THE EFFECT OF VIDEO INTERVIEWS WITH STEM PROFESSIONALS ON STEM-SUBJECT ATTITUDE AND STEM-CAREER INTEREST OF MIDDLE SCHOOL STUDENTS IN CONSERVATIVE PROTESTANT CHRISTIAN SCHOOLS

by

Philip R. Alsup

Liberty University

A Dissertation Presented in Partial Fulfillment

of the Requirements for the Degree

Doctor of Education

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ABSTRACT

Inspiring learners toward career options available in STEM fields (Science, Technology, Engineering, and Mathematics) is important not only for economic development but also for maintaining creative thinking and innovation. Limited amounts of research in STEM education have focused on the population of students enrolled in religious and parochial schools, and given the historic conflict between religion and science, this sector of American education is worthy of examination. The purpose of this quantitative study is to extend Gottfredson's (1981) Theory of Circumscription and Compromise as it relates to occupational aspirations. Bem's (1981) Gender Schema Theory is examined as it relates to the role of gender in career expectations, and Crenshaw's (1989) Intersectionality Theory is included as it pertains to religion as a group identifier. Six professionals in STEM career fields were video recorded while being interviewed about their skills and education as well as positive and negative aspects of their jobs. The interviews were compiled into a 25-minute video for the purpose of increasing understanding of STEM careers among middle school viewers. The research questions asked whether middle school students from conservative, Protestant Christian schools in a Midwest region increased in STEM-subject attitude and STEM-career interest as a result of viewing the video and whether gender interacted with exposure to the video. A quasi-experimental, nonequivalent control groups, pretest/posttest factorial design was employed to evaluate data collected from the *STEM Semantic Survey*. A Two-Way ANCOVA revealed no significant differences in dependent variables from pretest to posttest. Implications of the findings are examined and recommendations for future research are made.

Descriptors: STEM career interest, STEM attitude, STEM gender disparity, Occupational aspirations, Conservative Protestant education

DEDICATION

I dedicate this work to my wife, Danielle, for her steadfast support of my personal and professional goals. She has tirelessly and unselfishly tended to the real business of our life to allow me the freedom to pursue this goal. I will always be in her debt.

I dedicate this work to my parents, Rod and Sherrie Alsup, for their cultivating in me from my childhood the ability and drive to be a life-long learner. I credit any personal successes to their influence and faithfulness as Godly parents.

I dedicate this work my children, Emma, Anna, William, Macy, Micah, and Maggie. May your lives brim with learning about God, His natural world, and His pursuit of your hearts.

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Table of Contents

CHAPTER ONE: INTRODUCTION 8
Introduction 8
Background 9
Problem Statement 16
Purpose Statement 17
Significance of the Study 18
Research Questions 21
Research Hypotheses 20
Null Hypotheses 22
Identification of Variables 23
CHAPTER TWO: LITERATURE REVIEW 25
Conceptual and Theoretical Framework 26
Theory of Circumscription and Compromise 26
Gender Schema Theory 30
Intersectionality Theory 31
Attitudes in STEM 33
Interest in STEM 36
Self-Efficacy and Student Motivation 39
Identity in STEM Careers 41
Gender and STEM Interests 43
STEM Education in Christian Schools 48
Review of Literature 50
Summary 52
CHAPTER THREE: METHODS 54
Design 55
Research Questions and Hypotheses 57
Participants and Setting 59
Instrumentation 63
Procedures 66
Data Analysis 69

CHAPTER FOUR: FINDINGS 72
Research Questions 72
Null Hypotheses 73
Descriptive Statistics 73
Results 77
Results for STEM-Subject Attitude 78
Results for STEM-Career Interest 80
Summary 83
CHAPTER FIVE: DISCUSSION 85
Discussion 85
Findings for Research Questions 1 and 4 87
Findings for Research Questions 2 and 5 89
Findings for Research Questions 3 and 6 90
Conclusions 91
Implications 92
Limitations 94
Recommendations for Future Research 96
REFERENCES 99
Appendix A: STEM Semantics Scale 126
Appendix B: Parent Informed Consent Form 128
Appendix C: Child Assent Form 131
Appendix D: Principal Consent Form 133
Appendix E: IRB Approval Letter 136
Appendix F: Teacher Pretest and Posttest Instructions 137
Appendix G: Script for Video Viewing 139
Appendix H: Author Permission for Use of STEM Semantics Survey 140
Appendix I: Biographical Information for Interviewees 141

List of Tables

Table 3.1: Control and Treatment Group and Size 58
Table 3.2: Composition of Groups by Gender and Grade Level 59
Table 3.3: Age and Grade Demographics of Sample 60
Table 3.4: Racial Demographics of Sample 60
Table 4.1: Composition by Group 73
Table 4.2: Descriptive Statistics for STEM-Subject Attitude Scores 73
Table 4.3: Descriptive Statistics for STEM-Career Interest Scores 74
Table 4.4: Summary of Findings for Research Questions and Null Hypotheses 81

CHAPTER ONE: INTRODUCTION

The prestige of American education among other developed nations of the world is at best tenuous. Several government, non-profit, and educational focus groups, such as the American Council on Education, the National Science Foundation, and the National Action Council for Minorities in Engineering agree that the United States is losing its footing in the global marketplace (Museus, Palmer, Davis, & Maramba, 2011). While the United States may be in danger of losing its edge in global competitiveness, countries such as China and India report significant increases of college graduates in science, technology, engineering, and mathematics (STEM) fields (Wissehr, Concannon, & Barrow, 2011). Advances in STEM research and development abroad are causing many American companies to expand their businesses overseas rather than in the United States (Goldbrunner, Doz, Wilson, & Veldhoen, 2006; Malecki, 2010). While other nations of the world have reported improvement in STEM educational programs and have expanded research and development initiatives, America has been comparatively stagnant in these areas in recent years (National Science Board, 2014). For example, in 2010, the National Science Foundation reported of the top 30 industrialized nations, students in the United States ranked 25th in math achievement and 21st in science achievement (National Science Board, 2010). The World Economic Forum (2009) made a comparable finding when ranking the quality of mathematics and science education in the United States as 48th in the world. Palmer, Davis, Moore, and Hilton (2010) warn that not only educators, but all Americans ought to be concerned with the direction of an education system that is falling behind globally, especially in areas important to innovation and economic success. The last century saw industries in STEM fields secure America's place as a global leader both economically and educationally (National Research Council, 2011). However, if the United States is to maintain, or perhaps regain, that position, there is work to be done to see that goal achieved.

Those charged with reviewing the status of STEM education in the United States call for increases in encouraging secondary students to pursue college degrees and careers in STEM fields (National Research Council, 2010; National Science Foundation, 2014). However, advancing that cause grows increasingly difficult in the current field of K-12 education that is presently experiencing a dearth of STEM-degreed math and science teachers (Office of Postsecondary Education, 2013). While opportunities for employment in STEM fields appear to be growing, there is concern that fewer young adults are interested in pursuing STEM-related careers. For instance, in 2009, more bachelor's degrees in America were awarded in business than in science, technology, engineering, and mathematics combined (National Center for Education Statistics, 2009). An alarming statistic presented by U.S. Department of Education shows that as many as 65% of students who begin a STEM major do not finish within 6 years (National Center for Educational Statistics, 2009). More work is needed to understand why students in the STEM fields are not interested in completing degrees, choosing careers, and entering the workforce as STEM professionals.

Background

The history of the STEM emphasis in the United States can be traced back to the post-World War II era as the national government recognized national research and scientific development had come to a standstill during the war years (Wissehr et al., 2011). A renewed emphasis on revitalizing America's ability to innovate and develop new technologies through scientific research culminated in 1950 with the establishment of the National Science Foundation, charged with distributing federal monies to institutions engaging in scientific research. However, the government's interest in renewing a national focus on science and research did not come only from the fact that these pursuits had diminished during wartime.

Other nations of the world were touting their own technological advances, and no achievement was more public than the launch of the Russian satellite *Sputnik* in 1957. Millions of Americans watched in awe as a foreign, communist power showcased its revolutionary innovations, and many citizens may have wondered what if any response the United States would have, should that technology be used against democracy. Hence, many viewed Russia's space superiority as a national security threat, realizing the potential that now existed for warheads to be delivered from across the globe. The nation quickly began to view science and technology as preservers of democracy, and a movement began to improve STEM education purely for the sake of self-preservation (Hein, 2006).

The launch of *Sputnik* was a stark reminder of America's need to revitalize scholarly scientific research and to increase the rigor of education for young Americans. Ironically, then-senator John F. Kennedy belittled the Russian's rocketry pursuits, suggesting that such investments were a waste of time and money as no legitimate world power was interested in venturing into space (Dickson, 2001). As history shows, Kennedy and other skeptics would come to understand that scientific innovation, regardless of its locus, would become the benchmark of global relevance in the coming years. As a result, science education became imperative as a means to advance society and culture.

The curricular and teaching reforms that took place in the post-*Sputnik* era placed more emphasis on science being taught as a system of thinking relevant to cultural advancement rather than a body of knowledge to be memorized. The National Research Council (2011) in summarizing the changing view of science in the decades since *Sputnik* remarks that "Science, mathematics, engineering, and technology are cultural achievements that reflect people's humanity, power the economy, and constitute fundamental aspects of our lives as citizens, workers, consumers, and parents" (p. 2). Essentially, STEM education should not be viewed as subjects to be learned and used only by those who excel at them but should rather be appreciated in the context of how they improve society and culture. Grover and Pea (2013) believe quality STEM education is valuable because it creates good thinkers who employ observations in rational decision-making. In this context, STEM education does not merely produce workers but well-rounded human beings who improve society and culture. Neither should STEM career paths be reserved just for those with high academic ability, as research shows that intrinsic enjoyment for a task can be a stronger motivator than performance ability alone (Nosek, Greenwald, & Banaji, 2007). If students can develop a connection between interests and related careers, regardless of academic ability, they may be more prone to perceive a STEM career path as a realistic goal.

While interest is a stratified concept, the construct of task value—that interest in an object is sustained long-term when practical relevance is perceived in the short-term—provides context in which to consider impacting student career interests at an early age (Wigfield, Tonks, & Klauda, 2009). Whereas students may normally assume that career paths are chosen based upon academic abilities, perhaps more students could be steered toward STEM careers if task value is taken into consideration.

The National Research Council (2011) proposes that more effort be directed toward developing interests in STEM subjects in Elementary students with the overall goal of encouraging the pursuit of STEM-career paths. Refining these recommendations, the National Academy of Sciences (2011) suggests several goals for American K-12 STEM education based on needs found in current research. Specifically, the National Academy (2011) recommends bolstering confidence and interest for STEM-careers in younger students and developing interventions for encouraging children, especially females, to enter the STEM arena. These initiatives are based in reports that the number of females entering STEM professions is alarmingly stagnant. For example, the National Science Foundation (2014) reports that the percentage of females in the workforce employed in the science and engineering sectors has risen only approximately 5% since 1993. As the fervency to increase the United States' STEM footprint intensifies, so too has the desire among researchers to strengthen students' awareness of STEM career options.

The study of career planning, or occupational aspirations, is clarified through an understanding of Gottfredson's (1981) vocational theory of Circumscription and Compromise, holding that young people advance through stages of development in their awareness of career options. Gottfredson's theory posits that children develop vocational aspirations at a young age but then progress through stages in which they begin to eliminate career interests for various reasons (Gottfredson, 1981). The Theory of Circumscriptions and Compromise suggests that as knowledge and experience develop, children refine their career interests, eliminating some possibilities and clinging to others. As young people age, personal experiences coupled with observations of adults create confidence in certain career paths (DeWitt et al., 2011). Therefore, Gottfredson's (1981) theory relates to the current study in that as young people are exposed to the realities of certain careers, they may tend to remain open to them, allowing more time for their interest in those fields to be strengthened.

Additionally, Bem's (1981) Gender Schema Theory provides insight into the role of gender in this study. Gender Schema Theory supposes that young children develop mental and emotional constructs about personal goals and future occupations based on society's transmission of ideas of masculinity and femininity. The process of *sex typing* causes occupations to be viewed as either masculine or feminine, resulting in notions of gender-appropriate occupations by adolescent children (Bem, 1981). These ideas form at a young age and are malleable to the extent of influencing both males and females to pursue occupations not traditionally considered to be within-gender (Bem, 1985).

Gender is a consideration in most studies of students and deserves attention here, especially as the literature is unified in its identification of wide gender disparity in STEM careers both in the United States and across the globe (Archer et al., 2013; Buse & Bilimoria, 2013; Diekman, Brown, Johnston, & Clark, 2010; Else-Quest, Hyde, & Linn, 2010; Goldman & Penner, 2014; Pearson & Miller, 2012; Rosser & Taylor, 2009). A growing number of studies are also focusing on specific gender identity models to explain these findings (Bruning, Bystydzienski, & Eisenhart, 2012; Hanson, 2013; Kessels, Heyder, Latch, & Hannover, 2014; Ko, Kachchaf, Ong, & Hodari, 2013). Therefore, to advance beyond merely exposing a gender gap in STEM-subject attitude or STEM-career interest, the present research employs Crenshaw's (1989) Intersectionality Theory as a final element of the theoretical framework. Although originally contrived to explain the oppression of black females, Intersectionality Theory has evolved into a basis for understanding how overlapping characteristics—such as gender, race, or political ideology—may cause groups to be marginalized by society. Recent studies in Intersectionality Theory have also analyzed religion as a potential challenge to success in areas such as careers and politics (Arifeen & Gatrell, 2013; Fitzgerald & Glass, 2014; Haq, 2013; Wadsworth, 2011). Given this study's population—middle school students in conservative, Protestant Christian schools—Intersectionality Theory may aid in understanding the conjunction of religion and gender in STEM education. Understanding more about how males and females differ in their perceptions of careers and what factors contribute to or detract from better gender diversity in STEM fields may be of value to educators, policy makers, and parents.

Refining the age in which career choices are solidified is an area of discussion and disharmony in current literature, as authors are mixed in their conclusions about the age when vocational ideas evolve from dreams to serious goals. However, there is agreement among researchers that the age of career decisions is younger than commonly assumed (Bardick, Bernes, Magnussen, & Witco, 2008; Johnson, Ozogul, DiDonato, & Reisslein, 2013; Karatas, Micklos, & Bodner, 2011; Reid, 2011; Watson & McMahon, 2008). Gottfredson (1981) suggests the middle school years are ideal for studying occupational aspirations as students at this age are letting go of childhood dreams and reevaluating the reality of their goals and desires. The role adults play in helping children form career identities is also viewed in research as an important construct of vocational aspirations, and yet the influence of adult models, specifically in relationship to gender, is not fully understood (Redmond, et al., 2011; Sonnert, Sadler, & Michaels, 2013).

No discussion of career interest would be complete without recognizing the role of attitudes toward certain school subjects in the career interest of students. Reid (2011) articulates the opacity in defining attitude and sees interest as intertwined with the concept, even though a clear delineation is not often made. While there remains work to be done in refining those constructs, the literature is clear about the facts that attitude and interest affect career choice and that both can be influenced at an early age (Krogh, & Andersen, 2013; Najafi, Ebrahimitabass, Dehghani, & Rezaei, 2012; Rivera & Schaefer, 2009; Suri, & Sharma, 2013). The current study seeks to broaden understanding of children’s malleability for STEM-career interest, specifically identifying the best age for intervention and the role that gender plays when modeling career options. Students' age, gender, attitudes toward school subjects, and perceptions of adults in certain career paths all contribute to the overall picture of understanding career interest. By studying specific interventions that may encourage students' participation in STEM careers, researchers may gain deeper insight into student career choices generally.

Within the context of science education, research suggests specific sectors of the American population have responded uniquely to science, specifically those groups holding politically conservative views and espousing strong religious values (Fitzgerald & Glass, 2014; Longest & Smith, 2011; McCright & Dunlap, 2011; Mooney, 2005; 2012; Taber, 2013b). Research in science education documents a long-running conflict between religion and science, and this rift has been held liable for individuals of faith being reluctant to trust scientists or express interest in science-related careers (Baker, 2012; Billingsly, Taber, Riga, & Newdick, 2013; Evans, 2013). Specifically, conservative Protestants have been outspoken in their disagreements with modern scientific claims on issues such as evolution, climate change, and cloning (Coyne, 2012; Evans & Feng, 2013; Hmielowski, Feldman, Myers, Leiserowitz, & Maibach, 2013). This tension has resulted in researchers such as Taber (2013b) concluding that religion is increasingly being viewed by secular educators and policy-makers as an unwelcome intrusion in authentic science education. However, despite the historic conflict between religion and science and current claims that conservative Protestants distrust scientists, relatively little research exists on the relationship between conservative Protestants and popular science (Bailey, 2012; Ceglie, 2013; Evans, 2013). The current study will seek to address this gap in the research by focusing on students enrolled in Christian schools that claim conservative Protestant moorings.

Problem Statement

Students in middle school are refining ideas about career goals and aspirations. Yet while these young people are making life-long decisions about jobs and occupations, few actually have well-rounded, personal experience with professionals in specific occupations, especially with those in STEM-related careers (Bardick et al., 2008; Chen & Cowie, 2014; Ware & Stein, 2013). This lack of exposure may cause students, especially females, to be disinterested in or unaware of STEM-related careers (Colvin, Lyden, & León de la Barra, 2012; Diekman, et al., 2010).

Providing young students with practical experiences with professionals in certain careers may serve to strengthen interest in those careers and enable students to have more positive attitudes toward entering those professions. While there are calls for educational interventions to increase STEM-career interest, further research is needed to identify practical techniques for promoting this awareness (DiDonato, Johnson, & Reisslein, 2014; Iskander & Kapila, 2011). Opportunities for STEM careers are abundant and yet interest in these vocations appears to wane significantly by the time students enter secondary school (Barmby, Kind, & Jones, 2008; Johnson et al., 2013). Educators would therefore be wise to offer more research-based interventions during the elementary and middle school years to increase student interest in STEM-careers (Rivera & Schaefer, 2009). While many teachers may support an increased STEM focus, there is a need to provide curriculum materials that are easy to implement and not time-consuming (DiDonato et al., 2014; Stoeger, Duan, Schirner, Greindl, & Ziegler, 2013; Tseng, Chang, Lou, & Chen, 2013). However, a review of current literature reveals a need for more practical, easily-implemented interventions to meet this need. Therefore, the current study will seek to fill this practical research gap by evaluating the use of video interviews with STEM professionals to increase STEM-subject attitude and STEM-career interest. While videos of scientists have been used in education, more empirical evidence for their effectiveness is needed (Ware & Stein, 2013). The current research will seek to fill this gap as well as extend the work of previous research by Wyss, Huelskamp, and Seibert (2012) in which video-podcasts of STEM professionals were used, refined, and then re-recorded to increase their effectiveness. The revised videos created by those researchers will be used and empirically tested in the current study, further contributing to the knowledge base of STEM education. In addition, this study responds to calls for research in STEM education in religious schools (Billingsley, 2013; Ceglie, 2012; Taber, 2013a; Wang & Degol, 2013) as well as calls for research specifically in Christian education (Bailey, 2012; Earwood & Suiter, 2012; Reiss, 2013; Stitzlein, 2008; VanBrummelen & Koole, 2012).

Purpose Statement

The purpose of this quasi-experimental, nonequivalent control groups, pretest-posttest factorial design is to test Gottfredson's Circumscription and Compromise theory as it relates to students' perceptions of STEM professionals on STEM-subject attitude and STEM-career interest. The independent variable, video interviews of STEM career professionals, will be generally defined as exposure to adult professionals from STEM-related vocations using video media. There will be two levels of the independent variable: exposure to videos and non-exposure to videos. A second independent variable will be the gender of the participants. The dependent variables will be generally defined as attitude toward STEM subjects and interest in pursuing STEM-related careers. The administration of a pretest measuring STEM subjects and interest in pursuing STEM-related careers will be used as a covariate during the analysis.

The main theory being tested is the Theory of Circumscription and Compromise proposed by Gottfredson (1981). This theory is referenced in literature examining occupational aspirations and career goals especially among developing adults (Junk & Armstrong, 2010; Lindner, Rayfield, Briers, & Johnson, 2012; Schuette, Ponton, & Charlton, 2012). The theory indicates that during childhood, young people are in a cognitive process of eliminating vocational options they begin to see as unrealistic goals.

As applied to the current study, Gottfredson's (1981) theory allows the expectation that the independent variable, video interviews with STEM professionals, will influence the dependent variables of attitude toward STEM subjects and interest in STEM careers. This expectation is reasonable because as the normality of scientists is solidified, young people may see STEM occupations as realistic goals for themselves. As the theory holds, if young people fail to eliminate STEM occupations from their mental list of realistic goals, they may remain open to STEM careers and express increased interest in them. It would also follow that as career interest is increased, interest in the subjects pertaining to those careers may increase as well. Bem's (1981) Gender Schema Theory also informs these variables as the gender of those viewing the videos may affect attitudes toward STEM subjects and interest in STEM careers, regardless of the presence of videos. Finally, the overlapping phenomena of gender and religion in this study warrant the consideration of Crenshaw's (1989) Intersectionality Theory as a lens for understanding the potential combined influence of these factors.

Significance of the Study

There are several reasons for educators to be concerned with STEM education in general and with encouraging STEM-career paths specifically. While many professions and jobs in America may not require STEM-specific degrees, there are few sectors of the labor market that do not hinge on a working knowledge of STEM-related principles (Capobianco, Diefes-Dux, Mena, & Weller, 2011; Lacey & Wright, 2009). In some ways, interest in science, technology, engineering, or mathematics is secondary, if not practically irrelevant, to the necessity of developing skills and thinking abilities desired by society and the labor market. Basic literacy in and even technical understanding of STEM concepts are required for individuals to distinguish themselves and advance economically and professionally. Beyond simply surviving in the workforce, current students and future workers need to recognize that scientists and engineers create jobs for others (Najafi et al., 2012). The National Academy of Sciences (2010) estimates that while scientists and engineers make up just 4% of the labor market, the other 96% of workers are employed because of the innovation and creativity of that small group. The trickle-down effect of scientific research and creativity impacts the manufacturing, sales, communications, and transportation industries that deal with the logistics of invention and creativity (National Science Board, 2014). Young Americans have the opportunity to impact society on several levels if their interest in STEM careers can be developed and maintained.

The National Academy of Sciences (2010) also articulates that the nation's ability to grow economically depends on its citizens' abilities to innovate and think critically about scientific issues and contribute to the ever-advancing technologies in society. Relatively few students may become white-coat, laboratory scientists, and yet this stereotypical identity is often associated with scientific careers (Bennett & Hogarth, 2009; Christidou, 2011; Zhai, Jocz, & Tan, 2013). The objective of increasing interest in STEM subject and career fields is not necessarily just to create more scientists but to increase the thinking ability of students in order that they become informed, rational thinking contributors of society (Wissehr et al., 2011). If students' attitudes toward STEM subjects are improved, they are more likely to recognize the importance of these fields to all occupations. If an increase in interest for STEM careers is a result of improved attitudes toward STEM subjects, then both students and society have benefitted.

This study focuses on the importance of influencing middle school students toward STEM-related careers through the use of video interviews with STEM professionals. The intervention, video interviews, if meaningful, could prove to be a practical curriculum addition for directing the thoughts of students toward those careers. Educators may find this intervention to be a simple, cost-effective way to improve attitudes toward STEM subjects and increase interest in STEM careers. The application of this intervention to other career fields is apparent and could also provide educators and researchers alike the impetus to apply findings in other non-STEM settings.

Additional significance for this study lies in the fact that this research will be carried out in the sector of Christian education in which relatively little empirical research has taken place, and yet one in which more is desired (Bailey, 2012; Ceglie, 2012; Earwood & Suiter, 2012; Reiss, 2013; Wang & Degol, 2013). Conservative Protestants comprise over 26% of the American population (Pew Research Center, 2008) and therefore hold significant sway in national politics and movements. Conservative Protestants have expressed skepticism of science and wariness toward scientists in general (Coyne, 2012; Gauchat, 2012; Li, 2013), and Evans and Feng (2013) have speculated that conservative Protestants may be a “reservoir of skepticism” toward popular science and scientists (p. 597). If these dispositions about science and scientists are being conveyed to students enrolled in conservative, Protestant Christian schools, then research in STEM education can be enhanced through an understanding of this demographic and their STEM-subject attitude and STEM-career interest. Additionally, research suggests examining barriers to entering STEM fields for females beyond simply the gender consideration (Cherney & Campbell, 2011; Ko et al., 2013; Warner & Shields, 2013). As this study brings into play both gender and a religious component, a better understanding of whether females of faith are at greater risk for low STEM-subject attitude or career interest responds to the call for increased research on this topic (Astley & Francis, 2010; Cho, 2012).

Research Questions

The following research questions are proposed for this study:

RQ1: Is there a significant difference between the mean STEM-subject attitude scores of middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores?

RQ2: Is there a significant difference between the mean STEM-subject attitude scores of male and female middle school students while controlling for pretest scores?

RQ3: Is there a significant interaction between the mean STEM-subject attitude scores of male and female middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores?

RQ4: Is there a significant difference between the mean STEM-career interest scores of middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores?

RQ5: Is there a significant difference between the mean STEM-career interest scores of male and female middle school students while controlling for pretest scores?

RQ6: Is there a significant interaction between the mean STEM-career interest scores of male and female middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores?

Research Hypotheses

The following research hypotheses are proposed for this study:

H1: There will be a significant difference between the mean STEM-subject attitude scores of middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores.

H2: There will be a significant difference between the mean STEM-subject attitude scores of male and female middle school students while controlling for pretest scores.

H3: There will be a significant interaction among the mean STEM-subject attitude scores of male and female middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores.

H4: There will be a significant difference between the mean STEM-career interest scores of middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores.

H5: There will be a significant difference between the mean STEM-career interest scores of male and female middle school students while controlling for pretest scores.

H6: There will be a significant interaction among the mean STEM-career interest scores of male and female middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores.

Null Hypotheses

Alternatively, the following are the null hypotheses:

$H_0$1: There is no significant difference between the mean STEM-subject attitude scores of middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores.

$H_0$2: There is no significant difference between the mean STEM-subject attitude scores of male and female middle school students while controlling for pretest scores.

$H_0$3: There is no significant interaction among the mean STEM-subject attitude scores of male and female middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores.

$H_0$4: There is no significant difference between the mean STEM-career interest scores of middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores.

$H_0$5: There is no significant difference between the mean STEM-career interest scores of male and female middle school students while controlling for pretest scores.

$H_0$6: There is no significant interaction among the mean STEM-career interest scores of male and female middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores.

Definitions

1. Attitude – "Attitude is a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor" (Eagly & Chaiken, 1993, p. 1). In the context of this study, attitude toward STEM subjects describes a participant's favor or disfavor of science, technology, engineering, or mathematics as an academic pursuit.
2. Interest – The combination of emotional attachment and personal valuation of a task resulting in a desire for various levels of enjoyment (Ainley & Ainley, 2011). In this study, STEM career interest indicates a participant's desire to pursue a career in a STEM field due to a perception of potential enjoyment.

3. STEM professional – An individual who works “in a science, engineering, technology or mathematical field, with at least a bachelor’s degree” (Wyss et al., 2012, p. 505).
4. Video interview with a STEM professional – A virtual encounter with an adult employed in a STEM field in which questions are asked related to job description, vocational enjoyment, and career preparation (Wyss et al., 2012).
5. Conservative Protestants—Individuals comprising a religious subgroup believing the Bible to be the ultimate source for truth claims about life and holding a literalist viewpoint of the origins of life as found in the book of Genesis (Evans & Feng, 2013).

CHAPTER TWO: LITERATURE REVIEW

Introduction

The purpose of this quasi-experimental, pretest/posttest factorial design study was to determine the effect of video interviews with STEM professionals on the STEM-subject attitude and STEM-career interest of middle school students enrolled in conservative, Protestant Christian schools. Current literature calls for interventions to support interest and positive attitudes toward science, technology, engineering, and mathematics and to encourage more school children to consider careers in those fields (Colvin et al., 2012; Hirsch, Berliner-Heyman, Cano, Kimmel, & Carpinelli, 2011; Kessels et al., 2014). The factors affecting children's aspirations toward vocations are diverse, and yet the body of literature on occupational development in STEM areas identifies several foundational, recurring constructs. As educators and researchers seek for practical ways to encourage positive STEM attitudes and career interest, the need is evident to provide cost-effective interventions to help teachers at all levels to promote these objectives. Informational videos in the classroom setting may prove to be a simple, cost-effective way to expose students to the real-life, day to day activities of STEM professionals. While the use of videos of scientists is not original with this research, few studies exist that empirically examine the influence of video interviews on the STEM-subject attitude and STEM-career interests of middle school students enrolled in Protestant Christian schools. There remains a gap in the current body of literature for research on whether videos with STEM professionals provide an educational intervention worthy of further use.

Chapter Two will discuss the conceptual and theoretical framework for the current study, including pertinent theories and constructs from the body of literature on the subject. In addition, a review of literature will support the need for continued research on the topic.

Conceptual and Theoretical Framework

Theory of Circumscription and Compromise

The selection of an occupation is a process young people begin at an early age and often do not end until well into adulthood. A person's self-concept of abilities, personality, and interests determines what vocations are viewed with potential and which are eliminated from consideration. Gottfredson's (1981) Theory of Conscription and Compromise informs the developmental process young people undergo as they advance through stages of vocational aspirations.

Gottfredson (1981) suggests a four-stage developmental theory of vocational aspirations to identify the cognitive processes young people engage in during the first two decades of life. In the first stage, *orientation to size and power* (ages 3-5), children begin to understand a realistic concept of adulthood and work—earning a living, being responsible, and making independent decisions. In the second stage, *orientation to sex roles* (ages 6-8), children develop conceptions of what society expects of males and females and the jobs that are typically held by members of each sex. In the third stage, *orientation to social valuation* (ages 9-13), young people develop ideas about how they fit into society's expectations by virtue of their abilities, intelligence, and gender. The final stage, *orientation to the internal, unique self* (ages 14 and older), brings the young adult into a realization of the opportunities available in the workforce and the role his or her interests, abilities, and social class play in choosing a career path.

During the latter stages of this development, young people engage in a process of eliminating certain vocational possibilities while retaining aspirations for others. Gottfredson's (1981) theory exposes the need to understand individuals' self-concept as a significant factor of vocational goals, causing them to "seek jobs compatible with their images of themselves" (p. 546). However, the experiences of young people are diverse, and some may never have opportunity to pursue career paths in which they would enjoy success simply due to lack of exposure to certain vocations (Gottfredson, 2006). Stated another way, a significant constraint to vocational aspirations is simply ignorance of the full range of occupations which may be compatible with a person's goals and interests. The challenge for educators according to Gottfredson (2006) is to "optimize experience, both by providing broad menus of vocationally-relevant activities for young people to sample and by promoting self-agency in seeking out formative experiences" (p. 168). The more vocational exposure and career education young people are provided, the better occupational decisions they are equipped to make.

The Theory of Circumscription and Compromise brings together several constructs into a framework for understanding occupational aspirations. *Self-concept* is essentially a set of beliefs about who a person believes he or she is now or could be in the future. These beliefs play a role in the person's actions as they make preparations to fulfill goals for the future. Gottfredson (1981) suggests self-concept includes interests, known skills, and desire to fit into a particular social class. *Occupational images* are perceptions of occupations based on a person's knowledge of employees and job roles within a certain vocation. The perceptions individuals develop about occupations include generalizations of personality type, working conditions, gender of employees, workload, compensation, and typical job responsibilities. These perceptions are a result of many influences, and as self-concept and occupational images are reconciled, a long-term effect on openness or reluctance to entering certain career paths results. *Occupational preference* then is a person's level of like or dislike for careers retained for consideration after self-concept and occupational images are weighed. This *social space* is the full set of perceived career possibilities the individual considers to have potential. Preferences may still include several improbable occupational goals, but the *accessibility of occupation* compels the individual to seriously consider potential obstacles for entry into certain fields. Economic, educational, social, and familial pressures may dissuade the person from continued consideration of certain fields, further narrowing viable career options. Gottfredson (2006) identifies this cognitive process of eliminating certain occupational choices as *circumscription* which is followed by a stage of *compromise* in which the individual yields to more agreeable alternatives. Gottfredson (1981) distinguishes the resultant *aspiration* as “the single occupation named as one’s best alternative at any given time” (p. 548), and although the specific selection may change, it is typically drawn only from within the social space. These constructs are constantly at work throughout the stage development outlined above and refine the self-concept of the individual as he or she nears the reality of choosing an occupation. In summary, the Theory of Circumscription and Compromise is essentially a narrowing process of eliminating vocational alternatives and determining a career path based upon one’s self-concept as it relates to the remaining options.

Gottfredson (1981) suggests the most significant factors impacting circumscription and compromise during development are gender, social class, intellect, skills, career interests, and personal values. As a young person develops, certain of these factors play a larger role than others in helping narrow the social space and determining which career aspirations should be eliminated. The Theory of Circumscription and Compromise helps answer the question of what factors cause an adolescent to be narrow in occupational aspirations when as a young child he or she was comparatively open to many career ideas. According to Gottfredson (1981), gender-role identification is the first delimiting force a child reconciles with his or her perceptions of occupation, shying away from careers seen to be in conflict with his or her gender. Second, based on a perception of social class, children eliminate vocations lacking in prestige equal to their social standing. Next, based on a self-concept of intelligence and ability, children do away with aspirations for jobs which would require significant effort on their part to overcome competence or aptitude deficiencies. Finally, by adolescence, young people begin to weigh more heavily their personal interests and values in their search for potential career paths. Thus, by adolescence, students have circumscribed a rather narrow social space from which to draw remaining options for occupational choice.

As the time for actual job selection or training arrives, young people may find themselves in a position of compromising preference for availability, taking advantage of job opportunities that are most accessible to them. Gottfredson (2005) points out the narrowing of career aspirations in childhood is largely based on social and economic perceptions of occupations and less on actual understanding of job descriptions, specific duties, and entry level requirements. In fact, while students may educate themselves on careers that are of most interest to them, few have a good understanding of occupations they eliminate from consideration (Gottfredson, 2005). The need to educate children about job functions, needed education, and day-to-day work duties is apparent in order for young people to make wiser, more informed vocational decisions.

The Theory of Circumscription and Compromise informs the current research by suggesting students should be influenced to refrain from eliminating careers (i.e. STEM careers) at an age when relatively little quality information is known about vocations. According to the theory, elimination of certain occupations based solely on gender, prestige, or extreme difficulty may have taken place by early adolescence (Gottfredson, 2005). Yet enough flexibility of perception may remain that STEM careers can be seen as not out-of-reach if presented in light of a student’s interests and abilities, typically strong influencers in the latter stages of development.

In short, rather than attempting to convince students that STEM careers are the best choice, perhaps educators would be wise to focus simply on keeping students from eliminating STEM vocations from their range of career options at a young age. Subsequently, students have the potential to develop the requisite skills and knowledge needed to further pursue a STEM career when the time for concrete decisions arrives. Furthermore, Gottfredson (2005) states the theory "predicts that career interventions will effect more change when they target narrow, specific attributes rather than highly general ones" (p. 85). Thus, this recommendation supports the current research which focuses specifically on increasing STEM-subject attitudes and STEM-career interest through a STEM-specific intervention.

Gender Schema Theory

Gender Schema Theory was developed by Bem (1981) and spawned from the study of androgyny, a child development concept that grew in popularity among researchers during the 1970s (Santrock, 2007). Androgyny is described as "the presence of a high degree of desirable feminine and masculine characteristics in the same individual" (Santrock, 2007, p. 185), resulting in lower stress and better mental health (Bem, 1977). Bem's (1977) early work involved developing the now-familiar *Sex-Role Inventory* to assess androgyny, and this work led to Gender Schema Theory as Bem's (1981) attempt to explain the cognitive and social factors at play in the androgyny of a developing child.

Gender Schema Theory suggests that as young people observe individuals in society they construct a mental framework about what it means to be male or female (Bem, 1981). These self-constructed gender schemes shape the child's beliefs about how he or she should behave, what he or she should be good at, and what interests he or she should have in the future (Ormrod, 2006). The theory suggests that as a child encounters new knowledge and makes observations, he or she assimilates that information in terms of schemes about gender (Bem, 1981). In this way, society has taught the child to *sex type* concepts such as occupations and domestic roles.

Bem (1981) describes *sex typing* as the transmission of ideas about masculinity and femininity by surrounding culture, and the theory essentially holds society responsible for children's standards of what entails male and female. Thus, sex typing plays a significant role in the developing child's self-concept as he or she assimilates into a gender role endorsed by society. Bem (1985) describes Gender Schema Theory as an amalgam of cognitive-developmental theory and social learning theory in that "sex typing is mediated by the child's own cognitive processing" while also "a learned phenomenon and hence…neither inevitable nor unmodifiable" (p. 186). The sex typed individual, according to Bem (1983), is in a sense handicapped by surrounding culture, and the more society transmits gender stereotypes to children, the greater the risk of wasting talent that otherwise might be tapped (Bem, 1984). As a resolution to this problem, Bem (1983) envisages a society that produces gender-aschematic children who are empowered to overcome sex typing and to explore social roles free from the perceived constraint of gender. While divorcing gender completely from social roles may be improbable, Bem's (1993) desire to promote un-gendered horizons of children in areas such as academics and vocation is an admirable albeit lofty goal.

Intersectionality Theory

The gender gap in STEM interest and vocations is well-established in current literature (Archer et al., 2013; Buse & Bilimoria, 2013; Liben & Coyle, 2014; Pearson & Miller, 2012; Rosser & Taylor, 2009; Suri & Sharma, 2013) and has drawn the attention of both private sector industry and the national government (National Research Council, 2011; Office of Postsecondary Education, 2013; National Science Foundation, 2014). Research suggests that males tend to have more positive attitudes toward STEM subjects and higher interest toward STEM careers. Gender Schema Theory (Bem, 1981) informs the tendency of males and females to think differently about gender-appropriate vocations and academic goals. However, Gender Schema Theory provides only a binary evaluation of the gender gap in science education studies. Therefore, the lens of a gender identity model employed in current research provides additional insight into the specific nature of female disinterest in STEM subjects and vocations.

Extending the general framework of Gender Schema Theory, Crenshaw (1989) was one of the first authors to popularize the concept of *intersectionality*, the notion that individuals are defined by multiple layers of group characteristics. According to Crenshaw (1989), intersections between traits such as race, ethnicity, and social class, must be considered when explaining the disenfranchisement of certain groups. Much of Crenshaw's (1991) work focused on the oppression of African-American females, and Crenshaw articulated the fact that although women in general suffered from discrimination, women of color were marginalized by society to a much greater extent than were Caucasian women.

Collins (1986, 2000) extended Crenshaw's thoughts on overlapping characteristics into a model now recognized as Intersectionality Theory: "the study of interlocking matrices of oppression" (Neitz, 2011, p. 59). Although the theory originated as an attempt to explain racial discrimination, Intersectionality Theory has since come to inform the hardships diverse groups in society experience in terms of the intersecting characteristics defining them (Knudsen, 2006).

Essentially, Intersectionality Theory examines the compounding of disadvantages individuals face due to their membership in specific groups. For example, Intersectionality Theory is currently informing disadvantages to individuals in such diverse areas as special education (García, Ortiz, & Sorrells, 2012), politics (Doan & Haider-Markel, 2010; Foster, 2013;

Levine-Rasky, 2011), sexuality (Collier, Bos, Merry, & Sandfort, 2013; Wadsworth, 2011; Warner, & Shields, 2013), and the legal system (Best, Edelman, Krieger, & Eliason, 2011). Intersectionality Theory has also recently served as a lens through which to interpret findings in research on STEM pursuits (Bruning et al., 2012: Hanson, 2012, 2013; Ko et al., 2013; Trauth, Cain, Joshi, Kvasny, & Booth, 2012), religion (Banton, 2011; Guittar, & Pals, 2014; Macey & Carling, 2010; Mirza, 2013; Schaeffer, & Mattis, 2012), and Protestantism (Bulanda, 2011; Henward & MacGillivray, 2012; Neitz, 2013; Whitehead, 2013; Wilkins, 2008). The existing research in these areas provides an excellent theoretical backdrop in which to ground the current research.

Attitudes in STEM

Efforts in education to increase positive attitudes toward STEM subjects, specifically toward science, have strengthened in recent decades and are now often included in state, federal, and private interest groups' curriculum standards (IPST, 2008). Increasing students' positive attitudes toward science is seen by some researchers as one of the primary responsibilities of the classroom teacher, and some would even suggest that positive science attitudes have more important ramifications than achievement (Bennett & Hogarth, 2009; Cheung, 2007; Najafi et al., 2012). Educational reforms that help students maintain high attitudes toward STEM subjects may improve the likelihood of high-attitude students pursuing STEM-related careers, regardless of achievement level. Definitions of attitude and its related constructs are abundant, and therefore this section will seek to clarify the meaning of attitude for this particular study.

The construct of attitude can be a somewhat all-encompassing idea when used in everyday conversation, and yet authors tend to describe attitude in similar ways as it relates to education. Oskamp and Schultz (2005) described attitude as the tendency for a person to respond positively or negatively toward a certain target based upon prior thought and experience with that target. Essentially, a person responds to ideas, concepts, and in this context, school subjects, with conditioned thought patterns based on internalized opinions.

Kind, Jones, and Barmby (2007) discuss attitudes toward academic subjects in light of the strength of emotion with which a person reacts to an object due to beliefs about the object's worth or desirability. While some stimuli may provoke strong emotional responses, either positive or negative, others with which the individual has less experience may cause minimal reaction. In a recent analysis of research on attitude, Reid (2011) reported that one of the most-cited and generally accepted definitions of attitude in educational research comes from the work of Eagly and Chaiken (1993), who defined attitude as "a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor" (p. 2). Reid (2011) suggests that perhaps the most important aspect of this and other definitions of attitude is the presence of a judgment on the part of the individual. Exactly where the respondent's attitude or internal perception of a target rests on the continuum between favor and disfavor is the concept of attitude which researchers attempt to quantify and describe.

Research contributing to knowledge about interventions that may affect attitude have value in their potential for long-term influence. Understanding the internalized beliefs and opinions of students is important as these are the foundation for future decisions about academic and career pursuits. Koballa and Glynn (2007) suggest that attitudes affect motivation, the driver of the individual's passion for learning, pursuit of a certain career, and his or her commitment toward obtaining certain life goals.

Although not the main theories of this study, two well-established and related theories in the literature inform the connection of attitude and motivation. Ajzen and Fishbein's (1975,

1980) Theory of Reasoned Action holds that behaviors can be traced to attitudes formed in the past that created intentions in the individual to perform certain actions in the future. The subjective norms of the individual's environment or social group also create pressure for the individual to behave in certain ways or make certain decisions in the future. This theory would have researchers understand that students' intentions ought to be directed during youth so that certain behaviors can be expected in the future.

Ajzen (1985) later refined the Theory of Reasoned Action and developed the Theory of Planned Behavior to first, encompass the constructs of prior attitude, subjective norms, and perceived behavior control, and second, to explain the decisions of individuals in the present. Ajzen (1985) suggested that the individual's goals for the future are subject to the amount of perceived control he or she has over factors relating to attaining those goals. In other words, individuals govern ideals and ambitions through an understanding of personal abilities and realistic expectations about factors under their control. The theories of Reasoned Action and Planned Behavior take a somewhat retrospective approach in determining factors affecting decisions in the present. Therefore, these theories provide a foundation for developing interventions in the present which will produce a desired outcome in the future.

Fostering positive attitudes toward academic subjects can certainly increase enjoyment for school subjects and thereby increase achievement in those studies as well. Interventions designed to increase enjoyment of and attitudes toward STEM subjects have generally been met with positive, and often long-term, results across various grade levels (Salta & Tzougraki, 2004; Wood, Ellison, Lim, & Periathiruvadi, 2011). Positive attitudes toward school subjects have been shown to be associated with strong motivation to do well in school, and researchers have argued for interventions and reforms to help teachers increase student motivation in the classroom (Koballa & Glynn, 2007; Koul, Lerdpornkulrat, & Chantara, 2011). Increasing motivation for school subjects not only raises achievement but also expands options for continuing education and career opportunities.

Student attitudes toward school subjects and careers can of course be influenced by many factors related to learning environment, subject matter, and personal feelings of ability (Tuan, Chin, & Shieh, 2005a). For example, studies have shown that teacher attitude, enthusiasm, and quality of teaching affect student science attitudes and career interests (Osborne, Simon, & Collins, 2003). Children are certainly influenced by parents, and students often imitate the vocational interests of their family members (Papanastasiou & Papanastasiou, 2004).

The gender of the student and his or her grade level in school have been shown to produce varying results when attitude toward school, school subjects, and career interests are examined (Barmby et al., 2008; George, 2006). Research instruments have been developed to quantify attitudes toward school, school subjects, and attitudes toward certain careers, and yet researchers tend to agree that attitude is a multi-faceted issue that is difficult to quantify with accuracy (Najafi et al., 2012; Reid, 2011; Suri & Sharma, 2013). In short, evaluating attitudes toward school subjects and careers and isolating constructs influencing those attitudes are not simple undertakings, and therefore research results must be interpreted with this caveat.

Interest in STEM

Attitude and interest, while often used synonymously in everyday language, are often differentiated in the literature. Eagly and Chaiken (2005) separate interest from attitude by describing interest as a willingness to take action based on an internalized attitude toward a target. Interest then can be described as the potential for a certain behavior to take place resulting from an attitude stance. Future actions cannot be guaranteed, and yet the willingness of the individual to pursue that action is considered his or her interest.

The connection between attitude and interest is important due to the fact that while positive attitudes cannot perfectly predict behaviors, openness toward a certain behavior certainly precedes engaging in action (Glasman & Albarracin, 2006; Oskamp & Schultz, 2005). It follows that if positive attitudes toward STEM subjects and STEM careers can be nurtured during the school years, higher interest in pursuing further education in those subjects and more openness to careers in these fields can be expected (Johnson et al., 2013; Kerr et al., 2012).

A student's willingness to re-visit and find meaning in school subjects, specifically STEM disciplines, and his or her interest in pursuing a career in a STEM field may hinge on whether positive and authentic experiences were provided by educators (Karatas, et al., 2011; Kessels et al., 2014; Renninger, 2009). Barmby et al. (2008) found that middle school students often find science in school to be inapplicable and irrelevant to real-life and explained poorly by many teachers. While of course not representative of all science classrooms and students, these findings may unfortunately typify the experiences of all too many students. Conversely, Dewitt et al. (2011) found overall positive attitudes toward science and perceptions of scientists among middle school students and yet also found measures of vocational interests for STEM fields to be very low. Even students who appeared to enjoy science and had positive attitudes toward studying science in school did not transfer that attitude into an interest in pursuing a STEM career.

Few middle school students are thoroughly knowledgeable about STEM vocational opportunities, and yet many young people narrow their career interests before full awareness has even taken place (Colvin, 2012; Johnson et al., 2013). Attitudes toward STEM subjects have been found to decrease rapidly during high school, further decreasing interests for STEM careers and possibilities (Lindner et al., 2012). There is a clear need to educate young students, especially those with positive STEM attitudes, on the variety of STEM occupations and opportunities available to them. Helping students value long-term goals and supplying information on steps needed to attain those aspirations may increase the number of students willing to remain open to the opportunities available in STEM fields (Koul et al., 2011).

Interest, as an extension of attitude, has been viewed as a leading factor of motivation to perform well in school and take on challenging tasks even more so than one's personal beliefs of intelligence or competence for the learning material (Inoue, 2007). Students who are motivated by interest in a subject are likely to persist in their study of that topic perhaps to a greater degree than those with stronger achievement (Diekman et al., 2010; Kerr et al., 2012; Ormrod, 2006). Mastery experiences in math and science may also cause students' interest levels and self-efficacy in those subject to be high, causing greater persistence in pursuing math and science in school and in career choices (Bøe, Henriksen, Lyons, & Schreiner, 2011; Usher & Pajares, 2009; Britner, 2008). Students, especially males, who establish strong interest in STEM subjects and careers during middle school and high school are also more likely to pursue a college degree with STEM focus (Eccles, 2011; Morgan, Gelbgiser, Weeden, 2013). When viewed in the context of long-term possibilities, efforts spent during middle school and high school years on increasing interest for STEM subjects and careers can be a worthwhile investment (Dionne et al, 2011).

The National Research Council (2011) in recent years has suggested that more should be done during the early school years to expose students to the day-to-day work of STEM career professionals. In this recommendation, the NRC (2011) supposes students' perceiving scientists, mathematicians, engineers, and technology professionals to be normal, everyday people may improve attitudes toward these career paths. However, Kimmel, Miller, and Eccles (2012) caution that while more young people entering STEM career paths may be desirable and that more should be done to increase student awareness, interest alone is not a sufficient prerequisite for a successful STEM career. Commitment to necessary education, possession of talent, and development of certain skills are also necessary to fulfill the demands of many STEM-related occupations. That point conceded, students are not likely to commit themselves to those requisite qualifications unless they have remained open to considering those career choices in the first place. Gottfredson's Theory of Circumscription and Compromise (1981) informs this concept of keeping students from eliminating career options at an uninformed stage of development.

Self-Efficacy and Student Motivation

Self-efficacy is often discussed alongside interest in the context of student motivation, and both play significant roles in school-subject goals and career aspirations (Inoue, 2007; Tuan et al., 2005a). Similar to interest, self-efficacy has also been found to increase aspirations for further study in science and pursuing science careers (Dewitt et al., 2011). Differentiating between the two concepts is tedious, and determining whether one factor accounts for greater gains over the other has been debated and studied. Researchers agree that self-efficacy coupled with interest is a very powerful combination for student success in academic pursuits (Dionne et al., 2011; Tuan et al., 2005a). However, self-efficacy may be an insufficient motivator without strong interest, which can cause actionable desire for pursuit of a target. Intrinsic desire to accomplish a goal can be a stronger motivator than feelings about the ability to be successful (Nosek et al., 2007), and therefore, encouraging students to explore interests regardless of efficacy level may be considered an important responsibility of the educational environment (Cotabish, Dailey, Robinson, & Hughes, 2013). In other words, educators would prefer to see young people prioritizing interest and openness to STEM career options rather than narrowing their options due to feelings of self-efficacy.

Self-efficacy is a psychological concept developed by Bandura (1997) which informs people's feelings of competence to fulfill a future task. Bandura (1986) identifies four motivational sources that impact a student's belief about future success in life activities such as learning and working: 1) Mastery experiences—views about previous performance levels, 2) Vicarious experiences—perceptions of behaviors by others being encouraged, 3) Social persuasion—opinions and viewpoints expressed by others, and 4) Physiological state—self-evaluation and interpretation of one's emotions. Self-efficacy is an internal construct that may or may not be evidenced through resultant actions but one that may nonetheless give the individual a sense of confidence. In the academic setting, self-efficacy might be adapted to describe a student's perception of his or her ability to succeed at a learning objective or activity. Students may also translate self-efficacy for an object into a conception about themselves and their self-worth in a certain academic area (Britner & Pajares, 2006).

Bandura (1997) believes that bolstering students' self-efficacy at an early age is highly important, and that doing so before negative beliefs can take root is imperative. Anxiety and negative feelings about school subjects can deter students from otherwise fulfilling careers in related occupations, and this is especially true in STEM-career fields (Bandura, 1986; Koul et al., 2011). Children develop emotional attachment or detachment for school subjects, and these feelings lead to higher interest and greater appreciation of learning's impact on the future (Glaser-Zikuda & Fusz, 2008). In the context of increasing STEM-career interest, the idea of self-efficacy would imply that young students should be given opportunities to build positive perceptions of STEM professions so that positive outcomes of learning are evident. Equipping students with strong STEM-subject abilities is essential for academic confidence, but exposing students to the potentialities associated with that knowledge may be equally important.

Identity in STEM Careers

Increasing student aspirations for careers in STEM fields can be furthered by attention to STEM-subject attitudes and by building interest in STEM professions. However, unless students realistically see themselves in those roles, their chances for actually pursuing those jobs may be reduced (Bennett & Hogarth, 2009; Karatas et al., 2011). Research distinguishes this construct as *identity*—individuals' projections about what and who they would like to become (Eccles, 2009).

Entering into any profession, especially science, involves a process through which young people construct an identity of themselves in light of their experiences with school subjects and their images of professionals in related fields (Christidou, 2011; Hoh, 2009; Karatas et al., 2011; Johnson et al., 2013). Krogh and Anderson (2013) further describe identity in terms of alienation from science or recruitment toward it—both internalized concepts of imagining oneself in the role of a worker in a STEM field. For example, while a student may enjoy STEM subjects and express interest in exploring a STEM career, he or she may perceive scientists through a negative, stereotypical lens as aging, white-haired men in lab coats (Farland-Smith, 2012). These perceptions of STEM professionals may unfortunately keep otherwise good science students with positive science attitudes from developing a 'scientist' identity (Dewitt et al., 2011). Research studies utilizing methods such as the "Draw a Scientist" often return boring, rigid, impersonal, or out-of-touch images of STEM professionals (Highfield, 2011; Zhai et al., 2013). For some students, and especially females, identifying with STEM professionals is difficult due to the pervasive presentation of scientists as an elite group of masculine, clever intellectualists immersed in academia (Archer et al., 2013; Carlone & Johnson, 2007; DiDonato et al., 2014). While this may be true of a sector of STEM professionals, many scientists, mathematicians, and engineers are occupied in work that can be highly interesting and engaging. In fact, students who have opportunities to experience the practical, hands-on work typical of STEM professionals, perceptions of scientists as 'normal' people increases (Covin et al., 2012; Welch & Huffman, 2011).

If children perceive STEM professionals in such a way that deters them from identifying with those careers, perhaps more should be done to promote positive, realistic imagery of STEM workers and the variety of jobs they hold. In two large studies of young students, both Archer et al. (2013) and Dewitt et al. (2011) found that many children and their parents are not knowledgeable about the diversity of jobs available in STEM fields. Both researchers suggested better exposure of children to potential careers in STEM. Understanding and evaluating the way in which identity construction impacts career choices is a valuable undertaking, and this is especially true in science education where future innovators and creative thinkers can be developed (Kessels et al., 2014; Tucker-Raymond, Varelas, Pappas, Korzh, & Wentland, 2007).

Two influential authors in the study of identity have provided analogies for the topic which provide clarity and have served as a foundation upon which others have built. Giddens (1991) describes identity as a mental narrative a person continues to write about him or herself, adjusting one's ongoing autobiography as more experiences and interactions take place. In this light, Gottfredson's Theory of Circumscription and Compromise can inform the concept of identity as young people eliminate certain goals and aspirations from their personal story which they view as incompatible with who they want to be.

Holland (2001) also approaches identity from a story-telling perspective but with the addition of an individual acting out a role he or she wants to project before others. In other words, identity can be understood in some contexts as the way in which a person wants to be perceived by others and that which a person is willing to make known to peers, teachers, and family. This perspective sheds light on the emotional element of identity and the strength with which a person can cling to an aspiration. Gottfredson's (1981) theory also suggests that some vocational aspirations can be tightly held and only relinquished in the presence of insurmountable obstacles to achieving those goals.

The current study evaluates the potential for impacting students' STEM-subject attitudes and STEM-career interests through the use of video interviews with STEM professionals. Providing images of STEM professionals may influence the identification of middle school viewers with these professionals and thereby increase interest and openness toward those careers. The influences of attitude, interest, self-efficacy, and identity on individuals' ideas about their future are closely knit. Differentiating between these constructs is tedious, and yet taking into account the variety of factors at play in a young person's career interests is important.

Gender and STEM Interests

There are few studies in educational literature in which gender is not viewed as a key construct, and research in STEM careers and education certainly appears to follow this trend (Eccles, 2007; 2011; Liben & Coyle, 2014; Stoeger et al., 2013). Methods for improving gender equity in STEM careers is debated in current literature, and there is still a disparity between males and females electing to major in STEM fields in college and a dearth of females pursuing

STEM careers overall (Hill, Corbett, & Rose, 2010; Miller & Kimmel, 2012; Smith, 2011; Smith, 2010; Watt, 2008). It is no surprise that students enter school with different ideas concerning what they want to be and about how education can assist them in meeting life goals. A child's family, social circle, and awareness of culture all affect his or her projections of self regarding work and education, but few factors seem to be of equal or greater influence than the child's gender (Archer et al., 2013; Ayalon & Livneh, 2013; Eccles, 2011; Else-Quest et al., 2010; Kanny, Sax, & Riggers-Piehl, 2014; Koch, 2007).

Several studies have revealed that school-age boys maintain more positive attitudes toward science than girls (Brotman & Moore, 2008; Caleon & Subramaniam, 2008), and yet the cause for this disparity has largely been viewed to be due to social reasons rather than merely gender (Ceci, Williams, & Bartlett, 2009). Females, for example, may view science as incompatible with aspirations for relationship-oriented careers or jobs conducive to family life. These concerns tend to be quite important for many young women as they contemplate career choices (Diekman et al., 2010; Eccles, 2009; Frome et al., 2006; Spearman & Watt, 2013). Males, on the other hand, do not typically prioritize these values in the same way, and this tendency may result in falsely associating gender disparity in STEM-career fields with female dislike for STEM-subjects (Barmby et al., 2008).

Other studies however have shown that not all high school females decline in attitudes toward science, and in some cases, females have shown to maintain or increase attitudes (Colvin et al., 2012; Cheung, 2007; Hirsch et al., 2011). For example, in a study of young girls, Archer et al. (2013) found that although no significance was found between boys and girls expressing disinterest toward science, significantly more boys than girls were found to be keenly interested in pursuing science. The study concluded that although girls may not necessarily have negative attitudes toward science at school, female interest in science certainly wanes beyond the classroom walls.

Although there is concern about the low numbers of students aspiring to science-related careers, research indicates that students typically have a high level of respect for STEM fields and vocations (Sjøberg, & Schreiner, 2007). Neither do wavering attitudes toward science and science careers appear to correlate to lack of aptitude for science or mathematics when accounting for gender (Haworth, Dale, & Plomin, 2008; Smith, 2011). In a study of engineering undergraduates, females tended to be more concerned with getting good grades and thus persisted in coursework to attain high marks, whereas young men were more persistent due to self-efficacy beliefs of accomplishing tasks (Concannon & Barrow, 2010). Boys may be less afraid of difficult courses and less concerned about grades than girls, opting for challenging experiences, such as high school calculus, even at the risk of reduced grades (Kimmel et al., 2012). To this point, Koul et al. (2011) discovered that although males aspire to STEM professions more than females, boys do so because they view themselves as suitable for STEM professions based on gender, not on grades or valuation of the subject. High school students who have experienced good achievement in math and science courses are likely to enroll in advanced math and science classes, but so too are students with high self-efficacy for math and science regardless of achievement (Eccles, 2009). Members of both sexes, while equally capable of achievement in STEM-related subjects, differ in motivation to pursue those subjects and thus a gender disparity may exist more due to matters of motivation rather than ability.

Research suggests that one of the strongest influences in the minds of young people when making judgments regarding STEM subjects and careers is a perceived masculine gender association with STEM subjects and professions (Diekman, 2010; Hoh, 2009; Spearman & Watt, 2013). Whereas many girls imagine themselves in careers involving working with people, expressing creativity, and having time for family, few young girls believe STEM careers match these descriptors (Archer et al., 2013). For example, young women's persistence in medical fields and nursing shows a preference for careers which encourage personal relationships and interaction with people, opportunities not normally associated with most STEM professions (Eccles, 2011; Kimmel et al., 2012). In one meta-analysis of occupational interest studies, Su, Rounds, and Armstrong (2009) found that males report much stronger desire to work with 'things' and conduct investigations in their work while females tend to prioritize social aspects of work when thinking about careers.

Science, math, and engineering are often viewed by females as masculine pursuits and not fitting within their perception of feminine work (Ayalon & Livneh, 2013; Carlone & Johnson, 2007; Goldman & Penner, 2014). In several studies, children have indicated their perceptions of math and science being subjects boys enjoy more than girls and therefore label STEM subjects as masculine (Adamuti-Trache & Andres, 2008; Caleon & Subramaniam, 2008). Students generally report their belief that typical scientists are male, and females have reported a hesitancy to identify with scientists due to their view that science does not lend itself to interpersonal relationships or to the female persona (Buck, Plano-Clark, Leslie-Pelecky, Lu, & Cerda-Lizarraga, 2008; Sjøberg, & Schreiner, 2007). Betz and Sekaquaptewa (2012) recently found that even highly feminized STEM role models were viewed as incongruent with typical femininity by female middle school students, indicating that gender stereotypes in STEM fields may be difficult to overcome.

While gender differences in STEM attitude and achievement develop early, these differences become much more apparent in the post-high school decisions of males and females.

Students develop interests and form attitudes throughout their school experience, and young people in middle school and high school are especially in a stage of life in which plans and goals are being solidified (Gottfredson, 1981). School experiences in STEM subjects have a lasting effect on whether a student will pursue a STEM major in college, and high school achievement in STEM subjects can predict interest and persistence in a STEM major (Eccles, 2011; Shaw & Barbuti, 2010; Spearman & Watt, 2013). For example, Ma and Johnson (2008) found that achievement in second year Algebra correlated highly with the likelihood of a student pursuing a STEM-related college degree. However, Shaw and Barbuti (2010) also found that among those choosing a STEM college major, females are less likely than males to actually finish a degree in a STEM field. Even high-achieving females who finish college degrees in STEM areas sometimes lose their desire to work in these fields early in their careers, citing reasons such as raising children or dissatisfaction with long work hours (Diekman et al., 2010; Ferriman, Lubinski, & Benbow, 2009).

These findings may lead to the conclusion that even females with strong aspirations for STEM careers in high school, college, and early adulthood are willing to relinquish this interest for the sake of achieving traditionally-held goals for women, such as rearing children. While many factors may contribute to females becoming discontented with STEM professions, many times females leave STEM careers, or fail to enter them, due to personal choices and preferences rather than lack of opportunity or gender discrimination (Ceci & Williams, 2010; Goulden, Frasch, & Mason, 2009). Increasing females' interest in STEM careers at a young age may be possible, but convincing them to stay later in life may be more challenging.

STEM Education in Christian Schools

Science education in the public arena differs considerably from science education in Protestant Christian schools (Armstrong, 2010; Van Brummelen, 2009). Knight (2006) articulates that science in Christian education is not merely a "modification of the approach used in non-Christian schools…it is rather a radical reorientation of that topic within the philosophical framework of Christianity" (p. 236). Understanding the fundamental differences in philosophies between secular and Christian educational institutions is important for interpreting outcomes found in either population.

Christian science education builds upon a foundation of truth established by a creator God through the world He created (general revelation) and His written communication with mankind (special revelation), known more formally as the Bible (Horton, 1992; Noebel & Edwards, 2002). Christian educators generally believe God established the natural world for man to enjoy, study, and derive insight into His character (Horton, 1992). Therefore, Christian science education holds that discoveries made by man are not a final authority but must rather be interpreted in light of Biblical principles. Van Brummelen (2002) suggests that this stance by Christian educators does not entail a blanket rejection of modern science but rather that scientific conclusions must be tempered against a Biblical understanding of the fallen human nature.

Christian educators view Darwinian evolution as one such example of a theory developed by individuals whose worldview sought to exclude a creator God from reality (Knight, 2006). In practice, this theory has led publishers of secular science textbooks to "promote values at odds with those of Christianity" (Van Brummelen, 2002, p. 157). The outcome of this view of origins is that mankind has the capability through science and ingenuity to perfect the human race and eradicate society's ills (Armstrong, 2010; Colson & Pearcey, 2004). Colson and Pearcey (2004) expose the irony that whereas secular science education boasts independence from religion, faith placed in science's potential to cure social problems may be just as strong a religious stance as the faith of Christianity. Knight (2006) reinforces this point by suggesting that public education produces students who place their "uncritical faith in science and mathematics rather than in the Creator of scientific and mathematical reality" (p. 238). Armstrong (2010) concludes that Americans have come to believe that God is not needed in order to interpret the world and have therefore come to expect science and religion to be in conflict. This alleged clash between science and religion is certainly a factor to consider when studying science education in schools with religious affiliations.

Despite the suspected conflict between science and religion discussed in literature, relatively little current research has specifically evaluated the relationship between religion and STEM-career interest. Research has examined the impact of religion on student beliefs about the veracity of concepts discussed in typical science classrooms (Billingsley, 2013; Hanley, Bennett, & Ratcliffe, 2014; Hoven, 2013), and studies relating religious views to acceptance or denial of Darwinian evolution are common (Astley & Francis, 2010; Baker, 2014). However, whether religion dissuades or encourages students to pursue careers in science-related fields is still uncertain. Recent research has speculated that religion may play a role in student attitudes toward STEM subjects (Astley & Francis, 2010; Cho, 2012; Liben & Coyle, 2014), and yet little research exists which closely examines religion's influence on STEM-career interest. Given the close relationship between attitude and interest (Reid, 2011), the expectation that religion may also affect career interest is reasonable.

Review of Literature

Children of various ages can be expected to respond differently to questions of career interests and goals as they cognitively balance desires with self-concept (Gottfredson, 1981). Whether students benefit more from interventions aimed at increasing positive attitudes toward STEM subjects and careers in elementary, middle, or high school has been a matter of debate. The National Science Board (NSB, 2010) has recommended more emphasis especially on teacher training and professional development in STEM content for elementary teachers with the goal of increasing STEM awareness and interest among their students. Both the NSB (2010) and the National Research Council (2011) have argued specifically that STEM-related careers should be emphasized during the elementary and middle school years to establish an early foundation for increasing the number of STEM professionals in United States. As with any subject, thoroughly developing talent and ability in STEM subjects take several years, and therefore, channeling the natural curiosity of children toward STEM topics at an early age is important (Capobianco et al., 2011; Colvin et al., 2012; Keeley, 2009; Pratt, 2007; Turner & Ireson, 2010).

In one study of influences on STEM career paths, a high number of STEM professionals indicated that their interest for science-related jobs began in elementary school (Maltese & Tai, 2010). A similar finding was reported by Benbow (2012) in an analysis of data collected from the longitudinal program, *Study of Mathematically Precocious Youth*, started by Julian Stanley in 1971. A high number of STEM professionals in that study reported that their talent and interest for a science career was solidified during late elementary school. Identifying young students with an affinity for STEM subjects and careers and supporting their interests with research-based interventions may be an important way to increase the number of STEM professionals in the workforce.

Natural curiosity is strong during early childhood, making this stage an ideal time to build a strong foundation for the relevance of STEM subjects and increase understanding of STEM careers. Although still viewing science as useful, students in late middle school and high school often report their desire to study science or pursue science-related careers has decreased significantly (George, 2006). Research also shows that late-secondary school students have formed strong opinions about STEM subjects and careers and time may be better spent on interventions with younger students more fluid in their thinking (Johnson et al., 2013; Turner & Ireson, 2010). Barmby et al. (2008) found a strong decline in science attitudes from grades 7 to 9, with girls' attitudes falling more than boys' attitudes. Although participants in that study did not devalue the importance of science, their interest in pursuing science outside of school or as a career diminished rapidly after elementary school. Likewise, Lindner et al. (2012) find the school years between elementary and high school to be a period in which attitudes toward science decline, and these authors lament the fact that middle school students especially too often eliminate STEM careers as options before they even know much about them.

A search for literature on implementing videos of scientists reveals studies in which videos have been used to educate students on various issues, and yet relatively few studies exist which have collected empirical data to measure the effectiveness of such an intervention on STEM attitude and career interest. For example, a qualitative study by Chen and Cowie (2013) used short video clips of scientists describing their work and daily responsibilities and then conducted interviews with students (ages 6-17) and teachers involved in nine classrooms. Although participants responded positively to the use of the videos, no data was collected to quantify the exact increase of attitude or interest toward STEM subjects and careers. Ware and Stein (2013) examined the impact of video vignettes of scientists on high school students and yet sought to differentiate between scientists as role models and scientists as mentors. The researchers made recommendations for implementing videos in STEM classrooms, but no evaluation of STEM professionals' influence on attitude or interest was made.

In a study by Wyss et al. (2012), videos of STEM professionals were created and then shown to middle school students over a period of 8 weeks. The study found a statistically significant increase in STEM career interest among participants within the first 4 weeks, and yet the effect size was very small. The instrument used in the study was developed by the researchers and had not been validated or proved reliable in previous research. Although the survey instrument contained 27 questions, the statistical results derived from just one Likert-scale statement on the survey: "I would consider being a scientist" (Huelskamp, 2010). The study was also conducted at one school and therefore the findings had limited generalizability.

Through personal communication with the principal researcher in the Wyss (2012) study, this researcher was able to obtain valuable information for modeling this research and expanding upon the findings. Through the use of a validated and reliable instrument, improved videos of STEM professionals, and a larger population, the current research sought to solidify the effect of videos of STEM professionals on middle school students. The specific methodology for carrying out this research will be discussed in the chapter to follow.

Summary

Current literature calls for interventions to address the loss of interest among students for STEM-subjects and careers, and there is much work to be done to grow the body of research related to these issues. Interventions that take advantage of curiosity from elementary years and bolster that openness during middle school may help reduce the rapid decline in STEM attitudes and career interests taking place before high school.

Addressing the related constructs in light of Gottfredson's (1981) Theory of Circumscription and Compromise will increase understanding of the best time to focus attention on supporting interest and whether males and females can be expected to differ on expected outcomes. Also, Gender Schema Theory and Intersectionality Theory provide context in which to consider the factors of gender and religion simultaneously. Hence, this study fills voids in extant research surrounding STEM-subject attitudes and STEM-career interest, specifically in conservative Protestant ranks, and it provides empirical support for the use of video interviews with STEM professionals as a curricular tool to affect change.

CHAPTER THREE: METHODS

The purpose of this quasi-experimental, nonequivalent control groups, pretest-posttest factorial design was to test Gottfredson's (1981) vocational theory of Circumscription and Compromise as it relates to the influence of career modeling on the STEM-subject attitudes and STEM-career interests of middle school students. Participants were given a pretest to determine existing levels of STEM-subject attitude and STEM-career interest. Subsequently, interviews with STEM career professionals were viewed by the participants, who were then tested again on measures of STEM-subject attitude and career interest toward STEM fields. Differences in pretest scores between groups were controlled during the statistical analysis.

This study was modeled after a similar study involving middle school students who viewed podcast interviews with STEM professionals (Wyss et al., 2012). While that study showed statistically significant increases in STEM career interest after viewing interviews, the effect size was small. Subsequently, the researchers in that study used their findings to create a new set of video interviews with STEM professionals. The new video interviews were professionally recorded and designed to use language more appealing to middle school students than the original videos (V. Wyss, personal communication, October, 2013).

Wyss described the small size of the study's sampling and a lack of diversity among participants as limitations of the original study (personal communication, October, 2013). An additional limitation to that research may have been the use of podcasts and personal electronic devices, which may have inadvertently increased interest in STEM professions due to the delivery medium rather than the podcast content. Therefore, the present study sought to refine that research and contribute to understanding of video interviews to increase STEM-subject attitude and career interest in several ways. First, this study used an instrument that had excellent validity and reliability. Second, personal electronic devices were purposefully not used in order to limit the potential for the medium of delivery to affect the participants' attitudes and interest. The use of a video recording was considered common-place, whereas personal electronic devices may not have been as typical and may have interacted with the treatment. Third, more population diversity was obtained by collecting data from six schools. Finally, the population chosen for the study was drawn from conservative, Protestant Christian schools in a Midwestern state. As a recommendation for further research, Wyss et al. (2012) suggested carrying out studies using video interviews with STEM professionals in diverse populations. The population in the current study has historically held unique views of science and scientists (Evans & Feng, 2013; Taber, 2013a), and therefore, the findings of this study were interpreted in light of the unique, conservative Protestant population.

The remainder of this chapter describes the research design, participants, setting, instrumentation, study procedures, and the statistical analysis.

Design

A quasi-experimental, non-equivalent control groups, pretest-posttest factorial design was implemented in this research. This design was chosen due to the lack of random assignment in the experiment that was carried out using pre-established, non-random groups occurring naturally in school settings (Gall et. al., 2007; Campbell & Stanley, 1963; Warner, 2013). The purpose of the design was to measure the effect of an intervention on one group while withholding the intervention from a control group (Creswell, 2009; Warner, 2013). As the intervention was able to be manipulated, the groups were non-randomized, and a pretest-posttest evaluation was planned to measure the effect, a quasi-experimental design was most appropriate (Campbell & Stanley, 1963).

This study used non-randomized groups drawn from a convenience sample, and at each site both the 7^{th} and 8^{th} grade science classes were part of the study. Four schools in this study had one section of 8^{th} grade science and one section of 7^{th} grade science, and two schools had a combined $7^{th}/8^{th}$ grade science class. In the schools with grade-level classes, one science class was assigned to the control group and the other to the treatment group, with the main considerations being equivalent size of groups and equivalent representation of grade level. Combined classes were assigned to the treatment group so that the intervention could be implemented at each school site.

The control group in this study was handled as a pure control group meaning that no level of the intervention was provided to its members and that no alternate treatment was administered (Gall et al., 2007; Shadish, Cook, & Campbell, 2002). Gall et al. (2007) suggest that the absence of an alternative treatment may increase certain threats to internal validity, namely: "experimental treatment diffusion, compensatory rivalry by the control group, compensatory equalization of treatments, and resentful demoralization of the control group" (p. 405). However, this study sought to measure participants' perceptions of STEM subjects and STEM careers after increasing knowledge on those topics through video interviews with real-life STEM professionals. It was feared that any alternate treatment to the control group may have affected the perceptions of group members about STEM subjects and careers, thus diminishing the overall effect attributed to the main intervention. In other words, it was desirable to keep the perceptions of the control group members completely unchanged and not risk tainting their opinions of STEM subjects, STEM careers, and STEM professionals. The ability to isolate the effect of the treatment on the experimental group was believed to outweigh the resultant threats to internal validity.

To reduce the aforementioned threats to internal validity caused by the absence of an alternate treatment, the control group members were informed that they would have an opportunity to view the video at the study's conclusion. This viewing by the control group took place after the posttest at the discretion of the participating teacher. The intervention, a 25-minute video of interviews with STEM professionals, was not believed to be such a dramatic treatment as to cause extreme resentment on the part of the control group. In addition, the science teacher(s) were asked not to discuss the video or its viewing with the control group until after the posttest. These measures were intended to reduce the threats to internal validity while isolating the main intervention to the highest extent possible.

Research Questions

The following research questions were proposed for this study:

RQ1: Is there a significant difference between the mean STEM-subject attitude scores of middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores?

RQ2: Is there a significant difference between the mean STEM-subject attitude scores of male and female middle school students while controlling for pretest scores?

RQ3: Is there a significant interaction between the mean STEM-subject attitude scores of male and female middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores?

RQ4: Is there a significant difference between the mean STEM-career interest scores of middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores?

RQ5: Is there a significant difference between the mean STEM-career interest scores of male and female middle school students while controlling for pretest scores?

RQ6: Is there a significant interaction between the mean STEM-career interest scores of male and female middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores?

Null Hypotheses

The following null hypotheses were proposed for this study:

$H_0$1: There is no significant difference between the mean STEM-subject attitude scores of middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores.

$H_0$2: There is no significant difference between the mean STEM-subject attitude scores of male and female middle school students while controlling for pretest scores.

$H_0$3: There is no significant interaction among the mean STEM-subject attitude scores of male and female middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores.

$H_0$4: There is no significant difference between the mean STEM-career interest scores of middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores.

$H_0$5: There is no significant difference between the mean STEM-career interest scores of male and female middle school students while controlling for pretest scores.

$H_0$6: There is no significant interaction among the mean STEM-career interest scores of male and female middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores.

Participants and Setting

The participants for the study were drawn from a convenience sample of middle school students selected from six Christian schools located in southeastern Michigan. The study took place at the beginning of the fall semester of the 2014-2015 school year. Christian schools were chosen for this study in order to gather more information about ways conservative Protestants view STEM subjects and STEM professionals. Each of the participating schools was considered to hold conservative Protestant values based upon correspondence with the school principal and personal familiarity of the researcher with the school through a statewide school association.

The data collection phase of the study took place during the months of August and September, 2014. The dates for the pretest, treatment, and posttest were coordinated with the science teachers at each school and depended heavily on school schedules and teachers' lesson planning. The researcher instructed that the data collection be performed during the months of August and September, with seven to ten days' time between the pretest and treatment and again between the treatment and posttest. This methodology implied the collection phase would last approximately three weeks.

The participating schools consisted of six private Christian schools with the students consisting of mostly middle-to-upper income students. Each school was either a member or closely affiliated with both the Michigan Association of Christian Schools and the American Association of Christian Schools, which is recognized by the U.S. Department of Education as a conservative Christian educational organization (NCES, 2008). The six participating schools were chosen because of the researcher's professional relationship with the school principals, the schools' proximity to the researcher, the principals' expressed interest in participating in the research project, and the principals' indication that the school was of conservative Protestant philosophy and belief.

Middle school science classes (7^{th} and 8^{th} grades) from the six schools were part of this study. The schools had a combined total of 177 students enrolled in 7^{th} and 8^{th} grades, 158 of whom provided usable data for this study. The classes from each school were placed into either the control group or the treatment group based on the number of students in each class. The desire to keep the control and treatment groups evenly matched in size was the main rationale for determining into which group each class was placed. Maintaining group equivalence was complicated by combined science classes at two schools as these classes were assigned to the treatment group so the intervention could be implemented at all sites. This procedure resulted in a control group with 61 participants and a treatment group with 97 participants. Table 3.1 provides assignments to the control and treatment groups at each school site.

Table 3.1

Control and Treatment Group Assignment and Size

School	Control Group	Treatment Group	Total
1	7^{th} (20)	8^{th} (21)	41
2	-	$7^{th}/8^{th}$ (27)	27
3	7^{th} (20)	8^{th} (19)	39
4	-	$7^{th}/8^{th}$ (17)	17
5	8^{th} (21)	7^{th} (16)	37
6	8^{th} (7)	7^{th} (9)	16
Total	68	109	177

Of the 177 potential participants of the study, five students opted out of the study and one student enrolled in school too late to participate. In seven cases, participant absenteeism led to either pretests or posttests not being completed on the date they were administered in the classroom. In six cases, collected data could not be used due to surveys not being completed correctly. These cases and the data screening procedures outlined in Chapter 4 reduced the number of participants to 158, making up 89.3% of the total number of 7th and 8th grade students from the six schools. The final sample was composed of 81 seventh grade students and 77 eighth grade students. Table 3.2 provides the final composition of groups by gender and grade level.

Table 3.2

Composition of Groups by Gender and Grade Level

	Male			Female			Total
	7th	8th	Total	7th	8th	Total	
Control	21	14	35	15	11	26	61
Treatment	19	25	44	26	27	53	97
Total	40	39	79	41	38	79	158

The study included a total of 79 males and 79 females with an average age of 12.5 years. The control group contained 35 males and 26 females, and the treatment group contained 44 males and 53 females. On both the pretest and posttest surveys, participants self-reported their gender, age, grade, and race. This information was collected to gather demographic data as well as to insure correct matching of pretests with posttests during data analysis. Table 3.3 provides information on age and grade distribution, and table 3.4 likewise provides the racial breakdown of the sample population.

Table 3.3

Age and Grade Demographics of Sample

Age	*N*	Percent	M	F	Grade 7	Grade 8
11	8	5.1	5	3	8	0
12	73	46.2	32	41	65	8
13	71	44.9	39	32	8	63
14	5	3.2	3	2	0	5
15	1	0.6	0	1	0	1
Total	158	100	79	79	81	77

Table 3.4

Racial Demographics of Sample

School	White	Black	Hispanic	Asian	Other	Total
1	29	4	1	2	3	39
2	24	0	0	0	0	24
3	28	2	2	2	2	36
4	13	0	0	0	1	14
5	30	1	1	1	0	33
6	11	1	0	0	0	12
Total	135	8	4	5	6	158
Percent	85.4	5.1	2.5	3.2	3.8	100

At schools 1, 2, 4, and 5, science classes used textbooks published by Bob Jones University Press®. At school 3, textbooks published by It's About Time Publishers® were used. Schools with individual grade-level science courses (schools 1, 3, 5, and 6) offered Life Science for 7th grade classes and Earth Science for 8th grade classes. The two schools with combined (7th/8th) science classes (schools 2 and 4) both offered Earth Science.

Instrumentation

The *STEM Semantics Survey*, developed by Tyler-Wood et al. (2010), was used as the pretest and the posttest in the study and was proctored by the individual classroom teachers before and after the intervention stage. The survey was administered as a paper and pencil survey (see Appendix A). Permission to use this instrument free of charge was granted through contact with one of the instrument's authors (see Appendix H). The authors of the instrument recommend this tool for both longitudinal studies as well as "snapshot analyses across groups" (Tyler-Wood et al., 2010, p. 360).

The *STEM Semantics Survey* served as the pretest and the posttest and measured the two dependent variables, STEM-subject attitude and STEM-career interest. The first four subscales of the instrument measured participant attitudes toward the four STEM subjects—science, technology, engineering, and mathematics. Scores on these four subscales was combined into a composite score to measure the first dependent variable, STEM-subject attitude. The fifth subscale of the instrument measured participant interest in STEM careers, and scores on this subscale were used to measure the second dependent variable, STEM-career interest. The instrument contained a total of 25 adjective differential items, 10 of which were reverse-worded items.

This survey instrument was developed through research on semantic differentials and uses adjective descriptors specifically geared toward the reading level of upper elementary and middle-school students (Tyler-Wood et al., 2010). This style of instrument, a semantic differential scale, is a type of Likert scale that "asks a person to rate a statement based upon a rating scale anchored at each end by opposites" (Rovai et al., 2013, p. 506). The instrument presents the participant with a statement such as "To me, Math is…" and then allows the participant to differentiate between two opposite adjectives on a scale of 1 to 7. There is a set of five adjective pairings for each subject of science, technology, engineering, mathematics, and one set of five adjective pairings for careers in a STEM field. The adjective opposites, such as interesting/boring and exciting/unexciting, evaluate a student's attitude toward STEM subjects and STEM careers.

Semantic differential instruments, such as the *STEM Semantics Survey*, often include reverse worded questions "to avoid inflation of scores because of yea-saying bias" (Warner, 2013, p. 1113). Yea-saying bias describes the tendency of test-takers to regress into a mode of agreement with questions regardless of the content, thus generating scores that are high but not truly indicative of thought-out responses (Warner, 2013). Reverse-worded questions increase the validity of the instrument by influencing the participant to evaluate each question carefully. As the *STEM Semantics Survey* contained reverse-worded questions, recoding of the reverse-worded items was necessary. Recoding procedures for reverse-worded items provided by Green and Salkind (2011) were followed so that all items were oriented in the same direction.

The content validity for the *STEM Semantics Survey* was evaluated by a research team involved in the *Middle Schoolers Out to Save the World* project through the University of North Texas, and several revisions were made to the adjective choices prior to the instrument's publication (Tyler-Wood et al., 2010). The construct validity for the *STEM Semantics Survey* was also analyzed through exploratory factor analysis and revealed that "the items targeted for assessing semantic perception of science, math, engineering, technology, and STEM career interests were most strongly associated with the intended construct in every case" (Tyler-Wood et al., 2010, p. 352).

In a study of middle school students, Tyler-Wood et al. (2010) reported internal consistency reliabilities of the five constructs ranging from Cronbach's Alpha of .84 to .93, which indicate a high to very high level of reliability (Rovai et al., 2013; Warner, 2013). Cronbach's Alpha is considered to be the best measure of internal consistency reliability for an instrument that contains a range of choices for answers (Rovai et al., 2013). In a more recent study of Elementary students and undergraduate teacher-education majors, Knezek et al. (2012) found Cronbach's Alpha scores for the *STEM Semantics Survey* in the technology construct of .72 and in the remaining four constructs ranging from .86 to .94, all within the range of high to very high reliability (Rovai et al., 2013; Warner, 2013). These two studies provide good evidence of the instrument's reliability as well as support for using the instrument with a variety of age groups. In summary, the *STEM Semantics Survey* has sufficient internal consistency reliability and evidence of content and construct validity to warrant its further use in assessing attitudes toward STEM subjects and interest in STEM careers.

Scoring of the *STEM Semantics Survey* pre-tests and post-tests in this study was conducted by the researcher. Pre-tests and post-tests were administered by classroom teachers and were retrieved personally by the researcher at each site. Demographic information and survey scores were coded and entered into a SPSS® spreadsheet. The four subscales measuring attitudes towards STEM subjects (science, technology, engineering, and mathematics) were tallied into an overall composite STEM-subject score. The fifth subscale measuring STEM-career interest was tallied separately. Each subscale contained five adjective differentials on a scale of 1 to 7. Therefore, the individual subscale scores can range from 5 to 35, allowing the STEM-subject composite score to range from 20 to 140. A score of 20 would indicate an overall negative attitude toward STEM subjects, while a score of 140 would indicate an overall positive attitude toward STEM subjects. The fifth scale, STEM-career interest, also contained five adjective differentials on a scale of 1 to 7, allowing for scores to range from 5 to 35. A score of 5 would indicate an overall negative interest in a STEM career while a score of 35 would indicate an overall positive interest in a STEM career.

Procedures

Upon obtaining Liberty University Institutional Review Board approval in April of 2014, the researcher contacted principals of seven schools in the southeastern region of the state of Michigan. These schools were affiliated with the Michigan Association of Christian Schools and the researcher had professional familiarity with the principals through that school association. The researcher explained the study, solicited each school's participation and inquired about the number of students enrolled in the 7th and 8th grade science classes. All seven school principals expressed interest in participating in the study.

Next, the researcher emailed the Principal Consent Form (See Appendix D) to each school principal asked that the form be signed, dated, and returned as soon as possible. All seven principals returned the signed forms indicating their interest and agreement that the study be conducted at their school. The researcher established contact with each school's science teacher(s) via email and telephone and explained the study's purpose, timeline, and the assistance that would be needed from the teacher. One teacher asked not to participate in the study due to scheduling constraints, leaving a total of six research sites. The researcher confirmed that teachers possessed a digital projector and computer in their classroom for viewing the video used in the study.

During the summer of 2014, the researcher confirmed the schedule for the intervention stage of the study by communicating with the science teachers. The intervention stage included distribution and collection of Parent Informed Consent forms and Child Assent forms, proctoring the pretest, establishing a time for the video to be shown, and proctoring the posttest. The schedule for the intervention stage included a 7-10 day gap between the pretest and intervention and between the intervention and the posttest.

During the first week of August 2014, the researcher sent teachers copies of the Parent Informed Consent form, the Child Assent form, the pretest and posttest, and a script for administering the pretest and posttest (see Appendices B, C, & G). For ease of organization, each document sent to the teacher was on colored paper with a different color used for each form. The researcher instructed the teacher to secure all completed documents in a locked location until retrieved by the researcher after the post-test.

The content of the video recording in this study was provided by Wyss (Wyss et al., 2012) through personal communication initiated by the researcher in July, 2013. In the Wyss et al. (2012) study, students' STEM career interest was measured before and after participants viewed several separate video interviews with STEM professionals over an 8 week period. After synthesizing the findings of the study, Wyss and associates (2012) recorded new video interviews with different STEM professionals through a commercial vendor and refined the interview questions based on earlier conclusions. The questions in the new interviews were designed to focus on the STEM professional's childhood background, work experiences, and the positive and negative aspects of their work (V. Wyss, personal communication, August, 2013). Wyss provided video recordings of eight STEM professionals to the researcher and gave permission for the videos to be edited and used to conduct further research. Interviewees were asked questions about their background, education, and job description. Interviewees ranged in age from approximately 25 to 50, and there appeared to be an age gap of approximately 15 years between six of the interviewees and the remaining two. The six younger interviewees appeared energetic and inspiring while the older two interviewees were less-engaging and less-interesting. The interviews with the two older individuals were also of lower sound and lighting quality than the interviews with the other interviewees. Therefore, the researcher determined to include the six higher-quality, younger-aged interviewees in a video compilation in order to present STEM professionals in as positive as a light as possible.

The researcher compiled the interviews into one 25-minute video using Microsoft Widows Live Movie Maker®. The video was organized by question with several interviewees responding to each question. The interviewees are employed in STEM professions and include a female Toxicologist, a male Chemical Researcher, a male Bioscientist, one male and one female Medical Technologist, and a male Wildlife Biologist. Brief biographical information for each interviewee is presented in Appendix I. The resultant video, *Interviews with STEM Professionals,* was used as the intervention in this study.

Approximately one week after the pretest, the researcher visited each treatment classroom to show the video. The researcher arrived at the school approximately 30 minutes before the scheduled class time and checked in at the school office. In the classroom, the researcher introduced himself and used a script for introducing the video (see Appendix G). After the video, the researcher thanked the class and teacher and left the school. The researcher continued to communicate with the teacher on the timeframe for administering the posttest and securing all materials until the researcher collected them. Once each school administered the post-test, the researcher returned to the school to collect all forms.

Analysis

In this study, null hypotheses 1 and 3 indicated a need to examine the mean levels of STEM-subject attitude and STEM career interest (dependent variables) between two groups that either did or did not receive the independent variable (viewing video interviews with STEM professionals). In addition, null hypotheses 2 and 4 indicated a need to examine whether a second independent variable, gender, influenced the dependent variables while the main independent variable was present. The presence of a confounding variable, pre-existing differences in levels of the dependent variables, necessitated a statistical analysis such as ANCOVA that would "adjust for relevant differences in study participants that exist at the start of the study" (Rovai et al., 2013, p. 317). Therefore, a quasi-experimental, non-equivalent control groups, pretest-posttest factorial design implementing a two-way ANCOVA data analysis was proposed for this research, and all null hypotheses were tested using two-way ANCOVA. The remainder of this section will describe the data analysis, provide a rationale for the use of two-way ANCOVA, and discuss statistical procedures that were followed.

Descriptive statistics of the sample were computed with SPSS 22® using data collected from the instrument (see Appendix A). These statistics included class populations, racial diversity, age, and the number of participants in the control and treatment groups. The mean scores and standard deviations on each subscale of the instrument were also evaluated.

The null hypotheses each were tested using two-way analysis of covariance (ANCOVA). In general, the ANCOVA analysis is most useful when randomization of participants is not practical or possible, as is often the case in educational research, and when the possibility exists that groups are different or non-equivalent (Campbell & Stanley, 1963; Creswell, 2009; Gall et al., 2007). The ANCOVA data analysis is especially useful as it allows researchers to compare the means of two groups to determine whether a statistically significant difference exists after the effect of a confounding or control variable is excluded (Rovai et al., 2013). The Two-Way ANCOVA with a pretest/posttest design is one of the most common methods for evaluating data in educational studies (Warner, 2013), and using a pretest as a covariate in this study allowed differences between groups on the dependent variables to be neutralized. A Two-Way ANCOVA analysis is appropriate when examining two continuous or categorical independent variables (Rovai et al., 2013; Warner, 2013) such as treatment and gender, as was the case in this study.

The researcher used SPSS 22® software to compile the data from the instrument. ANCOVA between groups has several assumptions which must be considered, and therefore, a preliminary data screening was conducted according to procedures and recommendations of current research texts such as Warner (2013), Rovai et al. (2013), and Green and Salkind (2011). This screening included examining histograms of data sets for normality of distribution, creating boxplots to test for extreme outliers, conducting Levene's testing for homogeneity of variances, and creating scatterplots to test for linearity. In addition to examining scatterplots, the homogeneity of regression assumption was tested statistically through univariate analysis.

Once assumptions were evaluated, Two-Way ANCOVA was conducted on the collected data due to the presence of two independent variables, interviews with STEM professionals and gender, among which an interaction effect may have been present and measurable. The significance level of $p < .05$ was used as an indicator of rejecting or accepting the null hypotheses, a standard which is typical in educational research (Gall et al., 2007; Warner, 2013). This significance level indicates a strong likelihood that the difference between two means is not due to chance, and this statistic can be further interpreted as a 95% confidence level that the null hypothesis being tested is untrue (Rovai et al., 2013). Effect size was measured as part of the ANCOVA using SPSS 22® and was described in terms of the partial Eta squared statistic when relevant. Rovai et al. (2013) suggest that effect size gives practical value to a study if statistical significance is found, and these authors argue that statistical significance alone is insufficient justification for an intervention being effective in real-world terms. Effect size gives the researcher an understanding of the extent to which a significant difference can be attributed to a treatment. In this study, the following threshold levels provided by Warner (2013) were used for interpreting the partial Eta squared statistic: small effect when η^2 is less than .010, medium effect when η^2 is between .022 and .059, a large effect when η^2 is between .083 and .138, and a very large effect when η^2 is above .168.

To test hypotheses 1 and 4, separate Two-Way ANCOVA tests were used to examine differences in mean STEM-subject attitude and mean STEM-career interest between those receiving the intervention and those not receiving the intervention. Levels of the two dependent variables were assessed using a pretest and were treated as the covariates in the ANCOVA. To test hypotheses 2 and 5, separate Two-Way ANCOVA's were used to examine the effect of gender on the mean levels of the dependent variables. Hypotheses 3 and 6 were likewise tested using Two-Way ANCOVA to determine whether an interaction effect was present. In all analyses, the pretest served as the covariate, the dependent variables were the composite score for STEM-subject attitude and the STEM-career interest score, and gender was the independent variable.

All data analysis was conducted using SPSS 22® and the findings from the study were reported to the participating principals who expressed interest in being informed of the results.

CHAPTER FOUR: FINDINGS

Research Questions

Six research questions were posed and their corresponding hypotheses were tested. The research questions are listed below:

RQ1: Is there a significant difference between the mean STEM-subject attitude scores of middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores?

RQ2: Is there a significant difference between the mean STEM-subject attitude scores of male and female middle school students while controlling for pretest scores?

RQ3: Is there a significant interaction between the mean STEM-subject attitude scores of male and female middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores?

RQ4: Is there a significant difference between the mean STEM-career interest scores of middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores?

RQ5: Is there a significant difference between the mean STEM-career interest scores of male and female middle school students while controlling for pretest scores?

RQ6: Is there a significant interaction between the mean STEM-career interest scores of male and female middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores?

Null Hypotheses

$H_0$1: There is no significant difference between the mean STEM-subject attitude scores of middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores.

$H_0$2: There is no significant difference between the mean STEM-subject attitude scores of male and female middle school students while controlling for pretest scores.

$H_0$3: There is no significant interaction among the mean STEM-subject attitude scores of male and female middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores.

$H_0$4: There is no significant difference between the mean STEM-career interest scores of middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores.

$H_0$5: There is no significant difference between the mean STEM-career interest scores of male and female middle school students while controlling for pretest scores.

$H_0$6: There is no significant interaction among the mean STEM-career interest scores of male and female middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores.

Descriptive Statistics

The data in the study was derived through the use of the *STEM Semantics Survey*, the authorship, reliability, and validity of which is discussed fully in Chapter Three. The survey contained five sections, four of which measured attitudes toward the four STEM subjects and one which measured interest toward STEM careers. Scores on the four STEM-subject constructs—Science, Technology, Engineering, and Mathematics—were compiled into one

STEM-subject attitude score while the STEM-career interest score stood alone, as was intended by the author (G. Knezek, personal communication, Oct. 15, 2014).

Seventh and eighth-grade students in six schools affiliated with the Michigan Association of Christian schools were given the survey, and participants were asked to complete the survey at the beginning of the study and again at the close of the study. The experimental group viewed a video-recording of interviews with STEM professionals after taking the first survey while the control group did not view the video until after taking the second survey.

Six middle school science classes (7^{th} and 8^{th} grade students) from six schools were used as the population for this study. The schools had a combined 7^{th} and 8^{th} grade population of 177 students. Two schools had combined science classes made up of 7^{th} and 8^{th} grade students while four schools offered separate grade-level science classes. The two schools with combined science classes were necessarily assigned to the treatment group for the sake of implementing the treatment at each research site. Science classes from schools with separate grade-level courses were assigned to either the treatment group or the control group based on class population. The goal of assignment was to keep the populations of the treatment and control groups as evenly matched as possible while allowing each research site to be part of the intervention.

Of the 177 potential participants of the study, five students opted out of the study and one student enrolled in school too late to participate. In seven cases, participant absenteeism from school led to either pretests or posttests not being completed on the date they were administered in the classroom. In six cases, collected data could not be used due to surveys not being completed correctly. The preceding cases and data screening procedures described below reduced the number of participants to 158, making up 89.3% of the total number of 7^{th} and 8^{th}

grade students from the six participating schools. The final sample was composed of 81 seventh grade students and 77 eighth grade students. See Table 4.1 for composition of groups.

Table 4.1

Composition by Group

	Males			Females			Total
	7th	8th	Total	7th	8th	Total	
Control	21	14	35	15	11	26	61
Treatment	19	25	44	26	27	53	97
Total	40	39	79	41	38	79	158

Scores for composite STEM-subject attitude had the potential to range from a low score of 20 to a high score of 140. Scores for STEM-career interest had the potential to range from a low score of 5 to a high score of 35. The mean STEM-subject attitude scores from the pretest and posttest are provided in Table 4.2 and the mean STEM-career interest scores are provided in Table 4.3.

Table 4.2

Descriptive Statistics for STEM-Subject Attitude Scores

Group	N	Pretest Mean	S.D.	Posttest Mean	S.D.	Mean Difference
M	79	104.53	18.85	104.03	21.82	-0.50
F	78	92.73	16.63	91.06	19.41	-1.67
CG	61	98.45	18.10	97.40	21.12	-1.05
M	35	102.14	19.09	101.11	21.20	-1.03
F	26	93.28	15.54	92.20	20.30	-1.08
TG	97	98.80	19.14	97.70	21.99	-1.10
M	44	106.43	18.66	106.34	22.28	-0.09
F	53	92.47	17.27	90.53	19.15	-1.94

Table 4.3

Descriptive Statistics for STEM-Career Interest Scores

Group	N	Pretest Mean	SD	Posttest Mean	SD	Mean Difference
M	7	24.53	7.48	24.56	7.14	0.03
F	7	22.45	7.36	22.19	7.25	-0.26
CG	6	23.37	7.86	24.20	7.10	0.83
M	3	23.43	7.29	24.29	6.61	0.86
F	2	23.28	8.74	24.08	7.87	0.80
TG	9	23.58	7.26	22.88	7.36	-0.70
M	4	25.41	7.59	24.77	7.60	-0.64
F	5	22.06	6.67	21.30	6.83	-0.76

Results

Data Screening

Data screening was conducted on the dependent variables and the covariate for data inconsistencies, outliers, and normality in keeping with procedures recommended by Warner (2013). To increase consistency, the researcher recruited an assistant to aid with data entry into SPSS®. The researcher visually and verbally verified the survey entries as they were read aloud by the assistant, thus reducing inconsistencies in data entry. Additionally, the researcher visually scanned the data after every 10 surveys were entered into SPSS® to ensure no unlikely or outlying responses were present.

During data entry, missing values were identified and procedures for entering neutral scores were followed (Warner, 2013). In the event that one and only one entry was missing from a survey section, a 4 (neutral score) was entered as the missing value. This technique for entering neutral values was performed on eight pretests and five posttests and allowed for surveys with minor omissions to be included. A survey was considered incorrect if it contained multiple entries per question or contained no entry for more than one question per section. Six surveys were completed incorrectly and were removed from the data set.

As the data was entered into SPSS® 22, the researcher was able to conduct an initial screening for outliers. On each question of the survey, participants chose a number between 1 and 7 to indicate their feelings about the various constructs. As the data was entered and visually scanned, no scores less than 1 or higher than 7 were discovered. Additionally, because the dependent variables and covariate were composite values, *z*-scores were used to screen for outliers. The standard for outliers was established as a z-score greater than 3.3 or less than -3.3 (Tabachnick & Fidell, 2007; Warner, 2013), and raw scores on the pretests and posttests for

STEM-subject attitude and STEM-career interest were converted to *z*-scores. This procedure revealed outliers for one participant, and that participant's scores were removed from the data set. Scatterplots were created to test for linearity in the collected data and these revealed the assumption of linearity to be tenable. Normality of distributions for the dependent variables of STEM-subject attitude and STEM-career interest were examined using the Kolmogorov-Smirnov test and through a series of histograms (Warner, 2013; Green & Salkind, 2011). No violations of normality were found for either independent variable on the dependent variable, STEM-subject attitude. Violations of normality were found for both independent variables on the dependent variable, STEM-career interest, and are discussed below.

Results for STEM-Subject Attitude

Assumption Testing

Two-Way ANCOVA required that three assumptions be met: normality of distribution, homogeneity of variance, and homogeneity of slopes. The normality of distributions was tested during data analysis and found to be tenable. The assumption of homogeneity of variances was examined using Levene's test, and no violation was found $F(3, 153) = 0.312$, $p = .817$. The homogeneity of slopes assumption was met, and the difference in slopes for the levels of the independent variables on the dependent variable were found not to be statistically significant for gender $F(1, 151) = .068$, $MSE = 107.71$, $p = .795$, partial $\eta^2 = .000$ or group $F(1, 151) = .163$, $MSE = 107.71$, $p = .687$, partial $\eta^2 = .001$.

Null Hypothesis One

The first null hypothesis states, "There is no significant difference between the mean STEM-subject attitude scores of middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores." This hypothesis addressed the first independent variable, group, on the dependent variable, STEM-subject attitude. A Two-Way ANCOVA was conducted, and the independent variable, group, included two levels, treatment and control. The dependent variable was the STEM-subject attitude posttest score, and the covariate was the STEM-subject attitude pretest score.

The Two-Way ANCOVA was not significant, $F(1, 152) = .000$, $MSE = 107.01$, $p = .988$, partial $\eta^2 = .000$. The means of the STEM-subject attitude posttest scores adjusted for initial differences were as follows across the two groups. The treatment group had a larger adjusted mean ($M = 97.65$) than the control group ($M = 97.62$). However, the differences in adjusted means did not differ significantly. Therefore, the first null hypothesis failed to be rejected.

Null Hypothesis Two

The second null hypothesis states, "There is no significant difference between the mean STEM-subject attitude scores of male and female middle school students while controlling for pretest scores." This hypothesis addressed the second independent variable, gender, on the dependent variable, STEM-subject attitude. A Two-Way ANCOVA was conducted, and the independent variable, gender, included two levels, male and female. The dependent variable was the STEM-subject attitude posttest score, and the covariate was the STEM-subject attitude pretest score.

The Two-Way ANCOVA was not significant, $F(1, 152) = .236$, $MSE = 107.01$, $p = .628$, partial $\eta^2 = .002$. The male group had a larger adjusted mean ($M = 98.07$) than the female group ($M = 97.20$). However, the differences in adjusted means did not differ significantly. Therefore, the second null hypothesis failed to be rejected.

Null Hypothesis Three

The third null hypothesis states, "There is no significant interaction among the mean STEM-subject attitude scores of male and female middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores." A Two-Way ANCOVA was conducted, and the independent variable, group, had two levels, treatment and control, and the independent variable, gender, had two levels, male and female. The dependent variable was the STEM-subject attitude posttest score, and the covariate was the STEM-subject attitude pretest score.

The Two-Way ANCOVA was not significant, $F(1, 152) = .263$, $MSE = 107.01$, $p = .609$, partial $\eta^2 = .002$. The means of the STEM-subject attitude posttest scores adjusted for initial differences were as follows: Treatment-Males ($M = 98.53$), Control-Females ($M = 97.63$), Control-Males ($M = 97.62$), Treatment-Females ($M = 96.77$). The interaction among adjusted means did not differ significantly. Therefore, the third null hypothesis failed to be rejected.

Results for STEM-Career Interest

Assumption Testing

Two-Way ANCOVA required that three assumptions be met: normality of distribution, homogeneity of variance, and homogeneity of slopes. Using the Kolmogorov-Smirnov test, a violation of normality was found for the treatment group on the dependent variable $F(1, 97) = .101$, $p = .015$). Using normality formulas provided by Warner (2013), the skewness of the treatment group data was found to be $z = -1.551$ and the kurtosis was found to be $z = -0.423$. Warner (2013) suggests that if z-values for both these measures fall between -1.96 and 1.96, the distribution may still be considered normal. Also, Rovai, Baker, and Ponton (2013) suggest that parametric tests such as ANCOVA are "considered to be robust to violations in the assumption of normality" (p. 224). This violation, although concerning, is not considered a serious threat to the validity of the ANCOVA, assuming other assumptions are met. The assumption of homogeneity of variances was examined using Levene's test, and no violation was found $F(3, 153) = 1.112$, $p = .346$. The homogeneity of slopes assumption was met, and the difference in slopes for the levels of the independent variables on the dependent variable were found to not be statistically significant for gender $F(1, 151) = .248$, $MSE = 22.58$, $p = .619$, partial $\eta^2 = .002$ or for group $F(1, 151) = .788$, $MSE = 22.58$, $p = .376$, partial $\eta^2 = .005$.

Null Hypothesis Four

The fourth null hypothesis states, "There is no significant difference between the mean STEM-career interest scores of middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores." This hypothesis addressed the first independent variable of group on the dependent variable of STEM-career interest. A Two-Way ANCOVA was conducted, and the independent variable, group, included two levels, treatment and control. The dependent variable was the STEM-career interest posttest score, and the covariate was the STEM-career interest pretest score.

The Two-Way ANCOVA was not significant, $F(1, 152) = 3.250$, $MSE = 22.541$, $p = .073$, partial $\eta^2 = .021$. The means of the STEM-career interest posttest scores adjusted for initial differences were as followed across the two groups. The control group had a larger adjusted mean ($M = 24.29$) than the treatment group ($M = 22.87$). However, the differences in adjusted means did not differ significantly. Therefore, the fourth null hypothesis failed to be rejected.

Null Hypothesis Five

The fifth null hypothesis states, "There is no significant difference between the mean STEM-career interest scores of male and female middle school students while controlling for pretest scores." This hypothesis addressed the second independent variable of gender on the dependent variable of STEM-career interest. A Two-Way ANCOVA was conducted, and the independent variable, gender, included two levels, male and female. The dependent variable was the STEM-career interest posttest score, and the covariate was the STEM-career interest pretest score.

The Two-Way ANCOVA was not significant, $F(1, 152) = .508$, $MSE = 22.541$, $p = .477$, partial $\eta^2 = .003$. The male group had a larger adjusted mean ($M = 23.86$) than the female group ($M = 23.30$). However, the differences in adjusted means did not differ significantly. Therefore, the fifth null hypothesis failed to be rejected.

Null Hypothesis Six

The sixth null hypothesis states, "There is no significant interaction among the mean STEM-career interest scores of male and female middle school students who view video interviews of STEM professionals and those who do not view the video while controlling for pretest scores." A Two-Way ANCOVA was conducted, and the independent variable, group, had two levels, treatment and control, and the independent variable, gender, had two levels, male and female. The dependent variable was the STEM-career interest posttest score, and the covariate was the STEM-career interest pretest score.

The Two-Way ANCOVA was not significant, $F(1, 152) = .349$, $MSE = 22.541$, $p = .556$, partial $\eta^2 = .002$. The means of the STEM-career interest posttest scores adjusted for initial differences were as follows: Control-Males ($M = 24.34$), Control-Females ($M = 24.24$), Treatment-Males ($M = 23.38$), Treatment-Females ($M = 22.35$). The interaction among adjusted means did not differ significantly. Therefore, the sixth null hypothesis failed to be rejected.

Summary

This chapter provided a description of the data collected in this study as well as the procedures for analyzing the data statistically. Data consisted of answers submitted by participants on a pretest and posttest regarding their attitude toward STEM subjects and their interest in STEM careers. The resultant analyses compared differences in posttest responses based upon treatment group and gender. Both descriptive and inferential statistics were reported, and ANCOVA was used for understanding differences between groups with the pretest serving as the covariate.

The main findings of the study were that participants in the treatment group did not have statistically significant increases in STEM-subject attitude or STEM-career interest when compared to the control group. Gender did not appear to influence scores from pretest to posttest as no statistically significant interactions were found between groups when controlling for gender. Likewise, group and gender did not appear to interact in the results of the posttest measuring the dependent variables. The conclusion can be made that no statistically significant differences in STEM-subject attitude or STEM-career interest appeared between participants who viewed video interviews with STEM professionals and those who did not. Table 4.4 summarizes the significance findings for each analysis of the six research questions.

Table 4.4

Summary of Findings for Research Questions and Null Hypotheses

Question	Null	*p*-value	Reject Null
RQ1	1 H_0	0.988	No
RQ2	2 H_0	0.628	No
RQ3	3 H_0	0.609	No
RQ4	4 H_0	0.073	No
RQ5	5 H_0	0.477	No
RQ6	6 H_0	0.556	No

Chapter Five analyzes the study's findings, relates those findings to the theoretical framework, addresses the limitations of the study, and makes recommendations for future research.

CHAPTER FIVE: DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Discussion

The purpose of this study was to investigate whether the viewing of interviews with STEM professionals by middle school students increased their attitude toward STEM subjects or their interest in STEM careers. A quasi-experimental, nonequivalent control groups, pretest-posttest factorial design was implemented to determine differences between students who viewed the interviews and those who did not. The study also examined differences in STEM-subject attitude and STEM-career interest between genders.

Research suggests that students in middle school are refining ideas about career goals and aspirations (DeWitt et al., 2011; Lindner, et al., 2012; Wyss, et al., 2012). However, young people often lack experiential knowledge of potential career paths, especially those in the STEM arena (Bardick et al., 2008). Females may especially be disinterested in or unaware of STEM careers, keeping them from pursuing occupations for which they may actually possess potential (Diekman et al., 2010). Practical experiences that expose young students to individuals in certain career paths have the potential to increase interest in those careers or at a minimum encourage positive attitudes toward those professions (Barmby et al., 2008; Hoh, 2009; Wyss, 2012).

This study sought to extend the work of Wyss et al. (2012) in which eight video-podcasts of STEM professionals were shown over an eight-week period to increase the STEM-career interest of middle school students. Those researchers found a significant difference in STEM-career interest after four weeks (midtest) and after eight weeks (posttest) but no significant difference from midtest to posttest. Following that study, Wyss et al. (2012) refined the questioning and filming processes and re-recorded interviews with STEM professionals in an attempt to increase the effectiveness of the intervention. Through personal communication with Wyss et al. (2012), the revised videos were obtained for this research study in order to test their effectiveness. The individual video interviews were compiled into one 25-minute video designed to be shown during one class period. Wyss et al. (2012) recommended the videos and future editions of the videos be evaluated in diverse populations, over varying time periods, and in conjunction with STEM attitude in order to determine the videos' effectiveness. This study sought to especially focus both on a unique population, middle school students in conservative Protestant Christian education, and on a shorter time frame for the intervention to be administered.

Six schools affiliated with the Michigan Association of Christian Schools volunteered to participate in this study. Four schools had separate, grade-level science classes for 7^{th} and 8^{th} grade students, and two schools had combined 7^{th} and 8^{th} grade science classes. Grade-level science classes from the schools with separate classes were assigned to either the control or treatment group while schools with combined classes were assigned to the treatment group. The control and treatment groups both took a pretest and a posttest, both consisting of the *STEM Semantics Survey*.

For the treatment group, the pretest was followed approximately seven days later by a viewing of the 25-minute video recording of interviews with STEM professionals. In this video, six individuals employed in STEM fields were asked questions about their jobs, experiences, and background. Approximately seven days after the intervention, the treatment and control groups both took the posttest, and after the posttest the control group was given an opportunity to view the video recording. Data collected on the pretest and posttest through the *STEM Semantics Survey* was analyzed using ANCOVA with the pretest score serving as the covariate. At each school, this process took place during the first several weeks of the 2014-2015 school year, and the pretest-intervention-posttest process was completed in approximately four weeks.

Findings for Research Questions One and Four

Research questions one and four focused on the impact of video interviews with STEM professionals on the STEM-subject attitude (RQ1) and STEM-career interest (RQ4) of middle school students. When comparing posttest scores on the *STEM Semantics Survey* for both STEM-subject attitude and STEM-career interest, no significant differences were found between the control group and treatment group on the posttest. Therefore, the first and fourth null hypotheses failed to be rejected. This result suggests that the viewing of video interviews with STEM professionals did not increase STEM-subject attitude or STEM-career interest over the pretest to posttest time period.

These results were in contradiction to Wyss et al. (2012) who found a significant difference in STEM-career interest after four weeks (midtest) and after eight weeks (posttest). This may suggest that for the treatment to be effective, the videos should be shown over a longer period of time. When a study is condensed, there is an increased risk of the treatment not having a full opportunity to make an impact (Bracht & Glass, 1968; Gall, et al., 2007). The duration of the treatment and the treatment's effect may interact differently as the timeline of a study is manipulated. A second consideration is that pretest sensitization may have caused participants to respond differently to the treatment than they may have without a pretest (Campbell & Stanley, 1963). In this case, the pretest may have diluted the effect of the treatment by raising participants' awareness of the dependent variables, STEM-subject attitude and STEM-career interest.

Finally, a statistical difference between the groups may not have been found because the control group was aware of the treatment being withheld from them. When a control group is aware of this inequity, members may exert non-typical effort to equate themselves with the group receiving the treatment. This tendency, the John Henry Effect, may cause the treatment to appear to have little effect when it may have otherwise produced results had the control group been less aware of the treatment (Gall et al., 2007; Rovai et al., 2013). In this study, participants were aware of the treatment due to the permission forms completed at the beginning of the study, and therefore, participants were aware of not receiving the treatment while another group at their school did receive it. At each school site, the 7th and 8th grade classes were taught by the same teacher, either in a combined setting or as separate classes. When the classes were assigned to either the treatment or control group, there is a good likelihood that the treatment was inadvertently discussed or described by the teacher in the presence of the participants in the control group. These factors may have contributed to the John Henry Effect, if it indeed was present.

As this study relates to Gottfredson's (1981) Theory of Circumscription and Compromise, the findings of this research neither support nor refute this theory. Gottfredson (1981) suggested that young students pass through phases of vocational aspirations in which they either strengthen interest in certain occupations or eliminate those career choices altogether. While this study did not show a significant increase in STEM-subject attitude or STEM-career interest, neither did this study show a significant decline in these dependent variables over the pretest to posttest time period. However, intuition suggests that the more vocational exposure and career education young people are provided, the better occupational decisions they are equipped to make (Ware & Stein, 2013). This study adds value to occupational and vocational research, although its evidence may be more anecdotal than empirical.

Findings for Research Questions Two and Five

Research questions two and five focused on the influence of gender on the STEM-subject attitude (RQ2) and STEM-career interest (RQ5) of middle school students. When comparing posttest scores on the *STEM Semantics Survey* for STEM-subject attitude and STEM-career interest, no significant differences were found between males and females on the posttest. Therefore, the second and fifth null hypotheses failed to be rejected. This result suggests that STEM-subject attitude and STEM-career interest were not influenced by gender over the pretest to posttest time period.

These results contradict some studies while aligning with others. Several studies show gender to be a strong predictor of STEM attitude and interest (Diekman et al., 2010; Hill, Corbett, & Rose, 2010; Miller & Kimmel, 2012; Smith, 2011; Smith, 2010; Watt, 2008). However, other studies have shown little difference between genders when comparing attitudes and interests in STEM subjects and careers (Else-Quest, Hyde, & Linn, 2010; Goldman & Penner, 2014; Stoeger, et al., 2013). An increased awareness of and commitment to closing the gender gap in STEM education in recent years may be partly to thank for any strides that have been made in making gender a non-issue, although there is still much work to be done (Spearman & Watt, 2013).

Because the videos in this study presented both male and female scientists, the effect of the treatment on each gender may not have been strong enough to elicit a response that was gender-specific. Unless a treatment is strongly geared toward a certain gender, it may be unreasonable to expect a gender discrepancy to surface in the final analysis (Britner, 2008;

Lindner et al., 2012; Kessels et al., 2014). The STEM professionals in this study consisted of four males and two females, and the video of these interviewees was organized by question rather than by individual. Had the video divided the professionals by gender or otherwise emphasized gender more strongly, the results for the gender analysis may have been more noteworthy. Wyss et al. (2012) did not find a significant difference between genders when video interviews were shown, and as the present research extends the Wyss et al. (2012) work, the lack of findings for gender in this study support the earlier findings of those researchers.

Findings for Research Questions Three and Six

Research questions three and six examined the interaction of group and gender on the STEM-subject attitude (RQ3) and STEM-career interest (RQ6) of middle school students. When comparing posttest scores on the *STEM Semantics Survey* for STEM-subject attitude and STEM-career interest, using the pretest as the covariate, no significant interaction was found between the independent variables of group and gender on the posttest. Therefore, the third and sixth null hypotheses failed to be rejected. This result suggests that neither STEM-subject attitude nor STEM-career interest were influenced by the viewing of video interviews with STEM professionals for males more than females, or vice versa, over the pretest to posttest time period. In essence, showing the videos neither helped nor harmed either group or gender in this context.

The finding of no difference between males and females across treatment and control groups solidifies the conclusion that gender did not play a role in this study. This finding is certainly related to the discussions above concerning the treatment (research questions one and three) and gender (research questions two and five). However, recent studies have also suggested that gender, although still a concern in STEM education, may not have as much of an influence on interventions as did several years ago (Ayalon & Livneh, 2013; Goldman & Penner, 2014). Although gender disparity in STEM is far from being a resolved issue, increased exposure to STEM for all students is helping to close the gender gap (Kanny, Sax, & Riggers-Piehl, 2014). This study lends support to the conclusion that gender may not influence interventions to the extent it once did.

Conclusions

The main conclusion of this study was that STEM-subject attitude and STEM-career interest were not increased by the viewing of video-recorded interviews with STEM professionals. This finding is contrary to the study of Wyss et al. (2012), mentioned above, in which a significant difference in STEM-career interest was found for participants after viewing podcasts of STEM professionals. This study differed from the Wyss et al. (2012) study mainly in its instrumentation and due to the interaction of length of measurement and treatment effect.

This study employed a widely-cited and validated instrument, the *STEM Semantics Survey*, to measure the effectiveness of the intervention. One limitation of the Wyss et al. (2012) study may have been the use of a weak or untested instrument to assess the value of the intervention. The conclusion could perhaps be drawn that the *STEM Semantics Survey* provided a more reliable and valid measurement of the effect (or lack thereof) of video-recorded interviews.

Perhaps the most noteworthy and influential variation between this study and the Wyss et al. (2012) study was the duration of the treatment. The relatively short duration of this study serves to support the literature's position that short-term studies tend to be unpredictable. In their meta-analysis of educational technology studies, seasoned authors Cheung and Slavin (2013) chose to exclude studies lasting less than 12 weeks because of the unreliable nature of such studies. These researchers suggest overly-artificial conditions and the "novelty factor" of short-term interventions cause results that are either inflated or untrustworthy (p. 5). Seeing duration of treatment as both an internal and external validity issue, Ross and Morrison (2014) suggest that while producing interesting findings on the surface, short-term studies lack robustness and practical significance. Applying these criticisms to this study and considering the lack of significant differences from pretest to posttest, the short-term nature of this study may have reduced the power of the intervention. If this were the case, a threat to the internal validity of the study may have been present due to the short-term nature of the treatment.

A secondary finding in this study was that gender did not appear to have a significant effect on STEM-subject attitude or STEM-career interest from the pretest to the posttest, a finding shared by Wyss et al. (2012). This finding contradicts other research in which gender has been shown to have an influence on attitude and interest toward STEM subjects (Archer et al., 2013; Brotman & Moore, 2008; Caleon & Subramaniam, 2008; Diekman, Clark, Johnston, Brown, & Steinberg, 2011). Males have been shown to have more positive attitudes toward STEM subjects in some settings and yet in other populations have shown little if any difference from females (Najafi et al., 2012; Suri & Sharma, 2013). Likewise, females have been found to exhibit lower attitudes toward STEM subjects and careers due to the perception that STEM pursuits are exclusively male. Remedies have been sought to ameliorate this misconception and to encourage females to reconsider STEM careers (Capobianco, Diefes-Dux, Mena, & Weller, 2011; Colvin, Lyden, & León de la Barra, 2012; Hirsch, Berliner-Heyman, Cano, Kimmel, & Carpinelli, 2011; Karatas, Micklos, & Bodner, 2011).

Implications

Research suggests that children often express interest in a STEM career field because of their knowledge of what a career path entails and their familiarity with those in the profession

(Colvin, Lyden & Leon de la Barra, 2012; Johnson, Ozogul, DiDonato, & Reisslein, 2013; Karatas, Micklos, & Bodner, 2011; Ware & Stein, 2013). Attitudes toward STEM subjects have been show to decline during the late elementary and middle school years (Bennett & Hogarth, 2009; Boe, Henriksen, Lyons, & Schreiner, 2011), and interest in school subjects is closely tied to attitude toward those subjects and careers (Reid, 2011). By helping young students be more aware of potential STEM careers through video interviews with STEM professionals, more students may feel compelled to pursue STEM degrees and careers themselves.

Both long-term interventions using podcast interviews with STEM professionals (Wyss et al., 2012) and short-term interventions using multimedia presentations (Johnson et al., 2013) have increased students' interest in STEM careers. In this study, no significant increases in STEM-subject attitude or STEM-career interest were observed when middle school participants viewed video recorded interviews with STEM professionals. However, this research does contribute to the knowledge base on STEM education in several important ways. First, this study was conducted in a population of students attending conservative Protestant Christian schools. Research in STEM education is lacking among religious schools (Bailey, 2012; Ceglie, 2012; Earwood & Suiter, 2012; Reiss, 2013; Wang & Degol, 2013), and this study helps close that gap by contributing to the literature in this area.

Second, research in STEM education that considers both gender and religion is lacking (Astley & Francis, 2010; Cho, 2012), and this study provides insight into the combination of these two components. As discussed in Chapter 2, Intersectionality Theory informs the hardships diverse groups in society experience in terms of the intersecting characteristics defining them (Knudsen, 2006). This research contributes to the literature base on Intersectionality Theory by examining STEM education at the intersection of gender, religion, and Protestantism. Calls for research in these specific areas have therefore been aided with this study.

Limitations

There were several threats to validity to be accounted for in this study, as articulated by Campbell and Stanley (1963) for all quasi-experimental research. First, to minimize the threat of multiple-treatment interference, the video recording of interviews with STEM professionals was viewed during one session, allowing the individual interviews to be analyzed as one treatment.

Second, the internal validity of the study was threatened by testing or pretest sensitization, which may have increased participants' sensitivity to the intervention and caused findings that would be different for those in the population not exposed to a pretest (Campbell & Stanley, 1963; Gall et al., 2007). Campbell and Stanley (1963) suggest that this threat becomes real when one test affects scores on a second testing. In this study, the pretest and posttest were identical forms, and given the short-term nature of this study, it is possible that participants recalled their selections on the pretest when they took the posttest. Therefore, a change from pretest to posttest may not have been discernible due to this threat. This situation could also be considered multiple-treatment interference and therefore a threat to external validity (Campbell & Stanley, 1963). In this case, the pretest may have had an effect that was not erasable before the taking of the posttest, and therefore participants' attitudes and interests were not purely measured with the posttest.

Finally, a threat to internal validity was selection threat which occurred due to the non-random nature of the sampling design. There is always a concern that non-random sampling will create groups which are not truly representative of the population (Gall et al., 2007). However, the homogeneity of the participants was enhanced through similar school philosophies, curriculum, and membership in a school association, thereby minimizing this threat (Creswell, 2009). In addition, this threat was minimized statistically by neutralizing differences among participants on the pretest through a covariate.

Several practical limitations were present in this study and may have also caused threats to internal and external validity. First, a threat to external validity should be noted in the limitation that the study took place within the first several weeks of the school year. Participants took the pretest during the first week of school in the fall semester. The video was shown about ten days after the pretest, and the posttest was taken ten days after the intervention. The fact that posttest scores actually declined slightly from pretest scores may indicate artificially inflated pretest scores due to the novelty effect of a new school term. At the beginning of the school year, participants may have been more eager to please and more enthusiastic toward school subjects than they would have been later in the school year. This study may have produced different results had it been conducted later in the year once participants were more acclimated to school.

Second, a lack of racial diversity among the participants was a limitation for this study. The population sample was 85% white, and perhaps while representative of this target population, this high percentage does not necessarily represent mainstream American education. A more diverse sampling may have produced different results and strengthened the external validity of this study.

Third, the internal validity of the study may have been weakened by a lack of gender and racial diversity among the interviewees. The video interviews consisted of 4 male professionals and 2 female professionals, and all 6 of these individuals were white. More diversity in both gender and race among the interviewees may have produced different results. The video interviews were graciously supplied to this study by Wyss and associates (2012) for the purpose of follow-up analysis. However, the videos contained content that was outside the control of the researcher in this study, and this limited the ability to manipulate the intervention fully.

Fourth, the findings of this study are limited in their generalizability due to the population sample. Participating schools were conservative Protestant Christians schools located in southeastern Michigan. Therefore, the results may not necessarily apply to students with different demographic, geographic, or religious characteristics, or to those attending schools with very different curricula. This threat to external validity must be weighed alongside any conclusions. Finally, a threat to internal validity existed in the study due to non-equivalent, preexisting groups. An effort was made to keep the treatment and control groups similar in size, yet equivalency in group demographics was marginalized by varying class sizes and combined classes. These factors caused the treatment (N = 97) and control (N = 61) groups to be non-equivalent in size and may have threatened internal validity. The use of the statistical technique ANCOVA made groups equal with respect to the control variable known as the covariate (Creswell, 2003), and in this study, pretest scores on the *STEM Semantics Survey* served in this capacity. The assumption was made that scores on the *STEM Semantics Survey* were an accurate estimate of the participant's attitude toward STEM subjects and interest in STEM careers.

Recommendations for Future Research

There are several areas related to this study in which additional research is desirable. First, it would be interesting to know if controlling for the gender of the STEM interviewees would produce different outcomes. The STEM professionals in this study consisted of four males and two females. However, as the literature suggests that females are inclined to avoid STEM pursuits, perhaps future video interviews should contain only female STEM professionals. Strengthening the intervention in such a way and obtaining a significant result may reveal the extent to which researchers must go to redirect the preexisting bent of female middle-schoolers back toward STEM pursuits.

Second, further research in STEM education within religious schools should be conducted to better understand the extent to which various ideologies within education affect student learning. Much research has been conducted in secular public education while relatively little has been carried out in religious schools. Yet even more scant are research designs which specifically compare STEM attitudes and career interests between public-school and religious-school students. Studies that consider both groups in one design, or in separate but similar designs, would close a research gap and contribute to the literature in a unique way.

Next, because engineering is often a misunderstood subject (Hirsch et al. 2011; Iskander & Kapila, 2011) and often avoided by females (Colvin et al., 2012; Diekman et al., 2010; Karatas, Micklos, & Bodner, 2011), future efforts should focus on educating middle school students, especially females, on engineering specifically. An intervention consisting solely of video interviews with female engineers should be created and tested for results to determine if the intersection of gender of the interviewee with the subject of engineering has a positive effect. More needs to be done to provide young students with high-quality, accurate information about the STEM subjects and the subsequent career opportunities that accompany them.

Finally, consideration should be given to conducting a similar study to this one using the *STEM Semantics Survey* but with different forms of the survey used for pretest and posttest. In this study, the pretest and posttest were identical forms, and given the short-term nature of the study, this may have contributed to the lack of significant differences. Alternate forms of the instrument would purify the measurement of differences from pretest to posttest and reduce the possibility of memories of the pretest influencing responses on the posttest.

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APPENDIX A: STEM Semantics Survey

STEM Semantics Survey

Name: ____________________

Date: ____________________

This five-part questionnaire is designed to assess your perceptions of scientific disciplines. It should require about 5 minutes of your time. Usually it is best to respond with your first impression, without giving a question much thought. Your answers will remain confidential.

What is your gender (circle one): Male / Female

How old are you? ___________

What grade are you in? __________

How would you describe your race/ethnicity? (circle one)

White Black Hispanic Asian Other: ______________

Instructions: Circle a number between each adjective pair to indicate how you feel about the object.

To me, SCIENCE is:

1.	**fascinating**	1	2	3	4	5	6	7	**mundane**
2.	**appealing**	1	2	3	4	5	6	7	**unappealing**
3.	**exciting**	1	2	3	4	5	6	7	**unexciting**
4.	**means nothing**	1	2	3	4	5	6	7	**means a lot**
5.	**boring**	1	2	3	4	5	6	7	**interesting**

To me, MATH is:

1.	**boring**	1	2	3	4	5	6	7	**interesting**
2.	**appealing**	1	2	3	4	5	6	7	**unappealing**
3.	**fascinating**	1	2	3	4	5	6	7	**mundane**
4.	**exciting**	1	2	3	4	5	6	7	**unexciting**
5.	**means nothing**	1	2	3	4	5	6	7	**means a lot**

To me, ENGINEERING is:

1.	**appealing**	1	2	3	4	5	6	7	**unappealing**
2.	**fascinating**	1	2	3	4	5	6	7	**mundane**
3.	**means nothing**	1	2	3	4	5	6	7	**means a lot**
4.	**exciting**	1	2	3	4	5	6	7	**unexciting**
5.	**boring**	1	2	3	4	5	6	7	**interesting**

Please continue answering questions on the back of this page:

To me, TECHNOLOGY is:

1.	**appealing**	1	2	3	4	5	6	7	**unappealing**
2.	**means nothing**	1	2	3	4	5	6	7	**means a lot**
3.	**boring**	1	2	3	4	5	6	7	**interesting**
4.	**exciting**	1	2	3	4	5	6	7	**unexciting**
5.	**fascinating**	1	2	3	4	5	6	7	**mundane**

To me, a CAREER in science, technology, engineering, or mathematics (is):

1.	**means nothing**	1	2	3	4	5	6	7	**means a lot**
2.	**boring**	1	2	3	4	5	6	7	**interesting**
3.	**exciting**	1	2	3	4	5	6	7	**unexciting**
4.	**fascinating**	1	2	3	4	5	6	7	**mundane**
5.	**appealing**	1	2	3	4	5	6	7	**unappealing**

Thank you for your time.
STEM v. 1.0 by G. Knezek & R. Christensen 4/2008

IRB Code Numbers: 1824.040314

IRB Expiration Date: 04/03/2015

APPENDIX B: Parent Informed Consent

PARENT CONSENT FORM

Title of study: The effect of video interviews with STEM professionals on STEM-Subject attitude and STEM-career interest of middle school students in Conservative Protestant Christian schools

Principal Investigator: Mr. Philip Alsup, Liberty University, Lynchburg, VA

Liberty University

Academic Department: Department of Education

Dear parent or guardian,

Your child is invited to be in a research study about Science, Technology, Engineering, and Mathematics education (STEM). This research involves viewing a brief video and completing a survey measuring attitudes and interest toward STEM subjects and careers. The survey asks for the student's name, grade, gender, and race and has questions about attitudes toward STEM subjects and STEM career interest. Your child was selected as a possible participant because he or she is enrolled in a school that is a member of the Michigan Association of Christian Schools. Please take a moment to read this form and ask any questions you may have before agreeing to have your child in the study. This study is being conducted by Philip Alsup, Principal at Springfield Christian Academy in Clarkston, MI, as a dissertation study for a Doctor of Education degree with Liberty University. Dr. Kurt Michael of Liberty University is the supervisor of the study. Your school principal has granted permission for this study to take place at your school.

Background Information:

The purpose of this study is to understand how viewing videos of scientists affects attitudes toward STEM subjects and STEM careers. The results of this study will help educators make informed decisions about the implementation of STEM curricula for the benefit of children such as yours.

Procedures:

If you agree to let your child to be in this study, he or she will be asked to do the following things:

1. Your child will be asked to return the signed Parent Consent form to his or her science teacher.
2. Your child will be asked to sign an assent form in which he or she will volunteer to take part in the study.
3. Your child will be given a brief survey to complete with a pencil during a regularly scheduled science class. The survey asks your child for his name, age, grade, race, and gender. All identifying information will be redacted once the study is completed to ensure confidentiality. The main portion of the survey asks questions about attitudes and interests related to STEM subjects and careers. Participants will make choices between two opposite adjectives describing STEM subjects and careers.
4. Seven to ten days after the survey is taken, some students will view a video lasting approximately 25 minutes in which STEM professionals are interviewed about their work. The video will be viewed with classmates during a regularly scheduled science class. After viewing the video, participants will complete the survey again to determine whether the video had an effect on attitude and interest toward STEM subjects and careers. Watching the video and completing the survey should take no more than 45 minutes. Participants who do not view the video will also be asked to complete the survey again and will be offered an opportunity to view the video at a later time.

Risks and Benefits of Being in the Study:
Watching the video and completing the survey does not cause any greater risk to students than would be encountered during typical school instruction. Non-participants may feel marginalized in this research process as an unintended consequence. Asking individuals to evaluate attitudes and interests can also invoke happy or unhappy feelings. However, these situations can also occur as part of the teaching and learning process under normal circumstances.

This research could slightly diminish the amount of time the student has to learn other science concepts, and yet viewing the video also contributes to your child's STEM learning. The researcher will work with your child's teacher to avoid interruption of critical times of lesson instruction. This study may benefit students by increasing understanding of STEM subjects and STEM careers. This research will help educators make informed decisions regarding the value and implementation of STEM curriculum.

Compensation:
Participants will not be compensated for enrolling in this research project.

Confidentiality:
The records of this study will be kept strictly confidential. Any published report will not include any information that will make it possible to identify a participant. Research records will be stored securely and only researchers will have access to the records.

A breach in confidentiality can only occur through signed signatures on the consent and asset forms and through participant names on the surveys. However, all documents will be secured in locked locations by your child's teacher and the researcher. Participant names will be redacted from the survey after its completion.

In order to protect student identities, the consent form, assent form, and the survey will not be stored together, further limiting the risk of breach of confidentiality. Signature forms and surveys will be secured in separate envelopes that have no means for personal identification. The data will be secured by the researcher for a minimum of three years. The aggregate data may be used for future writings and studies regarding STEM education. After completion of future writings and studies, the data will be shredded.

Voluntary Nature of the Study:
Participation in this study is voluntary. The decision whether or not to participate will not affect any current grades or relationship with his or her current school or with Liberty University. If you decide to allow your child to participate, he or she is free to not answer any question or withdraw at any time without affecting those relationships.

Contacts and Questions:
The researcher conducting this study is Mr. Philip Alsup who is being supervised by Dr. Kurt Michael of Liberty University. **You are encouraged** to ask any questions you have at any time by contacting these individuals at the following email addresses:
Philip Alsup: palsup@liberty.edu *Dr. Kurt Michael*: kmichael9@liberty.edu

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher(s), please contact the Liberty University Institutional Review Board, 1971 University Blvd, Suite 1837, Lynchburg, VA 24502 or email at irb@liberty.edu

(Please continue reading the back of this form)

PARENT CONSENT FORM

Please return only this page to your child's science teacher. You may keep the 1st page of this information for your records.

Statement of Consent:

I have read and understood the information provided on the research study through my child's science class. I have been given an opportunity to ask questions and have received answers to my questions (if applicable). I consent to having my child participate in this study.

Student's Name: ________________________________

Signature of parent or guardian: __________________________________ Date: ___________

Signature of Researcher: ____ Date: ___________

IRB Code Numbers: 1824.040314

IRB Expiration Date: 04/03/2015

APPENDIX C: Child Assent Form

Assent of Child to Participate in a Research Study

What is the name of the study and who is doing the study? My name is Mr. Philip Alsup and I am the Principal of Springfield Christian Academy in Clarkston, MI. I am conducting a research study with Liberty University on attitudes and career interest in Science, Technology, Engineering, and Mathematics occupations (STEM). I am supervised by Dr. Kurt Michael from Liberty University.

Why are we doing this study? As you may know, there is a national push for the promotion of STEM education. Understanding practical methods for increasing student learning in STEM subjects and promoting STEM careers are of concern to many educators. This study will help educators make informed decisions regarding the implementation and value of using videos to accomplish these goals.

Why are we asking you to be in this study? You are invited to be in this research study because you are attending a school in the Michigan Association of Christian Schools (MACS) where Mr. Philip Alsup is also a member. Mr. Alsup is a friend of your principal through MACS and asked him or her to help with this project. Several other students your age in MACS are also being asked to participate.

If you agree to participate, what will happen? You will be given a brief survey to complete with pencil and paper during science class. You may be asked to take the survey in a different area like another classroom or the library. The first part of the survey asks your name, age, grade, and gender. The second part of the survey asks you to rate your feelings or attitudes about science, technology, engineering, and mathematics as well as your interest in pursuing a career in one of those fields. The survey asks questions in which you will choose between two opposite adjectives describing these subjects and careers. This survey should not take more than 15 minutes.

You may also be invited to watch a 25-minute video in which several STEM professionals are interviewed and asked questions about their jobs. After the video, you will be asked to complete the second part of the survey again. If you are not part of the group viewing the video, you will also complete the second part of the survey again and will be given an opportunity to view the video later with your teacher. You may stop the survey anytime you wish.

Any information you provide during this study will not be shared with anyone, unless required by law. The results of this survey will be maintained by me, Mr. Philip Alsup. The results of this study will be published, but again, your identity will be kept anonymous.

(Please continue reading the back of this form)

Do you have to be in this study? No, you do not have to be in this study. If you do not want to be in this study, please tell the researcher or your teacher and do not sign this form. If you don't want to participate, it's OK to say no. The researcher and your teacher will not be upset with you. You can also say yes now and change your mind later.

Participation in the survey does not affect your grade in any manner. You will not receive any payment for your participation.

Do you have any questions? You can ask questions any time. You can ask now or later. You can talk to the researcher or your teacher. If you do not understand something, please ask the researcher to explain it to you again.

If you have any questions or if you would like to receive a final copy of the study results, please contact me at (248) 625-9760 or by email at palsup@liberty.edu If you or your parent has any questions about your rights as a participant, you may email the Internal Review Board at Liberty University at irb@liberty.edu.

Signing your name below means that you want to be in the study.

___________________________________ ____________________

Printed Name of Student Date

____

Signature of Student

____

Signature of Researcher

Please return this form to your science teacher. Thank you!

Researchers:
Mr. Philip Alsup at palsup@liberty.edu
Dr. Kurt Michael at kmichael9@liberty.edu
Liberty University Institutional Review Board
1971 University Blvd, Suite 1837, Lynchburg, VA 24502
email at irb@liberty.edu.

IRB Code Numbers: 1824.040314

IRB Expiration Date: 04/03/2015

APPENDIX D: Principal Consent Form

PRINCIPAL CONSENT FORM

Title of study: The effect of video interviews with STEM professionals on STEM-Subject attitude and STEM-career interest of middle school students in Conservative Protestant Christian schools

Principal Investigator: Mr. Philip Alsup

Liberty University

Academic department: Department of Education

Dear Sir or Madam,

Your school is invited to be in a research study examining how attitudes and career interests toward STEM subjects are impacted through video interviews with STEM professionals. You were selected as a possible participant school because of your affiliation with the Michigan Association of Christian Schools and your professional relationship to the researcher.

I ask that you read this form and ask any questions you may have before agreeing to be in the study. This study is being conducted by Mr. Philip Alsup, a doctoral student in the School of Education at Liberty University, and is supervised by Dr. Kurt Michael of Liberty University.

Background Information:

The purpose of this study is to understand how viewing videos of real-life scientists impacts middle school students' attitudes toward STEM subjects and STEM careers. There is a national push for STEM education, and understanding how students view science and related fields is of concern to many educators. This study will help educators make informed decisions regarding the implementation of STEM curricula and increase understanding of effective ways to promote interest in STEM, specifically in the realm of Christian education.

Procedures:

If you agree to allow your school to participate, 7th and 8th grade science students will be asked to do the following things:

1. Return a signed consent form from parents granting permission to participate. This form and instructions will be provided by the researcher and coordinated with middle school science teachers.
2. Sign a child assent form in which he or she will volunteer to take part in the study.
3. Complete a brief survey to with a pencil during a regularly scheduled science class. The first part of the survey asks the student for his/her name, age, grade, gender, and race. Part II of the survey asks questions about attitudes and interests related to STEM subjects and careers.
4. Some students will be asked to view a video in science class lasting approximately 25 minutes in which several STEM professionals are interviewed about their work. Students will then be asked to complete the survey again. Watching the video and completing the survey should take no more than 45 minutes. Students who do not view the video will also be asked to complete the survey again and will be offered an opportunity to view the video at a later time.

(Please continue reading the back of this form)

If you agree to allow your school to participate, science teachers for the 7th and 8th grade science classes will be asked to do the following things:

1. Meet with the researcher to discuss the research study details prior to the study beginning.
2. Proctor a survey called the STEM Semantics Survey. This survey will be given twice—once at the beginning of the study and once at the close of the study. The survey will take approximately 5 minutes to complete.
3. Allow class time to be used for the researcher to show a video lasting approximately 25 minutes.
4. Store parent consent forms, student assent forms, and survey forms securely until they are retrieved by the researcher.

Risks and Benefits of Being in the Study:

This study does not cause any greater risk to students than would be encountered during typical instruction in school. Non-participants may feel marginalized in this research process as an unintended consequence. Asking individuals to evaluate attitudes and interests can also invoke happy or unhappy feelings. However, these situations can also occur as part of the teaching and learning process under normal circumstances.

Taking the survey during scheduled and planned lesson time could diminish the amount of time the student has to learn science concepts, and yet viewing the video also contributes to students' STEM knowledge and learning. The researcher will work with the teacher to avoid interruption of critical times of lesson instruction**.**

This study may benefit students by increasing their understanding of STEM careers. This survey will help educators make informed decisions regarding the value and implementation of STEM curriculum.

Compensation:

Participants will not be compensated for enrolling in this research project. Several teachers from your school will be asked to help with this research and will be given a $25 gift card for their time and assistance.

Confidentiality:

The records of this study will be kept private. Any published report will not include any information that will make it possible to identify a participant. Research records will be stored securely and only researchers will have access to the records. Personal identification information will be collected, including parent signatures on the consent form, student signatures on the assent form, and participant names on the survey. A breach in confidentiality could occur from signatures on the consent and asset forms or through written names on the survey. However, all signed forms and documents with personal information will be secured in locked locations both during and after the study. The signature forms and surveys will be sealed in envelopes and personal identification information will be redacted and coded once collected. The data will be secured by the researcher for a minimum of three years. The aggregate data may be used for future writings and studies regarding STEM education. After completion of future writings and studies, the data will be shredded.

Voluntary Nature of the Study:

Participation is voluntary. Participants are free to not answer any question or withdraw at any time.

(Please continue reading the back of this form)

Contacts and Questions:
The researcher conducting this study is Mr. Philip Alsup who is being supervised by Dr. Kurt Michael of Liberty University. **You are encouraged** to ask any questions you have at any time by contacting these individuals at the following email addresses:
Philip Alsup: palsup@liberty.edu *or* mr.alsup@scaeagles.org
Dr. Kurt Michael: kmichael9@liberty.edu

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher(s), please contact the Liberty University Institutional Review Board, 1971 University Blvd, Suite 1837, Lynchburg, VA 24502 or email at irb@liberty.edu

Please return only one signed form. Keep the 2nd copy of this information for your records.

Statement of Consent:

I have read and understood the above information, and I have been given an opportunity to ask questions and have received answers to my questions (if applicable). I consent to having my school participate in this study and am authorized to do so.

Name of School: ____

Printed Name of Principal: ________________________________

Signature of Principal: ___________________________________ Date: _______________

☐ **I would like to be informed of the results of this study**

IRB Code Numbers: 1824.040314

IRB Expiration Date: 04/03/2015

APPENDIX E: IRB Approval Letter

LIBERTY UNIVERSITY.
INSTITUTIONAL REVIEW BOARD

April 3, 2014

Philip R. Alsup
IRB Approval 1824.040314: The Effect of Video Interviews with Stem Professionals on Stem-Subject Attitudes and Stem-Career Interest of Middle School Students in Conservative Protestant Christian Schools

Dear Philip,

We are pleased to inform you that your above study has been approved by the Liberty IRB. This approval is extended to you for one year. If data collection proceeds past one year, or if you make changes in the methodology as it pertains to human subjects, you must submit an appropriate update form to the IRB. The forms for these cases were attached to your approval email.

Please retain this letter for your records. Also, if you are conducting research as part of the requirements for a master's thesis or doctoral dissertation, this approval letter should be included as an appendix to your completed thesis or dissertation.

Thank you for your cooperation with the IRB, and we wish you well with your research project.

Sincerely,

Fernando Garzon, Psy.D.
Professor, IRB Chair
Counseling

(434) 592-4054

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APPENDIX F: Teacher Pre-Test and Post-Test Instructions

Teacher Pre-Test and Post-Test Instructions

The *STEM Semantic Survey* is used in this research project to collect data from the participants on their ideas about STEM subjects and careers. The survey is given at the beginning of the study (pre-test) as well as at the end of the study (post-test).

1. The Pre-test should be given 7 days before the video will be viewed.
2. The Post-test should be given 7 days after the video has been viewed.
3. The study will be completed within approximately 3 weeks.

Dates for each task should be the same for both control and treatment groups:

Pre-test (both groups): ____________

Show video (treatment group only): ____________

Post-test (both groups): ____________

All forms collected by researcher: ____________

- **Pre-Test Instructions:** Please read this paragraph word-for-word to the students:

"Recently, I discussed with you a study we have been invited to take part in. This study looks at science, technology, engineering, and mathematics (also known as STEM) and what middle school students think about those subjects and careers. A few weeks ago, I sent two forms home with you—one of them to be signed by your parents and one to be signed by you. If I have received those signed forms back from you, then today you will be taking a brief questionnaire as part of the study. Here are a few things to remember as you take the survey:

1. *Please <u>do not</u> write your name on the survey. Only supply the information that is asked for.*
2. *Please read the instructions carefully before starting and do not talk during the survey.*
3. *Read each question and statement carefully and then darken in the number between the two adjectives that best describes your feelings.*
4. *This survey will not affect your grade. Please just answer each question honestly.*

Once I see that everyone has finished, I will collect the surveys. I will now distribute the surveys, and you may begin."

Once students have finished the survey, please collect surveys and store them in a locked location in the envelope provided.

<u>Post-Test</u>: Please be sure each student has the correct form of the survey—check the Coding List before distributing the surveys

- **Post-Test Instructions:** Please read this paragraph word-for-word to the students:

"A few weeks ago, we took a survey about STEM subjects and careers as part of a research study. Today, we are going to take the survey again so that the data for the study is complete. Let me repeat a few quick instructions before we take the survey:

1. *Please <u>do not</u> write your name on the survey. Only supply the information that is asked for.*
2. *Please read the instructions carefully before starting and do not talk during the survey.*
3. *Read each question and statement carefully and then darken in the number between the two adjectives that best describes your feelings.*
4. *This survey will not affect your grade. Please just answer each question honestly.*

Once I see that everyone has finished, I will collect the surveys. I will now distribute the surveys, and you may begin."

Once students have finished the survey, please collect surveys and store them in a locked location in the envelope provided

IRB Code Numbers: 1824.040314

IRB Expiration Date: 04/03/2015

APPENDIX G: Script for Video Viewing

Script for Video

Before the video:

"Hello, my name is Mr. Philip Alsup, and I am the principal at Springfield Christian Academy in Clarkston, MI. I am conducting a research project with Liberty University as a doctoral student. I have been in touch with your teacher about a research project I'm doing on middle school students and their ideas about careers in science, technology, engineering, and mathematics. This field is also sometimes referred to using the acronym S-T-E-M, or "STEM". Today I'll be showing you a DVD called "Interviews with STEM Professionals". This DVD was made to help students your age understand a little more about what people in science, technology, engineering, and mathematics jobs do each day. In this video, you will hear from a Toxicologist, a Chemical Researcher, a Bioscientist, a Medical Technologists, and a Wildlife Biologist. They will describe to you the things they do in their jobs, the skills a person needs to do their job, and what they dreamed about being when they were a kid. The video lasts about 25 minutes, and I think you will enjoy it. Let's get started."

After the video:

"I hope you enjoyed the video. I appreciate your good attention and your time today. I'd also like to thank Mr./Mrs./Ms.[teacher] for allowing me to visit your class. Have a great day and thanks again!"

IRB Code Numbers: 1824.040314

IRB Expiration Date: 04/03/2015

APPENDIX H: Author Permission for Use of STEM Semantic Survey

Philip Alsup <palsu979@ Sat, Oct 26, 2013 at 1:23 PM
To: gknezek@

My name is Philip Alsup and I am a doctoral candidate at Liberty University. My dissertation topic involves STEM-career interest in middle school students.

I would like to request permission to use your survey instrument, Career Interest Questionnaire, in my dissertation study. I read about this instrument in the article, Instruments for Assessing Interest in STEM Content and Careers, published in the Journal of Technology and Teacher Education (2012).

I appreciate your time and consideration. Thank you.

Philip Alsup
palsu979@

Gerald Knezek <gknezek Sun, Oct 27, 2013 at 9:38 AM
To: Philip Alsup <palsu979@
Cc: Rhonda Christensen <rhonda.christensen@

Hi Philip,

You have our permission to use the STEM Semantics Survey and the Career Interest Questionnaire in your dissertation research.

We only ask that that you cite the authors on the instrument when you use them, and that you inform us of your findings from your study.

Best Regards,

Gerald Knezek
Regents Professor of Learning Technologies, University of North Texas
http://courseweb.unt.edu/gknezek

STEM Semantics Survey

Gerald Knezek <gknezek@ Mon, Feb 23, 2015 at 10:38 PM
To: Philip Alsup <palsu979@
Cc: Rhonda Christensen <rhonda.christensen@

Hi Philip,

As long as you put the credits to the authors on the instrument itself when you reproduce, it should be fine.

You have our permission. We also like to publish the instrument that was used to gather the data with the writeup in our studies.

I am CCing the Co-author Dr. Christensen.

Regards,
Gerald Knezek

On Mon, Feb 23, 2015 at 8:14 PM, Philip Alsup <palsu979@

> Dr. Knezek,
> Do I have your permission to reproduce the STEM Semantics Survey in my dissertation manuscript? The dissertation will be published through Liberty University.
>
> Thank you for your time.
> Philip Alsup

APPENDIX I: Biographical Information for Interviewees

Provided through personal correspondence with Vanessa Wyss

Tim Carter: Ph.D. in Zoology from Southern Illinois University in Carbondale; currently an associate professor of Wildlife Biology at Ball State University.

Faith Musko: Professor at Waynesburg University; B.S. from Waynesburg University; M.S. from the University of Central Oklahoma. At the time of the recorded interview, Faith Musko was employed as a toxicologist.

Kevin Shanks: Certified forensic toxicology specialist with the American Board of Forensic Toxicology (ABFT); B.S. in Biology from Franklin College; M.S. in Forensic Toxicology from the University of Florida's Veterinary School of Medicine.

Michael Pugh: Bioanalytical Scientist at Endocyte in Lafayette, IN.; B.S. in Biology from Wabash College. At the time of the recorded interview, Michael Pugh was employed as a Bioscientist with AIT Bioscience, LLC.

Chris Malek: Medical Technologist at Indiana University Health; B.S. in Medical Technology from Purdue University.

Amanda Stone: Medical Technologist at Indiana University Health; B.S. in Medical Technology from Purdue University.