about students’ favorite classes, their strengths in classes, their
afterschool activities, and how these personal characteristics could benefit them in a STEM field. Students were asked to explain their responsibilities as a STEM professional, their educational path, their starting salary, how long they have been working in the field, and how much they make to date. They were also asked to describe their job environment, including the physical location of their job, what people wore to work, if they saw their coworkers outside of work, and what someone would find when entering in their workplace. Then students also listed what they would need to videotape their STEM career videos, including costumes and props.

All careers that were chosen to be featured in students’ videos were documented. Only questions on the video planning sheet that addressed why students “went into the career” were coded. These included:

- I decided to go into this career because (3-5 reasons):
- Why do you think that you will be good in this job?
- What will your parents say when you tell them that you get this job?

Each response was assigned an a priori code related to aspects of the social cognitive career theory, including self-efficacy, outcome expectations, interest, personal inputs, background/context of the job, and contextual supports and barriers. The planning guides were then assigned a descriptive code to operationalize the SCCT aspect for this population. For example, if someone reported that they were really good with technology, which helped them do fast calculations in their mind, this would be coded- self-efficacy: technology and doing quick mental calculations. These codes were organized by SCCT aspect and themes were common themes were found that were representative of students responses.
STEM Career Video

Students used an iPod Touch® to film themselves in STEM career videos. Using the video camera on the iPod Touch® allowed them to easily delete portions that they did not wish to use. When the students were finished recording, they uploaded their videos on the primary researcher’s computer for editing. The videos are described descriptively, in terms how many students took part in the video and how the videos were produced in groups.

Findings

Initial Interest in STEM Classes and Careers

When the students were introduced to the primary researcher and asked to name STEM careers, they were able to name a total of ten careers. This included five medical careers: nurse, doctor, vet, obstetrician, pediatrician; one career that uses math: construction worker; two careers that use technology: someone who works with computers and someone who makes video games and two types of engineers: civil and mechanic.

Pre survey. The maximum score on the survey is 165. The average score for all of the students was 128 (3.87 avg.), with a standard deviation of 14.33. This indicated a higher than neutral interest in science, technology, and mathematics, with students being extremely interested in STEM and students who were not that interested. When comparing scores between male and female students, there was no significant difference between them. An ANOVA was performed on the total score within science, mathematics, and technology subscales, and found a significant difference (p<0.02) between the mean science score of females and males, females having a higher average score (µ=42.25) than males (µ=28.46).
ANOVA tests were also run on every item to determine significant gender differences within aspects of the SCCT. The results of this test found significantly (p<.05) higher means of females’ self-efficacy in completing science homework, females knowing more family members that had careers in science, and females knowing more family members that use technology in their career (μ=4.06).

Step-wise regression modeling was also performed using the dependent variables of interest for each subject (science, mathematics, and technology), and the independent variables of self-efficacy, outcome expectations, contextual supports, and personal inputs for the three subject areas. See Methods section for variable names used for dependent and independent variables within the analyses, and criteria for selecting the best-model fit. Regression models predicted best model fits predicting best model fit are summarized in Table 4.4.

Table 4.4

Pre survey summary of best fit models for interest in science, mathematics, and technology

<table>
<thead>
<tr>
<th>Measuring Interest in science careers S#7</th>
<th>Best Model Predictors in Presurvey (greatest to smallest)</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Personal disposition of being comfortable talking to people who work in science careers S#10</td>
<td>0.482</td>
</tr>
<tr>
<td></td>
<td>2. Family member in career S#11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Good grades in science S#1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Parental approval of science career S#6</td>
<td></td>
</tr>
</tbody>
</table>
The table of best fit models show that the personal input (disposition), I feel comfortable talking to people in science careers, was a significant predictor of science interests in science careers and their science class, and having a family member in science influenced interest in science careers.

Although a personal disposition conducive to pursuing a career in science, technology, and mathematics careers was significant in predicting interest, it did not explain much of the variance ($R^2$) in science career interest. Self-efficacy and outcome expectations of science played a role in predicting interest in science careers. None of the models were
significant in predicting interest in math class; however, outcome expectations were the
overwhelming predictors for interest in math careers. Similar to science, interest in using
technology in class and in careers was influenced by having a family member who used
technology in their career, and being able to talk to someone in a technology career
influenced interest in technology careers. In addition, self-efficacy influenced interest in
using technology in class.

Career exploration 1. Seventy-five students (N=75) took part in the first career
exploration and selected the career from the video bank that most interested them (summary
of students’ career choices in Table 4.5). Twenty-seven of the seventy careers were chosen,
with critical care nurse, fashion designer, motorcycle engineer, and robotics engineer selected
by more than five students during the exploration. Males predominately chose careers
related to engineering (17) whereas many females chose careers in the life sciences or health
careers (22).
Table 4.5

*Careers selected by students during the first career exploration*

<table>
<thead>
<tr>
<th>Career Selected</th>
<th>M</th>
<th>F</th>
<th>Career Selected</th>
<th>M</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace Engineer</td>
<td>2</td>
<td>0</td>
<td>Mathematician</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Biologist</td>
<td>2</td>
<td>2</td>
<td>Mechanical Engineer</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Chemist</td>
<td>2</td>
<td>1</td>
<td>Motorcycle Engineer</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Critical Care Nurse</td>
<td>0</td>
<td>7</td>
<td>Neonatal Nurse</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Dairy Scientist</td>
<td>1</td>
<td>1</td>
<td>Nursing Assistant</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Dental Assistant</td>
<td>1</td>
<td>0</td>
<td>Product Designer</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Ecologist</td>
<td>0</td>
<td>1</td>
<td>Robotics Engineer</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Engineer for Supersoaker</td>
<td>1</td>
<td>0</td>
<td>Roller Coaster Designer</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Fashion Designer</td>
<td>2</td>
<td>7</td>
<td>Science Photographer</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Food Scientist</td>
<td>1</td>
<td>1</td>
<td>Sports Medicine Physician</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Forester</td>
<td>1</td>
<td>0</td>
<td>Veterinarian</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Frog Scientist</td>
<td>2</td>
<td>0</td>
<td>Video Game Designer</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Geologist</td>
<td>1</td>
<td>0</td>
<td>Zookeeper</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Marine Biologist*</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. * This career video was not yet in the bank, the student found her own video and looked up factual information to answer question of the fact sheet
Of the 75 students who worked individually on career exploration sheets. Ninety-five percent (who responded) accurately reported salary, and 55% correctly reported the level of education needed for the career. Overall, students reported that interest was the most important factor for selecting the career that they did (51%), with outcome expectations being their next most important influence (15%). Student interest was characterized by their enjoyment of similar recreational activities related to the career. Outcome expectations showed that a high proportion of males wanted to make a lot of money, and many females wanted to help others. Field note observations on the first exploration documented that males were competing with their friends to find the job that made the most money. Students indicated outcomes of being satisfied by the responsibilities of the career and also receiving benefits that were likely to come with a job, such as meeting famous people and getting to travel. After watching the video, students documented negative outcome expectations such as required too much work or did not make enough money were usually listed as the aspects that they did not like. However, these outcomes did not deter students from saying that they would choose to go into the career that they selected.

Out-of school experiences with family members were coded as learning experiences that led them to having interest in a career that they selected. Family members were also the most common contextual support listed by students. Self-efficacy had very little influence on selecting a career; rather, it was mentioned as a reason that students may not be able to see themselves in a particular career (e.g. I’m not good at math).
Summary of Students’ Initial Interests in STEM Careers

Based on the initial survey analyses and students’ first exploration sheet, the following findings were observed.

- The survey showed varying interest in STEM careers with large standard deviations within each scales.
- Females had higher science self-efficacy than males, as well as significantly more family members in science careers.
- Student interest in STEM courses and careers was predicted by the ability to talk to professional in STEM careers, and family contextual supports.
- Interest in related recreational activities guided students’ first exploration of career videos.
- The outcome expectations of making a lot of money and getting to have fun were the predominate reason for interest in careers.

**Interest.** Overall, on all of the exploration sheets, 948 student statements were coded according to the aspect of the SCCT to which it most corresponded. Of all of the statements made by students on their exploration sheets, 334 statements (35%) were classified as positive interest. Within this category, approximately 80 different descriptive codes were assigned to students’ statements, which were then grouped into ten categories by type of interest. These categories included: interest in featured aspects/product of the career, interest in recreational activities related to the career, interest in the physical processes of the career, interest in the mental processes required by the career, initial interest in the career...
description, interest in the tools of the job, general interest in the career, interest in the work environment, interest in helping others, and interest in the subject/discipline used most by the career. When students documented reasons for disliking careers, the statements were classified as negative interest. Only 32 statements were classified as negative interest (3%), indicating that students who had chosen the career to explore due to initial interest generally did not lose interest after exploring the career. Most of the statements that were characterized by negative interest were provided during Exploration 6 when twenty-seven exploration sheets were completed on a profession that students could not see themselves pursuing.

**Outcome expectations.** Outcome expectations were categorized by descriptive codes, and 243 statements were coded as positive outcome expectations. These descriptive codes were condensed into 8 major categories of positive outcomes on the exploration sheets. These categories included: high salary, a reasonable amount of schooling, enjoying what they would be doing if they were a professional within the career, taking care of others, tangible benefits received for the career, enjoying the physical processes of the job, enjoying the mental processes needed for the job, doing meaningful things within the career.

Although students were told to select careers in which they were interested, they also documented aspects of the career that they did not like. Overwhelmingly, outcome expectations were the dominant reason for not liking the selected career. There were 151 statements coded as negative outcome expectations (16%) including: having to complete too much education, the salary was too low, negative aspects of the job (e.g. putting an animal to
sleep when it was sick), having to work too long/wait for the product to be made, and the danger of the job.

**Learning experiences.** Out of 948 students, there were only three instances of students recalling previous positive learning experiences with family members leading to selecting a particular career. Eighteen of the 21 statements listed examples regarding positive impressions of experiences with the career videos, leading to interest in the selected career. For example, one student said:

*The physicians [in the video] all had a smile which means good working conditions.*

Students only provided negative learning experiences about the career video, and did not provide any out of school experiences. Out of the 948 statements, 17 were coded as a type of negative learning experiences. These categories included- the job in the video was boring, the video did not provide enough information about the job, and the professionals in the video left a poor impression of the career.

**Supports and Barriers.** Few supports and barriers were listed on the exploration sheet (4 supports and 2 barriers). Those who documented contextual supports as a reason for selecting a career identified a parent/family member as the support structure. Only two barriers were listed that were considered societal barriers, specifically gender stereotypes. For example one student stated: *Fashion designer [is a career that I am not interested in] because men doesn’t sopose to do that, that’s a women job and most men that do that their life aint straight, that’s why I would never do that.*

When students were asked to select careers that they could not imagine themselves in, a variety of careers were selected. Out of thirty-three responses from students, both males
and females selected careers of disinterest that included ones that would frequently use computers and mathematics. These included quality control technician, cartographer, construction worker, engineers and geology technicians, graphic designer, petroleum technician, rocket designer, and NASA information specialist. Healthcare careers were also selected by females who did not believe that they had dispositions to work in these fields. These careers included dentist, doctor, critical care nurse, and brain surgeon.

Disinterest in the processes and aspects of jobs (39%) were frequently listed by students as well as outcome expectations (39%) such as negative incidents that could occur on the job, low salary, too much education, poor work conditions, and time spent at work as reasons for not pursuing a career. Students identified some jobs were not conducive to their skill set (11%), or that their disposition would not be conducive to pursuing a career (8%). One student described a time when his uncle was shot by a police officer and identified this incident as a negative learning experience persuading him not to pursue a career as a police officer.

Career Video Planning Guides

When students were asked why they chose the career that they did for the career video, 33 SCCT codes were applied to their statements. Of these 33, sixteen codes related to a type of interest, 13 as outcome expectations, 2 were coded as learning experiences, and 2 as contextual supports. Interest was operationalized by the students primarily as liking the process of the job. Examples included: I love to help others; I love to take care of babies; I like studying different organisms; I like discovering new things; we love to take apart and build. The most common outcome expectations included money, having fun, genuinely
loving their job, and helping sick or injured people. One student identified her aunt who is a nurse as a contextual support; another student documented his cousin was his support, teaching him to build cars. Both of the males who listed learning experiences for the reasons that they wanted to be mechanical engineers said that they have experiences fixing cars.

Students were asked to give reasons why they would be good at the chosen career. Their responses were coded by the SCCT factors. Nineteen codes were assigned, and 9 of the statements, approximately half, were related to self-efficacy. These self-efficacy statements were characterized by being good at the processes required in the job, such as: We are good at taking care of babies, I’m good at fixing things, I’m good around blood, and I have a steady hand. Interestingly, being a successful student in science, math, and/or technology classes was only documented by two students, one of whom planned to create a video in which she would portray a microbiologist and one student who had the goal of becoming a veterinarian. Learning experiences were documented three times; two students reported that they had experience performing tasks associated with the selected career, and one student documented times that her sister explained the responsibilities of a nurse and used tools to check the diagnostics of patients. Three students indicated high self-efficacy in performing the responsibilities of the job. One student documented a personal disposition (I am caring and kind to others) that would be conducive to her career in healthcare.

The last question was intended to have students think about whether they saw their parents as a support structure. For the most part, students wrote that they would receive some sort of verbal praise from their parents, such as I am so proud of you or I thought that was something you might do. Three of the students’ responses were characterized as being more
of an indirect praise/humor, e.g. *Good, now where’s my money for the past 18 years of you living here*, or a “tough love” approach to pushing their children to accomplish their goals; this included: *you gotta do good in school* (veterinarian), and *I hope you know what you are getting into* (instrument designer).

**Summary of Students’ Explanations of STEM Career Interests**

Students operationalized the aspects of the SCCT through their exploration sheets and planning guides. Students’ career explorations were primarily guided by their interests. They described their interests in what was made in the career, how the career aligned with their own recreational interests, and the physical and mental processes they enjoy both in school and out of school, their interest in science, mathematics, and technology, their intrigue with the job description and desire to learn more, their interest in the tools used in the job or environment in which the job takes place (e.g. computers, surgical instruments), and their love for doing something positive and helpful in society.

Earning a high salary (listed frequently by males), and helping others (listed frequently by females) were predominant positive outcome expectations. Self-efficacy tended to be more evident on students’ planning guides for their videos, because the questions explicitly asked about students’ strengths and how those relate to their selected career. Students wrote mostly about their dispositions and how they would serve as strengths, rather than how ability in their classes could benefit them in the future career. Low self-efficacy (I’m not good at this) was not listed often on students’ exploration sheets in an explicit manner. However, students frequently listed that a career required too much school as a
negative outcome expectation, potentially suggesting that students did not feel able to attain the level of education required.

Students addressed family members as their only forms of contextual supports on their exploration sheets, and most indicated they believed this support to be rather strong on the career planning sheets. Personal inputs were only addressed in the form of personal dispositions (e.g. being creative, being female), and this SCCT aspect, as well as learning experiences, were not operationalized well by the students; that is, they were not frequently given reasons for considering or not considering a career and mostly related to things that students saw in the career video.

**Effects of a STEM career intervention on student interest**

**Exploration 2.** Career names were removed and replaced with age-appropriate descriptions of careers and were organized according to educational requirements during Exploration 2. Students were allowed to explore individually or in pairs, choosing twelve careers that were not explored the previous week. These included: architect, athletic trainer, bio-behavioral scientist, contractor, forensic science technicians, industrial designer, materials engineer, operations technician, pediatrician, physician, physician’s assistant, and space suit designer. Males selected careers using technology, engineering, and math compared to females who selected careers in the life sciences. For example, five male student groups selected mechanical engineer, one selected a carpenter, and one selected operations technicians; whereas, females selected critical care nurse, veterinarian, bio-behavioral scientist, dental assistant, and forensic scientists. On their career exploration sheets, students showed that positive outcome expectations became more of an influencing
factor than interest. Students described positive outcomes such as high salary, processes that they would be able to do if they took part in the job, and benefits/perks that would come with the career. For example, students gave responses like the pay is awesome, I would get to work with my hands, you could stop someone from dying and I would get to travel. Negative outcomes were overwhelmingly characterized by the amount of school; I have to go through a lot of college education; also, students frequently documented that careers entailed too much work. Self-efficacious responses were more prevalent in this exploration (12%) than any other exploration.

**Exploration 3.** In this exploration, students selected nine new careers that were not explored in Exploration 1 and Exploration 2. These included atmospheric scientist, carpenter, dentist, dolphin trainer, graphic designer, nuclear medicine technologist, rocket designer, speech pathologist, and surgical assistant. During the previous week, the primary researcher had asked students to let her know if they would like any careers to be added to the exploration. They suggested dolphin trainer, graphics designer, marine biologist and speech therapist, all of which were added and selected by students during this exploration. Nine of the twenty-eight career exploration sheets (approximately one-third) were completed when exploring these newly added careers. Males continued to select careers that they could use creativity and design such as rocket designer, carpenter, and aerospace engineer. During this exploration, females selected more engineering and technology based careers. For example, females explored careers such as product technician, nuclear medicine technician, graphics designer, and roller coaster engineer.
As seen in Table 4.6, the SCCT factors identified during Exploration 3 were similar to that of Exploration 2; outcome expectations were listed often (approximately 30% of all explorations) and interests (34%) still continued to guide students’ selections, their reasons for liking the career, and reasons for seeing themselves in the career. Outcome expectations focused on fun things they would expect to do if going into the job, such as solving crimes, interacting with animals, and creating animated characters. Interests were still classified as liking/enjoying featured aspects or processes of the job; however more students appeared to choose careers that they had never seen. This was evident in their responses to why they selected the career. For example, one pair of students described why they selected a nuclear medicine technician to explore: *We all decided this video because it seemed interesting to be able to know how to take proper pictures of somebody's insides.* Students showed an eagerness to know more with phases like *I thought it would be cool to see what they make* (carpenter); *I wanted to know how much money they made; It sounded very interesting to make characters drawing them, then make them come alive.*

**Exploration 4.** During this exploration, 21 sheets were completed, and 11 different careers were explored. New careers were added: *sports analytic software developer, marine biologist, operations technician, water safety specialist, flash animator and large animal veterinarian.* Eight exploration sheets were completed on these newly added careers. Popular choices for males were *sports analytic software developer* (5 male groups), *graphics designer*, and *flash animator*. Females tended to select slightly more healthcare and life science careers than technical careers. Healthcare careers included critical care nurse, dolphin trainer, pharmacist, speech pathologist, and small animal veterinarian. Technical careers
included flash animator, graphics designer. During this exploration, the frequency of outcome expectations (40%) surpassed the frequency of students documenting students’ interest (22%) as their reason for selecting or seeing themselves as a professional in the career. In addition, negative outcomes were listed more frequently than in any other career exploration, with students describing possible negative incidents that could occur in the job, as well as a continued emphasis on low salary and too much education.

**Exploration 5.** Prior to this exploration, students took part in a class discussion about the amount of years associated with educational degrees, how much money they needed in a career, and other ideas that they felt were important when considering a career to take part in for the rest of their lives (see an example of thoughts generated by the class in Figure 4.3). As students shouted out responses to how many years of college a degree required, and what they valued in future job, the primary researcher quickly wrote them down on the board to discuss further. Audio discussions and field notes revealed that students valued things like a good schedule, positive working conditions, having vacation days, making friends with the people that you work with, and being close to the city yet having land to hunt. Students had a difficult time conceptualizing the amount of money needed to survive within different locations in the country and cost of living.
The students who discussed where they wanted to live agreed that they did not want to stay in Washington County (pseudonym) because it was poor, did not have fun things to do, and lacked opportunities for good jobs. Students were encouraged to provide a little more detail on their responses on the last exploration sheet, explaining more about what they liked and disliked about job outcomes.

The final exploration showed the largest variety of selection with 22 different careers being explored. No new careers were added and careers were organized by discipline.
(many careers overlapped between STEM subjects). Eight explorations sheets completed by female groups were related to health-related careers; eight groups explored engineering and technology-based careers. Three exploration sheets were completed by males interested in careers dealing with life sciences (athletic trainer, dairy scientist, vet technician), and the rest (13) were characterized by technology-based, hands-on careers. Like previous explorations, students frequently documented positive outcome expectations and personal interest when listing reasons for selecting, liking, and seeing themselves involved in the career. Students recorded more realistic expectations of their necessary salary, and also commented about the importance of selecting a job that did not require them to be in school for more than four years. For example, one male student recorded, *I feel good [about being a carpenter] and I would do it because I like this career and I don’t have to go to school almost my whole life and then work. It doesn’t pay like I want it but it enough.* One female also reported: *I feel good and I would do it because I like this career and I don’t have to go to school almost my whole life and then work.*

When students wrote about careers in which they could not see themselves involved, they wrote statements characterized by disinterest and negative outcome expectations. These jobs included a brain surgeon, petroleum technician, graphic designer, and zookeeper. Students identified that low self-efficacy (approximately 8% of responses) was a reason why they could not pursue a career in aerospace engineering and biology teaching. The summary of SCCT influences are compared between all five explorations in Table 4.6. This table shows the importance of personal interests to students as well as their high frequency of documented outcome expectations. Comparatively, self-efficacy was not documented very
frequently as reasons for exploring a career. Exploration 2 showed the highest frequency of self-efficacy responses by students (12%), when careers first were organized by educational levels and labeled with short descriptive statements.
Table 4.6

*Calculated percentage of positive and negative SCCT factors recorded on students’ exploration sheets during each exploration (rounded to nearest whole percent)*

<table>
<thead>
<tr>
<th>Exploration 1</th>
<th>SE+</th>
<th>SE-</th>
<th>OE+</th>
<th>OE-</th>
<th>INT+</th>
<th>INT-</th>
<th>LE+</th>
<th>LE-</th>
<th>G+</th>
<th>G-</th>
<th>in+</th>
<th>in-</th>
<th>sup</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploration 2</td>
<td>12</td>
<td>5</td>
<td>30</td>
<td>11</td>
<td>25</td>
<td>2</td>
<td>0</td>
<td>7</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Exploration 3</td>
<td>7</td>
<td>5</td>
<td>31</td>
<td>9</td>
<td>34</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>6</td>
<td>&lt;1</td>
<td>0</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Exploration 4</td>
<td>2</td>
<td>2</td>
<td>40</td>
<td>23</td>
<td>22</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Exploration 5</td>
<td>2</td>
<td>2</td>
<td>34</td>
<td>17</td>
<td>34</td>
<td>2</td>
<td>3</td>
<td>&lt;1</td>
<td>3</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>AVG of 5</td>
<td>5</td>
<td>3</td>
<td>30</td>
<td>14</td>
<td>33</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>&lt;1</td>
<td>1</td>
</tr>
</tbody>
</table>

* SE-self-efficacy; OE-outcome expectancy; INT-interest; LE-learning experience; G-goal; in-input/disposition; sup-support; bar-barrier+ and – notes if the response was supporting interest in the career or deterring interest in the careers*
Student’s Planning Sheets and Video Selections

Only 12 planning guides were turned in. These planning guides were worked on by 26 students. These planning sheets include one instrument designer, three mechanical engineers, one microbiologist, three nurses, one pathologist, two pediatricians, one physical education teacher, and one veterinarian. For this study, only three questions regarding interest and influences of interest were analyzed according to the SCCT. These questions included: List 3-5 reasons why you go into the career, why do you think that you will be good at this job, and what will your parents say when you tell them that you got the job. For the reasons that students chose these careers two of which were not featured as a video; these planning sheets included one for a mechanical engineer and one for a physical education teacher. When students were asked why they chose the career that they did for the career video, 33 SCCT codes were applied to their statements.

Of these 34 fifteen was categorized as a 16 as a type of interest, 13 as outcome expectations, 2 two were coded as learning experiences, and 2 as contextual supports. Interest was operationalized by the students primarily as a love of the process of the job. Examples include: I love to help others; I love to take care of babies; I like studying different organisms; I like discovering new things, we love to take apart and build. The most common outcome expectations included money, having fun, genuinely loving their job, and helping sick or injured people. One student listed a contextual support as her aunt who is a nurse and the other student wrote that his cousin was his support in building cars. Both of the males who listed learning experiences for the reasons that they wanted to be mechanical engineers said that they have experiences fixing cars.
Students were asked to give reasons why they would be good at this career. The responses to these questions were coded with by SCCT factors. Nineteen codes were given to these statements and not surprisingly 9 of those statements were self-efficacy statements. These statements were characterized by being good at the processes required in the job, such as: *We are good at taking care of babies, I’m good at fixing things, I’m good around blood, I have a steady hand.* Interestingly, being a successful student in science and/or technology classes was only documented by two students, one who planned to create a microbiologist video, and one who wanted to be a veterinarian. Learning experiences were documented three times, with students saying that they have had practice doing responsibilities required in the job, and one listing the contextual support of her sister teaching her how to do some of the responsibilities in the nursing profession. Simply being interested in a career was written by three students as their reason why they would be good at the career duties. One student documented a personal disposition (*I am caring and kind to others*) that would be conducive to her career in healthcare.

The last question was intended to have students think about whether they saw their parents as a support structure. For the most part, students wrote that they would receive some sort of high verbal praise from their parents, such as *I am so proud of you* or *I thought that was something you might do.* Three of the students were characterized as having more of an indirect praise/humor (Good, now where’s my money for the past 18 years of you living here-mechanical engineer), or a “tough love” approach to pushing their children to accomplish their goals; this included: *you gotta do good in school*-veterinarian, and *I hope you know what you are getting into* (instrument designer).
**STEM Career Videos**

Nineteen career videos were created. A total of 61 students filmed and acted in the 20 videos (out of 85). Somewhat surprisingly, the video planning sheets and career videos described careers that were familiar to the students prior to the intervention (see Table 4.7). Students chose to either work with classmates to create a drama of the career (e.g. Doctor’s practice, anger management specialist), do a one-on-one interview that one partner read questions from the planning sheet and one student answered as the professional (e.g. DJ).

Table 4.7

*Students’ STEM career videos*

<table>
<thead>
<tr>
<th>Student Created Videos</th>
<th>Students per group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anger Management Specialist</td>
<td>3 students</td>
</tr>
<tr>
<td>DJ</td>
<td>2 students</td>
</tr>
<tr>
<td>Doctors Practice</td>
<td>8 students</td>
</tr>
<tr>
<td>Fashion Designer</td>
<td>2 students</td>
</tr>
<tr>
<td>Forensic Science Technician</td>
<td>7 students</td>
</tr>
<tr>
<td>Instrument Designer</td>
<td>2 students</td>
</tr>
<tr>
<td>Motorcycle Engineer</td>
<td>2 students</td>
</tr>
<tr>
<td>Microbiologist</td>
<td>2 students</td>
</tr>
<tr>
<td>Nurses</td>
<td>Group 1: 2 students</td>
</tr>
<tr>
<td></td>
<td>Group 2: 2 students</td>
</tr>
<tr>
<td></td>
<td>Group 3: 3 students</td>
</tr>
<tr>
<td>Pathologist</td>
<td>3 students</td>
</tr>
<tr>
<td>Psychologists</td>
<td>2 students</td>
</tr>
<tr>
<td>Pediatricians</td>
<td>Group 1: 3 students</td>
</tr>
<tr>
<td></td>
<td>Group 2: 5 students</td>
</tr>
<tr>
<td></td>
<td>Group 3: 5 students</td>
</tr>
<tr>
<td>Product Engineer</td>
<td>2 students</td>
</tr>
<tr>
<td>Veterinarian</td>
<td>4 students</td>
</tr>
</tbody>
</table>
**Quantitative changes in SCCT factors**

When students finished exploring videos and created their own, students watched all of the videos edited and compiled by the primary researcher, and took the post survey. Sixty-four students completed the post survey and these scores were compared to the pre survey scores. The range of the survey is from 33 to 165, and the average score on the post survey was 120.4 (approximately a 3.65) with a standard deviation of 18.39. A paired sample t-test was performed finding a significant decrease in students’ total mean scores on the STEM-CIS (p<0.003). Paired t-tests were also done within each subject area (science, mathematics and technology) to find differences and means. Science and mathematics scores showed a significant decrease from pre survey to post survey (science, p-value<0.048; mathematics, p-value<0.000), whereas technology scores slightly decreased, without significance.

Two-tailed mean comparisons were also performed on each SCCT factor (e.g. self-efficacy for science, mathematics and technology). There was a significant decrease from pre to post survey on the following science question: *I will work hard in my science classes.* Although not significantly, students showed a more positive belief that their parents would be happy if they chose a career in science. Post survey, students had significantly lower self-efficacy, goals, and beliefs that if they do well in their technology classes, it will help them in their future career. Like science, a non-significant increase was found in the belief that their parents would be happy if they chose a career in technology, as well as a small increase in their perception that they had a role model in technology. Only one statement showed a
difference in gender, with females reporting a significantly higher mean than males of knowing family members that used technology in their career.

As was done with the pre survey data, a regression analysis was performed on the post survey results. Table pre survey shows the best fit models (i.e. the most influential independent variables that influence interest), variance ($R^2$), and significance (p-value) of the independent variables in predicting interest in science, mathematics, and technology on the pre survey and post survey. There are two statements on the STEM-CIS (see Appendix A for all Likert-type statements) that measure interest in each subject; science (S#7 and S#8), mathematics (M#18 and M#19), and technology (T#29 and T#30). As shown in Table 4.8, post survey regression models explain more of the variance $R^2$ of students’ interest in STEM than the pre survey regression models. The variables in the best fit models that were the same in the pre survey and post survey models are bolded in Table 4.8.

**Summary of best fit post survey models predicting interest.**  
*Interest is science careers* are best predicted by having a role model in science, the ability to talk to science professionals, and parental approval influences interest in science careers. *Interest in science class* is best predicted by self-efficacy in science, making good grades, and being able to complete homework. *Interest in math careers* are best predicted by having a role model in a math career, having parental approval, and the expectancy that if successful in math class, it will help them in their future career. *Interest in math classes* is predicted by the ability to complete math homework, and the disposition of being able to talk to people in math careers. *Interest in using technology for class work* is predicted by students’ expectancy that using technology will influence better grades. *Interest in technology careers* is predicted by having
a role model in a technology career, being able to learn new technologies, having a family member who uses technology in their career and the ability to talk to professionals in technology careers.

**Trends identified in pre survey and post survey regression models.** Four major trends were identified in analyzing pre/post regression models predicting interest:

- The ability to talk to someone in science, mathematics, technology, and careers likely influences interest in careers (science and technology) and math class.
- Role models are only a predictor after the intervention, on the post survey, predicting interest in science, mathematics, and technology careers interest.
- Models suggested the importance of family members; specifically, the approval by family (outcome expectation) influenced interest in science careers and knowing a family member in technology (contextual support) influenced interest in technology careers.
- Self-efficacy is only a predictor after the intervention, on the post survey, predicting interest in science and math class and careers using technology.
Table 4.8

*Multiple regression summary of best model fits for interest in pre survey and post survey*

<table>
<thead>
<tr>
<th>Measuring</th>
<th>Best Model Predictors (Pre)</th>
<th>Best Model Predictors (Post)</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest in science careers</td>
<td>1. Personal disposition S#10</td>
<td>1. Role model S#9</td>
<td>0.482</td>
</tr>
<tr>
<td>S#7</td>
<td>2. Family member in career S#11</td>
<td>2. Personal disposition S#11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Good grades in science S#1</td>
<td>3. Parental approval S#6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Parental approval S#6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interest in science class</td>
<td>1. Personal disposition S#10</td>
<td>1. Good grades S# 1</td>
<td>0.125</td>
</tr>
<tr>
<td>S#8</td>
<td>2. Ability to complete science homework S#2</td>
<td></td>
<td>0.486</td>
</tr>
<tr>
<td>Interest in math careers</td>
<td>1. Expectancy that math will help in a future career M#16</td>
<td>1. Role model in math M#20</td>
<td>0.413</td>
</tr>
<tr>
<td>M#18</td>
<td>2. Parental approval M#17</td>
<td>2. Parental approval M#17</td>
<td>0.622</td>
</tr>
<tr>
<td></td>
<td>3. Expectancy that math will help in a future career M#16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4.8 Continued

<table>
<thead>
<tr>
<th>Interest in math class M#19</th>
<th>No Best Model Predictors</th>
<th>Interest in careers that use technology T#30</th>
<th>Interest in using technology in class T#29</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1. Ability to complete math homework M#13</td>
<td>1. Family member in a technology career T#33</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N/A</td>
<td>Expectancy that using technology will influence better grades T#28</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Personal disposition M#22</td>
<td>2. Being able to learn new technologies T#23</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. Having a family member who using technology in their career T#33</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4. Personal disposition T#32</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Ability to complete math homework M#13</td>
<td>1. Role model T#31</td>
<td>0.394</td>
<td>0.257</td>
</tr>
<tr>
<td>2. Personal disposition M#22</td>
<td></td>
<td>0.534</td>
<td>0.316</td>
</tr>
</tbody>
</table>

Note. P-values < 0.01
Student Engagement and Motivation over Time

Students increased the completion of their exploration sheets over the course of the intervention. Initially, the average completion of the exploration sheet was 71.5%. Over time, students increased their completion on the exploration sheets: Exploration 2 83.2% complete; Exploration 3, 92.1%; Exploration 4, 96.6%; and Exploration 5, 95.8%. [As a reminder, students’ career exploration sheets were not graded.] Students’ motivation to find factual responses to the questions about salary and education attainment also improved (initial 70% and 49%; final 95% for both). Despite their motivation to find these facts, it appeared that students did not take as much time to read through the job responsibilities, often writing an assumption of what the professional did based on the job description displayed on the STEM career poster. Figure 4.2 summarizes these trends and suggests by the high accuracy and completion rates that students found salary to be important. Accuracy and completion rates regarding the education required for the job gradually became more important throughout the intervention. In addition to students’ increased completion of exploration sheets and increased awareness of career descriptions and requirements as the intervention progressed, students showed an increased awareness of jobs in STEM. Students were able to provide Ms. Cruz with a total of seventy-six STEM careers approximately three months after the intervention, 66 more than pre intervention (a 660% increase). The list of careers that students generated can be found in Table 4.9.
Table 4.9

*STEM careers stated by students after intervention*

<table>
<thead>
<tr>
<th>STEM Careers Stated by Students After Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Video game developer</td>
</tr>
<tr>
<td>2. Nurse</td>
</tr>
<tr>
<td>3. Bio Engineer</td>
</tr>
<tr>
<td>4. Scientists</td>
</tr>
<tr>
<td>5. Aerospace Engineer</td>
</tr>
<tr>
<td>6. Chemist</td>
</tr>
<tr>
<td>7. Geospatial Scientists</td>
</tr>
<tr>
<td>8. Pathologists</td>
</tr>
<tr>
<td>9. Economists</td>
</tr>
<tr>
<td>10. Civil Engineers</td>
</tr>
<tr>
<td>11. Industrial Safety Engineer</td>
</tr>
<tr>
<td>12. Surgeon</td>
</tr>
<tr>
<td>13. Doctor</td>
</tr>
<tr>
<td>14. Dentist</td>
</tr>
<tr>
<td>15. Orthopedist</td>
</tr>
<tr>
<td>16. Psychiatrist</td>
</tr>
<tr>
<td>17. Pediatrician</td>
</tr>
<tr>
<td>18. Orthodontist</td>
</tr>
<tr>
<td>19. Veterinarian</td>
</tr>
<tr>
<td>20. Actuaries</td>
</tr>
<tr>
<td>21. Architect</td>
</tr>
<tr>
<td>22. Mathematician</td>
</tr>
<tr>
<td>23. Astronaut</td>
</tr>
<tr>
<td>24. Geologists</td>
</tr>
<tr>
<td>25. Marine Biologist</td>
</tr>
<tr>
<td>26. Statistician</td>
</tr>
<tr>
<td>27. Science Teacher</td>
</tr>
<tr>
<td>28. Math Teacher</td>
</tr>
<tr>
<td>29. Aerospace Engineer</td>
</tr>
<tr>
<td>30. Marine Architects</td>
</tr>
<tr>
<td>31. Dairy Engineers</td>
</tr>
<tr>
<td>32. Biochemist</td>
</tr>
<tr>
<td>33. Fashion Designer</td>
</tr>
<tr>
<td>34. Biomedical Engineers</td>
</tr>
<tr>
<td>35. Cosmetologist</td>
</tr>
<tr>
<td>36. Computer Technician</td>
</tr>
<tr>
<td>37. Nutritionists</td>
</tr>
<tr>
<td>38. Mechanical Engineers</td>
</tr>
<tr>
<td>39. Zookeeper</td>
</tr>
<tr>
<td>40. ER nurse</td>
</tr>
<tr>
<td>41. Forester</td>
</tr>
<tr>
<td>42. Horse Trainer</td>
</tr>
<tr>
<td>43. Accountant</td>
</tr>
<tr>
<td>44. Mechanic</td>
</tr>
<tr>
<td>45. Zoologist</td>
</tr>
<tr>
<td>46. Nuclear Engineers</td>
</tr>
<tr>
<td>47. Therapists</td>
</tr>
<tr>
<td>48. Computer Engineers</td>
</tr>
<tr>
<td>49. Foot Specialist</td>
</tr>
<tr>
<td>50. Graphic Designer</td>
</tr>
<tr>
<td>51. Paramedic</td>
</tr>
<tr>
<td>52. Ophthalmologist</td>
</tr>
<tr>
<td>53. Physicists</td>
</tr>
<tr>
<td>54. Park Ranger</td>
</tr>
<tr>
<td>55. Nautical Engineer</td>
</tr>
<tr>
<td>56. Veterinary Assistants</td>
</tr>
<tr>
<td>57. Pilot</td>
</tr>
<tr>
<td>58. Software Developer</td>
</tr>
<tr>
<td>59. Database Administrator</td>
</tr>
<tr>
<td>60. Agricultural Scientists</td>
</tr>
<tr>
<td>61. Anesthesiologists</td>
</tr>
<tr>
<td>62. Astronomers</td>
</tr>
<tr>
<td>63. Physical Therapists</td>
</tr>
<tr>
<td>64. Pharmacists</td>
</tr>
<tr>
<td>65. Behavioral Scientist</td>
</tr>
<tr>
<td>66. Chiropractor</td>
</tr>
<tr>
<td>67. Critical Care Nurse</td>
</tr>
<tr>
<td>68. Dental Assistant</td>
</tr>
<tr>
<td>69. Dolphin Trainer</td>
</tr>
<tr>
<td>70. Entomologist</td>
</tr>
<tr>
<td>71. Environmental Engineer</td>
</tr>
<tr>
<td>72. Midwives</td>
</tr>
<tr>
<td>73. Flash Animator</td>
</tr>
<tr>
<td>74. Paleontologist</td>
</tr>
<tr>
<td>75. Neonatal Nurse</td>
</tr>
<tr>
<td>76. Dieticians</td>
</tr>
</tbody>
</table>
Summary of Changes in Students’ STEM Interests

This section addressed specific changes in students’ STEM interests that occurred over time and that were unique to each exploration. Prior to the intervention, students only knew of ten STEM careers and months after the intervention were able to name 76. Survey analysis suggests that prior to the intervention, students were considering STEM careers based on more indirect influences (e.g. comfort in speaking to professionals in science and math careers), rather than self-efficacy. Although post surveys indicated a relatively high interest in STEM (average score 120.4 out of 165), mean comparisons show a decrease in interest and factors related to interest from pre to post survey; post survey self-efficacy became a more prominent predictor of interest.

The intervention changed the way that the students explored career videos. Students began by exploring careers that were familiar to them or ones in which they had prior interest related to the processes and end products of the job. Although interest continued to guide the rest of their explorations, outcomes of the career became equally as important as interest. Outcome expectancies were consistently characterized by reports on salary level, helping others, and education; however, students increased their documentations of outcome expectations that were specific to the job (i.e. things that they would be allowed to do if they went into the career) as they became more knowledgeable of what career names meant in terms of the actual job (e.g. biomedical engineer). When filling out their STEM career video planning sheet, interest (47%), outcome expectations (34%), learning experiences (6%) and family support systems (6%) were provided as reasons for going into careers. About half of the students (47%) documented how their skills that were developed outside of the classroom
could contribute to the job responsibilities and 86% of exploration sheets documented a positive family reaction to choosing a STEM career.

**Discussion**

**Students’ Initial Interest in STEM**

The average score on the pre survey (128/165) indicates that this population of students shows interest in science, math, and technology classes and potential careers. The high standard deviation (14) suggests students reported on either low or high ends of the STEM interest spectrum (e.g. some students, very high interest in math, some low). As Kitts’(2009) finds, many students have interest in STEM, but cannot see themselves in STEM careers. Further survey analyses suggest that initial interest in all three subject areas was significantly influenced by having family members in these careers. Although contextual supports are influential in developing goals (Lent, Brown, & Hackett, 2000), self-efficacy and outcome expectations are identified as the most prevalent predictors in influencing academic and career interest (Ferry, Fouad, & Smith; Fouad & Smith, 1996; Tang, Pan, & Newmeyer, 2008). This study finds that the outcome expectation of making a parent proud influenced interest in math and science, and that self-efficacy in technology use influenced interest in using technology in class.

Bandura (1986) and Lent, Brown, & Hackett (1994) place great emphasis on the direct influence that self-efficacy has on developing interest. Self-efficacy was not prevalent on the first explorations sheet as a reason that students selected the careers that they did. One reason that students may not be able to develop clear paths between self-efficacy and interest
is their limited awareness of STEM careers (shown in Week 1 when students showed that they could only name ten STEM careers). Bandura (1986) suggests that learning experiences encourage self-efficacy, and students’ lack of awareness suggests few learning experiences in STEM. This lack of awareness of STEM careers is consistent with many populations of students (Draper & Blackwell, 2009; Habash & Suurtamm, 2010) and specifically corroborates the implications of other researchers, that rural students lack exposure to careers outside of their rural setting (Avery, 2013; Griffin, Hutchins, & Meece, 2011).

Female students scored significantly higher on the STEM-CIS science subscale than males, having a higher self-efficacy and higher reports of having family members involved in science careers. When comparing this to their first career exploration, 22 out of 32 females selected careers related to health and life science, similar to findings showing that females have more interests in life science careers. Students selected their first careers to explore based on a general interest in recreational activities related to the career and their familiarity with products created in the job and processes done in the job (Baram-Tsabari 2007, 2008; Baram-Tsabari, Sethi, Bry, & Yarden, 2009). In addition to general interest in the career, outcome expectations such as helping others, making a lot of money, and getting to have fun were their second most documented reason for selecting careers of interest. In a study of general career exploration with college students (Betz & Voyten, 2012), multiple regression analyses found self-efficacy to most influential in career indecision, whereas, outcome expectations to be the best indicator of intention to explore careers. This study finds outcome expectations to be significantly influencing interest in science careers, and interest in math careers. However, the personal disposition of being able to talk to people in science and
technology careers influenced interest in these careers and in science class, and the contextual support of family was influential in the interest of science careers, interest in using technology in class, and interest in technology careers. Self-efficacy showed to be influential in science career interest and interest in using technology in class.

Research suggests that students learn best when they are presented with information that they consider valuable (Orthner, Jones-Sanpei, Akos, & Rose, 2013). Students’ high levels of accuracy in answering the questions on the career exploration sheets as well as their level of completion indicates a relatively high level of interest in exploring STEM careers, especially considering that exploration sheets were not graded. Students completed over two-thirds of the exploration sheet, with high levels of accuracy. Students who reported a salary had nearly perfect accuracy (suggesting this was influential in their interest), approximately 87% were correct on job responsibilities, and a little over half of students’ completed sheets reported accurate educational requirements for the explored career. Findings later in the intervention, which documented students’ more detailed and accurate factual responses and increasingly sophisticated responses, supports the value students placed on learning about careers.

**Students’ Explanations of their Interests and Influences to Pursue a Career in STEM**

Throughout the intervention, students’ responses operationalized the aspects of the SCCT and provided insight into how rural, middle school students may be thinking about STEM careers. This is important, because past researchers who have used the SCCT to examine interest have emphasized the importance of defining these aspects and making them
relevant to the population being studied (Lent, Lopez, Lopez & Sheu, 2008). Students’ career explorations were primarily guided by their interests. They described their interests in: what was made in the career; how the career aligned with their own recreational interests; the physical and mental processes they enjoy both in school and out of school; their interest in science, mathematics, and technology; their intrigue with the job description and desire to learn more; their interest in the tools used in the job or environment in which the job takes place (e.g. computers, surgical instruments); and their love of doing something positive and helpful in society. Other studies have similarly found that personal interest influences students’ selection of a college major, and that this interest can be heightened or lessened by presenting students with the factual information (e.g. salary, educational requirements) about the career all of which moves students forward in their consideration of careers (Beggs, Banthum, & Taylor, 2008; Hall et al., 2011).

Career research suggests that career explorations at the middle school level should guide students to negotiating the working world and how their dispositions fit into that world (Hartung, Porfeli, & Vondracek, 2005). When presented with more information about the career, students explained other influential SCCT factors. Outcome expectations were the most prevalent guiding influence to interest. Overall, positive career outcomes listed by males and females were consistent with the literature on career choice by gender. Earning a high salary (listed frequently by males), and helping others (listed frequently by females) were predominant positive outcome expectations. Other studies have similarly found that females base science and math interests on their desire to help people, animals, or the planet and males base their interests on a high paying jobs and high status (Ceci & Williams, 2007;
Jones, Howe, & Rua, 2000; Li, 2008; Tan & Barton, 2008.) Negative outcomes were characterized by negative aspects that could occur on the job (e.g. getting blown up, having to put an animal to sleep, too much work/too much education/ hours too long, and not enough money). When examining the literature on high poverty students’ development of possible career professionals, Destin & Osyerman (2009) found that in one study with low-income urban students, students tailored their career goals to be more realistic with their family’s financial circumstances. This may explain one reason why students consistently documented education as a negative outcome expectation in careers that they selected of interest.

Self-efficacy was listed on exploration sheets in terms of traits/personal dispositions that would make them good in a career (e.g. I’m interested in being a surgeon because I’m good around blood), or being good in math and/or science class. Explanations of self-efficacy tended to be more evident on students’ planning guides for their videos, because the questions explicitly asked about students’ strengths and how those related to their selected career. Students described their dispositions and how they would serve as strengths, rather than how ability in their classes could benefit them in the future career. Low self-efficacy (I’m not good at this) was not listed often on students’ exploration sheets in an explicit manner. However, students frequently listed the negative outcome of a career as requiring too much education. This could suggest that students did not feel able to attain the level of education required, a feeling of low self-efficacy. Another study compared self-efficacy of nearly two hundred diverse sixth grade students found, and that African American males had significantly lower self-efficacy than males of higher socio-economic statuses (SES), white
males, and girls of all races and SES (Gibbons & Borders, 2010). Although this study is not explanatory, it corresponds to findings of lower self-efficacy among the males in this study.

Students addressed family members as their only forms of contextual supports on their career exploration sheets, and most indicated they believed this support to be rather strong. Personal inputs were only addressed in the form of personal dispositions (e.g. being creative, being female), rather than being born a specific race, gender, and/or having a physical/mental disability. Personal inputs and learning experiences were SCCT aspects that were not operationalized well by the students; that is, they were not frequently given reasons for considering or not considering a career, and when given, related mostly to things that students saw in the career video. Barriers related to gender roles were evident when students were asked to choose careers they could not see themselves pursuing, and student statements support findings that engineering and technology careers are often considered by students to be more masculine (Capobianco, Diefes-Dux, Mena, & Weller, 2011). It was promising that by the end of the study, females showed more instances of exploring careers that are more traditionally held by males.

For more in depth accounts of perceived personal inputs, background, and contextual supports and barriers, it may be beneficial to use a different methodological approach such as interviewing students or following up with specific students throughout an intervention like this (see Chapter 5). STEM education and career literature identify a variety of barriers that students internalize, which influence them not to select a career. For example, career researchers suggest that socio-economic status, parental and peer support, and lack of guidance in deciding future academic courses and goals (Akos, Lambie, Milsom, & Gilbert,
2007) are influential in career considerations of younger students. For this study, the middle school students responded to prompts on the career exploration sheet in ways that were more focused on their own abilities and interests, rather than external barriers. However, the STEM-CIS provides quantitative implications that students may be considering their ability to talk to professionals, their parental support, and role models when considering interest in STEM careers and maintaining interest in courses.

Barriers related to gender roles were evident when students were asked to choose careers they could not see themselves pursuing, and student statements support findings in the literature that engineering and technology careers are often considered by students to be more masculine (Capobianco, Diefes-Dux, Mena, & Weller, 2011). It was promising that by the end of the study, females showed more instances of exploring careers that were more technology and engineering based.

**How STEM Career Interests Changed throughout a Video Intervention**

Survey analyses showed significantly lower scores within all subject areas from pre survey to post survey. Although it was surprising to see interest and factors influencing interest decline on the STEM-CIS, this was not the case in the qualitative data analyzed on the career exploration sheets. This suggests that perhaps the initial scores on the STEM-CIS were based on a lack of familiarity with what STEM careers are, and that the post survey results shows give a more realistic measure, even a starting point for where students’ SCCT factors related to STEM careers lie. Take self-efficacy, which started higher on the STEM-CIS and then declined Psychology literature has found that adolescents often rank their self-
concept very highly (i.e. I am a very good reader), with little regard to their actual performance (Eccles, 1999; Nicholls, 1979; Wigfield et al., 1997). This also could explain why students are found to lose interest in STEM courses and majors prior to high school (VanLeuvan, 2007), as they are better understanding their strengths and weaknesses. This implies that practitioners and researchers carefully design STEM interventions that utilize all of Bandura’s (1986) strategies for increasing self-efficacy, including activities that allow for mastery of the material, vicarious experiences where students can see professionals coming from similar backgrounds overcoming low perceptions of self-efficacy, and providing students more social interactions with others doing well in STEM (particularly females; see Zledin, Britner, & Pajares, 2007).

As the intervention changed, it seemed that students changed the way that they explored. As mentioned earlier in the discussion, students were initially guided by their interests similar to other career study findings (Beggs, Banthum, & Taylor, 2008; Kuechler, McLeod, & Simkin, 2009; Hall et al., 2011) and positive outcome expectations related to salary, helping others, and playing with the products of the careers, similar to trends found in studies researching gender influence in STEM (Ceci & Williams, 2007; Jones, Howe, & Rua, 2000; Li, 2008; Tan & Calabrese Barton, 2008.) Although interest continued to guide the rest of their explorations, when students were shown an age-appropriate description of the career and was directed toward the educational requirements of the careers, outcomes of the career became equally as important as interest. Based on the job descriptions seen prior to exploring the videos and fact sheets, it is likely that students could think more about possible outcomes that were desirable to them while watching and reading through the career.
information, making outcome expectations more prevalent in exploration. Betz & Voyten, (2012), found that outcome expectations of college students were the best indicator of intention to explore careers.

Negative outcome expectations were consistently documented as too much education or inadequate salary levels. Because careers were organized by educational level for the second, third, and fourth exploration, students likely took into consideration their pathways to entering these careers and the finances involved in obtaining this education. Destin & Osyerman (2009) find in one study with low-income urban students that students tailored their career goals to be more realistic with their family’s financial circumstances. In regards to students’ emphasis on salary, few studies have investigated their conceptions of money and the costs of salary and living. One study suggests that low income elementary and middle school students see cost as a barrier to entering college, but were unclear to how much college actually cost (Elliott, Johnson, Guo, 2010). Similarly, students in this study, when taking part in a class discussion prior to the fifth exploration, indicated students have varied perceptions of what is an adequate versus good salary and how much money was enough to live in large cities. Future studies may want to address how students obtain accurate perceptions of salary levels and cost of living.

Following the class discussion what influences students interest in careers, students explored careers that were organized by their discipline (e.g. science-related career, math-related career). Students increased their documentations of outcome expectations that were specific to the job (i.e. things that they would be allowed to do if they went into the career). When asked to select careers that they could not see themselves in, students primarily
selected careers that they viewed as boring or unappealing due to the processes that were included or the subjects that they dealt with. This suggests that students have not had meaningful experiences with these careers. One study that investigated when and how scientists became interested in their field found that that both males and females could recall a memorable event prior to middle school, females remembering more formal in-class activities and males remembering more informal events that’s drew them into science. This implies that students need more experiences with STEM careers, and perhaps especially in careers that students would identify as boring based on their initial description.

Students documented brief examples of how their learning experiences, self-efficacy, outcome expectations, and support systems influenced them to create a video on a career of interest. Students were given little guidance when creating videos, other than to include items from their planning sheets. This was also the first time that students had created their own career video, or possibly any video. Unlike later explorations of a wide variety of STEM careers, students selected careers that they were familiar with for their videos. It is likely that students selected careers that they could act out easily, have fun while filming, and could utilize some of the props that the primary researcher had brought in, as well as props brought from the student’s home. Most of the careers involved people and animals (see Table 4.9 for a list of the careers featured in videos). It is possible that the novelty of the video creation caused students to select something that seemed easier or safer. In the future, it may be worthwhile to have students create more than one video so that they are familiar with the context of videotaping careers. It also may be beneficial to have students create one video of
their choice and another assigned career related to the physical sciences, mathematics, technology, and engineering.

Again, as Orthner, Jones-Sanpei, Akos, & Rose (2013) postulate, students are more motivated to learn when they consider instructional material or activities to be of value to them later on in life. Students took part in this intervention eagerly, without the incentive of a grade at the end. While students explored, they asked for new careers to be added to the bank of videos. When these videos were added, there was an increase in the selection of those careers. Participation throughout the intervention, class discussions, and the voluntary creation of twenty videos by 72% of students suggests that students view thinking about careers as valuable to them. Following the intervention, students named 76 diverse STEM careers. This indicated that students’ motivations to explore careers resulted in understanding more about what can be done in STEM.
CONCLUSIONS AND IMPLICATIONS

This study addressed rural middle school students’ interests in STEM careers as they explored and created STEM career videos. Students selected careers that they were interested in and provided aspects of the job that they liked and disliked. They also responded to prompts regarding whether or not they could see themselves in the career after their exploration of the outcomes. After 6 explorations, students found and created a STEM career video, usually with peers. The findings corroborate literature, personal interest is the most important factor when students choose a career. Their responses operationalized the social cognitive career factors to give a better understanding of students’ reasons for being interested or not interested in STEM careers, heeding calls in the literature (Tyler-Wood, T., Knezek, & Christensen, 2010). These rural, high poverty, minority students provided more age-appropriate examples of the constructs, and showed that throughout this class intervention, they continued to think about their own interests and the outcomes of going into a career more than they thought about their self-efficacy in the discipline of STEM, in contrast with findings by Ferry, Fouad, & Smith; Fouad & Smith, 1996; Tang, Pan, & Newmeyer, 2008.

This study provides implications that those future interventions include expanding the awareness of these students, particularly those who are underrepresented in STEM, to consider STEM professions. The career exploration sheets were designed based on the literature showing that high school students believe that STEM careers are too difficult and require too much college (Drew, 2010) and they could make more money in non-STEM careers such as business (Basso, 2012). Given the results of this study, future research
explorations may want to have students research different types of outcome expectations, as well. For example, by having students investigate the environment of the professional, the social setting, and the impact of a wind engineer, students may be able to describe more thoughtful examples of outcome expectations, including the expectations that the profession would involve thoughtful relationships with others, all the expression of new ideas, and would benefit the environment.

In this study, a school-wide commitment to promoting interest and intent to pursue STEM careers facilitated student’s actions in future course choices and college decisions (Blanchard, Albert, Alsbury, & Williams, 2012). It is likely that similar programs that emphasize STEM career exploration in school, as well as devising more ways to connect students’ interests out of school to STEM, will encourage positive self-efficacy with corresponding interest in and expectations for success in STEM classes and careers. The use of short videos in this study, which included personal interests of the STEM professionals, as was done in this study, seemed to personalize the minority and female STEM professionals so that students could see how their dispositions and early interests related to their career. This approach may be helpful for others who are trying to help students connect with STEM professionals.

Although this study carried out STEM career exploration in a remediation period of the day, teachers can help to make STEM career exploration a part of their curriculum, weekly, monthly, or using STEM career videos, as is being done in the STEM Career Awareness project (Blanchard, 2010). Teachers can help to augment the work of overburdened school counselors, especially since there is usually only one is higher poverty
schools. This exposure can play a role in moving students from their interests in STEM careers to setting achievable goals to obtain STEM careers, creating easily accessible and comprehensible pathways towards different types of education with different focuses and requirements (Orthner, Akos, Rose, Jones-Sanpei, Mercado, & Wooley, 2010).

Career videos used in this study allowed students to be exposed to a variety of careers with different types of professionals, who would not have been available to them in their rural setting. This study does not argue that career professionals on videos can replace real-life STEM professionals. However, in remote areas where exposure to STEM professionals may not be as feasible, or even in urban or suburban schools, with limited time to add to the curriculum (Collinson & Cook, 2001), short videos offer a feasible alternative to encourage career discussions more frequently, especially if they relate to the curriculum standards (see www.stemcareerawareness.wikispaces.com for a video bank of careers linked to national standards). STEM Career interventions, such as the one conducted in this study, can provide feasible yet meaningful learning experiences that encourage students to think more about their strengths and the positive outcomes that can come from a career in STEM.
CHAPTER FIVE: HOW DO FOUR RURAL MIDDLE SCHOOL STUDENTS EXPLAIN THEIR STEM INTERESTS AND STEM IDENTITIES WHEN EXPLORING AND CREATING A STEM CAREER VIDEO?

Abstract

National initiatives emphasize connecting K-12 students to diverse opportunities in STEM to foster a desire to pursue STEM major and careers. Research suggests that these efforts begin at the middle school level. A STEM career emphasis is especially needed for rural students, a population who is less likely to be aware of high tech careers compared to urban students who have more access to STEM careers. Research suggests that middle school and high school students are interested in STEM, but longitudinal data documents a decrease in interest with age, primarily because many students cannot identify with STEM professionals. Studies find that K-12 students perceive STEM professionals to be well-educated, males, who are obsessed with work, and socially inept. This study follows four rural, middle school students as they take part in an intervention in which they are invited to explore STEM careers of interest, reflect on and write about those experiences, and to create an original STEM career video. This research study asks: How do four rural middle school students explain the social cognitive career influences that lead them to explore and create STEM career videos?, and How do these students negotiate a potential STEM career identity? Data sources include students’ career exploration sheets, video planning sheets, scripts, STEM career videos, and identity interviews. Student interest in selected careers is analyzed using aspects of the Social Cognitive Career Theory (SCCT), a predictive model that examines such factors as self-efficacy and outcome expectations as predictors of career
interests and goals. Students’ STEM career identities also are analyzed by using the theory of possible selves. By exploring how students see their present self in relation to STEM interests and careers, and how they interpret their social roles and group memberships, this study finds that issues of gender, race/ethnicity, and location play an integral role in how these rural students negotiate a their identity in relation to a possible career in STEM.

Introduction

Science, technology, engineering, and mathematics (STEM) professions are responsible for producing innovations that save energy, lives, and time (National Science Board; NSB, 2010). These innovations must continue to evolve in order to address current and future challenges of our nation, as well as to keep the United States economically competitive with other nations of the world (Lohr, 2009). Yet the majority of the workforce is not in STEM careers (United States Bureau of Labor Statistics, 2011). The 18% of individuals who hold bachelor’s degrees in STEM (U.S. Congress Joint Economic Committee, 2012) are a relatively homogenous population of predominately white and Asian males, with women and minorities showing disproportionate representation in these fields. These statistics show that only 20% of bachelor’s degrees obtained in physics, engineering, and computer science combined are by women (Hill, Corbett, & St. Rose, 2010). Of the degrees awarded to women, only 15% are earned by African Americans and 12% by Hispanics (NCES, 2012).

The untapped human resources of women and minorities are critical to providing perspectives needed to advance innovations and meet the needs of all people in the United States.
States (Cataldi et al., 2010; Griffith, 2010). The lack of STEM professionals and the racial/gender inequity within STEM careers has led policy makers to mandate initiatives intended to recruit women and minorities into STEM fields (Association for the Advancement of Science; AAAS, 2012; White House Office of Science and Technology Policy, 2012), emphasizing the role of K-12 educators to begin this recruitment, and finding ways to interest students in STEM (National Science Foundation; NSF, 2012).

Studies find that many students in middle school and high school, particularly females and minority students, have many barriers to entering a career in STEM (National Academy of Sciences, Global Affairs & Institute of Medicine, 2011). One barrier is that students perceive these careers to be difficult, requiring many years of college and intensive work in math and science (Drew, 2010). Also, studies find that many students have negative and inaccurate perceptions of STEM professionals and careers, perceiving these careers to be isolated and boring, and relating these professionals to being older white males who work alone in a lab (Masnik et al., 2010). In addition to these psychological barriers to entering STEM, many students lack technology and exposure to STEM careers, particularly students in rural areas (Wright, 2012).

Rural school systems make up 20% of the nation’s schools, and 40% are characterized as high poverty (Mahaffey, 2012). National organizations and researchers suggest promoting students’ interests in these fields as early as middle school (American College Testing; ACT, 2011; Howley & Howley, 2010; White House, 2010). Key elements found in effective research interventions have included: providing career discussions and real-world connections between the curriculum and STEM careers so that students can see
how learning in class is applied to a future career; diverse role models; role playing as career professionals; and making adult decisions in imaginative environments (Bergen & Fromberg, 2009; Singer & Singer 2006). Given that females and minorities are underrepresented in these fields (Hill, Corbett, & St. Rose, 2010; National Science Board; NSB, 2010; National Science Foundation; NSF, 2009), the use of relevant role models in STEM disciplines has been found to be encouraging (Horn, 2011).

A population of students who are often described as lacking access, quality preparation, and exposure to technology are enrolled in rural school systems (Avery, 2013). Mahaffey (2012) reports that 20% of the nation’s public schools are in a rural area (one in five students), and within that group, 40% live in poverty and 25% are non-white. Studies that report how rural high school students feel about their opportunities find that these students often associate their rural home as a place where success cannot be obtained and that prosperity is associated with large cities (Corbett, 2007). Also, findings suggest that student morale and perseverance to succeed are lower in rural high schools because many students perceive that their teachers consider them unmotivated and apathetic toward their future (Gilbert & Yerrick, 2001).

For students in rural areas, interventions that explore diverse opportunities in STEM as well as local jobs in their community are encouraged as ways to provide encouragement in career endeavors (Howley & Howley, 2010; White House, 2010). In rural districts with high populations of underrepresented minority students, Bayer (2012) recommends exposure to non-white professionals with college degrees and exciting careers in STEM. These interventions can be difficult to prioritize in the middle school classroom because teachers
are under the pressure of high stakes testing and bound to district pacing guides (Stansbury, 2010).

Little research has investigated the interest and perceptions of rural, minority middle school students in STEM careers (Usher, 2009). In general, middle and high school students show a high interest in STEM, but few see themselves pursuing a career in these fields (Kitts, 2009). Reasons for this include students having inaccurate understandings of what STEM jobs entail, misconstrued visions of what professionals look like, and negative perceptions of how professionals manage a work/life balance (Bouchey & Harter, 2005; Burke and Mattis (2008) Capobianco, Diefes-Dux, Mena, & Weller, 2011; Fralick, Kearn, Thompson, & Lyons, 2009; Thomas & Allen, 2006). Studies investigating identity development of women and minorities in STEM (Carlone & Johnson, 2006; Tan & Calabrese Barton, 2008) found barriers related to race, gender, and ethnicity. Given the additional barriers associated with rural schools, similar barriers likely play a role in middle school students’ imagining themselves in STEM.

**Literature Review**

**The Development of STEM Career Interest**

Career literature has influences on students developing career interest and provided suggestions for furthering this interest. Cole, Ray, & Zanetis (2011) suggested that when students show interest in a career path, it is important to provide them with information that allows them to envision a future in the career, including daily responsibilities and salary. At the high school level, students reported self-efficacy, the belief they would do well, as the
When selecting a major, Betz & Voyten (2012) found that low self-efficacy by college students caused students not to commit to a major, whereas outcome expectations were the best indicator of intention to explore careers. Few research studies have investigated important influences on STEM career interest for middle school students, compared to the secondary and post-secondary level (Usher, 2009). Bandura (1986) suggested that self-efficacy beliefs have a strong influence on career interest, and that these beliefs are influenced not only by mastery experiences but by vicarious experiences and social influences, and psychological factors. Usher (2009) interviewed students with high and low self-efficacy in math and found that students with high self-efficacy mentioned teachers whose structured assignments allowed them to be successful during the class and parents who that reinforced their confidence in math. Students with low self-efficacy named few experiences of mastery in math, becoming increasingly frustrated with their low grades in math at an early age.

A survey analysis of 2500 middle school and high school students found that they reported high interest in science (7.0 out of 10.0) but low desire to become scientists (Kitts, 2009). Studies have shown that STEM interests and influences to persist in STEM differ by gender. Males were more likely to ask questions about the physical sciences and females were more inclined to ask about the biological sciences (Baram-Tsabari 2007, 2008; Baram-Tsabari, Sethi, Bry, & Yarden, 2009).

A national survey of eighth grade students found that females had fewer informal experiences with science, and suggested that K-12 teachers find ways to connect females
with outside science experiences and apply the physical sciences to real-world scenarios (Brotman & Moore, 2008). Similar to previous studies, Burke and Mattis (2008) found that high school females have little knowledge of what an engineer does on a daily basis or how to relate to an engineer. Millward, Houston, Brown, and Barrett (2006) suggest presenting information on the balance of work with a home life and home life to help females consider STEM careers. This knowledge can be gained by giving females more exposure to professionals in technology and engineering, which ultimately increases their interest in these STEM careers (Koch et al., 2012)

Perceptions of STEM Professionals and Careers

As previously described, many students hold inaccurate views of STEM careers and STEM career professionals, which deter their interest in STEM fields (Masnick, Valenti, Cox & Osman, 2010). By having students draw scientists and engineers, researchers have elicited students’ perceptions and inaccurate views of STEM professionals (Bouchey & Harter, 2005; Capobianco, Diefes-Dux, Mena, & Weller, 2011; Fralick, Kearn, Thompson, & Lyons, 2009; Thomas & Allen, 2006).

These inaccurate perceptions of STEM professionals continue into middle school. Fralick et al. (2009) analyzed 1600 underrepresented minority middle school students’ drawings of scientists and engineers. When asked to draw engineers, they one-third of the students did not draw anything, 50% of the engineer drawings were male, 13% were female, and 37% could not be identified by gender. Approximately 12% of students depicted engineers in overalls, with others seen in lab coats, wearing goggles and/or having crazy hair.
Most drawn engineers were shown to either have no action at all or fixing something (e.g. working on car). Over half of the pictures showed the engineer as working outdoors. Similar to the engineer drawings, stereotypic views were seen in the scientist drawings, with over half being white males, mostly without coloration of skin, drawn doing experiments in a lab (Fralick et al., 2008). One study found that computer science fields also have these associated stereotypes; college students saw these careers as being boring and lacking creativity (Thomas & Allen, 2006). In contrast, Kitts’ (2009) survey of 2500 suburban and urban middle and high school students showed accurate perceptions of science professions and reported high interest in science, but a low number of students reported that they wanted to be a scientist (3.0 out of 10.0).

Thomas and Allen (2006) investigated why 98 Australian first year undergraduate students (62 males) did not pursue information technology (IT) courses and careers. Twenty four percent stated that IT careers were too boring and 22% stated that IT careers did not have a creative environment. Likert scale survey results found that students believe that professionals in these careers do technical work on a computer all day and have few opportunities to work with others. Johnson & Miller (2002) suggest that these careers are not attractive to students, particularly females, because of the manner that in which they are advertised (e.g. a men-only environment, long hours not conducive to a family).

**Suggested Strategies to Increase Interest and Awareness in STEM**

Many organizations suggest that teachers should begin discussing STEM career opportunities with students at the middle school level (ACT, 2011; Skamp, 2007). By the
age of thirteen, most students have made decisions about what they do not want to do in a future career, a decision that influences their career goals into high school and college (*Extraordinary Women Engineers Project*, 2007). Unfortunately, these decisions often translate into a sharp decline in females’ interest in science by the time they reach high school (VanLeuven, 2004).

The inclusion of role models is a way to increase the interest of females and minorities in STEM. However, middle and high school students commonly indicate that they do not know anyone personally in STEM fields (Zeldin, Britner, & Parajes, 2008). This is even more likely with minority students who face the additional barrier of lacking role models in these professions who are similar to them ethnically (Stout et al., 2011) and in rural areas where high technology careers are not prevalent (Avery, 2013). Providing similar role models (i.e. female engineers to female students) is a promising way to allow students to better see themselves in a future STEM career (Stout et al.). Adult females, in particular, recall role models such as teachers, mentors, and family members as the reasons that they persisted in STEM careers (Zeldin, Britner, & Parajes). In science education, studies using relevant role models have helped students to build positive attitudes toward science, and better understand how cultural identities and science identities coincide (Aikenhead, 1996, 2006).

Logistically, it can be difficult to recruit similar or relatable role models. Rosenberg-Kima, Baylor, Plant, & Doerr, (2008) found a promising alternative approach of having undergraduate college students interact with animated engineering characters who were young, attractive, and female. Female students’ interactions with these characters increased
their self-efficacy and interest in engineering careers. Similarly, vibrant interactive characters were found to encourage middle school students to pursue engineering (Ashby Plant et al., 2009). These studies imply that it is possible to make great strides with students to connect to STEM careers, given mentoring and role models with whom the students can identify, real or digital.

Video technology is another promising avenue for helping students to use their own voice in STEM careers. Wyss, Heulskamp, & Seibert (2012) created a classroom environment that allowed students to create their own video interviews with STEM professionals. When researchers piloted a Likert-type survey measuring interests and attitudes related to becoming STEM professionals, they found that students increased their interest in STEM related goals after recording and watching STEM interviews.

Social Cognitive Career Theory in the Context of STEM

Lent, Brown, & Hackett’s (1994) social cognitive career theory (SCCT) is a predictive model that has analyzed how internal (self-efficacy and outcome expectations) and external influences (background experiences, contextual supports and barriers) guide interest and intention to pursue STEM careers. They posit that individuals who have positive learning experiences will have higher self-efficacy and hold beliefs that they can be successful in a class or career. A number of studies have used Lent, Brown and Hackett’s (1999, 2000) factors (e.g. self-efficacy, personal goals, outcome expectations, personal inputs) to predict the interests of middle school students to enter STEM careers (Fouad & Smith, 1996; Navarro, Flores, & Worthington, 2007). Other studies have used these factors to predict general career choice at the high school and college level (Hackett, 1985; Lent,
It is recommended that future research be done to operationalize factors influencing academic and career decisions based on the specific age groups and population being studied (Flores & O’Brien, 2002; Gushue, 2006). This call was addressed in research by Kier, Blanchard, Osborne, and Albert (in review) who developed a STEM Career Interest Survey (STEM-CIS) based on factors of the SCCT to measure STEM career interests of rural middle school students in high poverty areas.

Although studies have explored how the SCCT works in explaining the STEM career interests of students in math and science, less research has been conducted at the middle school level. Fouad & Smith (1996) tested Lent, Brown and Hackett’s (1994) propositions to see how self-efficacy and outcome expectations affected goals when surveying 380 ethnically diverse seventh and eighth grade students from a low socio-economic school. As these students increased in age, their interest in science and mathematics decreased corroborating other findings by VanLeuvan (2004).

**STEM Identity**

Several studies have looked at how underrepresented students in STEM make sense of science and create positive and negative identities in STEM courses and careers, taking gender, ethnicity and socio-economic status. Researchers recommend examining students’ science identities and the meanings they make of science by identifying what engages students and how this relates to who they think that they are (Brickhouse, Lowery, & Shultz, 2000). Witz (2000) suggested that students make ‘meaning of science’ when they connect science to
other parts of their life, which inspire them to better understand who one is as a person and who one wants to become. Kozoll (2005) suggested that teachers provide opportunities for their students to discuss how science in the classroom is relevant to their own lives and how it can be used to benefit society.

Several studies have analyzed adolescents’ science identities in urban settings (Archer et al., 2010; Aschbacher, Li, & Roth, 2010; Varelas, Martin, & Kane, 2013). Archer et al. (2010) reported that urban students from lower socio-economic status (SES) backgrounds could not identify with the formal science experiences that students of high SES backgrounds experienced (e.g. traveling to museums with family members and doing science experiments at home). Given that most studies have found females have difficulty identifying with science, one study analyzed the characteristics of six females (age 10-14) who were perceived by their teachers and peers to be strong science students, feminine, and popular. The researchers found that these females all had strong social support systems that encouraged them in science; they also worked very hard to be involved in afterschool clubs and sports to foster their relationships with their peers (Stake & Nickens, 2005). In Tan & Calabrese Barton’s (2008) case study, they found that one seventh grade teacher used strategies such as creating raps and having students share personal experiences with science to help his diverse students merge their cultural and science identities.

Studies that have examined high school students in rural settings suggest that many lack access to diverse career opportunities, are hesitant to stray from traditional family-centered jobs, and have less support to pursue higher post-secondary degrees (Fowler, 2010; Jacobs, Finken, Griffin, & Wright, 1998). Gilbert and Yerrick (2001) conducted a focus
group with high school students in a rural schools- six African American, one white student and one Cuban student in lower level sciences classes. These students reported that they enrolled in lower level science classes because their friends took these classes, good grades were easier to obtain than higher-level classes, and because they were planning on going into alternative careers that would not require much post-secondary education. The African American students believed that their peers (of the same race) that took honors level classes were trying to “act white.” These findings paralleled another earlier study in which successful African American students in science reported that they had to negotiate a new identity to do well in school, causing them to feel ostracized from their peers (Fordham, 1997). Lower-level students also believed that in their teachers perceived them to be not smart and unmotivated, often talking to them in a condescending manner (Gilbert and Yerrick, 2001).

In summary, these research studies indicate that the identity lens can be useful for giving students a voice to make meaning of science, using their lived experiences. Studies that have used an identity framework have shown that some women and individuals of color feel marginalized in science. However, it is promising that some studies have found that teachers can mediate this marginalization by providing meaningful science and cultural experiences, providing all students with a place in science. Studies that examine students forming science identities have predominantly been done in the urban context and in the high school setting, creating a need for more identity research on rural, middle school students.
Theoretical and Conceptual Frameworks

This mixed-methods study utilized two theoretical frameworks to interpret students’ interest in STEM and STEM career identity, the social cognitive career theory and identity theory. These hold promise for researchers to better understand student interests and goals in STEM careers and how they can see themselves within these careers. In an effort to analyze students’ STEM career identity, the framework of possible selves is also used to analyze students’ self-concept in STEM.

Social Cognitive Career Theory

Derived from Bandura’s (1986) social cognitive theory, the social cognitive career theory (SCCT; Lent, Brown, & Hackett, 1994; 2000) addresses three key aspects of Bandura’s theory that are believed to directly influence career interest: self-efficacy, outcome expectations, and personal goals. The SCCT framework shows how learning experiences interact with personal and contextual factors to affect students’ initial interest in careers. These learning experiences impact an individual’s self-efficacy, which, in concert with contextual influences such as students’ interests and goals, lead to positive or negative (outcome) expectations of how they will perform tasks. These tasks (e.g. completing science homework, solving equations in physical science problems) potentially relate to (STEM) careers (Lent, Brown, & Hackett, 1994).
Researchers who have utilized the SCCT with middle school students have found self-efficacy, a belief in being able to complete a future task (e.g. balance a chemical equation) can be built through such things as successful mastery experiences, seeing others master tasks similar to those that the learner is asked to do, social persuasion, and feelings of positive emotions during learning (Bandura, 1986). The SCCT framework also incorporates personal factors such as race, dispositions, ethnicity, gender, and contextual factors such as supportive structures and barriers to help explain influences on students’ perceptions of careers. One such example is a study pointing out that undergraduate minority science and
engineering majors attribute their successes to having had previous science experiences, family support, teacher encouragement, personal perseverance and supportive communities (Russell & Atwater, 2005).

**Science Identities**

Socio-cultural perspectives have also been used as lenses to analyze underrepresented individuals in science, because they allow for better understanding of how learning is shaped by environmental influences in individuals out of mainstream science (Brickhouse, Lowery, & Schultz, 2000; Brickhouse & Potter, 2001; Brown, 2004; Carlone, 2003, 2004; Gilbert & Yerrick, 2000, Tonso, 2006 and others). Carlone and Johnson (2007) assert, “Cultivating short-term knowledge and interest are not enough to develop sustained interest in science; we need to look beyond achievement and interest to understand how and why some students persist in and others opt out of science” (p.1190). Focusing on science identities allows researchers to see how the culture of science can promote or hinder individuals, taking into account race, gender, class and ethnicity (Carlone & Johnson).

Carlone and Johnson (2007) proposed a model (see Figure 5.2) to explain how undergraduate and professional women of color make sense of science and science careers comprised of three components- competence, performance, and recognition by others. They emphasized the recognition component in their model because the female scientists they studied expressed that their experiences with others, both positive and negative, were highly influential when negotiating a science identity. The social experiences documented by these 15 women incorporated issues of gender, race and ethnicity.
With these factors in mind, this study also considered the role of place on individuals when forming an identity in science. The literature on rural schools suggests that living in a rural area may affect how students recognize themselves as members of a STEM community (Gilbert & Yerrick, 2001). Therefore, rural place was added to the original model of Carlone and Johnson, and then was adapted to encompass all STEM areas for the middle school population as well as the influence of rural place. This revised model was used as a starting point to frame students’ negotiations of a STEM identity, in a predicted model of rural middle school students’ STEM identity (Figure 5.2).

![Figure 5.2. Predicted model of rural middle school student STEM identity.](This model was adapted from Carlone & Johnson, 2007).
Similar to this model, Martin and Anderson (2007) contributed to an understanding how middle school students form identities in math. They suggest that four factors are essential for students to have a strong math identity: a positive perception of their math abilities; a deep understanding of the importance of math now and in the future; a high level of engagement and experience with mathematics activities; an understanding of how these activities affect their future ability to learn math and a motivation to succeed in mathematics despite adversities.

**Possible Selves Theory**

To better understand how students develop a STEM career identity while exploring and creating STEM career videos, this study employs the conceptual framework of “possible selves” (Markus & Nurius, 1986). The idea of possible selves invokes a consideration of what someone believes that they might become, what they want to become, and what they fear becoming. When exploring the possible selves of students, Oyserman & Fryberg (2006) suggest having them share past and present experiences, social roles, and group memberships to analyze how these experiences and roles define who they were, who they are, and who they will become. Several studies have utilized possible selves theory as a means to explore the identity of preservice teachers, as well as to explore the identities of students negotiating possible selves through extracurricular activities (Hamman, Gosselin, Romano, & Bunuan, 2010; Slay & Smith, 2011; Stevenson & Clegg, 2011). In these studies, possible selves theory elicits thoughts about the future and provides identity relevant information and motivation to pursue future goals. Possible selves theory was used to explore the possible
selves of underrepresented minorities in STEM, and how students in middle and high school negotiate possible selves within the discipline while participating in science games, engaging in mathematics content, and taking part in STEM enrichment programs (Beier, Miller, & Wang, 2012; Harper, 2010; Varelas, Martin, & Kane, 2012).

**Research Questions**

This study explores the STEM career interests and identities of four rural middle school students throughout a STEM career intervention, during which they explored and created STEM career videos. Given that little research has examined the effects of classroom STEM career interventions on middle school students’ STEM career interests, this study asks:

1. How do four rural middle school students explain the social cognitive career influences that guide them in exploring and creating STEM career videos?
2. What role do gender, race, ethnicity, and rural location play in these students’ STEM career identities?

**Methods**

The purpose of this study was to compare how four students, with different interests and experiences in STEM, explored and created STEM career videos. This study compares these students’ social cognitive influences when considering a STEM career, as well as their experiences in school and out of school that influence the way that they identify with STEM.
Setting

This study took place at Washington Middle School (pseudonym: WMS), a school in a rural county in the southeastern United States. This county is characterized by cotton, tobacco, and soybean fields and country roads. Small, family-run businesses can be found within this district, many of which are struggling through economic decline, with an unemployment rate of approximately 13.1% (US DOL, 2012). According to the WMS website, the largest employers in the county are the school system, the prison, and the county government. There are 13 small industrial companies employing about 1,000 people. In the community served by the school district, the poverty rate is approximately 27%, approximately 67.5% of the population graduate with a high school degree, and 11.6% have some form of post-secondary education.

Participants

Four eighth grade students participating in a semester long STEM career intervention were selected to take part in this study, Colton, Darius, Mariah, and Theresa (all names are pseudonyms). These students were representative of the gender and ethnic makeup of the school (Table 5.1). Darius is an African American male, Elle a white female, Mariah an African American female, and Theresa is a Native American female. These students were studied because they portrayed very different STEM experiences in school and potentially could offer insights into how students in this setting identified with STEM based on the way which they described themselves in relation school, society, and a future in STEM.
Table 5.1

Demographics of Washington Middle School Students; 2011-2012

<table>
<thead>
<tr>
<th>Washington Middle School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Students in the School</td>
</tr>
</tbody>
</table>
| Student Ethnicity | 71 % African American  
| | 18% White  
| | 6% American Indian  
| | 5% Hispanic  
| | 1% Pacific Islander |
| Students on Free and Reduced Lunch | 76.6% |
| Students who passed the state test in mathematics | 69% Sixth Graders  
| | 70% Seventh Graders  
| | 79% Eighth Graders |
| Students who passed the state test in science | No Science Test in Sixth Grade  
| | No Science Test in Seventh Grade  
| | 70% Eighth Graders |

Source: www.greatschools.com (2011-2012)

Context

This research is part of larger three-year NSF ITEST grant serving five rural districts, with four intervention schools and one comparison school. The focus of the grant was to increase the awareness of, interest in, preparation for, and intention of middle school students to enter science, technology, engineering, and mathematics (STEM) careers (NSF#1031118). As part of the grant, approximately 12 teachers within each of the four intervention schools (45 teachers total) received one week each summer of extensive technology-enhanced...
professional development, modeled in pedagogically appropriate ways consistent with technological pedagogical content knowledge (TPACK) (Koehler & Mishra, 2008) and reform-based practices (National Research Council, NRC, 2000). Teachers also received ongoing support throughout the year from two coach teachers, and through synchronous, online Collaborate sessions each semester (3) with project leaders. During this professional development, teacher participants were provided with a STEM career awareness wiki for each school that a small team of project researchers developed. This wiki hosts a bank of 5-7 minute STEM career videos featuring female and minority professionals, corresponding age-appropriate fact sheets, and scripts for students to place themselves in the role of a STEM professional. For more information on the development of this STEM career video bank, see Chapter Four.

The researcher for this study helped to facilitate the summer workshops and helped to develop many of the professional development resources, and thus was personally familiar with all of the teachers in the project. During the second summer workshop (2012), the primary researcher (and author of this dissertation) approached Ms. Cruz (a pseudonym), an eighth grade science teacher from one of the four middle schools taking part in the grant, Washington Middle School (pseudonym; WMS), and invited her to take part in an intervention that implemented these career videos in a unique way with her student. She eagerly agreed to participate in this study, which took place during Fall 2012.
Data Sources and Analyses

Pre Survey/Post Survey

The STEM-Career Interest Survey (STEM-CIS; Kier, Blanchard, Osborne & Albert, in review) version used for this study consisted of thirty-three items with eleven questions pertaining to science, mathematics and technology (Appendix A). Each item was based on a five point Likert-scale, ranging from 1-5; 1 corresponding to strongly disagree and 5 corresponded to strongly agree. An engineering scale has been developed; however, it was piloted for validation after this study occurred (to see more about the development of the survey see Kier, Blanchard, Osborne, & Albert, in review). Within each subscale, there were questions that addressed the factors of the social cognitive career theory (Lent, Brown, & Hackett, 1994); specifically, two questions on self-efficacy, two on personal goals, two on outcome expectations, two measuring interest, two measuring contextual supports, and one measuring a positive personal disposition conducive to pursuing a career in STEM. These aspects of the SCCT were operationalized and appropriately worded for middle school students. For example, the questions measuring science self-efficacy were: I am able to get a good grade in my science class, and I am able to complete my science homework.

Implementation and Analyses. The STEM-CIS (science, mathematics, and technology subscales) was given to the students before the project began and after the intervention; students scanned a QR code with an iPod Touch®, linking them directly to the online survey. Seventy-four students took the pre survey. Basic descriptive analyses were performed on initial data and post data, including means, and standard deviations. These means were compared to the post survey of the class. A total of 64 students completed both...
the pre survey and post survey. One-way ANOVA was used to determine significant differences between males and females in their overall scores on the STEM-CIS, their individual scores in science, math, and technology, and SCCT factor scores (i.e. self-efficacy, outcome expectations, interests, etc.) between science, technology and math. Repeated ANOVA measures were used to determine how the students changed after the intervention.

Multiple regression modeling allowed for analyzing which factor or combination of factors predicted the dependent variable, interest (Draper & Smith, 1981). There were six items on the STEM-CIS that measured interest. Two in each subject area measured career interest and class interest respectively: science interest (S#8, S#9), math interest (M#18, M#19) and technology interest (T#29; T#30; see Appendix A for statement numbers on the STEM-CIS). Six step-wise multiple regressions were run on these six interest items to determine which SCCT factors (self-efficacy, outcome expectations, contextual supports, and personal disposition) were significant predictors. The two items within each subscale related to goals were not calculated in the multiple regression model, because Lent, Brown, & Hackett’s model suggests that interest predicts goals, and this study specifically analyzed which variables were best predicting student interest. A correlational analysis was performed on the post survey items to see which SCCT factors were related to students’ goals.

Interest in science careers (S#7; see Appendix A for items on the STEM-CIS for science, mathematics, and technology subscales) was entered as the first dependent variable to find a best fit model. Independent variables were entered; these included, science-self-efficacy (S#1, S #2), science outcome expectations (S#5; S#6), science contextual supports (S#9, S#11), and personal disposition to talk to scientists (S#10). These same independent
variables were entered to measure interest in science class (S#8). Similar regressions were computed for the dependent variables of interest in math careers and math class (M#18 and M#19), and for interest in using technology in class and using technology in careers (T#29 and T#30). Regression modeling was computed for interest on both the pre survey and the post survey.

**Student Career Video Exploration Sheets**

Once a week for five weeks (approximately half of a class period; 45 minutes), students used a career video exploration sheet (Appendix B) to document which video they watched, what they learned about the career, why they selected this career, aspects that they liked/disliked about the career and if they could ever see themselves in this career. In all, there were 200 exploration sheets collected, approximately 4 per student pair. In some instances, both students were interested in the career and supplied reasons together. In other instances, one student selected the career, and the other student would write down the students’ responses to the exploration sheets as if one were interviewing the other. In either case, each week when students turned in an exploration sheet, their names, career selection, and percentage completion/accuracy of their exploration sheet were documented by the researcher. In situations where only one student in a pair was interested in the career being explored, only that student’s career selection and completion/accuracy was noted.

There were three factual questions on each exploration sheet, specific to the career video watched and related fact sheet: *What are the responsibilities of someone in this profession? How much money does a professional in this career earn? And, how much*
education does someone need to go into this career? The intention was to gain an understanding of how closely the student had investigated the career; therefore, these questions were scored based on the level of completion/accuracy.

When scoring the sheets, the researcher assigned students’ responses into 3 categories based on completion and/or accuracy of their open-ended responses. Students received 33% if they provided a response that was only assumed based on the title of the video (e.g. video game designers make video games); responses received 66% if they were accurate, but with little detail (e.g. veterinarians check for symptoms of illness in pets); and 100% was assigned to responses that showed a detailed understanding to these questions about the career (e.g. [Fashion designers] direct and coordinate workers involved in drawing and cutting patterns and constructing samples of finished garments; design specific fabrics that block UV rays; develop new cosmetic formulas select materials and product on techniques to be used for products.) A 0% was to be assigned for no response, but there were no career exploration sheets without responses.

For the salary information, a score of 100% was assigned to correct responses and 0% was assigned to an incorrect response not seen in the video or on a fact sheet. Similarly, 100% was given to students who listed the educational degree one must obtain to enter a career and 0% for an incorrect degree listed. For the job responsibilities, salary information, and educational requirements, averages were calculated for the total number of students/student pairs that provided responses for each of these. For example, if 60 students/student pairs provided a response to the salary and 72 documented educational requirements, the salary average was calculated based on dividing the total points by 60
students, and the educational requirements average was calculated by dividing the total points by 72 students. Students who left questions unanswered did not get responses scored as inaccurate but responses were scored as incomplete.

Non-factual items on the exploration sheet included: Why did you choose the career? Are you comfortable with the job duties, salary, and level of education? Provide three reasons why you like this career. Provide three reasons why you do not like this career. And, could you see yourself in this career? These questions were assigned a priori codes (Creswell, 2007) based on factors in the SCCT (e.g. self-efficacy, outcome expectations, goals) then given a descriptive code (Saldana, 2009) to operationalize the SCCT factor to reflect middle school wording of responses. For example, if a student wrote, I want to be a plastic surgeon, because they make a lot of money, the associated code was outcome expectations: make a lot of money. Another example is, I want to be a video game designer because I am good at technology. The associated code assigned by the researcher was self-efficacy: good at technology.

Every SCCT factor was characterized as either corresponding positively or negatively to a career, and was categorized by the factor of the SCCT to which it corresponded (e.g. contextual support/barrier, personal input, learning experience). For example, I can’t go into this career because my parents would not approve, was considered a negative contextual support, or a barrier. An example of a negatively coded personal input could be, I don’t want to be in this career because I am not a social person. This personal disposition (not being social) was expressed by the student as unfavorable to Pursing the particular future career. For this age level, phrases were coded as goals when they denoted future
plans/desires, such as, *I have always wanted to be,* or *I would really like to be* [insert career professional]. Goals were not classified as positive or negative, rather in alignment or not in alignment with expectations of the career being explored (e.g. *I would rather go into the military*). Alternatively, many students identified that they had different goals than the career being explored or that they did not have a desire to go into the career after exploration. These responses were coded as *alternative goals.* Learning experiences were also coded as positive or negative. When students mentioned positive things about the STEM career video, such as *I loved how the video showed how they used technology to make different types of fabric,* a code of *positive learning experience: STEM career video* was applied. Alternatively, if students said *the video didn’t show me enough about the career,* this was labeled as a negative learning experience.

**Coder reliability.** The primary researcher and another coder, with knowledge of the SCCT framework and the literature base that had utilized the framework, developed a standard protocol that operationalized the factors for coding. This was first done by selecting initial examples within all of the exploration sheets that were representative of the favorable and unfavorable versions of the SCCT factors (e.g. positive/negative self-efficacy about activities in the career, positive and negative outcome expectations of pursuing a particular career, related interests and unrelated/disinterest to pursue a given career /other goals). When some of the student responses did not fit with other examples that were found for each factor, the coders created a list of working definitions that could aid in classifying student responses. This often depended on the way that the student phrased their response. For example, a reason one student may like a job as a pediatrician is because they *like to help*
people. This was coded as an interest in the process of a career. However, if another student said that they liked the pediatrician job because they will get to help people; this was coded as an outcome expectation of the career, an expected belief about the outcome of performing a certain job.

To assess reliability, the coders independently coded and negotiated all of the students’ first and fifth exploration sheets. On the first exploration sheet that was coded together, 330 codes were assigned, and the two coders agreed on 94% of the codes. On the second sheet coded together (Exploration 5) 215 codes were assigned, 10 codes were disagreed upon for a 95% inter-rater reliability (Creswell, 2003). All disagreed upon codes were discussed until 100% agreement was reached between the coders on student responses in relation to SCCT factors (Patton, 2002). Given the high level inter-rater reliability, the primary researcher determined that coding the other sheets did not require dual coders, and she completed the rest of the coding herself.

For each student, percentages were calculated for the factors specified by the students. For example, if a student’s exploration sheet was coded with 2 positive interest codes, 1 negative interest code, 1 positive contextual support code, and 1 negative personal input code, this was considered a total of 5 codes- 40% positive interest, 20% negative interest, 20% positive contextual support, and 20% negative personal input (a personal input that they consider not conducive to be in a career). The coding of the students’ exploration sheets each week allowed a way to track any changes in the way students were thinking about factors related to careers and to chart them in relation to the SCCT over time.
STEM Career Video Planning Guides

Students received one planning guide per group of two or three students, after six explorations were completed (Appendix C). The planning guide asked students to write about themselves and were told that they needed to include things about themselves when they wrote their script and filmed the STEM career video as if they already held the career featured in the video. These personal questions asked about their favorite classes, their strengths in classes, their afterschool activities, and how these personal characteristics could benefit them in a STEM field. Additionally, in planning for the video, students were asked to explain their responsibilities as a STEM professional, their educational path, their starting salary, how long they have been working in the field, and how much they make to date. They were also asked to describe their job environment, including the physical location of their job, what people wore to work, if they saw their coworkers outside of work, and what someone would find when entering in their workplace. Students listed what they needed to complete their STEM career videos, including costumes and props.

Responses to three items on the sheet were coded using the SCCT, including student-identified strengths, reasons for becoming interested in the profession, and regarding parental support. These items were assigned a priori codes related to aspects of the social cognitive career theory, including self-efficacy, outcome expectations, interest, personal inputs, background/context of the job, and contextual supports and barriers. These codes were then assigned a descriptive code to operationalize SCCT aspects for this population of students. For example, if someone reported that they were really good with math, which helped them do fast calculations in their mind, this would be coded- self-efficacy: math and doing quick
mental calculations. These codes were organized by SCCT aspect and common themes were found that were representative of students responses.

STEM Career Scripts

Students were given the option of writing a script to be used when videotaping their STEM career. These included a line by line account of what each student in the video would be saying. These scripts were compared to the planning sheet and the video to see how students assumed the role of a STEM professional.

STEM Career Video

Students used an iPod Touch® to film each other in STEM career videos. Using the video camera on the iPod Touch® allowed them to easily delete portions that they did not wish to use. When the students were finished recording, they uploaded their videos on the primary researcher’s computer for editing. These videos were descriptively analyzed to depict the four different ways that students created career videos within Mrs. Cruz’s classes.

STEM Career Identity Interview

The primary investigator interviewed nine students throughout the intervention, while the classroom teacher facilitated the STEM career explorations and video planning with the rest of the class. The four students of focus for this comparative case study analysis were chosen because they were representative of the racial and ethnic diversity in the classroom, they conveyed diverse experiences in STEM, each had a complete data set, and their videos represented diverse careers from all STEM disciplines (Yin, 2008).
Students were interviewed about their experiences in school and out of school related to STEM, how they felt about their science and math classes, and their feelings toward engineering. The protocol also asked students questions regarding how they felt about being a male or female in society, and how they believed their gender, race, and location to affect their future career choices (see Appendix D for the STEM Career Identity Interview). These interviews were open coded and organized into themes related to how they viewed themselves in STEM and how they feel that others see them as a member of STEM (Aschbacher, Li, & Roth, 2010; Creswell, 2012). Students’ responses were described and analyzed according to Markus & Nurius’ (1986) possible selves theory, which describe one’s possible self as their future self-concept. They explained that understanding a future self-concept depends on understanding how past and present experiences, social roles, and group memberships have influenced the individual and who they want to become.
Findings

Darius

Darius was a gregarious student who talked to anyone who would listen. He played several instruments in the band and described himself as being creative. He said, *sometimes I just be bored so I just start writing down letters then I start playing them notes and I organize 'em.* Darius lived with his mom and two older brothers in his grandmother’s house. His parents were divorced. His mother’s house was being built nearby, and he believed that his family was only going to be living with his grandmother for the next 4-5 months. After school, he sometimes helped his grandmother clean houses for extra money. On the weekends, he went to his dad’s house. Darius’ mom graduated from high school and went to community college for one semester and then dropped out. At the time of the study, she worked at a major retailer’s distribution center. His dad attended community college and then went into the Air Force. Upon leaving military service, he became a manager of a large food service company. At the time of the study he had reenrolled in community college supported by federal loans to become a math teacher. He also worked full time at a food distribution center.

**STEM Career Interests**

STEM career interest pre survey/post survey. Prior to gaining exposure to any STEM careers, Darius took a version of the STEM-CIS, measuring his interest and intention to pursue science, mathematics, and technology. Overall, his total score summed 129 out of a maximum of 165. He had a score of 44 in science, a 42 in mathematics, and a 43 in
technology, indicating that he ‘agreed’ (3.9 avg.) with such things as getting a good grade in science class, being able to complete his math homework, and planning to use technology in his future career. Each subject area was out of a possible 55 points. Following the intervention, Darius scored a 40 in science, 35 in mathematics, and a 43 in technology for a total score of 118 (3.6 avg) indicating that he had become more neutral on some aspects of STEM subjects and career interest.

**STEM career video exploration.** During the STEM career exploration and video creation, Darius needed constant attention. He participated in all of the activities but almost never without the assistance of the researcher, who helped to keep him on track by asking him to explain to her more about the things that he would write on his exploration sheets and planning guide. Darius personally selected three careers to explore. He worked on these first three explorations alone. The last two explorations were completed with a partner and Darius allowed his partner to select and complete the exploration sheets. In the first three explorations, Darius selected an aerospace engineer, a motorcycle engineer, and a carpenter. In the fourth exploration, Darius let his partner select a career of interest, an internet entrepreneur. When asked after the intervention to select a career that he could not see himself in, he chose *any job that works in a hospital.* The summary of Darius’ selections, reasons for his liking or disliking, and likelihood of pursing the explored career can be found in Table 5.2. Darius was unique with respect to the rest of his classmates (see Chapter 4) in that he listed a feeling of self-efficacy in math and science and a negative learning experience as a reason for not going into a medical profession. His other responses were similar to the responses of his classmates, which documented and emphasized personal interest and
outcome expectations as reasons for exploring and liking selected careers. Darius expressed general interest in the processes done in the careers and products being constructed within careers. His outcome expectations focused on the themes of money, school, and on having fun in the career and his interests were stated very generally. This is also consistent to how his peers interpreted outcome expectations and interests.

Table 5.2

Summary of Darius’ career selections and SCCT influences

<table>
<thead>
<tr>
<th>Career Selections</th>
<th>Likes?</th>
<th>Dislikes?</th>
<th>Could you realistically see yourself in this career?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace Engineer</td>
<td>You make a lot of money.</td>
<td>None written</td>
<td>No, too much college</td>
</tr>
<tr>
<td>Motorcycle Engineer</td>
<td>I thought he was cool and fun.</td>
<td>4 years of college-It is too long</td>
<td>Yes, I love these subjects (in reference to science and math).</td>
</tr>
<tr>
<td></td>
<td>[Motorcycles] are fast.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[Motorcycles] are cool.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carpenter</td>
<td>It seemed cool.</td>
<td>It’s too much college.</td>
<td>Yes for the money.</td>
</tr>
<tr>
<td></td>
<td>Math is easy for me.</td>
<td>You can get hurt.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>It includes math.</td>
<td>It’s too much work.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The money</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Career that he could not see himself in:</td>
<td>I could never see myself working in the hospitals. I do not like hospitals. My uncle was in the hospital, and he died and I did not go. I don’t like no hospitals.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Planning Guide.** Darius provided few details on his planning sheet, with short notes for each question. He selected a mechanical engineer as the focus for his career video, primarily because of his love of math (interest) and his previous experiences in the field (learning experiences). Without elaborating, Darius wrote that math would help him to be safe on the job. Darius’ previous experiences in the field always included his family members (contextual support). He included unexplained notes of his father mentioning “not to over torque”, and wrote about racing cars with his cousin Marcus and riding four-wheelers on his mother’s land.

**STEM Possible Self**

**STEM career video.** Darius did not want to write a script. He agreed to create a video if the researcher asked him questions from the planning guide, and he was videoed out in the hallway rather than in the media center with his classmates. In his STEM career video, he spoke fondly of school, enjoying math and science, and enjoying going to band practice. Darius wants to be a mechanical engineer and shows a clear vision of owning his own business, named Quick Clutch (because his cousin has given him this nickname), and fixing cars, motors and appliances. He understands how he will use his strengths in math; he says that he will use ratios, understanding compression, and making sure that he does not blow up the car engine, an event that has occurred on several occasions. *Put it this way. I was racing too fast and forgot to shift gears with the clutch and it said bah bah bah and it blew up.* He also recognizes that he is very organized, a characteristic that will be helpful in keeping tiny parts in order when he is working.
He brought up his family on numerous occasions throughout the video. He wants to build his business on a plot of land that his mom owns in a nearby town. He said that he would only hire family members in his business and if they slacked off, he would put them on probation and not let them in the shop. He attributes all of his knowledge about cars to his dad, saying:

*I was told when I was about six or seven, when I blow up one of the motors on my dirt bike, I’m gonna have to fix it. So my dad taught me once how to do it, so every time that I blow something different up, if it’s a new kind of motor, he’s teaching me how to do it and then I have to fix it on my own if I blow it up again. So ever since I was about six or seven and he taught me, I’ve been fixing motors on my own. I haven’t really had to use any help because I knew what I was doing.*

While at work he said that he would wear a sweatshirt, blue pants and an old pair of shoes or a pair of boots, but when he worked on things that were meaningful to him, he would wear the special coat that my uncle gave me before he died. He believes that his parents would support a decision to enter into a mechanical engineer profession, perhaps saying, *That’s something that we thought you would do.* He also talks about racing with his cousin, someone who really likes to do what he enjoys.

Darius plans a life with his own small family, making about 60,000 dollars a year, which would be used to support them as well as things that he likes doing, such as going to motor cross races. He says that he would support his wife whether she went to work or not, and could imagine himself marrying a nurse because his mom always wanted to be a nurse, and he wanted to make her proud.
STEM Career Identity Framework

**Past and present experiences in STEM.** Darius enjoyed all of his classes, and indicated a high interest in math and science. He said that numbers were easy for him. He was extremely confident in math, recounting a time that one of his teachers got annoyed because he kept correcting him during class. He is good with technology and played with his mother’s iPad outside of school. Darius’s recalled many experiences with mechanical engineering and viewed this job as an extension of what he already enjoyed. He said that fixing car was his outlet; *It's what I do when I get mad.* Darius defined individuals as someone fixed things like a mechanic. He believes that men of different races and ages could be engineers, as he has experiences with many types of these professionals.

**Gender roles.** Darius said that he had no respect for females in his school, believing that they act a certain way to get the attention of males. However, Darius was sitting near a male friend when asked this question and may have been swayed by his friend’s negative reaction to females in their school. Field notes and observations documented Darius’ behavior as kind and thoughtful, showing respect to all females in the class. He shared that females cared more about school than males because most females just *take more time in doing their work,* and talk to each other about school, grades, and their future more than males. He believes that teachers think females are more successful than males, based on his perception that they favored females in his classes.

**Race/Ethnicity.** Darius said that he has friends from all different races and ethnicities. Although Darius feels that he does not really think about racial interactions, instances at school and at home suggest that racial barriers exist for him.
He provided an account of a teacher who he felt treated him unfairly, yelling at him more than his classmates. When Darius told his mother that he felt like teachers reprimands him but not others, his mother said, you need to act like white people...because most of the time they have high expectations.

He provided an example to explain how he felt about his teacher:

Yesterday, and the day before she told me to tuck in my shirt because I needed to tuck in my shirt. And then she said today, if I see you come back in here one more time with your shirt untucked Imma write you up for dress code violation and you won’t come back in this class. I really didn’t care because I wanted to get out of that class anyway...a lot of people say she racist anyway, so I don’t care.

Peer membership. Based on the observations and field notes of the primary researcher and through discussions with Ms. Cruz, Darius gets easily distracted by students in the class, talking too much and being reprimanded daily. Darius was in Ms. Cruz’s most social class, the last period of the day. As a class, many students had been assigned lunch detentions and had been suspended for incidents such as fighting and drug possession. Darius too, had several lunch detentions throughout the school year, but had never has been suspended. Field notes captured his unique ability to easily switch from academic related talk, to sports, hunting, cars, or illegal activities. He described himself as social, saying, Wherever I go...I could just meet you...we could be line waiting for something and I’ll just start talking to you.

When asked about his group of friends friend group, Darius explained that he had good friends and bad friends. He related to his good friends more in school and his bad
friends more during recreational activities. He occasionally talked about grades with his friends, saying, *usually* [with] *my bad friends they’ll come up to me* [and ask] *guess what I got ...they be like a D or a F.* [When I tell them that I got an A], *they like, man you smart, Imma copy off you.* He said that his choice of friends concerned his mom and dad, who feared that he would be influenced to take part in activities for which he could be arrested.

**Family.** A significant part of Darius’ experiences in STEM incorporated his family. He became interested in mechanical engineering because his father was a *classic car freak.* He also describes his relationship with his cousin, as a friend who shares his passion for working on cars. He explained, *my cousin doesn’t work with classic cars but he goes with tuners as I call them.* *He had this Nissan 240SX and me and him put that together.* He said that his cousin worked as a *mechanical engineer* in a nearby auto shop with his other cousins. Similar to their concerns with Darius’ friends, he also conveyed that his parents were not happy with the relationship he has with his cousin. They just wanted him to go to college and stay out of trouble. Darius provided a thoughtful description about how he felt torn between his relationship with his cousin and the concerns by the rest of his family: *My cousin has a bad reputation. I think he’s been to jail like twice and most of it’s because of racing and others were because of drugs...well ever since [he got back from jail] I can really talk to him....My [other] cousins live in Tennessee... that are like very fancy people and they don’t deal with my cousin because he’s been to jail a few times and they stereotype him because he’s been to jail...I like both* [ie. all of his cousins].

**Rural school and community.** Before Darius entered middle school, his family moved from an adjacent county (approximately 270 sq. miles and 43,000 people), to the
more rural Washington County (approximately 444 sq. miles and 20,000 people). When comparing these counties, he says that that his old county was similar to this one but here there are a lot more good people and academically, Darius could not relate to students in his old county which caused him to get into more trouble.

However, there were some things about his previous school that he liked more than WMS. For example, he believed that his old school provided more opportunities for field trips in science and history. He said that even when he didn’t like the subject, after going on a field trip and talking to his teacher about the things that he saw, he felt inspired to go see the world. [He believed that it would be] so fun to go see different countries and their stuff. He said that teachers at WMS could not take students on field trips because it was not as academically successful as other schools in the area, and that the teachers thought that students needed to be physically present in a classroom to learn. Darius was not sure where he wanted to live when he grew up but in the event that he resided in his rural community, he imagined owning a mechanic shop on his mother’s land in the nearby town. He vividly depicted this shop with land behind it, where he could ride four-wheelers with his cousin.

**Future self.** Through Darius’ planning guide, video, and STEM career interview, Darius saw himself as a member of the STEM community. He reported in his interview that he may attend a technical high school as an alternative to the county high school. He imagined going into the Air Force as a means to fund his enrollment in a two year technical program designed to teach about the work of a mechanical engineer. He then explained that when he returned from his duties in the Air Force and in his program, he would work in a local mechanic shop to gain the experience needed to open his own shop. He said that this
shop would be on his mother’s land, that he would only employ family members, and that they would work on dirt bikes, cars, and appliances. He even described the clothes that he would wear in his shop, including a shirt that his uncle gave him before he passed away. He envisions working closely with family and using managerial skills to make sure everyone is doing their part.

Elle

Elle was an intelligent and articulate white female. Elle identified herself as a straight A student... I’ve always been a smart kid, always been able to do everything advanced. She played first base for the school’s softball team and has played the piano for seven years. She, her family, friends, and teachers characterized her as being very opinionated and arguing her-view point at home and at school.

Elle was an only child who lived with her mother and father, who had her when they were teenagers. Her mom worked as a nanny during the day, and was currently going to a the local community college to earn an early childhood associate’s degree. Her dad became a policeman after high school and was now taking classes at the community college to become a social studies teacher. Outside of school, Elle enjoyed going over to her friends’ houses, or going to the mall with her grandparents, with whom she spent a lot of time with while her parents were at work or in school.

STEM Career Interests

Pre survey/post survey. Elle’s total score on the pre survey was a 109 out of a maximum of 165, with a 36/55 in science, 38/55 in mathematics, and 35/55 in technology (3.3 avg; between neutral and agree on STEM subject and career interest). Following the
intervention, Elle’s scores slightly decreased with a total score of 106, a 35 in science, 35 in mathematics, and a 36 technology (3.2 avg.; slightly more neutral).

**STEM career exploration.** Elle always completed her explorations in a group of two or three females and always came to an agreement with her group on which careers to explore. The summary of her exploration sheets are in Table 5.3.

**Table 5.3**

Summary of Elle’s career selections and SCCT influences

<table>
<thead>
<tr>
<th>Career Selections</th>
<th>Likes?</th>
<th>Dislikes?</th>
<th>Could you realistically see yourself in this career?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical Engineer</td>
<td><em>I love roller coasters and I also enjoy designing things.</em>&lt;br&gt;&lt;br&gt;<em>It was fun and very creative.</em>&lt;br&gt;<em>It provides a challenge which I like; you can design things the way you want to.</em></td>
<td>None</td>
<td><em>Yes, it is very fun and creative. Also you get to design things and it seems like the profession that would provide a lot of excellent and challenging opportunities.</em></td>
</tr>
<tr>
<td>Materials Engineer</td>
<td>We both love roller coasters. and thought that the profession would be fun. We think that with some experience it would become easier and fun. Because we like roller coasters and would love to build them as well as other things. We love the amount of money.</td>
<td>None</td>
<td>We can see ourselves in this career. We love the science part and the designing part. We would love to design and make it our own.</td>
</tr>
<tr>
<td>Registered Nurse</td>
<td>It was interesting. We are [good at] critical thinking, compassion, [being] emotionally stable, [being] organized. You get to help people. You get payed good. Interesting work hours.</td>
<td>None</td>
<td>Yes because it’s fun.</td>
</tr>
<tr>
<td>Graphic Designer</td>
<td>We thought it would be interesting. We like magazines and posters, and would like to design them. To see your designs on public places. Getting to design your own stuff. Using technology to design stuff.</td>
<td>[We want] more money.</td>
<td>Yes, we are both artistic and love designing.</td>
</tr>
<tr>
<td>Career that you cannot see yourself involved in</td>
<td>I could not see myself as a registered nurse. We thought that it would be fun to look at but then realized it wasn’t our thing. I really can’t see myself taking care of people because blood and stuff creeps me out.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
STEM Career Planning Guide

Elle decided not to create her video with the same person with whom she had explored all of her videos. She and two other white females created a video that featured a day in a hospital. Elle and her group members role-played being nurses. Each female participated in creating the planning guide, supplying individual responses to each question. For example, Elle wrote that her strengths were in English, which would help her speak to patients, whereas another partner wrote that her strength was in math, which would help in measuring medical dosages. The third female documented having strength in social studies, allowing her to understand the history of diseases and other things.

Elle chose this career because she liked to help people. She indicated that daily responsibilities included administering medication, checking vital signs, monitoring patients, and teaching new nurses. The students indicated that they attended four years of college, earning bachelor’s degrees in nursing, and now make $152 dollars per hour. They reported that they enjoyed their colleagues, wore scrubs, had experiences working with dying or injured people, used computers, and were always busy with a full waiting room. All females reported that their parents would be proud of their career choice. They all planned to participate in the video and asked the researcher if she would film them.

STEM Possible Self

Career script and video. The three nurses joined with another group of three students who were doctors; a Hispanic female, an African American male, and an African
American female. Together, these six students cooperatively wrote a very detailed script that they all followed, using small notecards during their video.

The students pretended that they were working at a large hospital in the city approximately one hour away from Washington County. The nurses alternated in their duties, such as answering phone calls and directing patients to come into the hospital. In the opening scene, the doctors and nurses find that they understaffed and could not attend to all of the patients who needed medical attention. They called another local hospital to send backup. As the professionals set up their workspace with medical supplies, patients were escorted into the hospital via wheelchairs, with a variety of injuries; this included one patient with a gunshot wound, a patient with a cut leg, and a patient with a broken arm. The doctors and nurses consulted with the patients and treated wounds. Elle spoke to her colleagues professionally and respectfully. She showed an understanding of medical language, how doctors use medical equipment, and how to treat patients. Despite her disinterest in pursuing a career in medicine, she showed her interest in the activities through thoughtful contributions in planning and playing an essential part in the STEM career video.

STEM Career Identity Framework

**Past and present experiences in STEM.** Elle is not interested in STEM; her true passion was English, being placed in advanced English classes since the 3rd grade. She excelled in math and science but could not see herself going into a career that used these subjects. She did however enjoy her science class this year, particularly the hands-on projects (e.g. creating cells, designing bridges, building towers) that allowed her to use her
creativity. She discovered that she was interested in astronomy when her parents enrolled her in an astronomy-based summer camp three years ago and reported that she would definitely take an astronomy class in high school if it was offered. Elle also enjoyed visiting the natural living museum and local aquariums, with her parents. Elle explained that she was unable to participate in the upcoming field trip to a beach approximately 4 hours away, with Cruz. The cost of the trip was fifty dollars per student and Elle explained *money’s tight and I go to the beach every year. I don’t need to go for a couple hours out of the day. It’s gonna take four hours to get there, four hours to get back.*

She is bored and frustrated with math because she had been covering the same topics for two years: *I took [Algebra I] last year in 7th grade and [now am] taking the Advanced Math course this year...we’re doing the exact same thing. We even had an Algebra I book.* Elle explained that the high school curriculum recently changed requiring all students in her county take Algebra I regardless of whether they took it in middle school. *I know I can do geometry. [Our teacher] actually gave some of us a little geometry book if we wanted one and I’ve been looking through it and it’s fairly simple. I did half of ‘em [problems].*

Elle believed that technology was not important, particularly in math, because people rely too much on their calculator. Although she liked using iPads and iPods, she believed that hands-on experiences were more important. She reported that she had very limited experiences with engineering. She recalled designing roller coasters in science, but explained that when she thinks about engineers, *I think of somebody that builds something, creates something new, stuff like that. I’m not really good with building stuff from the start and coming up with stuff that I don’t already have and everything like that.*
Despite her lack of interest in science, math, technology, or engineering, Elle was very positive about the emphasis being placed on STEM careers by WMS. *I liked this year a lot because even though I don’t see myself in a STEM career, I like that you’re focusing on it and that we have people like you coming in, talking to kids, doing interviews and stuff.* That’s a lot better. Um…I feel like we’re doing more this year. Like last year I just kind of sat around and did absolutely nothing all year and it was an easy A, but this year I feel like you have to work a little bit more for it.

**Gender roles.** Elle believed that there were expectations held by teachers for females to do better than males academically because the school and parents placed too much influence on males being athletically talented. She expressed annoyance about this, because she enjoyed sports but did not feel that female sports mattered as much at WMS. She believed that females probably were more academically successful because their maturity level was higher than males. She asserted that males in her grade did not care about school because they just did not pay attention in class; they focused on *trying to impress females…they’ll get around their friends and want nothing to do with anything education-wise.* She believes that males and females at this school *try to act tough because in this school a lot of fights going on.* She said people should *act how they act and not…not just act one way because somebody’s around them or they’re with their friends.* Elle associated women as teachers, bankers, and nurses. She believed that engineering was one of those “more difficult” jobs that were associated with males. When I ask her who she would expect to be a brain surgeon, she replied, *A man.* *My dad was in the military so I always had a*
military doctor. Most of my doctors were always males...I’ve only had like one or two female doctors.

**Race/Ethnicity.** Elle is a white female in a predominately African American school and classroom. She said that *it is kind of hard going to a school like this because of the racial differences. There’s so many more of one race than there are of another.* She revealed that her family had very clear rules against dating non-white males or any male that does not come from a respectable family. She explained,

*I think it’s because of the way my parents were both raised. You know, when they were raised they weren’t allowed to do it. When their parents were raised, they weren’t allowed to do it. I just think it has to do with the upbringing of them. But, you know, if my friend was white and she dated a black person, I wouldn’t care. I wouldn’t judge them based on their decision because it’s their decision.*

She also explained that,

*slavery was down here too and you [still have] white families who do not believe in their children dating other races and that comes up through generations. We’re not really as revolutionized as other places and...you know, we’re not gonna be if nobody tries, nobody cares. [In] itty bitty towns, you know, the past has a lot of effect on the future of other generations.*

She does not believe that the color of someone’s skin should provide someone with more opportunities. In saying this, she followed up with:

*You look at the stats online and you see... bigger percentage of whites graduating and everything like that, and I don’t think it should be that way. But...I think most white*
families will put an expectation on most of their children because of the way they were raised.

**Peers.** Elle associated herself with other academically driven, athletic females who were not characterized by a single race. She enjoyed diverse perspectives of people who did not think like she did. She and her friends occasionally talked about careers, and she recalled that one friend wanted to be a pediatric nurse but said that most of her friends did not really know what they want to be when they grow up. Elle was comfortable talking about her successes with her friends and was not embarrassed to tell them if she did not perform well on a class assignment.

**Family.** Elle did not really talk to her parents about academic and career goals but consulted them when scheduling for classes each year. She said that they were not concerned about her grades but once took away privileges when she received a C because they knew that she was capable of more. They told her often that they want her to do better than them.

*They were both teen parents, so they didn’t really get to do anything...their childhood was kind of cut off because of me. Well, because of them. They want to see me excel and not turn out, you know, 31 years old and trying to scrounge money up for college.*

**Rural school and community.** Elle identified a time when she felt that she held different academic expectations than many of her classmates. At WMS, if students did not pass the state test in required subjects, they were allowed to retake the tests. She remembered being in one of only two classrooms of students who not have to retake the state tested. She believed that most students had to retake their tests because, *nobody tries and nobody cares. I think parents do have a lot to do with it, the way they up-bring their child.*
You know. If they raise them to believe that you don’t have to care about stuff like that, then they won’t, and if you raise them to believe that you do, then most of ‘em will.

Elle attributed her personal interests and successes to her English teacher, identifying her as a role model.

She’s kind of more than a teacher, she’s your guidance counselor and everything…you can tell her anything and she’ll help you as long as your life is not in danger or anything she’ll keep it to herself; and, she does tries to help you any way she can.

Elle has lived in Washington County since she was six years old, moving to the town due to her father being stationed there through the military. She believed that most people in Washington County did not place an emphasis on education and that there were clear racial divides. She saw limited opportunities for careers, saying that most people waitress, teach, have cell phone businesses, and cut hair.

**Future Self.** Elle did not have an interest in a STEM career but wanted to be an elementary English teacher. At the beginning of middle school, she wanted to be a writer, but said, there’s so many writers out there that are so good at what they do and I just didn’t think I was good enough. Elle’s hope is to get a teacher’s recommendation to attend the local early college next year, where they would guide her through a teacher preparatory program for two years. Afterwards, she hoped to obtain a scholarship to be transferred to a four year university that was approximately 2 hours away to complete her teaching degree. After college, Elle planned to return to the military base where she was born, located in a southern state near the water, where she was born; the base would provide her a home for a low-cost rent. The base also had several elementary schools where she could get a job.
Mariah

Mariah was a smart, quiet-spoken African American female. She described herself as crazy because *I do stuff out of the ordinary, like not like other people do...I’ll laugh at stuff that’s not even funny and I don’t know why*. She was interested in Language Arts and enjoyed writing fictional stores. She also enjoyed singing and playing video games with her younger cousins. Mariah lived with her mother, father, and brother, and was surrounded by her grandparents, aunts, uncles and cousins. Her mother was in a nursing program, and her father drove a recycling truck. She was academically and emotionally supported by her entire family. She has not really enjoyed middle school and only recently became more serious about her grades. She disclosed that prior to this year she had not had good relationships with her teachers, and earned Cs and Ds. This year however, Mariah had all A’s in her classes.

**STEM Career Interests**

Prior to the intervention, Mariah’s STEM-CIS (science, mathematics, and technology subscales) summed 114 (3.45 avg., between neutral and agree on items positively related to STEM subjects and careers), a 37/55 in science, a 36/55 in mathematics, and a 41/55 in technology. Following the intervention, her scores increased to a 48 in science, a 44 in mathematics, and a 52 in technology, a total score of 144/155 in the three disciplines together (4.36 avg.), between agree and strongly agree to science, technology and mathematics subjects and careers).
**STEM career exploration sheets.** Mariah selected three STEM careers that she was personally interested in, allowing her partner to choose one STEM career of interest (radiologic technician). She selected a video game designer, a veterinarian, and a marine biologist. Her explorations were guided by positive outcomes the career would afford her, such as having fun in her career (video game designer), helping others (veterinarian, marine biologist), and making money. Her negative outcomes were characterized by negative incidents that could occur on the job (e.g. having to hurt an animal/put it to sleep). The researcher returned back to the school at a later date to ask Mariah which STEM career she could not see herself involved in. She could not see herself as a fashion designer, because she was generally disinterested in the process of designing clothes. A summary of Mariah’s career selections and the reasons for her selections based on her career exploration sheets are in Table 5.4.
Table 5.4

*Summary of Mariah’s career selections and SCCT influences*

<table>
<thead>
<tr>
<th>Career selections</th>
<th>Likes</th>
<th>Dislikes?</th>
<th>Could you realistically see yourself in this career?</th>
</tr>
</thead>
</table>
| Video game designer | *Because I want to design games for kids to play*
  
  *To be able to play games all day*
  
  *They use motion in their games.*

| Veteranarian | *We wanted to be a veterinarian to work with animals.*
  
  *It’s good pay.*
  
  *You get to help animals.*

| Marine Biologist | *Because we thought that it would be an interesting career to*
  
  *We know how to swim*
  
  *We want to be able to swim with all the animals.*
  
  *We get to interact with the animals.*
  
  *We get to take care of the animals.*

| Career she could not see herself involved in. | *Fashion Designer, because I like to wear clothes, I don’t like to make them.*

| *I liked everything about the video* | *Because it is sad when one of the animals doesn’t make it* | *I can see myself being in this career because I love animals and I always wanted to be a veterinarian. I love working with them.* | *Yes* | *Yes, because it is an exciting career and you get to work and swim with animals.* |
**STEM Possible Self**

Mariah planned a video for an anger management specialist, with another female in the class. They asked the researcher to play the role of the patient. Mariah had no interest in playing a role in the video. She agreed to have a small part on the film, and took on the role of an assistant to the doctor. Although Mariah and her partner said that they were typing up the responses to their planning sheet during designated planning days, they were researching different tests to measure stress, typical diagnoses, and prescriptions for high stress patients. They created their own renditions of stress tests and Likert scale surveys so that they could ask the patient (the researcher) to rank her stress levels on different scales.

**Script.** Mariah and her partner eventually created a script that they memorized for their career video. The script was brief, featuring the anger management specialist testing the stress levels of her patient, and having her take a stress inventory. The doctor believed that the patient was stressed because she was bullied at school. She provided the patient with information on stress management and recommends exercises to build self-confidence.

**STEM career video.** Mariah and her partner’s video performance did not stay true to the script that they created. The patient (researcher) pretended to be a high strung and an extremely uncooperative patient, and both students stayed in their professional roles, addressing the patient in a manner similar to a real anger management specialist. They had the patient undergo each stress test and offered professional opinions and diagnosis, telling the patient to eat more balanced meals, exercise, sleep, and then return for a follow-up appointment. Mariah played a nominal role in the anger management video, serving as the
physician’s assistant and calling the patient into the doctor’s office from the waiting room.

In a follow-up discussion with Mariah, she said that she did not really want to be on camera.

**STEM Career Identity Framework**

**Past and present experiences in STEM.** Mariah has disliked math since elementary school and particularly hated this year’s word problems. She believed that her teacher last year was a better teacher, because he was able to explain the material better. Mariah was not giving up on using math though, and said, *I’m gonna try to get over my fear of having to do hard word problems and long division and all that stuff.* When she had questions about math, she waited until after class to ask her teacher in private or turned to her friends for help. She enjoyed science, understood the material, and liked performing experiments and working in groups. Mariah enjoyed using technology and did her homework on an iPad at home. She believed that iPads helped students to be more engaged in school, and that technology was important for future generations. *Technology is like in our DNA because we grew up in technology... there’s more technology these days than it was when our parents and our grandparents were growing up...so we should know more about it.*

Mariah perceived an engineer to be similar to a contractor saying, *they do lots of building… they like to build and construct and make blueprints and stuff, or plans.* She cannot recall any experiences in school or out of school in which she has taken part in engineering. She could not recall many experiences outside of school when she had engaged in STEM. In late elementary school, Mariah recalled going to the Smithsonian and a life science museum with her parents and brother. She really wanted to experience a college
campus, go into the classes and take notes to learn more about what college kids did on a daily basis.

**Gender roles.** Mariah believed both males and females could do any job that they wanted to do. However, she held the opinion that her teachers:

*make exceptions for males. They try to help them but they still don’t listen cause they’re trying to act like they’re not as smart as they should be.* If the teacher gives hem something to do...they know how to do it but like if their friend’s in the room beside ‘em, they want to show off and, you know, act crazy around them to impress them, to say like, you know, “I’m bad. You can...you can mess with me but like...you know. And some of the boys, like they think they can fight. Like they talk like they’re big and bad but like when they get around someone that really knows how to fight, they just like get soft and just like try to walk away and act like they didn’t even want to fight them because they know they’re probably gonna lose.

**Race/Ethnicity.** Mariah describes many incidences when she has thought about race. In school, Mariah believes that teachers pay more attention to white students. She brings up a specific white teacher twice during the interview, saying,

*I raise my hand and she’s sees somebody else...doesn’t even call on me. I was in here trying to give the answer and she just passes by me and I feel like rejected like she doesn’t even want to talk to me and that makes me feel really bad because I know I’m smart and I don’t need nobody to tell me that I’m not....Even though there’s not a lot of white kids in our class...it’s mostly black but she still like ignores mostly all of them.*

She shares a feeling of sadness, when saying,
She’s telling us we’re not smart, we don’t know what we’re talking about, and that’s making us feel bad. Like that’s making us feel like we don’t want to raise our hand and show that we can do stuff. She’s actually making us feel like we’re not smart enough to be in that class. That’s what it feels like to me, like ‘cause she never calls on me ‘cause I always raise my hand and she never calls on me. She just looks and calls on somebody else.

Mariah confided in her grandmother about her feelings in this particular class, asking her why teachers think that white students are smarter than black students. She [said] we should try more because when somebody say black, [others think] we’re not smart ... she tells me try to do things better. Mariah also turns to an African American female teacher that she feels comfortable talking to about things that she is concerned about in school and out of school. I asked, why does it seem like most white kids are smarter...she said because the white kids are not from the slavery and had more education. Mariah interprets this to mean, we weren’t smart because we were always out there picking and they (white people) were in there getting taught by the best teachers.

Despite racial incidents at school, Mariah is proud of her family because she believes that they welcome people who look different than they do, and who come from different places. No matter what color your skin is, you’re all....you’re all human beings. I have lots of Caucasian people in my family too... I love my family and like being with my family, it makes me really happy because I know that nobody’s gonna say, you know, “Look at that white girl over there,” and stuff like that. It makes me feel really good that everybody in my family is like one and they know where they come from.
She believes that a person of color can be a STEM professional but that certain nationalities are better at STEM because they *are actually learning*. For example, she shared that she has a family member who is a forensic technician and that she loves her job. However, she believes that students here are not as smart as students in other parts of the world. She said that her aunt went to Japan and students there knew more than students here because they had better schools.

**Peers.** Mariah has been loyalty to her small group of friends from late elementary school until now. She wants to go to college.

**Family.** Mariah shares a deep connection with her family. *As long as I’m spending time with my family...I know they care about me.* She particularly acknowledges the sacrifices that her mother has made to save money for her and her brother to go to college.

*My momma said she wants me to go to college so I can get the education I need and try to have the life that she never had because my mom she went like...I think she was like twelve when she had her first job and she’s been working ever since she was twelve...my momma has never been without a job even though she didn’t go to college and couldn’t follow her dreams that she set for her when she was little. My mom’s told me that she expects great things for me since she didn’t go to college and neither did my dad go to college.*

Both of her parents provide her with encouragement to pursue her dreams and do well in school. Mariah said that being able to give back to her family when she was older would be one of her greatest accomplishments. She also talked about her sister-in-law, another role model in her life, who came from poverty and had a learning disability, but persevered
through college. She watched her sister-in-law use the support systems of friends and family to help her to not give up. Mariah believes that she will need those same support systems herself.

**Rural school and community.** Mariah was proud of being in the small “safe” town in Washington County. She feels that it is her duty to stay in the area to make it better. We could help it. We could bring it up and make it seem like we’re not the poorest county everywhere around… it would make us seem more lively. There’s a lot of history down here and [if] a group of women got together and helped each other out, we could make it really big. She was offended by others who said that the county means nothing to them, who did not believe that it was or would be a place with limited opportunities.

**Future self.** Mariah is desperate to get out of middle school, particularly from her teachers, and knows that in order to do this she must do well in her classes. She wants to go to early college high school, and then go to a university for two years. She shared that she still has a lot to think about because she cannot imagine being far away from her family, even though she wants to go to a good college. Her career goals change frequently. I was gonna be a nurse but then I changed my mind cause my mom bought me a dog and I really liked it and I went to a veterinarian and I got to spend a day with a veterinarian and it was really fun and I wanted to be a veterinarian so I did want to be a teacher at first but I changed my mind a lot about jobs. Presently, Mariah wants to be a veterinarian because she love animals and loves working with people, letting them know that how to best take care of their pets and reassuring them that they will feel better. She believes that she will even be able to handle the negative aspects of the job. I’m not a very emotional person at times so I wouldn’t be as
sad as other people would be like if their pet would die. So I think I would be, um, a good person for that because like I lost lots of pets. So it wouldn’t hurt me in any way.

Theresa

Theresa is a confident and intelligent Native American female. She prides herself on her consistently good grades and knows that she has to continue doing well in school so that she can get into college and eventually pursue graduate school. She describes herself as social, crazy, and honest, and believes that crazy most accurately describes her because her mind is always “busy” and she is always saying things to teachers and friends that are not related to the subject at hand. She believes that this characteristic will be helpful in a future job because it will bring laughter to a job and let her try new things to solve problems.

She really likes social studies because she likes learning about history and enjoys learning about different cultures. She likes to socialize with friends on the phone, through social media, and enjoys safe fun. She says, I just like to have fun, I like safe fun, I’m always about safe fun, not like you know…not bad fun but good fun. I go to church. I sing in the chorus at my church, I mean up in the choir. I’m guess I’m gonna start as an usher.

STEM Career Interests

Prior to the intervention, Theresa’s STEM-CIS (science, mathematics, and technology subscales) summed 126 (avg. 3.82), She scored a 41/55 in science, a 45/55 in mathematics, and a 40/55 in technology. Following the intervention, her scores increased with a 48 in science, a 44 in mathematics, and a 52 in technology, a total score of 130/155 (3.94) in the three disciplines together (avg. 4.36, between agree and positively agree).
**Exploration sheets.** Theresa’s career selections, reasons for why she likes and dislike the career, and her ability to see herself in selected careers are summarized in Table 5.5.

Table 5.5
Summary of Theresa’s career selections and SCCT influences

<table>
<thead>
<tr>
<th>Career Selections</th>
<th>Likes?</th>
<th>Dislikes?</th>
<th>Could you realistically see yourself in this career?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Scientist</td>
<td>I like food.</td>
<td>It doesn’t fit my personality and my style.</td>
<td>No, it doesn’t really interest me.</td>
</tr>
<tr>
<td></td>
<td>I like trying new stuff.</td>
<td>I like solving stuff...eating food all day...I’m not trying to be overweight...</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I like playing around with food.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgeon</td>
<td>You make good money.</td>
<td>It requires a long time to be in college.</td>
<td>Maybe, because they make good money and I like to help people.</td>
</tr>
<tr>
<td></td>
<td>I get satisfaction from helping people and you can do this in this job.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paleontologist</td>
<td>I like finding things</td>
<td>I don’t really like rocks.</td>
<td>Maybe, I think that I could get my Ph.D., I love to travel.</td>
</tr>
<tr>
<td></td>
<td>I like history.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I like finding stuff about the past earth.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Career that she could not see herself in:</td>
<td>I could never see myself as a teacher, because when kids be disrespectful, I have a quick temper. It doesn’t take very long until I can’t handle it. Teachers have a lot of patience, I</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
STEM Career Planning Guide

Theresa planned to create a video on being a forensic pathologist. She wrote that her strengths are in science, which will help her in this profession. Her experiences that led her to this career choice occurred in an out of school program with which she has been involved that promotes STEM achievement in minorities, low income students, females, and first generation college students. She uses technology outside of school through her phone, computer and iPod. She is interested in a forensic pathology career because she likes to solve mysteries and believes that this profession will allow her to earn more than $100,000 a year. According to her planning guide, her daily job responsibilities would include testing DNA and determining how people die, and her responsibilities would be consistent from day to day. Her bachelor’s degree was in Biology, and she spent approximately 5 years after that in medical school. In her lab, there are dead bodies, policemen, technology such as high-tech computers, medical tubes, and a freezer. She plans to wear a “special hat for your hair, goggles, and a mask for your mouth and nose.” Theresa plans for her lab to be located approximately 30 miles from her hometown, in a small city. She says that she has support from her parents, writing that they would say “I’m proud of you” when she told them her career goals. She plans to use a large rectangular table covered with a sheet for her sterile work environment, and asked one of her male peers to be the victim in her video.

STEM Possible Self

Script. Hi my name is Theresa I am a pathologist. I work to find why somebody dies. I make an average $240,414 per year. I’m trying to figure out why this person died.
Now I’m gonna cut open this person’s stomach. Well Mr. Yancey my boss said, “Theresa, is this Dr. S [Principal’s name]?” I said “yes it is” and when I went through his medical records I saw he had some stomach problems in his elderly years. While I was doing my research about him, it had appeared that he had taken some pills that wasn’t subscribed. Well I have to go to school for pathology for 4 years then 4 years of medical school, then 4 years of residency combining anatomic and clinical pathology then some people do the 1 year of fellowship. This is what I do for a living. Thank you for watching what I do for a living.

**STEM career video.** Theresa’s video of a pathologist featured herself. She read directly from her prepared script, and wore a fashionable black hat, a sparkling silver jacket and held a microphone while she spoke. Beside her, one of her male peers pretended to be a dead body lying on a white sheet covering a table in the media center. She pretended to cut open his stomach to determine the cause of his death. Another male peer stood silently near her pretending to be her, portraying her boss in the video.

**STEM Career Identity Framework**

**Past and present experiences in STEM.** Theresa is confident in science and in math. She is happy with her science teacher and mostly understands the content taught in class. At the time of the study, she was learning about physical and chemical changes and was a little confused by the topic. She would rather being doing something more hands on, like mixing chemicals and real experiments. She prefers science this year to last year because she believes the teacher taught what she wanted to teach about, spending most of the
year on a unit in weather. She also likes the way that Ms. Cruz incorporates social media, allowing students to privately send questions to the teacher and get extra help without other students knowing she has asked.

Theresa likes this year’s math class better than last year because she felt that her teacher last year did not explain math so that students could understand it, making the material too complicated. She says that one drawback to her math class this year is that the class is disruptive and some people “play” too much. She says, *Yeah, I like having fun outside of classroom, when I'm in a classroom I like being serious and stuff and take my work serious.* When she finds herself bored in class, she admits to becoming social and distracted by others. She was chosen by her sixth grade science teacher to be a part of an out of school STEM program that meets eleven Saturdays throughout the school year (the program is a part of the larger project in which this study is embedded). She has continued in the program through her eighth grade year, traveling on a bus with 14 other teacher-recruited students from Washington Middle School to a university that is approximately an hour and thirty minutes away, where she works with mentors in science, technology, engineering, and math, meets real STEM career professionals, and travels to local colleges. For the past two summers, Theresa has gone to a residential, week-long camp at this large university, and engaged in STEM courses and competitions (e.g. designing robots to carry out different functions). The STEM professionals and role models are predominantly minorities. This out of school program made her consider the possibility of being a pathologist because she had the opportunity to meet one.
Other than her appreciation for the integration of social media in science class, Theresa is rather indifferent about using more technology in class. She prefers doing experiments in class rather than online and is content with working through a textbook. She does believe that technology can make things more engaging for students. When asked about her definition of and experiences with engineering, she replied, *I think engineers create products and then if it doesn’t work right then they go back and they figure out why and they try different methods until they get the right solution.* She clearly articulated the engineering experiences in her out of school program, including designing an egg drop and creating a robot out of LEGO®MINDSTORMS®. Although she recognizes that she has done engineering, she perceives engineers to be male. She says that she knows one Native American engineer who fixes cars in a nearby town. She describes a time when she considered doing engineering: *I always had this little dream in my head. I made a roller coaster go through a big giant waterfall and you just get soaked.* Then I told my daddy and he was “well, you should think about a real career.”

**Gender roles.** Theresa believes that if males and females behave like they are supposed to and attend to their education, there are no differences in their opportunities or the way that they are treated by teachers.

**Race/ethnicity.** Theresa is Native American and is actively involved in understanding her traditions and background.

*I know a lot about being Native...I’m proud of it. On my dad’s side we’re very strong Indian people. I talk about it, I dance in a pow wow...I sing back up for a drum group called Blue Moon, it’s a young drum group that you know we’re getting together... I go to a bead*
class, coach class, um I’m all about the natives. We are the smallest minority in [state name] and being the smallest minority we will have more opportunities. At pow wow’s we know each other because we grew up together, even if we….we might not have the same last name, we might not be from the same tribe but we’re always together. I’m just expected to carry myself in a young ladylike way. Like I got my eagle feathers and that means that I’mma become a young lady and I’m supposed to act like I’m responsible, I’m mature, I respect, I’m just a good all-around person.

**Peer memberships.** Theresa identifies herself as “everywhere”, being friends with many groups and types of people. She does not really talk about her grades with her friends but if they directly ask her what grade she received on an assignment, she will tell them. She does talk to her friends about what they want to do when they grow up and where they would like to go to college. Her role model is her god sister, an older female mentor, who is a senior enrolled in a large university in her state who is planning to pursue a master’s degree in nursing. She believes that her mentor’s advice is better than her parents because she is closer in age to Theresa and can better remember what it is like to be a middle school female.

**Family.** Theresa believes that her mother is a fairly good support system. She pushes Theresa to do well in school, and although she does not punish her for bad grades, she discusses how to improve. As mentioned previously, Theresa’s father encourages her to embrace her Native American heritage and act like a young, responsible woman. She loves her family, and says that she will always be excited to see them, but she does not necessarily want to live by them forever. She wants to go to a place where there will be opportunities for her to pursue her dreams in pathology.
Rural school and community. Although Theresa speaks fondly of her ties with other Native Americans in her community, Theresa believes that she will leave Washington County when she gets out of high school. She says that the county is too small and doesn’t even have a skating rink. She has a male friend who wants to play football for the Baltimore Ravens, and she says that she would be willing to go to this city and work as a pathologist if they were married. Until then, she believes that she would be happy in a medium size city, even one that is 20 minutes away.

Future Self. Theresa’s exploration sheets, planning sheet, and STEM career video indicate that she can envision a life in STEM. She is confident in her abilities in STEM, her performance in STEM, and she recognizes the potential of a career in STEM. Theresa is ready to pursue four years of college and graduate school. She is currently considering going to the nearby early college instead of Washington High School so that she can earn some college credits prior to going to a university.

Summary of Participants’ STEM Interest According to the SCCT

Based on the data from four eighth grade students who explored and created STEM career videos, the following findings are summarized:

- Students’ explorations were guided by their interests in school and out of school.
- When students were provided with descriptions of jobs, short career videos and information regarding salary and education, their outcome expectations immediately became focused on them and later became more sophisticated, describing outcomes
- of processes and dispositions that could be used in the career on their exploration sheets.

- Darius, Elle, and Theresa had slight decreases in STEM subjects and career interest on the post survey; Mariah significantly increased in her score on the post survey. The students’ STEM-CIS scores are shown in Figure 5.3 and are compared to the averages for the whole class.

![Figure 5.3. Participants’ changes in STEM interest based on pre and post STEM-CIS surveys.](image-url)
Elle, Mariah, and Theresa did not identify STEM self-efficacy as a reason for selecting careers on the career exploration sheets but all students acknowledged strengths in math and/or science on their video planning sheets, in their videos, or in their interviews.

Interviews elicited learning experiences that contributed to this self-efficacy, such as an out-of-school STEM program (Theresa), informal experiences using STEM (Darius), and mastery experiences in school (Elle and Mariah).

Contextual supports were highlighted in students’ accounts of young mentors, cultural groups, family role models, and teachers.

Contextual barriers were identified as negative experiences with teachers, the disruptive behavior of their peers, lack of resources, lack of access to courses, few opportunities provided by their school, racial and gender stereotypes, and inaccurate perceptions of scientists and engineers.

**Discussion**

Two theoretical frameworks are used in this study; the social cognitive career theory (SCCT) and STEM career identity. Lent, Brown, & Hackett’s SCCT guides a broad analysis of students’ STEM career interests and reasons for selecting their videos based on multiple data sources (STEM-CIS results, career exploration sheets) linked to aspects leading to career choice, such as self-efficacy, contextual supports/barriers, and interest. STEM identity contextualizes students’ experiences through longer, in depth interviews about their school, family, and rural culture, and the STEM career video planning guide and script, as well as classroom observations/field notes.
Students’ Changes in STEM Interest through a Video Intervention

Based on STEM-CIS survey analyses, at the beginning of the intervention Darius perceived himself to be interested (approximately a 4/5) in STEM, and Elle, Mariah, and Theresa were more neutral (approximately 3.3/5) in regards to their STEM subjects and career interests. By the end of the intervention, Darius became more neutral, Elle stayed approximately the same and Mariah and Theresa became more interested. Therefore, the overall STEM subject interest and career interest did not seem to change very much, as measured on the STEM-CIS. Mariah’s changes were the greatest, and they positively changed to be more interested in STEM subjects and careers. A look at Mariah’s raw scores indicates that the largest changes were in science and technology. This is perhaps not surprising, as Mariah shared that her career plans were changeable, from thinking she would be a teacher to a nurse to a veterinarian. Also, Mariah disliked math, and may have been associating all STEM careers with extensive mathematics, similar to student perceptions in the literature (Change the Equation, 2013).

Career Goals. The goal of career exploration is to allow students to first investigate careers based on student interest, and then to have them explore career information that can heighten their interest and help them think about realistic goals or deter their interest (Orthner, Akos, Rose, Jones-Sanpei, Mercado, & Wooley, 2010). These students demonstrated interest in exploring STEM, even if they had other ideas in mind of what they wanted to be, similar to findings by Kitts (2009). Students’ initial career choices for exploration included an aerospace engineer (Darius), a mechanical engineer (Elle), a video game designer (Mariah), and a food scientist (Theresa). Although Darius’ choices were
aligned with previous gender interest findings, the choices made by the females did not corroborate other gender studies, which found females to be interested in life science with the goal of helping others (Baram-Tsabari & Yarden, 2007, 2008; Baram-Tsabari, Sethi, Bry, & Yarden, 2009; Ceci & Williams, 2007; Jones, Howe, & Rua, 2000; Li, 2008; Tan & Calabrese Barton, 2008).

The selections by these females also were not typical of selections made by other females in the class on the first exploration (see Chapter 4), which predominantly were focused on medical careers. Darius currently intends to become a ‘mechanical engineer’ and to own his own auto mechanic business. He does not talk about college plans. Elle plans to become an elementary teacher, and described clear plans to go to early college high school, then a four year university. Mariah plans to be a veterinarian, but often vacillates to nursing, and does not discuss specific college plans. Theresa wants to become a forensic pathologist, mentions specific college plans at early college high school then college, and says she will consider earning a Ph.D.

**Interest.** This study was framed by using aspects of the Social Cognitive Career Theory (Lent, Brown, and Hackett, 1994) as a priori codes (e.g. self-efficacy, interest) to see if the STEM career exploration responses of students resonated with them. Indeed, they did. Throughout their career explorations, Darius, Elle, Mariah, and Theresa were guided mostly by personal interest in careers, initially based on the career title (Exploration 1) and in later explorations by a description of the job, the amount of schooling required, and the salary of the job. They also were enticed to consider careers by the positive outcome expectations that could occur if they were followed a career path. For instance, students documented that they
liked a career because it related to something they currently do recreationally, a class that they see as fun, interest in the product being made and/or processes that they currently enjoy outside of school. Other studies have similarly found that personal interest influences students’ selection of a college major, and that this interest can be heightened or lessened by presenting students with the factual information (e.g. salary, educational requirements) (Beggs, Banthum, & Taylor, 2008; Hall et al., 2011).

Two students chose to create videos that they could see themselves in (Darius and Theresa) and Elle and Mariah chose to be part of a video featuring a career that they did not have any intention to pursue. Elle had other interests, but still was actively involved in planning and creating the video, suggesting that she enjoyed the process. Studies find that students participate and engage when they find material valuable and relevant to their own lives (Orthner, Jones-Sanpei, Akos, & Rose, 2013). Mariah, on the other hand, was shy (personal disposition) and she did not feel comfortable being videotaped in a career that was focused on her.

**Outcome Expectations.** This factual information (i.e. outcome expectations of pursuing a particular path) was found in one study to be the predominant influence of exploring careers. When students were provided with age-appropriate descriptions of the careers prior to exploring and the amount of education that the careers needed (Explorations 2), students were still guided by their own interests, but Darius and Theresa stated that careers that they were interested in required too much schooling. There are a number of possible explanations for their comments about the amount of schooling required. It could be that the students did not believe they could be successful in college (Betz & Voyten, 2012).
It could be that they do not like school enough to continue for so many years; however, all four of these students expected to attend at least community college, and Theresa planned to pursue a graduate degree. It could be that these students did not feel they could afford to attend college long enough to achieve the education level required for the position (Destin & Osyerman, 2009).

**Outcome expectations influenced students’ positive interest in careers.** This was the case with all four students identifying high salary as something that they liked about the career. The three girls were influenced explore and consider careers based on positive outcome expectations. Elle listed positive outcome expectations related to engaging in fun physical and mental processes (e.g. designing and critically thinking). Mariah too, was excited about the possibility of being involved in positive and fun processes, as well as being able to help people and animals. Theresa also was positively influenced by helping others, similar to findings in science interest studies between gender (Ceci & Williams, 2007; Jones, Howe, & Rua, 2000; Li, 2008; Tan & Calabrese Barton, 2008).

**Self-efficacy.** Many studies cite the influence of self-efficacy in interest and intent to pursue career related goals from middle school to college (Ferry, Fouad, & Smith; Fouad & Smith, 1996; Tang, Pan, & Newmeyer, 2008). In their last explorations, findings suggest that students began to consider their strengths in relation to the selected career. Darius recognized his strengths by documenting that being a carpenter would be easy for him because he is good at math. Elle documented how her ability to think critically would help her as a registered nurse. During their interviews, Darius, Elle, and Theresa all acknowledged being strong in science and/or math, and Mariah exhibited confidence that she
could overcome her fear of math and solve math-related problems. In the interview, her personal disposition (lacking emotion) could contribute to her ability to be professional as a veterinarian.

**Learning experiences.** Zeldin, Britner, & Pajares, (2007) suggest that mastery experiences encourage males to pursue their interests whereas social persuasion is more influential on what careers females pursue. Interviews with students elicited the learning experiences that encouraged their positive self-efficacy in science and math classes, such as out-of-school STEM programs (Mariah), informal experiences using STEM (Darius), and mastery experiences in school (all four students).

**Contextual influences: Supports and barriers.** Contextual supports were highlighted in students’ accounts of young mentors, cultural groups, family role models, and teachers. Elle and Mariah have strong family and peer support systems that are conducive to their success. Theresa has an incredibly strong supportive network in an out of school setting allowing her to associate with other people her age who value school and are interested in pursuing a career in STEM. Contextual barriers were identified as negative experiences with teachers, the disruptive behavior of their peers, lack of resources, lack of course access or opportunities provided by their school, negative racial and gender stereotypes, and negative perceptions of scientists and engineers. These contextual barriers are strongly tied to their present social experiences with peers, teachers, and family as well as the social roles that are that are seen in middle school. These barriers have been cited in the career development literature, particularly in studies analyzing the barriers of African American youth (Alliman-Brissett, & Turner, 2010). In one interview study, Gilbert and Yerrick (2001) identified that
non-honors students in high school perceive rural communities had limited opportunities where people could be successful. Theresa does not believe that her future lies in Washington County, stating that she will likely move to a larger city, where pathology careers may be more prevalent. Elle also wants to move away from home to go to college, feeling that a university will be able to better prepare her to be an English teacher, rather than options within the county.

How Students’ Negotiated STEM Career Identities

Carlone & Johnson (2007) concluded that competence, performance, and recognition by self and others influence the positive and negative identities held by underrepresented women professionals in science. This model provided a starting point to frame how rural middle school students negotiate a career identity of their own in the context of STEM. The conceptual framework of Markus & Nurius’ (1986) possible selves was thought to be a promising framework to better explain how these students’ experiences, social roles, and group memberships influence their identity formations. This conceptual framework has been used to provide thoughtful analyses of career identities for middle school and high school students (Destin & Osyerman, 2009). Although one of the four students in this study did not want to be a STEM professional, the students’ depictions of their possible future, created through their experiences, provided insight into how the culture of a high poverty, predominately African American middle school in a small rural community shaped these students’ understandings of their career goals. Table 5.6 aligns the findings of Darius, Elle,
Mariah, and Theresa in terms of aspects of a career identity employed by Carlone & Johnson (2007)
Table 5.6

Comparison of students’ STEM professional identity based on the model by Carlone and Johnson (2007)

*Future Self: Students’ perception of who they would like to become; ▫ Language: Ability to use the appropriate terminology within the career as well; ▲ Experience with appropriately using equipment in the job; ▫ Recognition: Perceiving oneself as a member of the STEM community as well as being perceived by others.

<table>
<thead>
<tr>
<th>Professional Identity</th>
<th>Darius</th>
<th>Elle</th>
<th>Mariah</th>
<th>Theresa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Possible Career Self</td>
<td>Mechanic</td>
<td>English Teacher</td>
<td>Veterinarian</td>
<td>Forensic Pathologist</td>
</tr>
<tr>
<td>Competence Grades</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Comprehension of future self*</td>
<td>Duties: Concrete</td>
<td>Profession: Concrete</td>
<td>Profession: Uncertain Education: Vague</td>
<td>Profession: Accurate Education: Vague</td>
</tr>
<tr>
<td>Professional duties</td>
<td>Concrete Education: Partial</td>
<td>Concrete Education: Accurate</td>
<td>Uncertain Education: Vague</td>
<td>Accurate Education: Vague</td>
</tr>
<tr>
<td>Education needed</td>
<td>Duties: Concrete</td>
<td>Profession: Concrete</td>
<td>Profession: Uncertain Education: Vague</td>
<td>Profession: Accurate Education: Vague</td>
</tr>
<tr>
<td>Performance Experiences</td>
<td>Direct</td>
<td>Indirect (e.g. reading)</td>
<td>Indirect (e.g. taking care of her pets)</td>
<td>Novice College student</td>
</tr>
<tr>
<td>Language▫ and Tools▲</td>
<td>Expert Family</td>
<td>Proficient Teacher</td>
<td>Novice Young relative</td>
<td>Novice College student</td>
</tr>
<tr>
<td>Role Models</td>
<td>Conflicted</td>
<td>Supported</td>
<td>Supported</td>
<td>Supported</td>
</tr>
<tr>
<td>Peers</td>
<td>Conflicted</td>
<td>Supported</td>
<td>Supported</td>
<td>Supported</td>
</tr>
<tr>
<td>Family</td>
<td>Conflicted</td>
<td>Supported</td>
<td>Conflicted</td>
<td>Supported</td>
</tr>
<tr>
<td>Teachers</td>
<td>Supported</td>
<td>Supported</td>
<td>Supported</td>
<td>Supported</td>
</tr>
<tr>
<td>Self</td>
<td>Supported</td>
<td>Supported</td>
<td>Supported</td>
<td>Supported</td>
</tr>
</tbody>
</table>
Students’ Conceptions of their ‘Possible Selves’

Interviews helped to reveal students’ visions of their future selves. STEM career videos also provided additional insight into how Darius and Elle could see themselves in their STEM careers. The literature has suggested that middle school students do not have a clear understanding of how their skills relate to their educational path and a working life (Orthner, Jones-Sanpei, Akos, & Rose, 2013). For these students, this was not necessarily the case.

Darius, for instance, had a clear understanding of his skills and their relationship to his working life. His ultimate goal was to become a mechanical engineer, a career that he associated with being a mechanic. He plans on opening up a mechanic shop on his mother’s land and working with his family. After high school, Darius wants to first go into the Air Force, next go into a two year technical program, and then get experience working at another auto shop before opening his own. He has defined a clear path to his future work life. He is good at math, and has a lot of experience with working on cars with his immediate and extended family. His conception of a future self is somewhat developed, as he thinks about his proximal and distant college and career choices. His parents support his career plans, but his relationships with peers and teachers, as well as his negative opinions about his low-achieving rural school likely negatively impact his full recognition in STEM.

Elle also has a clear understanding of her skills, her educational path, and her intended career. She wants to be an elementary English teacher, demonstrating a misconception that elementary teachers have an option of majoring in English and/or teach mostly English. Elle is academically advanced in all subjects and presently has many
interests that relate to her career goals including reading and writing. She is recognized by peers, teachers, and family as being smart and capable of great things. Elle recognizes herself as different from her peers because she is a minority (white) in a predominately African American school. Elle’s conception of her future self is the most developed of the four students, as it provides examples of how her present skills relate to her future work, and portrays a clear path of how she plans to reach her goal.

Mariah presently wants to be a veterinarian but admits that her career goals change frequently. She would like to go to early college and then transfer to a university but she does not want to be far away from home. Mariah’s conception of a future self is the least developed of the four students. Her experiences and strengths do not align with becoming a veterinarian, but she is recognized by her family and small peer group as being able to achieve anything that she puts her mind to doing. Mariah believes that African Americans have to work harder than white students to achieve their goals, a view shaped by her role models, her grandmother and her teachers.

Theresa wants to be a pathologist because she recently had an experience with a pathologist in an out of school program. Although this is not a firm career goal compared to those of Darius and Elle, who provide accounts of present experiences that relate to their future career, her STEM career selections indicate that she is interested in a medical field. Theresa wants to go to a four year college and graduate school, and provided specifics of her path from her middle school self to this successful future self. She feels supported by peers and mentors in an out of school STEM program and identified another supportive network in cultural activities with fellow Native American peers and family members.
STEM Identities

**STEM academic and career competence.** The students in this study all earned good grades in science and math, and were confident using technology. One barrier that all four students talked about during their interviews was disruptive behavior in their classes. These students specifically identify males as the students who tend to play around with friends during class and who care less about school achievement.

Ohkee Lee (1995) suggests that when middle school students are not engaged in the curriculum they may become bored, get easily distracted, and impede the learning of other students. Her recommendation relates to a barrier (an aspect of the SCCT) that students identified in their experiences, a teacher’s inability to make complex topics understandable to them (i.e. poor pedagogy). These concerns were raised by all of the students in this study: Darius identified a time when he corrected his math teacher during class; Elle said that she got an *easy A* last year for doing nothing; Mariah liked last year’s math class better because her teacher explained concepts more clearly; and Theresa thought last year’s math teacher made concepts too difficult.

Another consistent perception held by these students, similar to findings in the literature (Capobianco, Diefes-Dux, Mena, & Weller, 2011), is that engineers primarily fix industrial machines and work on cars. Darius does not appear to have a full understanding of the job of a mechanical engineer, believing it to be preparation for running a mechanic shop. He also seems to be unaware of the education needed to become a mechanical engineer. Likewise, the vague responses of Mariah and Theresa about their educational course to become (respectively) a veterinarian and a pathologist, suggest that these students need more
information about educational options and its relationship to career goals. This is highlighted when Theresa talks about knowing a Native American engineer who works on cars. Or when Darius talks about his desire to become a mechanical engineer, owning his own shop and working on cars, bikes, and machines. He shared that he wants to go to a technical institute, obtain a two-year degree, and gain experience working for someone else. Two of the three females cannot give examples of ever doing something they define as engineering. This suggests a need for teachers to make explicit ties to engineering careers and real world applications when they ask students to use critical thinking to solve problems, draw designs, create models, and modify structures in their classes (Rennie, Venville, & Wallace, 2012).

**Performance.** Three of the four students want to pursue STEM careers, and three of the four students had supportive experiences outside of the classroom setting. For example, Theresa was involved in STEM extracurricular activities, where she engages with peers within her school as well as peers in other rural schools that are also underrepresented minorities. Therefore, she has a strong supportive network in an out of school setting that she can relate to and where she can build mastery in social settings that encourage self-efficacy (Bandura, 1986). Darius talked about many experiences with his father, uncle, and cousin that have fueled a deep passion for working on cars. He vividly described different experiences while working on cars, and uses formal vocabulary in the career (i.e. torque, clutch, compression). Elle talked about her passion for reading and writing, which she looks forward to continuing as she pursues a career as an English teacher. Although Mariah described an interest in pets, she did not provide examples of engaging in the processes of a veterinarian.
Findings from career studies encourage students to seek aid from parents, teachers, and counselors in career planning and selecting courses from year to year (Sciara, 2010). Darius does not identify the strong support of an adult who guides him on a career path. Elle believes that her parents would have some knowledge about this because they are currently in school, and also identified her English teacher, who is likely supplying guidance for her future. Mariah and Theresa indicated that their parents are aware of their goals but did not indicate whether they provided guidance on course selection. Theresa’s mentors in the out of school program encourage enrollment in honors and advanced placement classes. Studies find that when trusted adults support and advocate for students, they feel more confident to take higher level courses related to their career goals (Sciarr).

**Recognition.** Adapted from Carlone and Johnson’s (2007) definition of science recognition, an individual who recognizes herself as a member in STEM can also identify others who recognize her as competent and proficient in STEM. Similar to their findings in which the professionals' perceptions of gender, race, and ethnicity played a significant role in minority female science recognition, these social factors played a role in these four middle school students’ development of a possible STEM self.

Social experiences affect students’ gender and racial identities (Brown, Alabi, Huynh, & Masten, 2011; DeCuir-Gunby, 2009) and affect their perception of who is good at STEM and who typically goes into STEM careers. Darius, Elle, and Theresa saw men when they thought about STEM professionals, even though Theresa plans to pursue a STEM career. This masculine perception associated with STEM is prevalent in the literature (Bouchey & Harter, 2005; Capobianco, Diefes-Dux, Mena, & Weller, 2011; Fralick, Kearn,
Thompson & Lyons, 2009; Thomas & Allen, 2006; Masnick, Valenti, Cox, & Osman, 2010), and therefore is an area that could be addressed by more exposure to diverse STEM professionals.

Students also identified issues of gender and race within their peer and family interactions. All students identified females as being more serious about academics and perceived teachers to inherently understand that females are more likely to succeed. Darius described a personal experience of a teacher forming early inaccurate opinions of him, and believes that she is racist. Theresa and Mariah brought up similar instances when they perceived themselves to be ignored by teachers, with reasons such as teachers deferring to the white students in class for answers, or the teacher being focused on the disruptive behavior of male students, and not having time to teach students who have a desire to learn the material. Mariah provided an account of her African American teacher explaining why people think that white people are smarter than black people. These feelings of racism identified by Darius, Mariah, and Theresa are similar to descriptions by other students and reinforce suggestions by Alliman-Vrissett and Turner (2010) that perceptions of racism be included as a factor in studies that examine the development of math/science interests among African American middle school adolescents. This study suggests that this is also the case with careers in technology and engineering, and that these issues need to be addressed.

Racial identity was seen in a variety of ways in students’ interactions with their family members. Darius’ mother told him to “act white”. Several ethnographic studies provide in depth analyses of the burden that African American students have to “act white” in order to succeed in school, describing the societal belief that African Americans do not
value education as much as white people (Cook & Ludwig, 2008). These students demonstrate that this is not the case for them. Student accounts within Cook and Ludwig’s ethnographies suggest that this view is carried into the classroom and teachers are not providing black students with the same educational opportunities as white students. This is certainly felt by the students in this study, even when they are in the majority of the students in a school with a predominantly African American population.

The close ties that students have to their family and their community are closely tied to their worldview (Shih, Miles, Tucker, Zhou, & D'Amico, 2010). Elle’s family will not allow her to associate with African American peers outside of school, specifically forbidding her to date African American males. Although Elle states that she holds no judgments about interracial couples and has friends who are African American, the belief held by her parents that that African Americans are less than Caucasians has been passed down to her (Grogan-Kaylor & Wooley, 2010). Mariah’s nuclear family is diverse and demonstrates love for all different types of people, but she recalls her grandmother saying that historically white people have had more education, and African American’s must work harder to achieve their dreams.

Theresa surrounds herself with other Native Americans, showing a strong understanding and pride of Native culture and practices. She believes that her minority status will provide her with more opportunities for scholarships. She provides no instance of her family perceiving another race as better than another. Gordon, Iwamoto, Ward, Potts, & Boyd (2009) refer to numerous studies finding that a strong racial and ethnic identity is positively associated with academic achievement. Indeed, Theresa is the only student who
believes that she will have no trouble leaving her rural town and pursing the path with the
most opportunities.

Mariah conveys a possible self as a veterinarian in her rural town. She is proud of her
home, attached to her family, and wishes that more successful people would stay in the area
to build a positive reputation of the county. Darius ultimately envisions himself owning a car
and automotive shop in Washington County and working with family members; but he wants
to experience the rest of the world through the Air Force. Elle is not entirely sure of where
she wants to be, but knows that she wants to experience college life, not too far from home.

Through the experiences and visions of possible selves, as well as Carlone and
Johnson’s (2007) model of science identity, a revised model can be developed that represents
these students’ negotiations of a possible STEM identity. These students’ STEM career
identity is a work in progress, with their experiences shaping their competence, performance,
and recognition. Unlike Carlone and Johnson’s model of female scientists, the students in
this study have not developed a career identity, but are negotiating career identities in
practice (Tan & Calabrese Barton, 2008). This means that the intervention and experiences
in middle school science and math are influential in shaping the experiences and identities of
students, leading to the modification of their model to show competence, performance, and
recognition to be of equal importance. These students will continue to participate in the
world, and will gain more experiences that will influence their self-concept and vision of a
future self. Figure 5.4 summarizes the influences affecting the competence, performance,
and recognition of four diverse, eighth grade students from a high poverty middle school in
the southeastern US.
Conclusions and Implications

This study followed four rural middle school students as they explored STEM careers and created STEM career videos. The interviews these students also took part in asked them to construct possible self (Markus & Nurius, 1986) depicted the culture of a high poverty, high minority, rural middle school in the Southeastern United States, and the hurdles this can create for students in STEM. Race and gender played major roles in how students thought about school, and educational and career opportunities. For minority females, race stereotypes negatively influenced their perceived options in STEM, but gender stereotypes were reduced with career exploration featuring diverse role models. For minority males, race stereotypes have been found to negatively influence their perceptions of school expectations.
and success. However, the male student, Darius, still felt capable of achieving his goals, and they fit in a STEM field. Interestingly, poverty was not a factor that was mentioned by the students, suggesting that students are unaware of many of the financial details of college.

The findings of this study corroborate findings in the literature, providing tentative implications for future STEM career interest interventions, and for future research. Findings showed that personal interest was the most important factor when exploring careers, and outcome expectations influenced students’ interest. Students’ limited descriptions of outcome expectations (e.g. a focus on known outcomes such as salary and required education) provide implications for future interventions to focus students’ attention on other outcomes that are not immediately thought about by students, such as the environment of the profession, the social setting and working relationships, and societal impacts of the career.

In-depth analyses of Darius, Elle, Mariah and Theresa found that students were unsure as to the degree of success in courses that would be required for access to careers, and none discussed expenses related to the costs of attending college. The ACT (2005) recommends interventions that develop students’ understandings of the importance of course selections in high school. Clearly, this needs to be addressed to help students prepare for careers. Also, students held inaccurate conceptions of what is done in STEM; specifically, in engineering. Elle associated all difficult STEM jobs with males, and the other students only had experienced male engineers, in the community. This implies that students need to be provided with alternative images of STEM professionals, such as those that include minorities and women (e.g. stemcareerawareness.wikispaces.com). Given that there are no
engineering courses at the middle school, this also suggests the need for more information about careers in this STEM area.

All students identified a role model that either shared similar interests to them (such as Elle and her English teacher), or was close to their age, making them more relatable (Darius and his cousin Marcus, and Theresa and her god sister in college). Mariah mentioned during her interview that she would like to experience what college was really like. This implies that college students could be ideal role models for middle school students because they have had recent experiences with high school, course selections, and decisions about their major.
CHAPTER SIX: CONCLUSIONS

The shortage of STEM professionals and the racial/gender inequity within STEM careers has led policy makers to mandate initiatives intended to recruit women and minorities into STEM fields (Association for the Advancement of Science; AAAS, 2012; White House Office of Science and Technology Policy, 2012), emphasizing the role of K-12 educators to begin this recruitment, and finding ways to interest students in STEM (National Science Foundation; NSF, 2012). Educational organizations identify late elementary and middle school as a time to encourage STEM career interventions that encourage this interest, allowing students to see the diverse opportunities available in STEM (ACT, 2011). Previous research has suggested that many students lose interest in STEM by the time they reach high school (VanLeuvan, 2007), and that many students who are interested in STEM courses cannot see themselves as STEM professionals (Kitts, 2009). Few studies have measured the impact of STEM interventions at the middle school level (Tyler-Wood, Knesek, & Christenson, 2010), and scant research has investigated the effects of in-school STEM interventions on the interests of rural, minority, middle school students (Elam, Donham, & Solomon, 2012).

This dissertation investigated students from a rural, high poverty middle school in the southeastern US. Four eighth grade students who represented a broad range of racial/ethnic backgrounds were studied over a one semester intervention to gain an understanding of changes in their STEM interest and how they negotiated a career identity in the context of STEM. In this chapter, the conclusions from the Chapters 4 and 5 will be summarized. Then, the implications of this dissertation study will be presented.
Finally, the theoretical frameworks used in the study will be analyzed in terms of their utility in understanding the population studied.

**Summary of Conclusions**

The findings from this study (Chapters 4 and 5) may inform future researchers as to the most salient aspects influencing students’ career goals in these settings and how students are thinking about STEM careers in the context of who they are.

The first major finding was that most students began exploring STEM careers based on their current recreational interests.

Second, student interest continued to guide career explorations throughout the intervention, but by the end of the intervention, positive outcome expectations were equally as important to interest (e.g. salary, education requirements, impacts that the career can make on others).

The third finding was that when students engaged in a class discussion on the possible positive outcomes of a career, their justifications for selecting careers to explore became more sophisticated (e.g. they documented outcomes of physical and mental processes that would be able to do in STEM).

Fourth, students held stereotypical views about the types of people that work in STEM careers (e.g. engineering was a job for men) and the responsibilities help in STEM professions, particularly engineering (e.g. engineering is the same as a job in mechanics or in construction) in STEM career; this was based on their experiences outside of school).
The fifth finding showed that self-efficacy was higher in females with regards to science and science careers, and interviews suggested that many male students conveyed apathy toward school to fit in with their friends.

Sixth, students’ learning experiences, particularly in real-world contexts, shaped their vision of a possible future self; the more involved students were in activities related to their career interests, the more articulate they were about how they were going attain future goals.

The seventh finding was that students do not fully understand the variety of responsibilities within a career, nor do they show a clear understanding of the academic pathway needed to obtain STEM careers.

Eighth, negative social experiences with family, teachers, and mentors influenced students’ competence (i.e. self-efficacy) in STEM, their desire to perform in STEM, and their recognition in STEM, particularly experiences that dealt with racial stereotypes.

The ninth finding was that students described their role models as people who shared their interests and were relatable (i.e. young enough to understand their experiences).

Finally, students’ increased engagement in the STEM career intervention led to an increased awareness of types of STEM careers (i.e. students could only recall 10 STEM careers prior to the intervention, whereas afterwards could name 76.)

**Implications**

This dissertation study focused on 85 students, four of whom were studied in depth. Participants in this study were from four classes of eighth graders in a rural, high poverty middle school; the four students who were closely analyzed were representative of the broad
diversity present in those classes. It is not possible to generalize the findings of this study to a larger population. However, because of the multiple data sources used, the extended engagement of the researcher with the students, and the purposeful selection of a diverse group of students for the case studies, it is possible that the findings may lend insight into important factors surrounding the STEM career interests and identities of students. Therefore, based on the findings of this study, we tentatively offer implications that may provide productive insights for future STEM career interest interventions and for future research.

Based on the findings demonstrating that students increased their awareness of STEM careers, and selected careers to explore based on personal interest and outcome expectations, it can be implied that this intervention was a good starting point. Given the increased level of depth as the weeks of the intervention elapsed, it seems likely that more extensive career explorations are preferable to shorter term experiences. Deeper explorations into preferred careers might help students to gain greater understandings of the requirements for obtaining the career, and how this fits with their own skills and visions of a future self. Although, middle school students may not be ready to commit to a career (Orthner, Jones-Sanpei, Akos, & Rose, 2013), Perry, Liu, & Pabian (2010) found that middle school students with greater exposure to career exploration and career planning made them significantly more likely to be engaged in their education.

Students began their career explorations by selecting a limited number of overall careers in which they were familiar. Interestingly, although the selections of STEM careers diversified during explorations, many students filmed each other in careers with which they
were familiar prior to the explorations. This implies that creating one video is likely not enough, just as the initial career explorations were not enough to engage students fully in their skill set and interests regarding career choice. Additionally, students may benefit from being immersed in the real-life, hands-on practices of STEM careers. While students engage in STEM, it may also be beneficial for practitioners to make explicit connections between the processes in which the students are engaging, and how they relate to real-world professions and professionals, particularly when students are performing aspects of engineering during classwork or laboratories, such as open ended problem solving (Next Generation Science Standards, 2013).

Second, this study found that all four students featured in the case studies (Chapter Five) recognized a role model and identified experiences that they took part of outside of the classroom that related to their career of interest. These findings suggest that college students could be ideal role models for middle school students, because they are closer in age and more relatable (identified as significantly influencing interest in careers on the STEM-CIS; I feel comfortable talking to people in science, mathematics, and technology), encouraging students to ask them about how their experiences before college led to academic and career decisions in college. As well as providing students with relatable role models, this study suggests that students are better able to recall learning experiences that are closely related to their lives and their society. For example, it may be beneficial to use cars or bicycles as a basis for a laboratory or have a involve discussions of animals of laboratories simulating the way veterinarians diagnose health problems in animals. Alternately, it is clear that many
students have had relevant experiences related to STEM; eliciting these could be a productive way of connecting classroom topics to students’ lives.

Third, in this study, students shared some of the same negative stereotypes of STEM professionals as others have found (Fralick et al., 2008; Masnik et al., 2010), implying that students need to be provided with alternative images of STEM professionals, such as those that include minorities and women (e.g. stemcareerawareness.wikispaces.com). Findings suggest that these rural students may only have had exposure to male engineers (Darius, Elle, and Theresa) and white STEM professionals (Darius, Elle, and Mariah) outside of school. This implies that a concerted effort must be made to connect students to diverse STEM professions, preferably at the local level, such as holding a STEM career day and hosting the local agricultural extension agent, a pharmacist, a farmer, and/or someone from the local energy company, which has been done effectively with this and similar schools (Blanchard et al., 2012).

Fourth, this study highlighted the potentially negative impact of school experiences on STEM subject interest. Negative class experiences, long lectures, lack of understanding of class material due to poor pedagogical approaches, disruptive classroom behavior, and most significantly, being ignored by teachers, all contributed to negative impressions of school and STEM subjects. This implies the need for culturally appropriate pedagogy that engages students through STEM processes, perhaps through teacher professional development, supporting findings by Lee (1995) at the middle school level.
The Utility of the SCCT in Understanding Student Interest

Through quantitative and qualitative methods, two theoretical frameworks were applied to better understand how students develop interest in STEM careers and how students negotiate a STEM identity and a possible self in STEM. These frameworks were Lent, Brown, & Hackett’s (1994) social cognitive career theory (SCCT) and Carlone and Johnson’s (2007) model of science identity. In this section, these frameworks will be examined to evaluate their utility for use with the students in this study.

Lent, Brown and Hackett (1994) pose a list of hypotheses and an illustrative and predictive model for researchers to utilize as a means to predict academic and career-related interests:

- Interest is dependent on an individual’s self-efficacy beliefs and outcome expectations;
- Career/academic ability is related to interest and mediated by self-efficacy;
- Self-efficacy beliefs are developed through mastery learning experiences, seeing others successfully perform tasks, social persuasion and emotional reactions to educational/career related activities; and,
- Gender, race and ethnicity create differences in educational and career opportunities and affordances that have a large impact on interest and choice goals.

The analyses for this study were organized around the aspects of the SCCT model of Lent, Brown and Hackett (1994), and ultimately, the findings were compared to their published results. The vocabulary from their SCCT model was used to develop a priori codes (Saldana, 2009) to classify students’ written responses on their STEM Career
Exploration Sheets (Appendix B) and their STEM Career Video Planning Sheet (Appendix C). This method was used in response to calls in the literature to operationalize the aspects of the SCCT for different populations, leading to it being used as a coding mechanism in this study to identify how students create their own definitions of these aspects (Lent, Lopez, Lopez, & Sheu, 2008).

Students’ responses fit readily into the coding categories of self-efficacy, outcome expectations, interests, goals, learning experiences, and personal dispositions, and easily were coded as positively or negatively relating to these aspects. There were few responses that could not be coded using SCCT factors, suggesting that this framework was fruitful in categorizing relevant aspects related to students’ STEM career interest. The main limitation of the use of the SCCT model for the student data did not deal with the model itself, but in the sometimes limited responses given by students, or those responses that could reasonably be placed in more than one category. For instance, one female student stated that her artistic abilities would allow her to be creative in a career as a graphic designer. This student believed that she was able to do a job because she is artistic (coded as self-efficacy); however, in saying that one is artistic, this could also be related to a personal disposition. In such cases, students’ responses were either placed in more than one category or interpreted based on the other information provided in the response.

**Assessing the use of the STEM Career Interest Survey**

The SCCT also was used to design the STEM-CIS (Kier et al., in review). Its use was helpful in finding which factors led to students’ career goals and outcomes (Chapter 4). The
intention was that the STEM-CIS would work in a complimentary way with the coding of the students’ career sheets, using the factors of the SCCT. In fact, this was the case. The STEM-CIS was able to quantify important factors of the SCCT (student interest and self-efficacy) in ways that were complimentary to the responses given by students as they explored careers and responded to what they thought about the careers. The STEM-CIS results were able to show differences by gender, infer causation, and compare means between the presurvey and the post survey. Thus, the STEM-CIS results enhanced our understanding of trends in all of the students, and the career exploration sheets using SCCT factors as codes allowed the students to express in their own words how they felt about careers, and thus operationalize those terms.

Examining the use of a STEM Identities Framework and Possible Selves

Identity theory was used to complement the use of the Social Cognitive Career Theory, and to generate a better understanding of the personal inputs that students think about, including gender and ethnicity. Heeding Carlone and Johnson’s (2007) call, “We need a better understanding of how students develop science identities” (p. 1190), we applied their identity theory to middle school students. Four students of diverse race and ethnicity, interests, and goals were selected to be interviewed about their experiences in school and out of school, and how these experiences and the social roles and memberships within them contributed to their development of a STEM career identity. In addition, Markus and Nurius’ (1986) description of possible selves theory was applied to interview data to better understand how students project a positive or negative image of their future self.
Identity theory dovetailed well with possible selves’ theory, and in combination with findings from data coded using SCCT factors, gave a much more rounded picture of the four individuals in the case studies (Darius, Elle, Mariah, and Theresa) than were understood without those frameworks. Competence corresponded to the SCCT factors of self-efficacy and added the aspect of a plan for a career path, and the degree to which this path was envisioned. Performance related to the SCCT factors of contextual supports and barriers and learning experiences, but additionally highlighted the extent to which an individual had experiences related to career choice. Recognition related to background and context, giving insight into the culture of their rural home lives and family values. Using possible selves’ theory, past highlighted the learning experiences that led to students’ career interests, present indicated their current experiences involving these interests, and future referred to a path from their interest to their goals. In these ways, these additional theoretical constructs gave holistic views of the individuals highlighting gaps in career understanding and thus helping to highlight potential conclusions and implications that would not likely have come to light without these frameworks. While multiple influences on career interest and choice are highlighted by the SCCT, the implications from the STEM identity model confer with Witz’ (2000) suggestion that identity theory allows a better understanding of the difficulties that many student have when participating and making meaning of the world.
REFERENCES


Aschbacher, P. R., Li, E., & Roth, E. J. (2010). Is science me? High school students' identities, participation and aspirations in science, engineering, and medicine. *Journal of Research in Science Teaching, 47*(5), 564-582.


Appendix A: STEM Career Interest Survey (STEM-CIS)

(Science, Mathematics, and Technology Subscales)

Directions: Students will complete the STEM-CIS online via an iPod Touch® or computers.

Each question is Likert scale with the following choices: Strongly Agree, Agree, Neither agree nor disagree, Disagree, Strongly Disagree

Science

1. I am able to get a good grade in my science class.

2. I am able to complete my science homework.

3. I plan to use science in my future career.

4. I will work hard in my science classes.

5. If I do well in science classes, it will help me in my future career.

6. My parents would like it if I choose a science career.

7. I am interested in careers that use science.

8. I like my science class.

9. I have a role model in a science career.

10. I would feel comfortable talking to people who work in science careers.

11. I know of someone in my family who uses science in their career.

Math

12. I am able to get a good grade in my math class.

13. I am able to complete my math homework.


15. I will work hard in my math classes.
16. If I do well in math classes, it will help me in my future career.

17. My parents would like it if I choose a math career.

18. I am interested in careers that use math.

19. I like my math class.

20. I have a role model in a math career.

21. I would feel comfortable talking to people who work in math careers.

22. I know someone in my family who uses math in their career.

Technology

23. I am able to use technology to complete my homework.

24. I am able to learn new technologies.

25. I plan to use technology in my future career.

26. I will learn about new technologies that will help me with school.

27. If I learn a lot about technology, I will be able to do lots of different types of careers.

28. When I use technology in school, I am able to get better grades.

29. I like to use technology for class work.

30. I am interested in careers that use technology.

31. I have a role model who uses technology in their career.

32. I would feel comfortable talking to people who work in technology careers.

33. I know of someone in my family who uses technology in their career.
Appendix B: STEM Career Video Exploration Sheet

1. Career Video Being watched: _________________________________

2. Which person was interested in this particular video that you are watching?

____________________________________________________________________

3. Why did you decide to watch this career video?

____________________________________________________________________

4. What are at least three daily activities in this career?

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

5. What is the median salary in this career?

____________________________________________________________________

6. What are the educational requirements for this job?

____________________________________________________________________
7. What are 3 things that you like about this career?

____________________________________________________________

____________________________________________________________

____________________________________________________________

8. What are 3 things that you did not like about this career?

____________________________________________________________

____________________________________________________________

____________________________________________________________

9. After watching this career video, could you see yourself in the career?

Why/why not?

____________________________________________________________

____________________________________________________________

____________________________________________________________

____________________________________________________________

____________________________________________________________
Appendix C: STEM Career Video Planning Sheet

1. What is/are your favorite class (es)? Why? How can you use things you learned from this class in a future STEM career?

2. Are you involved in any clubs/sports/activities outside of school? Do any of these involve science, technology, engineering, or math? Could you use any of these things in your STEM career?

3. What types of things do you do at home? Would you be able to do any of these things in a future STEM job (For example: Use the computer, talk on the phone, play video games, take care of your siblings)?

4. For my STEM career video, I would like to be:

5. I decided to go into this career because (3-5 reasons):

6. Why do you think that you will be good in this job?

7. What will your parents say when you tell them that you get this job?
8. Do you every spend time outside of your job with the people that you work with? Are they fun?

9. Where is your job located? City? State? Why do you want your job to be in this location?

10. How many years did you have to go to school? What degree (s) did you have to get? What did you major in?

11. Tell me about what kinds of things that I would see in your place of work? Are there lots of people? What technology would I find?

12. What do you usually wear to work?

13. Tell me what you do each day? Is it the same most days? If you do many different things, describe them.

14. How much money did you start making when you came out of school? How much money do you make now? What do you spend your money on?

15. What are some things that you need to make your video?
16. Who is going to star in it?

17. In 5 years, would you like to stay in this career or do something else? Describe.

18. My parent or guardian would be happy if I chose to marry someone who works as a:

______________________________________________________________

Why? _________________________________________________________
Appendix D: STEM Career Identity Student Interview Protocol

Adapted from 8th Grade Science Identity Protocol with permission from Pam Aschbacher

ALL BOLD STATEMENTS AND QUESTIONS (NUMBERED) ON THE PROTOCOL WILL BE ASKED. PROBES WILL BE ASKED AS NEEDED. EVERY PROBE WILL NOT BE ASKED, ONLY THOSE THAT MAKE SENSE OVER THE COURSE OF THE CONVERSATION AND WOULD ENRICH THE UNDERSTANDING OF THE STUDENT’S EXPERIENCES.

I. INTRODUCTION

ESTIMATED TIME: Less than 5 minutes

Thank you for agreeing to talk with me today! I would like to know more about what you have been thinking as you watched these videos about careers and want to tape-record this conversation so I can focus on what you have to say without having to write everything down, but I will turn off the tape-recorder at any time you wish.

TURN TAPE RECORDER ON.

There are no right answers—I am interested in all of your thoughts and experiences and I won’t tell anyone else about your answers.

Before we begin, do you have any questions for me?

II. ACADEMIC AND EXTRACURRICULAR BACKGROUND

ESTIMATED TIME: (Less than) 5 minutes

1. Let’s start with your typical school day. Which classes are you taking this year?

2. Which is your favorite class? What about it do you really like?

3. Which is your least favorite class? What about it do you not like?
4. Now I’d like to get a sense of what you do outside of school. Can you tell me a little bit about how you spend your time when you are not at school and which kinds of things you are involved in?

Probes:
- Are you involved in clubs, groups, or sports teams after school? Which ones?
- How long have you been involved in these activities? Are these activities different from last year? What got you interested in these activities (e.g. did your parents sign you up for these activities)?
- Which groups or activities do you like best? Why?
- What do you do in the evenings and on weekends? Do homework? Do chores? Hang out with your friends? Talk on the phone?
- What do you do for fun, to relax and get your mind off things?

II. MATH, SCIENCE, TECHNOLOGY, AND ENGINEERING BIOGRAPHY

(ESTIMATED TIME: 10-15 minutes)

5. (a) Which math class are you taking this year?

(b) How do you feel about your math class this year?

(c) How have your feelings about math changed since you were in elementary school?

(d) Why have your feelings changed?

Probes:
- How do you feel about your math teacher? How do you feel about your math homework assignments?
- Do you like doing math generally, when you are not in class, just on your own?
-How do your family members and friends feel about math?

-If you could take an easier or harder math class, which one would you choose? Why?

-Is math important to you (to your goals for high school, college, after college)?

-Is math important to the science classes that you would like to take in high school?

6.  (a) How would you describe your science class experiences this year?

(b) How do you feel about your science class this year?

(c) How have your feelings about science class changed from last year?

(d) Why have your feelings changed?

Probes:

-How would you describe your science teacher this year?

-Which kinds of things are you learning?

-Do you enjoy your science class? What about your science class do you really like or really dislike?

-Do you feel like you are doing well in your science class this year?

-Are the things that you are doing in science class more or less important to your future goals this year as compared to last year? Why? How?

-Did other subjects become a lot more interesting to you this year?

Which ones? What got you interested in these other subjects?

7. (a) Have you had any experiences with technology in your classes?

(b) How do you feel about using technology in your classes?

(c) Have your feelings changed about using technology in your classes from last year?

(d) Why have your feelings changed?
Probes:

-How have some of your teachers used technology in their classes?

-Which kinds of technology are you learning how to use?

-Do you enjoy your using technology in your classes? What about your using technology do you really like or really dislike?

-Do you feel like you do better in classes that you can use technology in your classes? Why?

-Are the types of technology that you are using this year that are things that you are more or less important to your future goals this year as compared to last year? Why? How?

8. (a) What do you know about engineering, or what engineers do?

(b) Can you think of a time in middle school that you have used engineering?

(b) Could you imagine having a job in engineering one day?

Probes:

-What kind of engineer would you be? Why would you choose this?

-Which kind of engineering-type things do you enjoy doing?

-How did you find out about this kind of career, or engineering generally?

-What or who got you interested in this career? (friends, parent, school activities or clubs, etc.)

-Are any of your friends or family members interested in engineering? Do you talk about engineering with them?

9. (a) How about your involvement in Science, Technology, Engineering or Math activities outside of school? Which kinds of things are you doing this year?
(b) Are you involved in any new science, technology, engineering or math activities this year as compared to last year? Which ones?

(c) How do you feel about these activities?

(d) How have your feelings about these activities changed from last year?

(e) Why have your feelings changed?

Probes:

- Whom do you do these activities with? (friends, family, youth groups, alone, etc.)
- What got you interested in these activities?
- Are these science activities more or less important to your future goals this year as compared to last year? Why? How?

10. (a) Can you think of any experiences that you’ve had in school that made you think you could be in a STEM career like the careers of some of the people in the videos you watched? Can you tell me about that experience?

[If student can’t think of an experience] Can you think of any experiences that you’ve had in school that made you think you could not be in a STEM career? Can you tell me about that experience?

(b) Can you think of (and tell me a story about) an experience outside of school (maybe at home, or with friends) that made you think you could be in a career that STEM?

[If student can’t think of an experience] Can you think of any experiences that you’ve had outside of school that made you think you could not be in a career using STEM? Can you tell me about that experience?
III. PERCEPTIONS OF STEM CAREERS AND STEM PROFESSIONALS

ESTIMATED TIME: 5 minutes

11. In your opinion, what sort of people work STEM careers? Which kinds of personal characteristics make people more or less likely to go into these careers?

Probes:

- Do you think some people are born to be in STEM careers, or that anyone can be in STEM careers? Why?
- What kind of training do people need to have in order to work in a career that uses STEM? What do people have to do after high school in order to work in these careers?
- How did you learn about working in STEM careers? How did you come to know that people in STEM careers have to do [x] as part of their training?

12. (a) [For students who are not interested in STEM careers, I can prefacing this question with something like “I know you’re not interested in STEM, but…”] Could you imagine having a job that uses STEM one day? (You might need to break this down like “a career where you use some technology. Or one where you have to figure out a math problem, like dealing with money or ordering things that cost money, etc.”)[If student is firm that s/he cannot imagine having any job that involves STEM] If you are not doing something related to STEM, what would you like to do? What do you dream about doing one day?

Probes:

- What sort of STEM job would you have? Why would you be in this type of job?
- What do you imagine yourself doing as a [x]? Which kinds of projects would you work on?
-How did you learn about this kind of job? Can you tell me a little bit about when you first got interested in this job?

-Have you talked to different people about having this job? Whom have you talked to?

What do you talk about?

(b) [For students who can imagine a science-related job] Which characteristics of being in a STEM career make this job seem like something you could do? [For students who can't imagine a STEM related job] Which characteristics of being in a STEM career make it seem like something you couldn’t do?

Probes:

-What types of STEM careers seem like you?

[Alternately: What about STEM doesn’t seem like you?]

[If possible, have student explore which parts of him/herself are like/unlike people in STEM care, rather than which parts of science are like/unlike student…good segue into next section (card sort)]

IV. SENSE OF SELF

ESTIMATED TIME: 10-15 minutes

13. (a) Now we’re going to do something a little different. I’m interested in getting to know a little about you and your classmates as people, as well as their interests, so we are going to do an exercise called a card sort. I have 20 index cards that have descriptive words printed on them.

(At this point: Deal the cards out on the table and read them as you go. Point to each card as you read it.)
The cards contained in the cart sort are: opinionated, competitive, observant, persistent, hardworking, social, rebellious, caring, responsible, loud, lazy, honest, creative, crazy, shy, assertive, smart, talented, curious, and confident.

Now, I would like you to choose the five cards with words that best describe you. It can be any five, you don’t need to think about it too long, just pick the ones that best describe you as you think about yourself.

(Give student a chance to pick five cards, if s/he asks about a word, you can define it in a casual way. Keep the tape recorder on.)

OK. So you have chosen X, X, X, X, and X. (Read aloud so the chosen cards will be in the transcript.)

Great. Now let’s talk a little about the words you have chosen, and how that helps describe you as a person. Which of these words do you think MOST describes you? Which is your favorite?

Probes:
-What does it mean to be [x]?
-Can you give me an example of a time when you were [x]?
-Can you tell me a story about a time when you felt like you were [x]? [If time, continue this probing with each of the characteristics; if short on time, focus on those that seem most provocative, contradictory, and/or representative]
-Do you think your family and friends would describe you in the same way that you describe yourself?
What are your strengths, or the things you are good at [in school and outside of school]? What are some of the things that you think you are not very good at?

Do you think of yourself as being pretty different from your friends or other students at this school? Or pretty much the same? How? In which ways?

14. (a) Now I would like to ask you some questions about what it means to you to be a [male/female] in society. Do you have any feelings about what it means to be a [male/female] in society?

Probes:

- As a [male/female], do you think there are certain ways you are supposed to be or act in society? Which ways?
- How about in your family? How are you supposed to be or act as a [male/female] at home?
- How about in school? How are you supposed to be or act as a [male/female] in school?
- How are these ways the same as or different from how [the opposite sex] are supposed to be?
- What do you think about the choices and opportunities available to you as a [male/female]?

Are these the same as or different from the choices or opportunities available to [the opposite sex]? How?

Why?

15. (a) You might remember that we asked you about your ethnic background on the STEM career interest survey that you took at the beginning of the semester. Now I would like to talk to you a little bit more about that here. You marked on the survey that you consider
yourself to be [x]. Do you have any feelings about what it means to be [x] in society? [If multiple backgrounds, ask about each]

Probes:
- [If multiple backgrounds] Which background do you consider yourself to be most? Why do you feel this way?
- Is your ethnic background important to your family? How?
- As a [x] person in society, do you think that there are certain opportunities or choices available to you and not to others? Or do you think that your choices or opportunities are mostly the same as others? How are these choices and opportunities the same or different?
- As a [x] person in society, do you think that there are certain expectations of you, of your future path and goals? Are these different from or the same as people of other backgrounds? How?

16. Now I would like to ask you about being a [male/female] and being [x(student’s ethnic background)]. Do you have any feelings about what it means to be [x male/female] in society? [If multiple backgrounds, ask about each]

Probes:
- In your opinion, how is this different from being an [x opposite sex] in society? Do you think that the choices and opportunities are the same or different? How?
- Do you think that expectations of you in your family are different from expectations of [x opposite sex][especially relevant if student has opposite sex sibling]? How? Why?
17. (a) Okay, now let’s think about all of this in relation to STEM. How does being a [x] [male/female] relate to your experiences in your science, math or technology classes? How does being a [x] [male/female] relate to the career that you would like to go in to?

Probes:
-Do you think that your experiences in your science, technology and math class are different from other students’ experiences because of who you are or what your background is? How?
-Do you think this is true of other classes too, or just science? How?
-Do you feel like your ideas in science class are respected by your teacher? By your classmates? How or how not? [have student give concrete examples of respect or disrespect] Do you think this is true of all students in your class? Why or why not?
-When you have an idea or question in class, do you feel like your science teacher and your classmates listen to what you have to say? Do you think that this is true of all students in your class? How?
-Is there anything about your science class—the way it is taught, or the topics you study, or the requirements, or the other students in your class—that does feel “right” or comfortable to you, or that does not seem like it’s related to your life as a [x] [male/female]? Is this true of just your science class, or other classes too?

(b) How does being a [x] [male/female] affect or shape how you think about being in a STEM career?

PROBES:
-Do you think there are different opportunities available to you in STEM jobs or careers because you are an [x] [male/female], compared to other students? Which kinds of different
opportunities? How do you know these things? Do you talk to family/friends about these things?

-How do you think being a [x] [male/female] would affect you being in a STEM job? Would you do your job differently? [reference students’ comments from “perceptions of science” section] [focus on students’ gender and racial/ethnic identity here…how would being an African American female, for example, mean that students ask different kinds of questions than males, either African American or not?]10

V. ROLE OF PARENTS, EXTENDED FAMILY, PEERS AND RURAL PLACE

ESTIMATED TIME: 5-10 minutes

18. (a) What do your family members [whomever student lives at home with] expect from you in middle school and high school? How do you know they expect these things from you?

(b) What do your family members expect from you in the future, after high school? What do they think you should do? How do you know they expect these things from you?

Probes:

-Do they have strong feelings about classes that you should or should not take, either now or in high school? What are their feelings? Did they go to college? What do they do now?

-Do your parents ever talk to you about going to college? Which kinds of things do they say? How do they feel about college? Where would they want you to go? What would they want you to major in? Why?
-Do you talk to your parents about jobs or careers? Which kinds of careers do you talk about with them? Do they give you advice?

What do they say?

-What would you say is most important in terms of what your parents want for you and your future?

-What do your parents worry most about you?

19. (a) Now let’s talk a little bit about your friends this year. Do you have different friends this year than you did last year, or are they pretty much the same?

[If different] Why did your friendship group change? What attracted you to your new friends?

[If same] How have the things that you do with your friends changed from last year to this year? Are there other ways that your friendships have changed since last year?

Probes:

-What types of characteristics make someone your close or best friends?

-What are your closest friends like? How would you describe their personalities? What are they interested in?

-Which kinds of things do you have in common with them? Do you like to do the same activities? Which kinds of activities? Do you have the same sense of humor? Do you share similar opinions? Which opinions?
20. (a) Do you and your good friends have the same opinions about STEM, or different opinions? How do they feel about these subjects and careers? Do they enjoy these types of classes? Do they do well in them?

Probes:
- Are any of your good friends in science, technology, engineering or math?
  Is that important to you?

- Do you talk these subjects with your friends? Which kinds of things do you talk about?

21. (a) At this school, what are students’ reactions to people who get really good grades in science and math? What are students’ reactions to people who get really bad grades in science and math?

(b) How do you feel when other students find out what your grades are in school?

Probes:
- Do you and your good friends share your grades with each other? Do you help each other with homework? How do you help your good friends? How do they help you?

- Do you think people whom you might like more than just a friend would like you more or less if they knew what your grades were? Why?

- Do you ever feel like you have to keep your grades private? Why?

22. How long have you lived in this area? Do you plan on living here for the rest of your life? [If no] Where would you like to live? Do you think living in a rural area affects your goals and what job you will decide to do? How?

Probes:
- Is your family in a local job that you would like to be a part of? What do they do?
- Do you want to live close to your family?
- Do you think most of your friends will live around here after high school?
- What do most people in this area do for jobs? Do those types of jobs interest you?

III. THE FUTURE:

Estimated time (Less than) 5 minutes

22. (a) Which high school will you go to next fall?
23. (a) Is there a STEM class that you are really looking forward to taking in high school? Which one? Why? What do you know about this class? How do you know about it?
(b) What kinds of things do you know about science in high school generally? How do you know these things?
24. (a) What do you see yourself doing when you’re all finished with high school?

Probes:
- What steps do you need to take to get to be a [x]? Will you have to go to college? What will you study there? Will you need any additional training after college? How did you get interested in this?
- How does your family feel about what you want to do? How about your friends?
- What are some things that might affect what you do? (friends’ choices and plans, financial assistance, etc.)
- Whom do you feel comfortable talking to about your future? Is there someone whom you trust most to give you advice? Who is this person?
25. (a) Can you think of someone who is very influential in your life, or someone whom you really look up to [not a celebrity, but someone student knows]? Who is this person? What is your relationship like with this person? [If a student does not have a role model…] If you had to choose a role model or mentor, what kind of qualities would they have? What would make someone a role model for you?

Probes:

- Which kinds of things do you do with [x]? Which kinds of things do you have in common with [x]?

- Does [x] give you advice about things? Which kinds of advice?

- Do you ever talk about science with [x]? Which science topics do you discuss?

- Why is [x] your role model? Thank you very much for speaking with me today! Do you think there is anything else I should know about your experiences before we wrap up?