The Rural Effect: How Male and Female Students' STEM Perceptions are Influenced by Attending a Rural Georgia High School

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ABSTRACT

This mixed-methods study was designed to examine the perceptions of students from a rural area regarding Science, Technology, Engineering, Mathematics (STEM), and STEM careers. STEM perceptions of high school students from a rural setting were determined using the STEM Semantics Survey. Survey results were analyzed to determine the mean ratings for each of five scales (Science, Technology, Engineering, Mathematics, and Careers in STEM) and to determine similarities and differences in female and male STEM perceptions. Results of a MANOVA indicated that males had statistically significantly more favorable perceptions of STEM and STEM careers overall. Independent samples *t*-test results for each scale indicated that the significant difference in female and male STEM perceptions was driven by the large difference on the Engineering scale. Females perceived engineering significantly less positively than did males, though females did have a slightly more positive perception of the field of Mathematics than did males. College students who attended the same rural high school as the high school student participants also completed the STEM Semantics Survey. Results of the survey were used to develop interview questions for the college students. Interview data from the college students revealed strong beliefs that, because they attended a rural high school, they had fewer, less engaging, and less rigorous STEM experiences than college students they knew who had attended more urban high schools. This rural effect permeated all discussions of their STEM perceptions. Having few STEM role models in their community, limited STEM resources in their school and community, and a community that did not place a high value on STEM were mentioned by college students as influencing their perceptions of STEM and STEM careers.

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Chapter I

INTRODUCTION

The recent rise in the economic and technological prowess of China and India coupled with the perceived decline in America's position in the world has led to calls by America's business, scientific, and political leaders to increase American schools' emphasis on and achievement in science, technology, engineering, and mathematics (Bush, 2006; Ellias, 2011; King, 2016; Obama, 2011). The concern these leaders expressed is that without increasing the number of Americans who enter careers related to science, technology, engineering, and mathematics (referred to by the acronym STEM), America will fall behind other nations. United States Secretary of Education John King, Jr. wrote in *USA Today* that tomorrow's American innovators should be provided hands-on opportunities to fabricate their own creations as a means for motivating students to achieve at high levels in STEM and developing vital attributes such as problem solving, imagination, self-efficacy, and collaboration (King, 2016). In the 2011 State of the Union address, President Obama (2011) discussed the increased emphasis in China and India on mathematics and science education and the United States must do so as well in order to stay competitive. President Obama challenged Americans to be at the forefront of innovation and stated that the United States government has historically helped to provide aid to scientists and innovators. He pointed out that "In America, innovation doesn't just change our lives. It is how we make our living" (Obama, 2011). President Obama linked innovation to education when he asserted that in

order for America to continue to be a leader in research and technological innovation, education must be a priority and he expressed a concern that the nation's mathematics and science education must be improved. He also called for a cultural shift in America that could lead Americans to embrace the idea that "it's not just the winner of the Super Bowl who deserves to be celebrated, but the winner of the science fair" (Obama, 2011).

President George W. Bush also called for more funding for STEM education in the 2006 State of the Union Address. He announced an initiative "to encourage innovation throughout our economy, and to give our nation's children a firm grounding in math and science" (Bush, 2006). He also called for increased funding for training mathematics and science teachers and for bringing more people into the teaching field for mathematics and science. President Bush stated that the initiative to improve mathematics and science education could lead to an increase in American competitiveness among other nations of the world. The last two American presidents touting the importance of innovation in the American economy and improvement in STEM education suggested that STEM education was an issue that goes beyond the school house doors. Rather, STEM education is vital to America's continued position as a world leader.

The importance of STEM has received attention from the media as well. While Presidents Bush and Obama suggested that STEM education is vital to the nation's prosperity, a *USA Today* article touted STEM skills as being vital to individual prosperity. A 2011 United States Commerce Department study found that STEM jobs paid on average 26% higher than other jobs and that the number of STEM jobs increased three times faster than other jobs during the last decade (Davidson, 2011). The article

reported a 17% forecasted growth in STEM jobs from 2008 to 2018. A *USA Today* article from October 11, 2011 stated that STEM is vital to encouraging innovation in America (Elias, 2011). The author called on industry and civic groups to promote STEM education among under-represented groups, including women. These recent articles in popular media outlets supported a conclusion that STEM education was a topic that extended beyond the world of education. Rather, the necessity of STEM education became a part of a national conversation about America's place in the world economy, its ability to innovate, and its competitiveness.

Academic literature about STEM demonstrated the importance of STEM education. The National Science Board (2006) asserted that there is a growing need for an emphasis on STEM because the workplace was changing to one in which skills related to science, technology, engineering, and mathematics were increasingly required. This need to bring more people into STEM fields made the low number of females pursuing careers in STEM a concern (Morganson, Jones, & Major, 2010). The National Science Foundation (2014) reported that fewer than 20% of undergraduate degrees in physics, engineering, and computer science are awarded to women. The United States Congress has been interested in increasing the number of females in STEM fields for three decades (Alvarez, Edwards, & Harris, 2010). Yet, female students have historically been less inclined to pursue careers in STEM fields than male students. Recent data (National Center for Educational Statistics, 2009) showed that despite earning 57% of the bachelor's degrees awarded by colleges in the United States, female students earned fewer degrees than males in STEM related fields. Tyson, Lee, Borman, and Hanson (2007) found that female high school students who took difficult mathematics and

science courses did not pursue STEM degrees in college at the same rates as their male counterparts. According to the 2009 Lemelson-MIT Invention Index, over half of the students surveyed were reluctant to pursue STEM careers, less than 20% believed scientists provide the largest contribution to society, and 5% believed engineering provides the largest contribution to society (Perry, 2010).

Because females are under-represented in STEM, determining how their perceptions compare to males was at the forefront of this study. The need for more people to enter STEM fields in order for America to remain competitive in the global economy and the realization that females are underrepresented in STEM fields suggested a need to study female students' perceptions of STEM careers and what can be done to increase their interest in STEM. The President's Council of Advisors on Science and Technology (2011) reported that "too many American students conclude early on that STEM subjects are boring, too difficult, or unwelcoming" (p. 33).

In a broad sense, this study was developed to determine the difference in the perceptions male and female students have about STEM. More specifically, the focus was on the students from a single high school in a rural setting in the southern part of the state of Georgia. Within the context of a rural setting, the perceptions of male and female high school and college students were compared along with the manner in which being from a rural part of the state impacted the STEM perceptions of college students who graduated from the rural high school.

Conceptual Underpinnings for the Study

To warrant educational research of STEM perceptions, it was necessary to establish how this topic relates to education. The rationale that studying students'

perceptions of STEM and the methods that can be used to increase their interest in STEM is important in the field of education as it relates to the social efficiency ideology of curriculum and instruction. One aspect of social efficiency ideology relevant to this study was that it emphasized preparing students for careers and for roles that are needed by society at large (Knoll, 2009). As described earlier, STEM professionals are needed to perform important roles in society. Thus, it is necessary to understand the STEM perceptions that students hold and to examine what impact attending a rural high school might have those perceptions. Teachers at all levels of education, school administrators, education policy makers, members of the business community, and practitioners of STEM-related careers could find value and interest in research such as this.

A theoretical base for this study is the social cognitive theory of Bandura. Part of social cognitive theory is the idea of self-efficacy which Bandura (1982) identified as being "concerned with the judgments of how well one can execute courses of action required to deal with prospective situations" (p. 122). His idea of self-efficacy formed the basis for studying STEM perceptions in prior research. Britner and Pajares (2006) based their research on the development of students' self-efficacy in science on social cognitive theory, because "self-efficacy has been found to be a strong predictor of academic achievement, course selection, and career decisions across domains and age levels" (p. 485). With self-efficacy impacting course selection and career choices, it is relevant to the topic of students' perceptions of STEM. As self-efficacy formed the basis of social cognitive theory (Zeldin, Britner, & Pajares, 2008), it is relevant to the study of students' perceptions of STEM. There is literature suggesting that lack of interest in STEM for female students has more to do with beliefs of self-efficacy and a willingness

to persevere than with actual achievement (Kurtz-Costes, Rowley, Harris-Britt, & Woods, 2008; Morganson, Jones, & Major, 2010).

Zeldin et al. (2008) suggested that people choose to engage in activities they believe that they can successfully accomplish and avoid those activities in which they believe they are less skilled. This was an important basis from which to explore the perceptions students hold of science, technology, engineering, and mathematics. Further, Zeldin et al. (2008) found contrasting self-efficacy beliefs between males and females who were successful in STEM careers. They found that female STEM professionals tended to rely on a social network of family, colleagues, and teachers to build the self-confidence needed to persevere in a STEM career, while males used the social network only to reinforce the confidence they already possessed. Zeldin et al. (2008) reported that male's self-efficacy came primarily from mastery experiences rather from social support. Morganson et al. (2010) found that female undergraduate STEM majors used social coping strategies more frequently than their male peers in order to persevere in STEM majors.

Statement of the Problem

Not enough is known about the effect growing up in a rural area has on students' perceptions of STEM. It is unknown whether perceptions of STEM are higher for students in areas with large populations that have more access to STEM professionals as mentors and role models than for students in rural areas where few STEM professionals live. In this study, the differences in perceptions of STEM held by male and female students who attend high school in a rural area and the impact the rural effect had on the perceptions of STEM held by current college students who graduated from a rural high

school are examined. All the participants, both from the high school group and the college group, were enrolled in mathematics or science classes that were the most rigorous offered at their high school.

While perceptions of STEM by undergraduates have been studied quantitatively, deeper understanding of STEM perceptions held by students who attended rural high schools has not been developed. Qualitative data from male and female undergraduates, those in STEM majors and those not in STEM majors, would add to the literature by providing a clearer picture of similarities and differences of STEM perceptions of male and female undergraduate students than through quantitative means alone. Qualitative data were collected in order to examine the STEM perceptions held by undergraduate students, both STEM majors and non-STEM majors, who attended a rural high school. The college students who participated in the study graduated from the same high school as the high school students who participated in the study attend.

One reason a rural focus is important is because of a lack of research about STEM as the field pertains to rural areas. Hartman (2013) noted the lack of research devoted to rural education in general, Waters, Howley, and Shultz (2008) identified a lack of rural mathematics education research, and Avery (2013) mentioned a lack of research on rural science education. Waters et al. (2008) reported that while mathematics education has been studied extensively, "the quantity devoted to rural issues is meager indeed" (p. 128). Avery (2013) pointed out that the amount of science education research devoted to rural and urban locales was not proportional to the number of students living in rural and urban areas.

Another reason a rural focus is important is because rural students face challenges that students in urbanized areas do not. For example, rural students may have fewer educational resources available to them than urban students (Avery, 2013; Boynton & Hossain, 2010; Khattri, Riley, & Kane, 1997). This lack of educational resources is evident in the findings that fewer advanced courses are typically offered in rural areas (American Enterprise Institute, 2016; Anderson & Chang, 2011; Carsey Institute, 2009). The Carsey Institute (2009) stated that "limited access to advanced mathematics courses adversely impacts the number of qualified students in science, technology, engineering, and mathematics (STEM) job pipelines" (p. 1).

Purpose of the Study

The research topic for this study was to determine the perceptions of STEM held by students in a rural area. One purpose of the research was to determine if differing perceptions of STEM held by twelfth-grade students are associated with different genders (male and female). Another purpose of the study was to determine the impact that attending a rural high school had on the STEM perceptions of college students. Answering the research questions could lead to a deeper understanding of the issue of female students' perceptions of STEM, potential reasons why females are under-represented in STEM college majors and careers, specific recommendations for increasing interest in STEM, and how the rural context may be associated with STEM perceptions. The research questions that guided this study are:

Research Question 1**.** How are the STEM perceptions of twelfth-grade female students enrolled in an advanced mathematics course in a rural high school similar to and

different from the STEM perceptions of twelfth-grade male students enrolled in an advanced mathematics course in a rural high school?

Research Question 2. How did attending a rural high school impact the STEM perceptions of female and male college students?

Definition of Key Terms

Several key terms were defined in order for their meaning to be clear throughout the study. When appropriate, a source for the definition is provided.

STEM. STEM is a commonly used acronym for science, technology, engineering, and mathematics.

STEM Fields. **"**Science, Technology, Engineering, and Mathematics (STEM) fields of study that are considered to be of particular relevance to advanced societies…STEM fields include agriculture and natural resources, biological and biomedical sciences, computer and information sciences and support services, engineering and engineering technologies, mathematics and statistics, and physical sciences and science technologies" (National Center for Educational Statistics, 2011).

Advanced mathematics course. An operational definition developed by the researcher is as follows: A mathematics course that is taken by students in Georgia public schools including Advanced Placement Calculus AB, Advanced Placement Calculus BC, and Advanced Placement Statistics.

Chapter Summary

Calls from the highest level of the United States government for more focus on STEM education and for more interest in STEM fields as a profession have come from the last two United States Presidents. As more STEM professionals are needed in the

United States, it is particularly troubling that females seem to be reluctant to enter STEM fields (Morganson et al., 2010). The United States needs males and females to enter STEM professions in order to meet the challenges of the 21st Century.

With this study the researcher sought to understand the perceptions of science, technology, engineering, and mathematics held by students from a rural background. The focus was on students who took advanced mathematics in high school because those were the students who tended to have the academic background necessary to enter a STEM field (National Center for Educational Statistics, 2009; Tyson et al., 2007). The students in the present study were enrolled in advanced mathematics courses and they also typically took the most rigorous science courses offered in their high school. Students who attended high school in a rural area were the focus in order to understand the perceptions held by students from rural areas who may have less access to STEM professionals than students in areas with larger populations and a more diverse economy.

The following chapters consist of a review of the literature that exists on the topic of STEM perceptions, a discussion of the research design and methodology that was used in the study, an analysis of the data, and conclusions drawn from the study. Literature that exists on the topic is reviewed in Chapter 2 so that the current study can be informed by prior research. The research design and methodology discussion found in Chapter 3 provides information about the population, sample data collection method, data collection instruments, and the data analysis techniques. Chapter 4 provides the results of the quantitative and qualitative instruments used in the study. In Chapter 5 conclusions are drawn and implications of the findings are discussed.

Chapter II

REVIEW OF LITERATURE

The importance of developing a strong pool of talent in the areas of science, technology, engineering, and mathematics (collectively referred to as STEM) has been well documented. According to the literature, STEM education has received attention at the highest levels of government. Williams (2011) described the level at which STEM education is being discussed in the United States and the United Kingdom. He described a variety of STEM undertakings unveiled by President Obama and explained that the United Kingdom recently established the position of national STEM Director. Williams (2011) stated that leaders in both countries view STEM education as necessary for strengthening their respective economies. Following the same belief that STEM is important to the nation's economic interest, the President's Council of Advisors on Science and Technology (2011) asserted that STEM education is necessary to solve the problems the United States faces by developing the professionals needed to work in an international economy. They suggested that STEM education fosters the type of learning that leads to innovation and discovery. Similarly, according to their website the American Association for the Advancement of Science promotes science, engineering, and innovation through a STEM mentoring program which connects STEM professionals with schools. Moskal and Skokan (2011) also framed their beliefs about the need for STEM education around the economic concern of United States competitiveness. They claimed that developing students' abilities in mathematics and science in addition to

piquing their interest in engineering is vital to the United States. They asserted that all students must receive a thorough education in mathematics and science.

Despite the attention STEM has garnered at the highest level of government, there remains a shortage of STEM professionals in the United States. Dave et al. (2010) provided data showing that demand for professionals in STEM fields was growing at twice the rate of all other occupations and predicted an extreme shortage of professionals in STEM fields. A concern held by Perry (2010) and Brett (2007) was that students in the United States were not expressing an interest in STEM, which would further lead to a shortage of STEM professionals. Perry (2010) described the annual Lemelson-MIT Invention Index survey showing that 51% of the students (age 12-17) surveyed did not know anyone who worked in a STEM field. He speculated that not knowing a STEM professional may lead students to not understand what people in STEM fields do, which might lead to a lack of interest in STEM. Brett (2007) cited data from New England that showed a lack of interest in STEM by high school students. The data showed that only 20% of New England students who completed the Scholastic Aptitude Test in 2005 were interested in pursuing a college major in a STEM field. Brett (2007) called for a national plan to increase interest in STEM in order to overcome the shortage of STEM professionals in the United States.

Of particular concern is the under-representation of females in STEM. Data from previous research suggested that females were less likely to pursue college majors and careers in STEM than males. National Science Foundation (2013) revealed data showing that in 2012 females earned fewer than 20% of the undergraduate degrees in physics, engineering, and computer science.

Research has been conducted in an attempt to determine why fewer females than males enter STEM fields. Su, Rounds, and Armstrong (2009) found that males tend to be interested in careers oriented toward working with objects, while females tend to be interested in careers oriented toward people. Using seven categories of vocational interest (realistic, investigative, artistic, social, enterprising, and conventional), males were found to be more interested in realistic and investigative type fields while females were found to be more interested in artistic, social, and conventional fields. Males were also found to be more interested in STEM fields than females. Similar results were found in a study of 80 high school students by Miller, Blessing, and Schwartz (2006). They found that female students were more interested in careers viewed as people oriented than male students. Female students who expressed an interest in pursuing a science major in college tended to mention their interest in the field was a result of wanting to help people. Most of the female students interested in a science field wanted a career emphasizing natural sciences rather than the physical sciences. The reason most female students provided for majoring in science was to pursue careers in medicine, rather than because they were interested in science. Paige, Bailey, and Van Delinder (2009) suggested that the under-representation of females in STEM fields is more complex than merely one of vocational interests. They argued that deeper barriers against females keep them from pursuing STEM fields, such as the relationship between work and family responsibilities and gender inequity in the workplace.

Misconceptions about what a STEM career entails may contribute to the under-representation of females in STEM. In the present study perceptions held by students from a rural area who were enrolled in advanced mathematics courses with the belief that

male and female students are equally capable of pursing college majors and careers in STEM were sought. Thus, it is necessary to establish that male and female students are equally capable of achieving success in the types of mathematics and science courses that are part of the STEM curriculum. Therefore, a review of research that studied the gender gap in mathematics and science was necessary. Campbell, Hombo, and Mazzeo (2000) reviewed National Assessment of Educational Progress (NAEP) results from the past 30 years finding that for 17-year-olds the gender gap in mathematics that had existed was not statistically significant in 1999. In science, the gap between male and female 17-year-olds had been reduced by 1999 but was still statistically significant. National Center for Educational Statistics (2013) reported that NAEP twelfth-grade mathematics results from 2012 showed that while males scored 4 points higher than females (308 compared to 304), the gender gap has been narrowing since the assessment's inception.

The data regarding a gender achievement gap in the United States were similar to those in other countries. Else-Quest, Hyde, and Linn (2010) found that gender differences in mathematics achievement were not significant when averaged across 46 countries. However, the variability between nations was high. They found three societal factors that were the best predictors of the variability in gender gaps. These factors were related to school enrollment for school age females, the proportion of research positions held by females, and the proportion of seats in the nation's legislature held by females. They reported that the gender gap in the United States was near zero as evidenced by the effect size ($d = 0.06$) of the comparison of male and female performance on TIMMS and its predecessors.

Hargreaves, Homer, and Swinnerton (2008) found no gender difference on the World Class Test in mathematics administered to 9 and 13 year olds in the United Kingdom. The test was designed for students classified as gifted and talented. In their study, the sample consisted of students who were considered to be in the top 10%. For both age groups, girls scored higher than boys, although the difference was not statistically significant. Mixed results were found by Preckel, Goetz, Pekrun, and Kleine (2008). While they found no gender difference in grades in mathematics for German students aged 11-15 who were classified as gifted, they did find that male students scored significantly higher on a test of mathematical literacy. The test of mathematical literacy required students to apply mathematics to solve real world problems, interpret results, think about how the problem was solved, and communicate results.

Rather than studying test results, Tyson et al. (2007) examined the high school courses taken and college degrees earned for 94,078 graduates of Florida high schools. Slightly more than half of the students in the sample were females and they attended 4-year public colleges in Florida at a higher rate than the male students in the sample, 21.5% and 14.6% respectively. It was found that, of the students who earned bachelor's degrees, females earned degrees in STEM fields at a lower rate than males (9.6% compared to 21.3%). The fact that females earned degrees in STEM at lower rates than males was despite the finding that female students completed high level courses in high school at slightly higher rates than male students. The findings varied for specific courses but the differences in courses taken by gender were slight. For instance, calculus was completed by 8.0% of males and 7.4% of females, while physics was taken by close to 25% for both genders.

Having established the importance of STEM for the nation, discussing the shortage of STEM professionals and the under-representation of females in STEM, and showing that male and female achievement in STEM courses is similar, the remaining topics of discussion will be the two research questions for the study. Therefore, the rest of Chapter 2 is organized around these research questions. The first research question was designed to determine similarities and differences between male and female students' perceptions of STEM. The second research question asked how attending a rural high school impacted the STEM perceptions of female and male college students.

Both research questions focus on students who attended a particular high school in a rural area in Georgia. A study involving students from rural areas is important because research on the challenges facing rural schools found that they lack cultural capital, have difficulty attracting high quality teachers in STEM subjects, have few STEM outreach opportunities available to them and have few curriculum specialists in mathematics and science (Avery, 2013; Blanton & Harmon, 2005; Boynton & Hossain, 2010; Dessoff, 2010; Hopkins, 2005). The literature regarding the rural context is described next.

Hopkins (2005) suggested that cultural capital can explain discrepancies in student achievement between rural and non-rural schools. Cultural capital was described as the activities outside of school that can lead to more academic success such as access to museums, books, and cultural events. She said these activities serve as "an 'apprenticeship' for students that allows for more success in school" (p. 26). Hopkins focused on the relationship between school locale (urban and rural), socioeconomic status, and student achievement. She suggested that cultural capital had the largest

impact on student achievement in urban areas of high poverty when compared to rural areas of high poverty. Her reasoning was that students at urban schools had more access to cultural capital than student in rural schools.

Challenges facing schools at the district level were described by Dessoff (2010), Boynton and Hossain (2010), Avery (2013), and Blanton and Harmon (2005). Dessoff (2010) studied the ways school districts attempted to attract teachers to rural school districts. He stated that rural districts faced challenges that non-rural district do not face including a reduction in the tax base and the difficulty of hiring and retaining good teachers particularly in STEM fields. Boynton and Hossain (2010) explained that rural school districts have few engineering outreach opportunities available for their students. Similarly, Avery (2013) explained that rural schools have limited access to educational resources related to science offered by colleges, businesses, and other educational organizations. Blanton and Harmon (2005) suggested that obstacles exist to improving mathematics and science education in rural areas including having few people with mathematics or science backgrounds working at the district level. They argued that most curriculum administrators must perform many functions and cannot focus on mathematics and science. They also explained that there are few jobs in rural areas that require high levels of mathematics knowledge and that "declaring all students must pass Algebra seldom serves to motivate students or their parents in rural communities where few opportunities exist to make use of the education" (p. 6). Funding a lower participation in Advanced Placement courses were challenges for rural districts identified by Guckian and Sarrio (2012). They reported that students in rural areas of Georgia took Advanced Placement exams at lower rates than suburban students (5% to over 20%), that

rural school systems spent $400 less per student than suburban school systems, and that teachers in rural areas had less access to professional development than their counterparts in suburban districts.

Literature regarding STEM perceptions of rural students is limited. Hartman (2013) noted in her study about mathematics coaching in rural schools that studies on rural education were limited. Avery (2013) explained that studies of science education within a rural context were scarce. A review of literature on rural mathematics education was described in a study by Waters et al. (2008). They found over 5000 articles on mathematics education published between 1985 and 2001, but only 20 studies focusing on rural mathematics education. They believed that since contextual factors matter there should be more research devoted to issues affecting rural mathematics education. A study that specifically related to STEM perceptions of people in a rural area was conducted by Lucas and Fugitt (2009). They used qualitative methods to identify the perceptions of mathematics held by rural Americans. The perceptions held by residents of the small Midwestern town where the study was conducted were that students cannot do basic mathematics, that calculators are used too often in mathematics courses, and that mathematics knowledge improves one's career options. These themes were further explored using a questionnaire. Half of the respondents believed that jobs in their rural community did not require advanced mathematics knowledge.

Research Question 1

The first research question was designed to determine similarities and differences between male and female students' perceptions of STEM with an emphasis on students attending high school in a rural area. Research Question 1 asked: How are the STEM

perceptions of twelfth-grade female students enrolled in an advanced mathematics course in a rural high school similar to and different from the STEM perceptions of twelfth-grade male students enrolled in an advanced mathematics course in a rural high school? A review of the literature surrounding this question reveals research related specifically to science and mathematics.

While most research about perceptions focused on science and mathematics, Grossman and Porche (2013) studied the perceptions students hold about STEM in general. In their study male and female students identified instances where family members made comments about certain careers not being suitable for females. The participants viewed these comments as harmful to promoting STEM interest for females. Wild (2015) studied the impact the perceptions students hold about the learning environment of their high school chemistry class have on their career interest in science, mathematics, computing, and engineering. He found that perceiving their high school chemistry class as being constructivist in nature was associated with a desire to pursue a science career, but that the association did not hold true for careers in mathematics, computing, or engineering. Robnett and Leaper (2012) found that male students had higher interest in STEM careers than females but that the difference was lessened when females had peer groups that they perceived as being supportive of STEM.

Several studies indicated that achievement in science and mathematics is generally similar between male and female students (Campbell et al., 2000; Else-Quest et al., 2010; Hargreaves et al., 2008; National Center for Educational Statistics, 2013; Preckel et al., 2008). Despite this fact, numerous studies have found a difference in perceptions between male and female students with respect to science and mathematics,

with female students viewing these subjects more negatively than their male counterparts (Barmby & Defty, 2006; Beghetto, 2007; Bhanot & Jovanovic, 2009; Brandell & Staberg, 2008; Britner, 2008; Britner & Pajares, 2006; Correll, 2001; Hargreaves et al., 2008; Kurtz-Costes et al., 2008; Miller et al, 2006; Preckel et al., 2008; Watt, 2008; Selimbegovic, Chatard, & Mugney, 2007).

Research of the perceptions students have about science can be grouped into two areas – 1) interest in the subject and 2) self-concept students have with regard to the subject. Studies support that male and female students have different levels of interest in science (Barmby & Defty, 2006; Beghetto, 2007; Miller et al., 2006;), while other research found that male and female students were similarly uninterested in science (Masnick, Valenti, Cox, & Osman, 2010; Sorge, 2007). There is also research indicating female students have lower self-concept in and more anxiety about science than male students (Barmby & Defty, 2006; Bhanot & Jovanovic, 2009; Britner, 2008; Britner & Pajares, 2006). First, the research about interest in science will be described followed by the research pertaining to science self-concept.

Miller, Blessing, and Schwartz (2006) found female students preferred biology more than male students. Females who were interested in science careers were more interested in people centered careers and considered science as something they needed for those careers (such as medical fields), and females considered science to be uninteresting and did not perceive the lifestyle associated with scientists as appealing. Beghetto (2007) found similar results from a study of 1289 middle and high school students. The author found that male students have more favorable attitudes toward science than female students. He also found the science perceptions of younger students to be more positive

than older students. Rather than studying science interest in general as Beghetto (2007) did, Barmby and Defty (2006) studied the views male and female students have about specific science courses. They found affinity for biology was greater for female students than for male students, while male students liked chemistry and physics better than female students did.

Research showing similar levels of interest in science also exists. These studies show male and female students both had low levels of interest in science. In a study of 45 high school and 58 college students in New York, Masnick et al. (2010) found that males and females both viewed science as uninteresting and unsocial. Sorge (2007) studied student attitudes toward science over time. It was found that attitudes became more negative over time, but there was no significant difference in attitudes toward science between male and female students.

The perceptions of science held by students regarding their self-concept and anxiety levels have also been studied. Findings indicated female students had lower self-concept and more anxiety than male students with regards to science (Barmby & Defty, 2006; Bhanot & Jovanovic, 2009; Britner, 2008; Britner & Pajares, 2006). The studies described next focused on science self-concept and anxiety.

Britner and Pajares (2006) studied science self-efficacy beliefs to determine if these were different for male and female students. They identified science self-efficacy as "a strong belief that they [students] can succeed in science tasks and activities" (p. 486). The researchers suggested that science self-efficacy should be studied because self-efficacy is "a strong predictor of academic achievement, course selection, and career decisions across domains and age levels" (p. 485). Female students were found to have

more anxiety about science class even though they were more confident they could manage their class work and had higher grades in their science class. The researchers found female students' science self-efficacy to be equal to male students but their science self-concept lower. Science self-concept was defined by the researchers as "students' perceptions about their science ability and their feelings of self-worth associated with this ability" (p. 490). Even though female students made higher grades than male students, they reported lower numbers of experiences where they felt they mastered a concept in science class.

Britner (2008) examined self-efficacy and motivation to determine if there was a relationship between self-efficacy, gender, and science courses taken among high school students. The study showed that female students' achievement in science was similar to male students, yet they had more negative feelings about science. Britner (2008) suggested that these negative feelings could be a reason why female students are less inclined to pursue careers in science than male students even though this study found science achievement to be the same or better for female students compared to male students. The author suggested science teachers acknowledge the achievement and effort of female students as a way to decrease their science anxiety. Barmby and Defty (2006) found that in biology, chemistry, and physics classes, the grades that male students expected to get were higher, on average, than the grades that female students expected to get. The expectation of course grades was unfounded since female students had higher average scores than male students in biology and chemistry and scores were almost the same in physics.

Bhanot and Jovanovic (2009) studied the effect of parents' involvement on their child's science schoolwork on the child's perceptions of science. The relationship was examined by gender of both the parent and the child. While grades made in the course did not differ for the male and female students in the study, male students were found to have more confidence in their science ability than female students. The researchers also found that mothers tend to engage in encouraging male students in science when the student is struggling. In contrast, they encouraged female students when the child is experiencing success in science. The researchers speculated that this is because parents expect more of boys than girls when it comes to science achievement.

As with science, research about the perceptions students have about mathematics can be grouped into two areas - research about interest in the subject and research about the self-concept students have with regards to the subject. Research about mathematics interest showed female students to be less interested in mathematics than male students (Brandell & Staberg, 2008; Preckel et al., 2008). Research also suggested that female students have more negative attitudes about mathematics and lower self-concept regarding the subject (Correll, 2001; Hargreaves et al., 2008; Watt, 2008).

Preckel et al. (2008) studied how male and female students differ in terms of mathematics achievement, interest, self-concept, and motivation. They found differences in male and female mathematics interest for students identified as gifted as well as for average ability students. The researchers suggested that societal factors, namely gender-role stereotypes, influence girls' beliefs about mathematics and that this may explain the lack of females in STEM fields. Brandell and Staberg (2008) sought to determine how high school students perceive mathematics (male, female, or gender neutral). They found

that students viewed mathematics as more of a male domain than a female domain and that male students held this view more strongly than female students.

In addition to studying the level of interest in mathematics for male and female students, research has been conducted on students' attitudes and perceptions of mathematics. Studies found that female students tend to have lower self-concept and more negative perceptions about mathematics than male students even though achievement in mathematics is not dependent on gender (Correll, 2001; Hargreaves et al., 2008; Watt, 2008).

In a large scale longitudinal study, Correll (2001) studied the idea that cultural stereotypes about mathematics ability of males and females affected people's self-assessment of their abilities. It was found that male students assessed their mathematics ability as higher than female students even though their grades and test scores in mathematics were the same. The author also found that female students valued feedback in the form of affirmation regarding their mathematics ability more than male students.

Hargreaves et al. (2008) found attitudes toward mathematics were more positive for male students than female students. This result occurred even though no significant gender difference in mathematics performance was found in their study of students identified as gifted. Consistent with the findings of Hargreaves et al. (2008), Watt (2008) found male students tended to favor mathematics more than female students, while female students tended to favor English more than male students. Both genders showed declines in their perception of their talent and in their intrinsic values in mathematics and English from seventh grade through eleventh grade. Both groups declined at similar rates, according to the study.

Mathematics and science perceptions were studied jointly by Selimbegovic et al. (2007) and Kurtz-Costes et al. (2008). Selimbegovic et al. (2007) studied the effect of providing fictitious expert information that female students are better at mathematics and science than male students. The result was less gender stereotyping but it did not affect female students' interest in pursuing a career in mathematics or science. Kurtz-Costes et al. (2008) studied how children's stereotypes and beliefs about adult stereotypes impacted their self-concept. The researchers found that even though male and female students achieved at similar levels in mathematics and science, males had higher self-concept about mathematics and science than females.

The research in science and mathematics perceptions of students generally showed that female students have less interest and lower self-concept in science and mathematics than their male peers. These findings occurred despite the fact that much research showed achievement in science and mathematics was close to the same for female and male students.

Research Question 2

Using a qualitative approach, Research Question 2 was designed to discover how attending a rural high school impacted the STEM perceptions held by college students. Research Question 2 asks: How did attending a rural high school impact the STEM perceptions of female and male college students? Consistent with the present study of STEM perceptions, a research question that Waters et al. (2008) determined needed to be studied was to determine if there are "differences in the life trajectories of mathematically talented rural and mathematically talented non-rural students" (p. 138). Literature related to Research Question 2 consisted of research about the perceptions of and interests in

STEM held by college students and the role high school course-taking had on these perceptions and interests. The literature related to the rural context was described earlier.

Hall, Dickerson, Batts, Kauffman, and Bosse (2011) found that both high school students and college engineering majors identified having school personnel who had knowledge of career options as being an important factor that influenced their career interest. A concern identified by the researchers was that parents and teachers often had limited knowledge of STEM careers. Starobin and Laanan (2008) interviewed female STEM majors at two community colleges that implemented programs to encourage female students to pursue bachelor's degrees in STEM fields. A theme that emerged from the interviews was that female students did not realize that engineering was an option for them. Several students expressed a desire to have received more encouragement from their teachers to pursue careers in engineering. One student stated that she was unaware what engineers did until she took physics. The researchers stated that students never mentioned a dislike or apprehension of mathematics or science. Rather it was "a lack of support, encouragement, and reinforcement" (p. 41) that led to low numbers of female students pursuing STEM majors.

College students' science perceptions were studied by Hutchinson-Anderson, Johnson, and Craig (2015). They identified factors that influenced college students' decision to major in science. These factors were feeling proficient in lab techniques, the number of science Advanced Placement courses taken in high school, and the students' perceptions of the amount of hands-on science work they did in high school, perceptions of how well their high school science experiences were connected to real life, and perceptions of how much exposure they received to careers in science while in high

school. Research by Hartman and Hartman (2008) and Nosek and Smyth (2011) found that perceptions of the challenges faced by female STEM majors differed between male and female students. Hartman and Hartman (2008) found female undergraduate engineering majors perceived balancing family and work responsibilities, the lack of role models in engineering, the view that females in STEM are unfeminine, and discrimination towards females to be viewed as more serious problems for them in STEM than male viewed these as serious problems for females. In majors where females made up less than 15% of enrollment, male students were more likely to consider these issues as problems for female students than male students in majors where female students made up more than 15% of enrollment. The researchers suggested that in the majors with very low female enrollment, female students' challenges were viewed as being different than male students when compared to majors with more evenly proportioned enrollment. Nosek and Smyth (2011) analyzed the relationship between gender stereotypes and perceptions of mathematics. Female's implicit stereotyping of mathematics as a male domain was associated with more negative attitudes toward mathematics, less identification with mathematics, and more mathematics anxiety. For males, the relationship between stereotyping and mathematics attitudes, mathematics identity, and mathematics anxiety were much weaker than for females. Female non-STEM majors were more negative about mathematics than male non-STEM majors. The same was true but at a lesser level for STEM majors. The effect sizes were $d = .38$ for non-STEM majors and $d = .33$ for STEM undergraduate majors. For students pursing graduate degrees in STEM, female students were still more negative than male students about mathematics but at much lower level ($d = .14$).

Similar to Nosek and Smyth (2011), Varma (2009) found gendered socialization to be a reason given by females for why more females did not major in the STEM fields of computer science or computer engineering. Varma (2009) studied the beliefs held by students studying computer science or computer engineering regarding the reasons for the under-representation of females in these fields. Gendered socialization and technical anxiety were the most often cited reasons for the lack of females in these majors by both males and female. The author described gender socialization as the way society adheres to gender roles. For example, Varma (2009) mentioned the belief that males are better in technical fields than females and that expectations are higher for males than for females as examples of gendered socialization. In the study it was found that female students attributed the low numbers of females in these majors to gendered socialization more often than male students (45.3% of females compared to 33.3% of males).

The interests of male and female students have been studied to determine if gender differences influence perceptions of STEM and undergraduate major and career choices. In a study of the vocational interests of males and females Su et al. (2009) found males tended to be more interested in working with objects and females tended to be more inclined to work with people. They reported on studies that found female undergraduates change from STEM to non-STEM majors for two main reasons. The most often cited reason was that the non-STEM major better matched the students' interests. The reason identified second most frequently was that the students' interest in STEM declined since they first chose a STEM major. Even among female students who stayed in STEM majors, 38% stated there were other majors they believed would fit their interests better than their current STEM major. The researchers suggested that when

females change majors from STEM to non-STEM fields it is due to a lack of interest in STEM. Buschor, Berweger, Frei, and Kappler (2014) found in their study of female high school students that a desire to have a job with a great deal of societal contact was negatively associated with an interest in a STEM career. Eccles and Wang (2016) identified altruistic goals of helping others as a factor impacting career choice. They found that college students with a lower interest in helping others and who perceive STEM as a field that is not involved in helping others are drawn toward STEM, regardless of gender. They suggested that an implication of their research is that more should be done to show that altruistic goals can be met in STEM.

Morganson et al. (2010) also studied the reasons for the gender gap in STEM. They sampled college students majoring in a STEM field where they found that successfully completing a degree in STEM was not an issue of ability for females but an issue of perseverance. For a longitudinal study of all high school graduates from a recent year in Florida, Tyson et al. (2007) analyzed data from 94,078 high school graduates to determine how demographic factors influence STEM interest. The researchers attempted to determine the relationship between race, gender, SES, high school mathematics courses taken, high school science courses taken, and STEM degree attainment. Enrollment in calculus and physics in high school was found to be particularly important for study of STEM fields in college. A National Center for Educational Statistics (2009) report found enrollment in trigonometry, precalculus, and calculus in high school was associated with STEM enrollment in college.

Chapter Summary

The review of literature showed that despite male and female students achieving at similar levels in mathematics and science, female students tend to hold more negative perceptions of the subjects than male students. Female students also tend to pursue degrees in STEM fields at lower rates. Literature related specifically to STEM perceptions of students from rural areas was found to be limited but those studies that have been conducted indicated the rural areas face unique challenges related to STEM education that urban areas do not face.

Chapter III

METHODOLOGY

The intent of Chapter 3 is to explain the research design and the methodology used in the study. The chapter contains an introduction, restatement of the research questions, explanation of the data collection method and instrumentation, discussion of the data analysis, and a chapter summary.

As the need for more people to enter STEM fields continues to grow, the lack of interest in STEM by females is a cause for concern (Morganson et al., 2010). Data showed female students earned a higher percentage of all bachelor's degrees in the United States, but male students earned a disproportionate number of degrees in STEM fields (National Center for Educational Statistics, 2009). Literature pertaining to perceptions of STEM by male and female students suggested that female students perceived STEM less favorably than male students (see for example Beghetto, 2007; Barmby & Defty, 2006; Miller et al., 2006). This more negative view of STEM by females was despite the fact that achievement in science and mathematics was similar between male and female students (see for example Campbell et al., 2000; Else-Quest et al., 2010; National Center for Educational Statistics, 2013).

In the present study, the STEM perceptions of high school seniors attending school in a rural area who were enrolled in advanced mathematics classes were studied with the STEM Semantics Survey (see Appendix C) and with two open-ended questions in order to determine similarities and differences between male and female students.

Then, a group of college students who graduated from the high school that the high school seniors attended were given the STEM Semantics Survey to gauge their STEM perceptions. Results gathered from the high school and college participants were used to inform a qualitative component consisting of interviews of college students.

The purpose of the qualitative element of the study was to determine the impact attending high school in a rural area had on the STEM perceptions of college students. Research has found that female undergraduates reported not realizing that STEM careers were an option for them (Starobin & Laanan, 2008), that male and female college students had differing perceptions of STEM (Hartman & Hartman, 2008; Nosek & Smyth, 2011), and that gender socialization as well as technical anxiety were often cited by college students as reasons for the underrepresentation of females in STEM (Varma, 2010).

Through the current study the researcher sought to further understand the STEM perceptions held by college students and the role in which attending high school in a rural area plays in shaping those perceptions. To learn more about the STEM perceptions held by high school and college students and the impact that attending a rural high school had on the students' perceptions, two research questions were developed.

Research Questions

Research Question 1. How are the STEM perceptions of twelfth-grade female students enrolled in an advanced mathematics course in a rural high school similar to and different from the STEM perceptions of twelfth-grade male students enrolled in an advanced mathematics course in a rural high school?

Research Question 2. How did attending a rural high school impact the STEM perceptions of female and male college students?

The purpose of the first research question was to determine if statistically significant differences in the STEM perceptions existed between male and female students who attended a high school in a rural area. Numerous studies have found a difference in STEM perceptions between male and female students but others have found none (see for example Brandell & Staberg, 2008; Britner & Pajares, 2006; Preckel et al., 2008). The second research question was designed to determine the impact attending a rural high school had on the STEM perceptions of college students.

Research Design

A mixed methods approach using both quantitative and qualitative techniques was used to answer the research questions. Mixed methods research was defined by Creswell (2009) as "an approach to inquiry that combines or associates both qualitative and quantitative forms" (p. 4). In planning a mixed methods study Creswell (2009) suggested determining the timing of each data collection component, the weighting of the quantitative and qualitative pieces, the manner in which the data are mixed, and the approach to theorizing. In this study, the timing for data collection consisted of quantitative data being collected first, followed by qualitative data. The quantitative and qualitative data were weighted equally. The mixing of the data followed what Creswell (2009) called a connected approach where the analysis of the data from one form is linked to the data collection of another form. Specific to this study, the analysis of the quantitative data was linked to the collection of qualitative data. Quantitative data collected from high school seniors in a rural high school and college students who

graduated from the same rural high school were used to develop interview questions for the qualitative phase. High school students also answered two open-ended questions. College students who graduated from the same rural high school as the students in the quantitative phase and who took similar courses while in high school completed a quantitative component that was used to develop interview questions. College students then participated in interviews. Creswell (2009) referred to theorizing in mixed methods studies as being done either explicitly or implicitly. He described explicit theorizing as stating the theory on which the study is based and implicit theorizing as not stating the theory on which the study is based. Implicit theorizing was used in this study.

Taking into account timing, weighting, mixing, and theorizing approaches planned for this study, the sequential explanatory strategy was used. This strategy consisted of performing the quantitative and qualitative data collection sequentially where "the initial quantitative results *informs* the secondary qualitative data collection" (Creswell, 2009, p. 211). While this approach, according to Creswell (2009), usually results in the qualitative element being used to follow-up with the participants from the quantitative phase, the current study was formatted differently since the participants in each phase were not the same. The quantitative results were used to inform the qualitative data collection by providing a rationale for selecting interview questions. This approach allowed for a deeper understanding of STEM perceptions of students from a rural high school than if only high school students were studied. Fraenkel and Wallen (2009) referred to the ability to study a topic more deeply as being a strength of mixed methods studies, yet the authors cautioned that the amount of time mixed methods research takes could be a weakness.

High School Students

Setting and participants. Participants in the part of the study focused on high school students were twelfth-grade students from a high school located in a rural part of southern Georgia. The unit of analysis was the student. The high school from which participants were found is a Title I school serving as the only high school in the county. Demographic characteristics were reported on the school district's website. The high school serves 1,722 students in grades 10 through 12. The school district's enrollment is 27% Black, 45% White, 25 % Hispanic, and 3% Other. Consistent with the county's agriculturally based economy, almost 7% of the school district's students are served through a migrant education program. Almost three quarters of the students in the school district are classified as Economically Disadvantaged. The school district reported that currently all students in the school district receive free breakfast and lunch through the United States Department of Agriculture's Community Eligibility Program. The school district's website listed information regarding the pass rates of high school STEM courses that are tested with and end of course test. The Coordinate Algebra course had 27% pass compared to a statewide pass rate of 34%, the Analytic Geometry course had 35% pass compared to a statewide pass rate of 29%, the Biology course had 35% pass compared to a statewide pass rate of 38%, and the Physical Science course had 22% pass compared to a statewide pass rate of 31%. End of course tests are not given in any other STEM courses.

The county which the school district serves has a lower per capita income than the state, according to the school district's website. The county's per capita income is $16,972 compared to $25,427 for the state. The website reported that 12.9% of the

county's residents have a bachelor's degree compared to 28.3% statewide. The county is a large agricultural producer and is located in a region of the state with a large agriculture base. According to the school district's website, the largest non-government employer in the county is a chicken processing plant.

The twelfth-grade students who participated in the study were enrolled in advanced mathematics courses. The advanced mathematics courses for twelfth graders at the school were Advanced Placement Calculus, Advanced Placement Statistics, and Move on When Ready College Algebra/Trigonometry. These courses were the twelfth-grade mathematics courses which were the most rigorous offered by the school. The participants also tended to take the most rigorous science courses offered by the school. Students from these courses were chosen as the participants because they are the ones most likely to have the academic background to major in a STEM field in college if they choose. National Center for Educational Statistics (2009) found that students taking more advanced mathematics courses in high school are more likely to enter STEM fields.

Instrumentation. The quantitative component of the study used the STEM Semantics Survey as the instrument for collecting data (see Appendix C). Additionally, two open-ended questions (see Appendix D) developed by the researcher were included with STEM Semantics Survey. Participants provided written responses to the open-ended questions. According to Tyler-Wood, Knezek, and Christensen (2010), the STEM Semantics Survey required students to choose between adjectives which were opposites of each other to assess their perceptions of science, mathematics, engineering, technology, and careers in STEM. The STEM Semantics Survey was used to answer Research Question 1 which pertains to the perceptions held by rural high school students.

The STEM Semantics Survey was also given to the college students in order to develop questions for the qualitative interview of the college participants.

On the STEM Semantics Survey, five adjective pairs were presented for each o the five scales. The scales are identified as science, math, engineering, technology, and careers in STEM. Participants chose a number between one and seven to indicate how closely aligned their perception is to the adjective. Adjective pairs were ordered in such a way that for some of the adjective pairs selecting the positive adjective would result in a high score on the one through seven scale, while for other adjective pairs a low score would result from selecting the positive adjective. Therefore, some of the adjective pairs were reverse coded after the surveys were completed. Reverse coding allowed the results to be compared numerically. Each of the scales had the same five adjective pairs. The adjective pairs were as follows: fascinating paired with mundane, appealing paired with unappealing, exciting paired with unexciting, means nothing paired with means a lot, boring paired with interesting. Having the same adjective pairs for each scale allowed for comparisons between scales to occur (Tyler-Wood et al., 2010). Reverse coding was performed on the fascinating/mundane, appealing/unappealing, and exciting/unexciting pairs so that a positive perception was scored with a high number.

Internal consistency reliabilities, as measured by Cronbach's alpha were .84 for the science scale, .88 for mathematics, .92 for engineering, .91 for technology, and .93 for STEM career (Tyler-Wood et al., 2010). Cronbach's alpha values higher than .7 are widely considered to indicate an acceptable level of reliability (Field, 2009). Using exploratory factor analysis, Tyler-Wood et al. (2010) found the STEM Semantic Survey to be a valid instrument. They stated that "the items targeted for assessing semantic

perception of science, math, engineering, technology, and STEM career interest were most strongly associated with the intended construct in every case" (p. 352).

Data Collection Procedures. Data collection took place in two phases. First, quantitative data were collected. Initial findings from the quantitative data were used to inform the qualitative part of the study. Permission for conducting interviews and collecting questionnaire data was sought from the Valdosta State University Institutional Review Board (IRB). The IRB granted approval (see Appendix A). Permission was sought of the principal of the high school where the questionnaires were used for data collection. The principal granted approval (see Appendix B). Using the format prescribed by the IRB, a participant consent form was developed and given to all participants. High school students were also given a parent consent form that was developed following the IRB's prescribed format. Consent forms were collected before data collection began.

The high school participants were enrolled in three different courses which were taught by two different teachers (the researcher and one other teacher). Therefore, the researcher elicited the help of the other educator to collect the data. A protocol was developed for the teacher to follow to ensure that data collection was done the same way for all participants. High school students were administered the STEM Semantics Survey and the two open-ended questions. The completed surveys and responses to the open-ended questions were stored in a locked cabinet and will shredded 3 years from the completion of the study.

Data Analysis Procedures. Data analysis occurred for the quantitative phase first and the results were used to inform the qualitative component of this study. Creswell

(2005) explained that data analysis "consists of 'taking the data apart' to determine individual responses and then 'putting it together' to summarize it" (p. 10). For the quantitative instrument, descriptive statistics were calculated for each item and for each domain. Biographical information was collected for each participant and aligned with their questionnaires. Biographical information was self-reported rather than retrieved by the researcher using the Statewide Longitudinal Data System available at the participants' school in order to maintain anonymity. Inferential procedures included multivariate analysis of the subscales of the instruments. Field (2009) described multivariate analysis as a way to "look at several dependent variables (outcomes) simultaneously" (p. 585). Cronbach's alpha was computed for four of the subscales from the STEM Semantics Survey (science, technology, engineering, and math) in order to determine the internal reliability. Cronbach's alpha measurements that are reasonably high (greater than .60) allows for comparisons of gender to be made by running a multivariate analysis of variance. The fifth subscale (STEM careers) was analyzed separately from the other four subscales using an independent samples *t* test. Quantitative data were analyzed using the Statistical Package for the Social Sciences (SPSS) software. The results of the two-open ended questions were analyzed to identify common themes.

College Students

Setting and Participants. The participants in the qualitative component were college students who attended the same high school as the twelfth-grade students who were the participants in the quantitative aspect of the study. The unit of analysis was the student. The participants were current college students or recent graduates who were enrolled in one of the advanced mathematics classes while in high school. Since these

students were enrolled in advanced mathematics classes in while high school they were likely to have had the high school academic background needed for success in a STEM major in college. Participants were chosen from multiple colleges and from a variety of college majors (both STEM and non-STEM). Thirty-five college students were administered the STEM Semantics Survey. Their results were used by the researcher to develop interview questions to ask a sub-set of the 35 participants. Twenty college students participated in the interviews.

According to Creswell (2005), purposeful sampling occurs when the participants are selected intentionally. Because participants for the qualitative piece who graduated from the specific high school involved in the study and who were enrolled in certain mathematics courses as twelfth graders were selected for the study, purposeful sampling was employed. A subset of purposeful sampling is called typical sampling. In this type of sampling the participants selected are those who are typical cases with respect to the situation being studied (Creswell, 2005). Participants for the qualitative part of this study were those who were typical in terms of the college they attend and their academic major.

Instrumentation. The qualitative part of the study relied on interviews of college students or recent college graduates. These interviews were used to answer Research Question 2 which pertains to the way in which attending a high school in a rural area impacts the STEM perceptions of college students. Prior to conducting interviews the participants were given the STEM Semantics Survey. Results of the STEM Semantics Survey were used by the researcher to develop the interview questions that appear on the College Student STEM Perceptions Interview Protocol (see Appendix E). Patton (2002) explained that the purpose of interviews was to "allow us to enter into the person's

perspective" (p. 341). Since perceptions were being sought from participants in this study, interviews were a useful technique for collecting data.

Patton (2002) described three methods for conducting interviews-informal conversational interviews, interview guide, and standardized open-ended interview. These methods offer varying degrees of flexibility and standardization. In this study two interviewing methods were combined, interview guide and standardized open-ended interview. Patton (2002) suggested these methods could be combined by "specifying certain key questions exactly as they must be asked while leaving other items as topics to be explored at the interviewer's discretion" (p. 347). The standardized approach was used to provide specific questions that were asked of all participants in the same way. This was combined with the interview guide, which serves as a general guideline of topics to discuss, as needed. Combining these approaches allowed for a degree of standardization between participants while allowing for flexibility to ask relevant questions that come up during the interview based on the participants' responses to the standardized questions. According to Patton (2002), an interview guide is developed to identify the topics the interviewer will cover and some general questions to be asked. The interview guide helps keep the interviewer focused on the important topics while providing some flexibility as to how the topics are discussed. Patton (2002) described the standardized interview as having "the same questions-the same stimuli-in the same way and the same order, including standard probes" (p. 344). The standardized interview is scripted while the interview guide allows flexibility. Combining these approaches for this study provided an appropriate balance of standardization and flexibility.

The details of the standardized interview questions and the interview guide were developed after the data from the quantitative instrument and the two open-ended questions were analyzed because these results informed the development of qualitative instrument. This was in keeping with the connected approach of data mixing described in the Research Design section of this chapter. A connected approach was described by Creswell (2009) as one in which analyzing data is used to inform the data collection.

Data Collection Procedures. Data collection for the qualitative component was conducted by the researcher using the College Student STEM Perceptions Interview Protocol, as described in the Instrumentation section. Using the format prescribed by the IRB, a participant consent form was developed and given to all participants. With the permission of the participants, interviews were recorded in order to fully capture the details of the participants' answers. The researcher scheduled the interviews at a time that was convenient to the participant. The recorded interviews were deleted once transcribed and the transcripts were stored on the computer of the researcher and will be deleted 3 years after the completion of the study.

Data Analysis Procedures. Data analysis for the qualitative element of the study included listening to and transcribing interviews, organizing notes taken during interviews, coding the interview transcripts and notes, categorizing the interview questions into six categories, and organizing the data into themes. Creswell (2009) provided guidance for analyzing qualitative data by listing a six step process that was followed in this study. In the first step data were organized by transcribing interviews. The second step included reading the transcripts and notes. Creswell (2009) described this step as a means "to obtain a *general sense* of the information and to reflect on its

overall meaning" (p. 185). The third step was to code the data. Coding was done by placing data into categories. The fourth step was to develop detailed descriptions about the participants and their perceptions of STEM. Using these descriptions and the coding from the third step, major themes were developed. In step five, the method for conveying the findings was developed. The last step included interpreting the data.

Chapter Summary

The Methodology chapter provided a description of the way in which data were collected and analyzed. The methods used were grounded in the principals of mixed methods research as prescribed by Creswell (2009), Patton (2002), Creswell (2005), and Fraenkel and Wallen (2009). The remaining chapters of this dissertation will provide an analysis of the data and a discussion of the study's implications. The data analysis will be reported in Chapter 4 and a discussion of the implications will be reported in Chapter 5.

Chapter IV

DATA ANALYSIS AND FINDINGS

The purpose of this study was to examine the perceptions of STEM held by students from a rural area and to determine the impact that being from a rural area had on their perceptions. Chapter 4, organized by individual research question, presents the data analysis and findings of the study. The two research questions for which data were collected are as follows:

Research Question 1. How are the STEM perceptions of twelfth-grade female students enrolled in an advanced mathematics course in a rural high school similar to and different from the STEM perceptions of twelfth-grade male students enrolled in an advanced mathematics course in a rural high school?

Research Question 2. How did attending a rural high school impact the STEM perceptions of female and male college students?

Two instruments were used to collect data for the study. The STEM Semantics Survey was administered to the high school students and to the college students. The high school students were asked to provide written responses to two open-ended questions. The College Student STEM Perceptions Interview Protocol developed by the researcher was used to guide the interviews of 20 of the college students.

Demographic information about the participants is provided for the two sets of participants: high school seniors and college students. Results of the STEM Semantics Survey and the statistical analysis of those results are presented for both sets of

participants. A discussion of the results of the two open-ended questions asked of the high school seniors is presented. An examination of the themes that emerged from the interviews is presented for the college students.

STEM Semantics Survey

High School Student Demographic Information. The demographic information for the high school student participants was self-reported. Thirty percent of the participants were males, 68% were females, and 2% did not provide their gender. The racial make-up of the males was as follows: 5 Hispanic and 10 White. The racial make-up of the females was as follows: 3 Hispanic, 25 White, 1 Black, 1 Native American, 1 Hispanic/White, 1 White/Native American, 1 Other, and 1 who did not provide a response. The 50 high school participants were students who were enrolled in Advanced Placement Statistics or Advanced Placement Calculus.

High School Student Survey Results. Participants were given the STEM Semantics Survey and two open-ended questions about their STEM perceptions. The STEM Semantics Survey was designed to gauge perceptions of STEM by having students identify their view of science, technology, engineering, mathematics, and STEM careers along a 7-point rating continuum. The 7-point ordered response scale had opposite adjective pairs on each end. Reverse coding was used when needed so that for each response a higher number indicated a more favorable rating.

Reliability for each of the five scales (Science, Technology, Engineering, Mathematics, Career in STEM) was determined by calculating Cronbach's alpha. The reliability measure for each scale is presented in Table 1.

Table 1

Scale Reliability Measure

Scale	Cronbach's Alpha
Science	.94
Mathematics	.91
Engineering	.95
Technology	.95
Career in STEM	.92

All scales had a high Cronbach's alpha, with the lowest being .91. This finding indicates strong internal consistency among items. Therefore, the results for the five items (adjective pairs) for each scale were summed across each of the scales to create a total scale score. All items on each scale had a corrected item-total correlation that was considerably higher than .3, suggesting that there was a correlation between the rating on the item and the total score of all five items for each scale (Field, 2009). Each scale except Technology had one of its five items with an item deleted Cronbach's alpha that was higher than, but not considerably higher than the overall Cronbach's alpha, so no items were eliminated.

Having examined each item, the summed scale scores for the high school participants was determined. Descriptive statistics for the summed scale scores are presented in Table 2.

Table 2

Descriptive Statistics of Summed Scale Scores for High School Students ($N = 50$)

Scale	Mean	*SD*
Science	28.27	7.08
Mathematics	24.41	7.90
Engineering	22.00	9.74
Technology	28.33	7.57
Careers	25.44	8.37

With five adjective pairs for each scale and an ordered response scale rating from 1 to 7, the highest summed scale possible is 35 and the lowest possible is seven. Results indicate that Technology and Science were viewed the most favorably of the five categories, with Mathematics and Engineering viewed the least favorably. Engineering had the most variability in the students' ratings.

The scale scores were analyzed to determine if male and female participants had different perceptions of STEM and STEM careers. Male participants gave higher ratings than the female participants on all categories except Mathematics. On average, males rated Technology 3.67 points higher, Science 1.84 points higher, Engineering 10.26 points higher, and Careers in STEM 2.63 points higher than females rated those categories. Engineering was the category with the greatest discrepancy between the ratings of male and female students. Female respondents rated Mathematics an average of 1.68 points higher than did the male participants. Female students rated Science most favorably, followed by Technology, Mathematics, Careers in STEM, and Engineering. Male respondents rated Technology most favorably, followed by Science, Engineering, Careers in STEM, and Mathematics. Table 3 shows the mean summed rating for each of the five scales for female and male high school students.

Table 3

Means of Summed Scale Ratings for High School Females and Males

Scale	Female[a] Mean	Male[b] Mean
Science	27.59	29.43
Mathematics	24.68	23.00
Engineering	18.74	29.00
Technology	27.12	30.79
Careers	24.44	27.07

[a] n = 34; [b] n = 15

Multivariate analysis was performed for the Technology, Science, Mathematics, and Engineering categories to determine if there was a statistically significant difference in the STEM perceptions held by female and male high school seniors from a rural high school. The Careers in STEM scale was analyzed separately using an independent samples *t* test because perception of a career in the STEM fields was considered by the researcher to be fundamentally different than a general perception of each of the fields. To establish the reasonableness of using a MANOVA, Levene's Test of Equality of Error Variances and Box's Test of Equality of Covariance Matrices were run. Levene's Test was not significant for the summed results for the Science, Mathematics, Technology, or STEM Careers scales. It was significant for the Engineering scale at the $p = .05$ level. Box's Test was significant at the $p = .01$ level, indicating that the observed covariance matrices of the dependent variables are not equal across groups. The violation of Box's Test made Roy's Root an unacceptable test statistic to use, but the other test statistics were viable as they are robust to violations of equality of covariance matrices (Field, 2009).

A one-way MANOVA revealed significant multivariate main effect for gender, Wilks' $\lambda = .67$, $F(8, 86) = 2.38$, $p = .023$, partial eta squared = .18. The power to detect the effect was .87. Thus, the result of the MANOVA revealed that STEM perceptions held by male high school students were significantly more positive than those held by female high school students. An independent samples *t* test was also used to determine for which scales a statistically significant difference occurred. Table 4 displays the results of the independent samples *t* test for the Technology, Science, Mathematics, and Engineering scales using the summed values for each scale.

Table 4

Results of Independent Samples t Test for STEM Scales for High School Students

Scale	*t*	*p*
Science	-0.68	.504
Mathematics	0.67	.506
Engineering	-3.85	.000*
Technology	-1.63	.109

* Indicates significance at $p < .001$

Results of the independent samples *t* test indicate that Engineering perceptions held by male high school students were significantly more positive than those held by female high school students, $t(47) = -3.85$, $p < .001$.

The Careers in STEM scale was analyzed using an independent samples *t* test. This scale was not included in the MANOVA because it was believed that the Careers in STEM scale was different from the other scales. The results showed no statistically significant difference in perceptions of Careers in STEM for female and male high school students, $t(47) = -1.02$, $p = .315$.

Along with the STEM Semantics Survey, the students were asked to respond in writing to two open-ended questions related to their perceptions of STEM. The first open ended question asked students what can be done by the school and/or community to increase interest in STEM. The participants' responses fell into the following categories: more hands-on activities, more relevance with a career focus, more technology use, broader STEM course offerings, and more outside-of-school activities such as field trips and contests. Having more hands-on activities in STEM classes and showing how STEM is relevant and necessary for many careers were brought up the most by students.

A female participant wrote that the school needs more "hands on learning classes with related jobs that may relate to these subjects." Similarly, another female

participant's idea for increasing interest in STEM was to "perform experiments and studies that are relatable to using the subjects in the real world." Another wrote that she believes the school needs to "encourage more real life examples of jobs." A female participant wrote that the school should "emphasize the need of people having careers in these fields." A male participant said, "One good way to increase interest in STEM is to focus more on how it is used in real life and use hands-on projects to encourage students to pursue careers in that field." Another male participant wrote that "There can be more hands on activities for the science, technology, and engineering areas." Similarly, another male participant suggested "inserting more hands-on activities into the class work."

The references to needing more of a career focus was consistent with the quantitative results that showed the Careers in STEM category being rated lower than the Science and Technology categories. Also, the Engineering scale was rated the lowest by the high school students. Qualitative data from the college student participants indicated that they had little knowledge of what engineering entailed because few engineers lived in their rural community. This low rating by the high school students, while not articulated in their qualitative responses, was consistent with the qualitative responses given by the college students.

The second open-ended question asked students what impact growing up in a rural area had on their STEM perceptions. The most common response was that they received less exposure to STEM because they lived in a rural area where STEM jobs are less prevalent, but almost as many respondents said that being from a rural area had no impact on their STEM perceptions. Several respondents wrote that their community's

agricultural focus had a positive impact on their STEM perceptions. A female participant wrote that being from a rural area "makes science seem hard and foreign and no one thinks they'll ever use it again outside of school." A female participant mentioned that "urban schools have a lot more options in the sciences and more opportunities for students to apply their knowledge." Similarly, a female participant wrote that students in her rural high school "are more limited in certain areas because you aren't being exposed to the same things as someone in a suburban area." A male participant wrote that "we're not as exposed to as much technology as other schools." Another male participant wrote about a lack of exposure to STEM because "many advances in STEM are not known or have not been personally witnessed." These views were contrasted with the view held by some that being from a rural area improved their perceptions of STEM.

A female participant who viewed their community's emphasis on agriculture as having a positive impact wrote that because of the area's agricultural heritage, "we see how all of these things [STEM] relate in real life." Another female participant wrote, "it is easier for me to understand certain areas of science, technology, and engineering because of our agricultural based community." A male participant similarly wrote that "the areas of science, technology, and engineering are more stressed than mathematics due to the agriculture influences in a rural area." Several respondents stated that their perceptions of STEM were not impacted by growing up in a rural area but they did not elaborate on the reasons for this viewpoint.

While the MANOVA results suggested that there were gender differences in the perceptions of STEM held by male and female students, the qualitative results of the two open-ended questions were consistent between male and female students. The

MANOVA was followed up with an independent samples *t* test which showed males had a significantly higher favorability rating than females for the Engineering scale. Quantitative and qualitative results from the high school participants along with quantitative results from the college participants were used to develop interview questions that were asked of a subset of the college participants. The results of analysis of responses to interview questions are presented next, and those results provide data for answering Research Question 2.

College Student Demographic Information. The participants in the qualitative component were college students who attended the same high school as the twelfth-grade students who were the participants in the quantitative piece. Thirty five college students were given the STEM Semantics Survey. Those results were used by the researcher to develop interview questions that were asked of a subset of the 35 participants. Twenty college students participated in the interviews. Of the 35 students who completed the STEM Semantics Survey, 49% were male and 51% were female. The racial make-up of the males was as follows: 1 Hispanic, 13 White, 1 Black, and 2 Asian. All 18 female respondents were White. Fourteen different colleges were represented among the participants. The colleges included institutions that are large and small, public and private, community colleges, and research universities.

Of the 20 students who were interviewed, 45% were male and 55% were female. The race of the male interview participants was as follows: one Hispanic, two Asian, and six White. All 11 of the female interviewees were White. There were eight students majoring in a STEM field, four of whom were male and four of whom were female.

Eight different colleges were represented among those participants who were interviewed.

College Student Survey Results. The 35 participants were given the STEM Semantics Survey and the results of the survey were used to develop interview questions that were asked of 20 of the college students. Results from the STEM Semantics Survey given to the college student students are presented first, followed by the results of the interviews.

As with the high school participants' survey data, the responses to the five adjective pairs for each scale were summed. The summed ratings could be between seven and 35, where higher summed ratings indicate a more favorable perception. Descriptive statistics for the summed scale scores are presented in Table 5.

Table 5

Descriptive Statistics of Summed Scale Scores for College Students ($N = 35$)

Scale	Mean	*SD*
Science	25.69	7.04
Mathematics	22.37	8.89
Engineering	23.03	7.43
Technology	28.03	6.51
Careers	25.91	7.06

Results indicate that Technology and Careers in STEM were viewed the most favorably of the five categories with Engineering and Mathematics viewed the least favorably. Mathematics had the most variability in the participants' ratings. These results were used to develop questions for the interview protocol that was used to determine participants' their perceptions of STEM and the impact attending a rural high school had on those perceptions.

Female college students rated Science, Mathematics, and Careers in STEM higher than males. On average, females rated Science 0.65 points higher, Mathematics 1.07 points higher, and Careers in STEM 1.15 points higher than males rated those categories. Male college students had higher ratings than females for Technology and Engineering. On average, males rated Technology 1.66 points higher and Engineering 5.32 points higher than did females. Female college students' perceptions were highest for Technology followed by Careers in STEM, Science, Mathematics, and Engineering. Male college students' perceptions were highest for Technology followed by Engineering, Science, Careers in STEM, and Mathematics.

As was the case with the high school students, the largest difference in ratings between female and male college participants was for Engineering. While the Engineering difference was the largest, it was half the difference of the high school participants. These results were used to develop questions for the interview protocol that sought to determine participants' opinions of the role gender plays in their perceptions of STEM.

College Student STEM Perceptions Interview Protocol

Results of the STEM Semantics Survey given to the high school and college participants were used to develop the College Student STEM Perceptions Interview Protocol. Interview questions fell into one of six categories. The categories were: Rural Effect, Gender, Obstacles to STEM, College Major/Career Interest, STEM Experiences, and Evolving Perceptions. Twenty of the college participants were interviewed. Results of the interviews are presented by category, but the notion of a rural effect on STEM perceptions permeated all of the categories.

Rural Effect Category. The category labeled Rural Effect consisted of questions asking participants about the impact attending a high school in a rural area had on their educational experiences, particularly those experiences related to STEM. The questions from the interview protocol that relate to the Rural Effect are as follows: Questions 3, 4, 14, 16, 17b, 20b, 21b, 23b, and 24b. These questions can be found on the interview protocol (see Appendix E). One theme emerged from the analysis of the data related to the Rural Effect category. This theme is that there is a lack of exposure to STEM and a lack of resources for STEM in rural areas. This theme was described by both male and female interviewees and by STEM and non-STEM majors alike.

Lack of exposure and resources theme. When describing a lack of exposure and resources with regard to STEM, female participants pointed to limited access to STEM classes and less rigor than their college peers from larger areas, less exposure to STEM outside of the classroom, and a community culture that did not value STEM. A female STEM major commented on the difference between the type of high school classes she took and those that her college friends from more populated areas took. She said the following:

> I remember after freshman year of college just comparing high school experiences with new friends and they would say "oh, like did you take this class in high school" and I would just say no. Like we just kind of took the basic ones. And they would ask me "did y'all, did people just not sign up to take those classes or what" and I told them they were just not offered. We just didn't have access to those resources or classes. And then whereas in the non-rural areas that was like a thing everybody did.

A female non-STEM major said "one thing I have noticed is that, I am going to college in the Atlanta area, and I've noticed that my friends who are from the Atlanta area, they have magnet programs." Another female non-STEM major, when talking about high schools from larger areas said "their concentration is more on STEM classes than it is here because we just don't have the funding to push that." Similarly, a female non-STEM major said that her friends from a larger area had an advantage in STEM because "their classes and their schools are so much more advanced." She said the following:

> When we would talk about AP scores and I would say like "I made 2s on all my AP tests" and they would look at me and be like "we made 5s" and stuff like that. And they would take so many more AP classes and they would have all these college credits already. And looking back on my high school experience it was just different. I felt like people made high on an AP test we were like "oh my gosh, they are so smart" and stuff like that. Yeah and a lot of them had so many hours going into it from AP scores and stuff, not just dual enrollment.

A similar view about the rigor of her STEM classes was held by a female STEM major who said the following:

> I thought it was normal for the computer class that I took, that I was mandated to take, we learned how to use PowerPoint. And at other places, like my peers in college, they were learning to program and stuff like that. There was just a completely different culture.

A female non-STEM major questioned whether or not STEM classes in her rural high school were as good as those at high schools in larger areas. She said the following:

> Whether the classes are quote as good or have the same resources as non-rural areas, I think that it where things start to vary. Teachers major in those things [STEM fields] and want to end up teaching those things they may go to a school in a non-rural area because they know people will appreciate them more.

Her concern about attracting high quality teachers to teach STEM classes in rural schools was consistent with the research of Dessoff (2010) and Blanton and Harmon (2005). Another female non-STEM major expressed a belief that students from non-rural areas "had so much more of an understanding of the basics of things when it comes to the STEM subjects" than she did.

A belief that they received less exposure than their college peers to STEM outside of the classroom was a view commonly held by the female students. A female STEM major stated the following:

> I was a biology major so we participated in STEM things like STEM night where we went to elementary schools, we had a STEM fair, this big thing in college where all of the community came to. And nothing like that happened here and I think it is because it's rural. So that's what I would say that cities have an advantage over rural. They have things outside of the things they learn in school.

A female non-STEM major explained that in her high school there were few STEM-related activities outside of the classroom. She said the following:

> There [was] not much presented to me for me to do in high school for STEM things besides science fair which I didn't really want to do. I felt like it would have been better if we had more technology things or engineering. Honestly I didn't even know like what engineering was in high school.

Consistent with Hopkins' (2005) assertion that students in rural schools lack the cultural capital available to students in urban schools, a female non-STEM major said the following:

> I feel like people in bigger areas…emphasize getting an education more than, I'm not saying people from down here and are like "don't get an education" but I feel like the focus is much more on where you're going to school for the future in a place like Atlanta or somewhere bigger. And like they can walk out their door and hop on the MARTA or whatever and go to a, I don't know, I feel like they could organize a class field trip to go see somewhere that does engineering.

A lack of exposure to STEM in the community was described by several female participants. A female STEM major said, "There is not any big employers of engineers or technicians or anything like where you need a real technical type of degree. It's just not here, so it's not really stressed." Another female STEM major had a similar view. She said the following:

> Just like if you grow up in a rural town you, you know, we still have doctors, we still have lawyers, we still have teachers, which are very universal jobs, but in larger areas, more industrial areas, there are also engineers and technicians and things like that. And we just don't have that. We just don't have anyone to model. There is no one who really wants to reach out to students and be like, "Hey, you should try engineering if you are good at math," not just be a math teacher and stuff like that. I think there are so many more opportunities in larger areas than there are here.

A female non-STEM major said, "the engineering stuff, that was never a thing down here because we're all so much more agricultural." Similarly, another female non-STEM major said, "I feel there's not as many opportunities here for kids to see math or science as being a different area than just school, whereas in more populated areas those jobs are there." The views expressed by both feel non-STEM and STEM majors support a conclusion that being from a rural area impacted their perceptions of STEM because they lacked exposure to STEM while in high school.

Participants also pointed to a community culture that does not emphasize STEM as being a characteristic of their rural community that shaped their STEM perceptions. A female STEM major stated the following:

> Well, in this community it's more about farming and football. So, I don't think there was much opportunity, well, there was opportunity, but I don't think there was much exposure towards the STEM experiences or STEM in general. So, perhaps the community didn't lend itself to STEM because it is such an agricultural community and football.

Another female STEM major discussed how she believes STEM is less valued in her rural community because STEM jobs are not prevalent. She said the following:

> I believe that students from my high school do not have the same access to STEM classes as students from an urban area. Just because here, in other areas it might be pushed. There the students are able to see the relevance of engineering. They can see and be exposed to the whole STEM field, whereas here…it's more agricultural and football. You know what I mean? I hate to say that, but it's the truth. We're not exposed to the more STEM fields as in the non-rural areas.

A female STEM major explained that students at her school were not interested in STEM when she said the following:

> I would say that my STEM experiences were limited based on the school's resources and just other students' lack of interest, I guess, in those areas so there wasn't a push to have more experiences in those areas, and after going to college and talking to other students I realized there is a big difference based on where you grow up.

These statements by STEM majors suggested that they perceived their community and their peers as not being supportive of STEM endeavors.

The lack of exposure to STEM and a lack of resources for STEM in rural areas was a theme that male students identified as well. Males had views that were consistent with those females. Male participants pointed to limited access to STEM classes and less rigor than their college peers from larger areas, less exposure to STEM outside of the classroom, and a community culture that does not value STEM.

A male STEM major commenting on the lack of STEM course offerings in high school said the following:

> I feel like we're kind of sheltered a little bit. We don't have some of the choices in classes and stuff that bigger schools have. Like my friends in bigger cities have all these cool classes and stuff that you can do and they have more funding for projects and stuff like that.

Another male STEM major commented on his high school science labs compared to those of his college classmates from more highly populated areas when he said the following:

> The labs we did were very basic labs compared to the ones I've heard others did where they incorporate more technology into their science classes. So even if they didn't have technology classes they incorporated technology in their science classes so they were able to do more in-depth science labs than we did in our high school.

Non-STEM majors had similar comments on the availability and rigor of high school STEM classes. One said, "We weren't offered the STEM classes that students who went to high school around the metro Atlanta area were offered." He elaborated by saying that other students from the Atlanta area had "engineering courses and really advanced mathematics courses in general and computer information systems classes in high school." A male non-STEM major said the following:

> I would say I had less early exposure to STEM classes. So a lot of other people that I know who were in urban high schools seemed to be able to take you know like an introductory computer science class or gain some form of exposure to engineering in high school. While in my high school it was mainly just the standard math and sciences that you would expect in like a formal primary education. And so it didn't, I guess it made me less aware of what majoring in computer science would be like.

He went on to say that you can get a strong STEM exposure at his rural high school but that the student must seek out more STEM experiences on his or her own in the following comment:

> You sort of have to go out of your way to get a really strong STEM exposure at our high school so you're not, you're on track to only have one calculus at

> graduation or like one statistics class or one AP science class at the most if you're sort of on the advanced track. So if you don't really go out of your way you're not going to have, if you don't go out of your way you're and like work really hard in those classes then you're not going to have a very strong exposure to the STEM classes and when you see that first, when you take that first biology class things may not go nearly as smoothly as if you'd gone to a city school and that may end up making a big difference in what you choose to major in.

A male non-STEM major said, "I feel the ones in non-rural areas are better prepared for STEM fields…because students in the rural areas again don't have access to the education in STEM that non-rural students do."

Like their female counterparts, male participants described a lack of exposure to STEM outside the classroom. A male non-STEM major explained that rural areas do not have many STEM jobs, which reduced the exposure high school students had to STEM. He said the following:

> I feel like also in non-rural communities you might have more of an exposure to people who are engineers and people who are math and physicists and all that type of other stuff because of the amount of people. So I feel like we did not have the same access basically because of our location.

Similarly a male non-STEM major described that not having many STEM jobs in the rural area leads to less awareness of the positive aspects of taking STEM classes. He explained the following:

> So part of it is that I guess the lack of engineers in a rural area. When you think of an engineer you think of somebody working in, generally in a more urban area

> and they probably make up a greater percentage of the population in an urban area so I guess if you think of just the network effect, parents in a rural area don't have many friends that, there are friends that are doctors who sort of see the science side of things, but they don't have as many friends that are former engineering majors and former math majors and using that in their career and especially technology. And so those parents don't, probably aren't aware of the positive outcomes that come from studying STEM.

This was echoed by a male STEM major who said, "I guess because a lot of people in this rural area come from like agricultural backgrounds…so that's [STEM] not as important because they're interested in the agricultural sector." Similarly a male non-STEM major said, "When we look around at our parents' job, they don't focus on [STEM]."

The belief that their rural community does not value STEM was held by male students as well as by female students. A male STEM major said that he believes "the culture of a rural area placed less emphasis on, like, STEM classes and STEM majors and STEM careers." He went on to say that "culturally people don't value it [STEM] as much" and that STEM is "not what people are excited about." This view was held by a male non-STEM major who said, "in a rural area like ours the focus is usually on sports and agriculture" and that "science and math weren't necessarily at the forefront of what we were doing in school." A non-STEM major explained that his STEM experiences were impacted by attending a high school in a rural area. He said the following:

> I think growing up in a rural area being prominently agricultural based region of Georgia we really didn't teach the math, the technology, the engineering and the

> math all of that mathematical based stuff because around here it's just not that important. And since not everybody goes to college these days, a lot of people do, the number keeps growing, but since a lot of people don't go to college it's like we need to prepare these kids for what's based around our county outside of high school and that's where the agricultural classes come in.

A male non-STEM major commented that "there's a significant cultural difference between the students I went to high school with and the students that I went to college with." He went on to say that his college classmates from urban areas "usually have greater push to study a STEM major, while in this rural area you wouldn't expect somebody's parents to recommend they major in STEM." The culture of the rural community has an impact on the way STEM is perceived by the college students who grew up in a rural area.

Summary of Rural Effect perceptions. The theme of a lack of exposure to STEM and a lack of resources for STEM in rural areas was described similarly by male and female participants. Both male and female interviewees perceived that they had limited access to STEM classes and less rigor than their college peers from larger areas, less exposure to STEM outside of the classroom, and a community culture that does not value STEM. These views formed a basis for many of their perceptions in the other categories that are described next.

Gender Category. The category labeled Gender consisted of interview questions that asked participants what role gender plays in the perceptions they hold about STEM and what role they believe gender played in the perceptions high school seniors from their alma mater hold about STEM. The questions from the interview protocol that

comprised the Gender category were as follows: Questions 17c, 19, 22, 26, 28, 30, and 32. These questions can be found on the interview protocol (see Appendix E). Two themes emerged from the responses to the questions in the Gender category. The first theme that will be addressed is the idea that a gender stereotype exists in STEM fields. The next theme is that more STEM exposure in college leads female students to improved perceptions of engineering and STEM careers. These themes were prominent in the responses from both male and female college students, including STEM and non-STEM majors. The rural effect was found in the Gender category as participants described the stereotypical female jobs of nurse and teacher as being common in their rural community and that few STEM role models existed for women in their rural community.

Gender stereotype theme. College student participants declared that gender stereotypes have an impact on STEM perceptions. The gender stereotype theme was discussed by female and male interviewees alike. A female STEM major succinctly explained her perceptions of STEM as male-dominated when she said, "there's a stigma associated with those [STEM] majors that might just deter females." This sentiment was not isolated to STEM majors. A female non-STEM major said "there are obstacles obviously because STEM is not easy but I do think it's probably harder for females, you know, because it's typically thought of as a male dominated field." Another female non-STEM major discussed the obstacles to STEM faced by females when she said "I feel like a career in STEM is stereotypical of a man's job." According to a female non-STEM major, the implication for this perception of STEM as a male field is that "girls feel like it's not…something they should do because it's for boys." Another female non-STEM

major whose roommate is a female engineering major discussed how her roommate talked about her classes as being overwhelmingly male dominated. Based on her roommate's experience as an engineering major, the non-STEM major stated the following:

> Maybe the girls are viewed as not quite as smart or quite as good as the boys because it's a boy field and not a girl field, you know. So I think yeah, I think there are definitely different obstacles. You know females are viewed as, um maybe not, that they're not going to be good enough to do that as well as a boy can do.

While many female students focused on what they see in their college classes and the majors that male and female students choose in college, others discussed how the stigma of STEM being a male field starts at an early age, especially as it relates to engineering. A female STEM major who has a twin brother shared a contrast between her brother and herself. It is interesting that this contrast exists in light of the fact they are twins who grew up together in the same household. She said the following:

> Personally, I was more of a Barbie Doll fan and my twin brother was a building, destroying kind of person – the stereotype of the female versus the male maybe wires them differently into thinking that engineering is more for males and not so much for females.

A female non-STEM major agreed that the stereotype of STEM, especially engineering, as a male field starts early. She believes that young girls are not encouraged to pursue a career in engineering. She said, "I feel like when you're a little girl your parents aren't going to be like 'you can be an engineer.'" She pointed out that parents are not explicitly

telling their girls to not be engineers but that "parents have the same mindset of, you know, that's more of a male's job so it's never really been encouraged."

The belief in a gender stereotype in STEM was not confined to the female college students who participated in the study. Their male counterparts identified this gender stereotype as an obstacle to STEM for females and as something that shapes perceptions students have of STEM. The male students tended to focus on engineering in their discussion of STEM as being stereotyped as a male field. In their discussions they frequently referred to the lack of female role models and mentors. This was a contrast to the female students who never mentioned role models and mentors when discussing the gender stereotype of STEM.

A male STEM major stated, "Whenever you see or think of engineers, for the most part, I think of a male doing that job." A male non-STEM major stated that when thinking of an engineer, "the first image that pops to mind is usually of a male and that probably discourages females from wanting to major in it." Another non-STEM major echoed the idea that the gender stereotype creates an obstacle to STEM when he said, "females kinda have to overcome [a] sort of pressure from just not being treated as, like, a strong quantitative student." Like the female STEM major who described how she and her twin brother played in different ways, a male non-STEM major described how the different ways young boys and girls sometimes play might have an impact on the gender stereotype of engineering as a male field. He said the following:

> Just in general boys grow up playing with Legos and just get that early exposure to thinking about things from an engineering perspective, while girls aren't really expected to build things or to, I guess, to study that area. And so by the same

> token men I guess are generally going to view a career where you are going to build something or to think about how something works more favorably just because you're sort of more experienced in it, while females on the other hand see it as something that's kinda like male dominated and they haven't really been exposed to it and kind of see it as unknown and view it unfavorably as a result.

The idea that STEM perceptions are developed early on, as expressed by the interview participants, was an important consideration for educators, parents, STEM professionals, and policy-makers trying to encourage more students to pursue careers in STEM. This concern was echoed by a female STEM major who expressed concern that her school district was not doing enough to promote STEM in the elementary schools.

The male interviewees frequently referred to a lack of STEM mentors and role models for female students, especially in engineering. This concern is exacerbated by in a rural area where few people are employed in STEM fields. The need for female mentors and role models was not mentioned by the female participants. A male non-STEM major stated that "one of the biggest barriers when you're actually pursuing a career is sort of having, like, mentors and sort of having people above you that you can relate to." When discussing why he thinks the female college students participating in the study viewed engineering less favorably than males, a lack of mentors and role models was a common reason given. One male non-STEM major said that engineering may be viewed in an unfavorable light by females "because not as many people in front of them have done it." Another noted that the cycle of viewing engineering as unfavorable by females will continue. He said the following:

> I think that a lot of our actions in college are based on our peers and I think a lot of people like if, being a female majoring in engineering isn't popular in general in colleges right now so it's just going to make it continue that cycle until females realize they can do it just as good as other people can, probably even better. So I think that it's just not popular right now and that's why they view it more unfavorably just because there's not a lot of people out there doing it.

Another male non-STEM major made a similar point when he stated that "if more females go into the field, they will start to change their perspective."

Male students had similar views regarding the role increased exposure to STEM in college played in improving the perceptions females had about engineering and STEM careers. Several male students referred to gaining more knowledge about engineering in college as a possible reason the female students had a better perception of engineering than high school students. One male STEM major said, "I think it's just that when you go to college you have more access to information and you got a lot of career advice." A non-STEM major pointed out that seeing other female students who are interested in engineering helped improve perceptions for female students. He said the following:

> I find that they view it more favorably because when they get out of high school here they go to college and they see females coming from different areas doing engineering so they feel more comfortable doing it. And when you feel more comfortable seeing other females doing it, doing the engineering field then you find it more favorable because you like "Oh, females can do engineering too," but in high school it wasn't really emphasized upon.

Similarly a male STEM major stated the following:

> In college you have more access to people doing other things and I guess women who may not have known anything about it [engineering] in high school might have talked to somebody in college and kind of got an idea of what it was and found that they liked it.

A non-STEM major addressed the notion that students have a limited view of what engineering is and that this limited view gets expanded in college when he said that female students "probably get to college and realize all of the different branches of engineering and realize that there are more opportunities than just building things." Two male non-STEM major believed the increased exposure to STEM resulting in improved perceptions of engineering and STEM careers was the product of the changing viewpoints of female college students. One said the following:

> I think it goes to females in college are, you know, from sitting in a high school classroom and socializing with high school friends who have the same world view as you to going to college and intermingling with people who have different majors, who have different worldviews than you, you see more and more women who are just exposed to other women who have STEM jobs.

The other said the following:

> Maybe the societal effect of females being viewed as less science-y sort of fades in college and females have the same exposure sort of, similar exposure to math and science once they get to college and they're able to do as well as they, they're able to reach more of their potential in college.

These comments point to the importance of exposing female students to STEM and STEM role models to broaden students' worldview and to help overcome the male

stereotype of STEM. These concerns about a lack of STEM role models for females were especially relevant in a rural community where few STEM role models exist.

Improved exposure/improved perceptions theme. "I would say for females, around here I feel like…the jobs are limited. It's like, teacher and nurse." This sentiment was expressed by a female non-STEM major who believed that in the rural area where she grew up, there are few opportunities for women to pursue careers in STEM and that there is limited exposure to STEM. A common theme that emerged from the interview questions related to gender was that female students' perceptions of engineering and STEM careers improve while in college due to more exposure to STEM. A female STEM major stated that female college students tend to have improved perceptions of engineering since high school because of "figuring out what engineering is exactly and just being exposed to it more in college than in high school." Another female STEM major speculated that in high school female students do not know as much about engineering as their male peers. She said, "I feel like we're limited in high school, the things we know about engineering versus college, especially as a girl maybe. Maybe it is a girl thing." Exposure to broader subject matter was a reason for improved views of engineering and STEM careers cited by several female college students. A non-STEM major said that while taking the core curriculum "you have all these classes to take and they expose you to everything. And I feel like if some girls went through that they might think: oh, I might be interesting in doing this technology or this engineering job." Another non-STEM major pointed out that "college students have been given more opportunity to explore their interests a little but more than the high schoolers." This idea of being exposed to more in college was echoed by a another non-STEM major who

stated that "females have seen, OK, maybe there are some jobs and careers that I can do with STEM instead of having that more narrow mindset in high school." A non-STEM female major stated that college students gain more exposure to STEM than they did while in high school. She pointed out that college students learn that a background in science is needed for many careers in healthcare. She said the following:

> I feel like in high school you just don't, you don't really know all that you can do with science or math fields or technology. And so I think once you get to college and start taking different classes that you realize oh I can do these types of things and again you don't realize like physical therapy and pharmacy and that type of stuff are in a science area. So I think just learning more about what really is in each category [of STEM] is helpful.

The sentiment that college exposes females to more STEM fields as careers options was echoed by a STEM major who said the following:

> You see more female students who are in the science and math fields versus the students in high school who may not think that science and math is so great. But once you get in college you see, well you know there are a lot of fields that you can go into that have a lot to do with science and math. So, it's the exposure. Seeing other females that are pursuing their career and not going with the stereotypical [view that] males have to do this.

The increased exposure to STEM and to other females pursuing STEM was critical to the improved view female college students had toward STEM.

This idea of improved self-efficacy was important because of the literature that identified low self efficacy in STEM as more of a reason for a lack of interest in STEM

than academic achievement in STEM (Kurtz-Costes et al., 2008; Morganson et al., 2010). A female non-STEM major pointed out the following:

> In high school the girls probably felt like this isn't really my thing or this isn't a career I could take on because there aren't a whole lot of females in it. Then when they get to college they are like "oh I can do this." I feel like when you go off to college you learn a lot about yourself. You learn that you can do things um that you maybe thought you couldn't do.

Another female non-STEM major said, "the females that were thinking less of themselves, that they couldn't do these hard classes and stuff, get into there [college STEM classes] and think that they can and they're working harder and they want to work harder for a STEM career." These comments point to the important part self-efficacy plays in shaping the perceptions females have about STEM.

Summary of Gender perceptions. The themes from the interview questions regarding gender involve gender stereotypes of STEM fields and how increased STEM exposure in college led to improved perceptions of engineering and STEM careers for female college students. These themes appeared in both the male and the female students' responses to interview questions about gender. Both STEM and non-STEM majors referred to these two themes. The consistency with which these topics appeared in the participants' responses suggested that these are important themes that impacted the perceptions college students held about STEM.

Obstacles to STEM Category. The category labeled Obstacles to STEM consisted of questions that asked participants their perceptions of the obstacles that exist to pursuing careers in STEM. The questions from the interview protocol that comprised the

Obstacles to STEM category were as follows: Questions 16, 17a, 17b, 17c, and 18. These questions can be found on the interview protocol (see Appendix E). This line of questioning was worthy of discussion due to the shortage of STEM professionals in America. Three themes emerged from an analysis of the interview data. The first theme that will be explored is that STEM coursework is challenging and that students are intimidated by it. The second theme to be examined is the concern held by the participants that their K-12 educational experience did not adequately prepare students for the rigors of college STEM classes. The third theme centered around the lack of resources available to rural school districts and a lack of exposure to STEM in rural areas. Ruralness was an important component of this study so the theme of lack of resources available to rural school districts and lack of exposure to STEM in rural areas was addressed in detail when the category labeled Rural Effect was discussed. As described in the Rural Effect category, participants said that they had fewer STEM courses, especially engineering and computer programming, than available to them in high school, than their college peers who went to high school in larger areas. They also explained that they perceived that they did not get much exposure to STEM in large part because their community's largely agricultural economy had few STEM jobs.

STEM is hard theme. Male and female interviewees alike voiced the perception that STEM classes are challenging and that the level of difficulty of these classes is an obstacle to students pursuing a college major or career in STEM. A female non-STEM major believes that "STEM classes overall are more of a challenge than other classes are." Another female non-STEM major stated that in STEM classes in college "you have to work at it a lot and I think that's a big obstacle for a lot of students." Male students

had similar views of STEM being difficult. A male non-STEM major said "there is a lot of fear" associated with majoring in a STEM field and another pointed out that it is "intimidating to look at getting a degree [in STEM]." Another male non-STEM major said the following:

> [STEM] degrees are very intimidating. Like having to take classes like differential equations and stuff that I don't even know what they mean. Like there is a whole class on something that I don't even know what the word means.

Similarly, another male non-STEM major mentioned a stigma that might exist about STEM where students believe that "science, technology, engineering sounds really hard and I might not want to do that just because of how hard it seems." This theme that STEM is hard has the implication that it "kind of scares some students away" from STEM, according to a male non-STEM major. He went on to say, "I also feel like if you like STEM and can be dedicated it's really rewarding to you."

Non-STEM majors were not alone in considering the difficulty of STEM to be an obstacle to pursing a college major or career in STEM. Even STEM majors pointed out that STEM is difficult. A female STEM major stated all STEM majors "would be one of the harder…majors in college." Two female STEM majors made reference to the difficulty of STEM classes by calling them "weed out" classes. One said that the STEM classes are "weed out classes to see who can persevere" and the other said that many of her peers change majors from STEM to non-STEM as a result of "professors trying to weed people out."

Unprepared for college STEM theme. The next theme to examine is the belief that their K-12 educational experience did not prepare participants for the rigorous STEM

courses that they took in college. Male and female students had similar perceptions of their K-12 educational experience. Participants consistently pointed out that their realization occurred after entering college and being exposed to students from other schools, particularly those from larger urban areas. A male non-STEM major stated that students from larger urban areas "come into college with better writing ability, more prepared to handle a heavy workload because they either dealt with it in high school or they had some type of formal training in high school for what to expect in college." Another male non-STEM major believed that success in college STEM classes was based on "how hard they [high school teachers] make classes." His concern was that his high school STEM classes were not hard enough to prepare him for the rigors of college. Another male non-STEM major believed that preparation for college STEM classes must start early in a student's education. He believed that students from some schools were getting more exposure early on. He said, "It's not just a high school thing it's a K through 12 thing where they are getting early exposure to complicated material and their skills are more refined than at a typical rural school."

The sentiment that exposure to STEM must start early was echoed by a female STEM major. She talked about working with elementary school students while in college to expose them to STEM and expressed concern that nothing like that was done in her community. She said, "In elementary school, I don't remember learning science…whereas these kids were exposed early to STEM." She went on to say, "I feel like exposing at a younger age will help them pursue it [STEM] because they'll know about it." A female STEM major explained that in her opinion "high school hasn't prepared them to know what to expect in these [STEM] college classes." Similarly,

another female STEM major said, "Just coming out of high school you're like 'ooh, I like science' and then getting there you're like 'oh my gosh, I'm not doing well in science classes.' But it's because we haven't been prepared for the science classes." A similar sentiment was expressed about the computer classes that a female STEM major took in high school. She said the following:

> I thought it was normal for the computer class that I took, that I was mandated to take, we learned how to use PowerPoint. And at other places, like my peers in college, they were learning to program and stuff like that. There was just a completely different culture.

Another female STEM major discussed the difference in the level of difficulty from her high school and the high schools of her college classmates when she said the following:

> I really did enjoy the labs [in high school]. I feel like maybe they aren't at as high a level as other places. Like people, when I talk to other people, at Georgia Southern there's actually a lot of Atlanta school people that come there. They have like harder, I would say, labs. They just have more of it.

A female non-STEM major said that her college peers "had so much more of an understanding of the basics of things when it comes to the STEM subjects." This belief was echoed by another female non-STEM major who said, "I feel like their classes and their schools are so much more advanced in a way, so I feel like that they're not, that the STEM experiences aren't the same."

Summary of Obstacles to STEM perceptions. Perceptions of the obstacles to STEM were consistently held by male and female students. Both believed that the difficulty of STEM courses in college served as an obstacle to students choosing STEM

as a career path. Both groups also expressed concerns that they were less prepared for the rigors of college level STEM than many of their college classmates, especially those from larger urban areas. The perceived difference in rural and non-rural educational experiences permeated the interviews were discussed in detail in the Rural Effect category.

College Major/Career Interest Category. The College Major/Career Interest category consisted of questions were asked to better understand why college students chose the majors and possible careers that they did. The questions from the interview protocol that comprised the College Major/Career Interest category were as follows: Questions 6, 7, 8, 9, 10, 11, 12, 13, 14, and 18. These questions can be found on the interview protocol (see Appendix E). The two themes that emerged were that many participants expressed an enjoyment of mathematics and science classes in college and that there were widely varying views about the impact the interviewees' high school STEM classes had on their choice of college major and career.

Enjoyed college mathematics and science theme. Liking mathematics and science classes in college was a common theme among STEM and non-STEM majors alike. Both male and female participants expressed an interest in math and science, but males and females expressed different reasons for liking these classes. A male STEM major explained that he enjoys science because "it's always changing and it's continually growing." Another male STEM major said that he found his anatomy and physiology classes to be interesting "because they were about how the body works and how the body reacts to changes and how certain drugs have an effect on the body and that was just really interesting to me." A third male STEM major spoke of microbiology as a major

because that made the most sense for his plan to become a dentist. He said that he enjoyed his science classes and that "science always came easiest to me." An additional male STEM major liked the interactive nature of his physics classes. He said his physics professors designed the course so that what was taught in labs coincided with what was taught in the lectures. He enjoyed making a connection between the content learned in lecture and the application of it in the lab part of the courses.

A few males who are not STEM majors mentioned math and science courses being among their favorite classes in college. A participant who had an interest in business mentioned enjoying math in college because of its applicability to business because "math goes into economics and any type of business." Another male non-STEM major who was interested in finance discussed how applicable math has been in his finance classes. He also talked about discovering an interest in computer programming while in college. He explained as follows:

> Math is also really big for computer science so having a good basis in thinking logically and walking through a problem in the most logical manner is a pretty helpful introduction to computer science and thinking about how that works.

It is interesting to note that males who were STEM majors pointed to science classes as the ones they enjoyed in college, while non-STEM majors mentioned math. It should also be noted that most of the male non-STEM majors did not mention any STEM course as being a class they enjoyed in college.

Like the male participants, two female participants found their anatomy classes to be interesting because of their interest in the human body. One female non-STEM major said, "I love anatomy and…the science part of the body." Another said, "Anatomy I

loved because I loved learning about different parts of the body and how everything interacts together." Also like the male interviewees, female participants mentioned that the STEM classes they were interested in lined up with their intended career. A female STEM major said, "The reason I chose biology was because I knew I wanted to do something in the medical field and I knew it was best to do a science." This was expressed by another female STEM major interested in a medical field. She said the following:

> The reason I was interested in that [science] is that I knew I wanted to do something in the medical field mainly because of my interest in science and math and I felt like I was stronger in those areas rather than English or history or something like that. So I knew I wanted to do something in the medical field and that major is kind of, if I would've completed that I could have gone on to any of those types of careers.

A female STEM major who wanted to teach math said the following:

> I wanted to be able to spread the love [of math] to everybody else and get everybody else to know about math and see that it really is relevant. Because a lot of people feel that "ugh, math" you know, so math overall is interesting to me and so I'd like to teach others about it.

A female STEM major echoed the thoughts of a male STEM major who said he liked science because it was constantly changing when she said, "I feel like in science you're always learning something new. They're always learning something new so it's always a growing field. That's what I like about science." A female STEM major described the hands-on nature of science classes as being appealing. This response is similar to that of

the male participant who described liking physics because it was interactive. Speaking about her college science classes, the female STEM major said, "I do like that it's always hands-on. In science there's always something to do." An interest in the human body, enjoying learning new things, having hands-on experiences, and an interest in a STEM career were reasons that both male and female participants expressed for why they enjoyed math or science. Another commonality between male and female students was the idea that the STEM fields are relevant. A female STEM major said, "I mean it's so relevant. Science is everywhere. Technology is everything. Everything has technology now. And obviously engineering is so relevant. And then math is just my heart. So, just the relevance and my heart I guess."

There were other reasons given by females for why they enjoyed math or science that were not given by males. One female STEM major and one non-STEM major described a STEM class as something that would help them impact the greater good of society. A STEM major who plans to attend medical school described how her science major would allow her to become a doctor. She said, "The whole reason I want to do it [become a doctor] is to use it in mission work." A female non-STEM major who enjoyed the biology and chemistry classes she took as a nursing major said, "I love knowing that as a nurse I can go and I can help someone who is sick whether it is comforting them emotionally or helping them physically in some way." The notion of their career affecting the greater good was not mentioned by any of the male participants.

An enjoyment of the challenge of STEM classes was discussed by female participants but not by male participants. A female non-STEM major said the following:

> I liked math because you come in and are focused on a specific thing. Like sometimes in this class we'd work on one problem for the whole class and at the end of class you'd have the answer and it was like oh my gosh I finally got it. That relieving feeling, that awesome feeling-I like that.

A female STEM major spoke of how she enjoyed the challenge that STEM courses offered. She said the following:

> I feel like the challenge of it and seeing how in those different areas everything works. It's not like English or language arts [where] you write a paper about what you think. I really like having to solve different problems and then in the end seeing how in the end it all came together. Mostly just it's a challenge to me.

Responses to the interview questions revealed that some students find STEM to be difficult and intimidating. Thus, insight was provided from responses of two students, both of whom are female, which described the challenge of STEM as something positive.

High school STEM impact on college major/career theme. Analysis of the second theme related to college major and career interest revealed that there were varying accounts of the impact the students' high school STEM classes had on their choice of college major and career. Thirteen participants declared that their STEM classes had a positive impact on their choice of major and career, five explained that their STEM classes had a negative impact on their choice of major and career, and two believed that there was no impact.

All female STEM majors and some non-STEM majors spoke of their high school STEM classes as having a positive impact on their choice of college major and career. One female STEM major spoke of the role her anatomy and physiology class she took as

a high school senior played in her decision to pursue a STEM field. She said the following:

> Every part of it, I loved it. The lecture and the dissections we had to do on the cat in there, I was very excited about it and so that actually I think helped steer me in the right direction for the medical field. So I would say that one was probably the most impactful but like I said I actually always enjoyed science classes since I started, even in high school. So I think all of them have helped me choose my career.

Another female STEM major realized that it was her STEM classes that she enjoyed the most in high school. This realization led her to a STEM major. Speaking of her STEM classes, she said the following:

> 100% had an impact on my choice of major. The STEM classes in high school were just the ones I enjoyed more and were the ones I thought I was better at, so I knew from sitting in those classes I knew I wanted to do something in that area and it was a big difference from sitting in other classes where I knew I would not want to do this every day.

This idea that high school STEM classes helped her to realize what she enjoyed was echoed by another female STEM major who said the following:

> I guess my math classes really assured me that I did like math and that my heart was in it, so I began college as a math major and so I did enjoy math. So, those classes had a huge impact on my major, all the math classes.

Those who said that their high school STEM classes negatively impacted their choice of college major and career declared that STEM classes led them to decided that

they were not interested in pursuing STEM. A female non-STEM major said the following:

> I think that has more of a negative effect because I think I never really did well in these classes and seeing myself not do well in the STEM classes made me think that if I did choose a major in STEM that I wouldn't do very well.

Struggling in high school STEM classes was a common way in which female non-STEM said they realized that a STEM major or career was not what they best suited for. One said that as a result of struggles in mathematics, she decided she "couldn't do engineering or something like that" and another said, "I knew for sure I didn't want anything to with science and math." Another female non-STEM major looked for a college major that did not require much math or science as a result of her high school STEM classes. She said the following:

> Well, whenever I was deciding on my major I was like which one would I not have to take science or math. So that was one of them but that was not majorly impacted but I knew I wasn't going to do anything with science or math. So I don't think it had too much but I knew I was like, I can't do that.

The negative experiences in high school science and math caused these female participants to pursue a college major in a non-STEM field.

Another reason for not pursuing a college major or career in STEM given by female non-STEM majors was a lack of knowledge in high school of what careers are available to STEM majors. A female non-STEM major said that in high school she "never heard about careers in STEM." Other female non-STEM majors suggested that

more emphasis on careers would help students better understand the options they have. One stated the following:

> I think in high school there needs to be some kind of like required class or something that goes over the different career paths, maybe not just in STEM but going over several different things. In my case, I just didn't know and especially the different sciences and technology and engineering, I just didn't know. And looking back it, hindsight is 20/20, I wish I would've looked into other things more instead of just jumping into something.

A similar thought was expressed by another female non-STEM major who said the following:

> It's hard when you have absolutely no clue what you want to do with your life and I feel like for people who want to do careers in STEM, in those STEM specific classes in high school, teachers can maybe get someone in the community to come talk or get an old friend to come talk or Skype with somebody and do some kind of question and answer thing or something to let the students know that it is attainable for you to do it as long as you work hard.

Not knowing what careers are possible from a STEM major impacted the interviewees' choice of major and career in a negative way.

Male participants also had varying views on the impact their high school STEM classes had on their choice of college major and career. As with the female STEM majors, male STEM majors consistently pointed to their math and science classes as positively impacting their decision to major in a STEM field and to pursue a career in STEM. A male STEM major said, "I've always been interested in biology and I had a

really good biology teacher my ninth grade year. [She] always made it really interesting and that's just something I've always loved and wanted to pursue." Another male STEM major explained that "enjoying science classes directed me toward a science major, then my experiences in college guided me to pre dental intent after becoming a microbiology major." A male STEM major had a similar view as the female STEM major who mentioned that her high school math classes helped her realize that she truly enjoyed math. The male STEM major said, "I guess it kind of helped me understand my love for math and science and helped me figure out that I really did excel in it and I needed to pursue a major in that field."

There were several non-STEM majors who explained that their high school STEM classes made them less likely to pursue a STEM major and career. A male non-STEM major explained that he did not enjoy math and that "the main effect STEM classes had on me was that they taught me that I didn't want to work in a STEM field." Others expressed a perception that was shared by the female students. Many said that in their STEM classes in high school they never learned about STEM careers. This lack of knowledge of what careers are available in STEM caused them to not consider a STEM major or career. A male non-STEM major said that he "didn't really know what a STEM major would do after graduation." He went on to say, "In high school you don't have exposure to what that [STEM] career looks like." Another male non-STEM major said, "I never really understood what all engineering is about because we never talked about it in any of my classes." One male non-STEM made a comment that no female participants made when he explained that a lack of STEM courses in high school impacted his decision to not major in STEM. He said, "Had I been able to take like an introductory

computer science, I probably would've ended up majoring in that or something that requires a significant amount of that, like a computer science or like an electrical engineering major." This comment was consistent with the rural effect in which a lack of computer programming courses available to students in their rural high school was mentioned. Not learning about careers in STEM while in their high school STEM classes negatively impacted the students' interest in pursuing a college major and career in STEM.

Summary of College Major/Career Interest perceptions. Male and female students similarly expressed an enjoyment of math and science in college but the females explained some specific reasons for their enjoyment that males did not, namely that STEM fields can be used to have a positive impact on humanity and the appeal for the challenging nature of STEM classes. Male and female participants both had varying views about the impact their high school STEM classes had on their choice of major. Both groups had those who described an enjoyment of math and science and both groups had those who described a dislike of those subjects. Both males and females also described a lack of emphasis on STEM careers in their high school STEM classes. Not learning about STEM careers as part of their high school education was an important concern because lacking STEM jobs in their rural community made it so that there was little knowledge of what opportunities exist for those in STEM fields.

STEM Experiences Category. The STEM Experiences category consisted of questions related to the high school and college STEM experiences that interviewees had both in their classes and outside of their classes. The questions from the interview protocol that comprised the STEM Experiences category were as follows: Questions 1,

2a, 2b, 4, 5, 11, 15, 35a, 35b, 36a, and 36b. These questions can be found on the interview protocol (see Appendix E). Two themes emerged from the responses to these questions. The first theme that will be discussed is the notion that participants lacked experiences related to STEM careers in high school. The second theme that will be described is that being from a rural area caused a lack of STEM experiences in high school but that STEM experiences in college was better than in high school.

Lack of experience related to STEM careers theme. The lack of experiences related to STEM careers in high school was identified as a concern by male and female students and by STEM and non-STEM majors. Within the rural context of this study, this discussion of a lack of exposure to STEM careers in high school was consistent with the idea that the rural community the participants grew up in lacked STEM jobs and STEM professionals. A male STEM major stated that "career options weren't really discussed as much as I feel like could be discussed." He went on to say that "choosing a college was emphasized rather than choosing a major." A male non-STEM major said "as far as STEM fields as a career option go, the exposure in high school was very weak." He said that he was "completely unaware going into college what a STEM career would look like." Another male non-STEM major explained the contrast he believes exists between students from a rural high school and those from more populated areas. He said the following:

> I really didn't have significant exposure in general to career options in high school but especially in STEM because sort of like I guess at school I didn't get exposure to STEM or anything. But then outside of school there's, being like from a rural area, there's exposure to the other careers you can have in a rural area

> as opposed to no exposure to STEM where in an urban high school you may not get exposure to any of these careers but at least outside of the classroom from people that you know, you may gain some exposure to STEM careers as well as to other careers.

Two male STEM majors explained that they perceived their high school's focus to be on graduation from high school rather than options for after high school. One participant said the following:

> I understand that graduation is the main goal of high school and y'all are rated on graduation rates and all that, but I just think maybe if we could have the teachers incorporate plans after graduation, maybe talk about that more. Have a speaker or something who could come and talk about the STEM field or something, would help some.

This belief was echoed by another STEM major who said the following:

> I always felt like the focus was on just getting us to graduate whether than what you can do after graduation. Because I like still don't know many career options in the mathematics field. And like I said earlier the engineering field didn't really ever cross my mind in high school. I don't feel like I was ever really exposed to that very much because I felt like the big focus was just on graduation.

The concern the participants did not receive enough experiences related to STEM careers in high school led them to provide suggestions on ways the school could improve.

A male non-STEM major suggested that teachers incorporate STEM careers in their lessons and to have a STEM week where teachers discussed "different components of STEM as a career." He went on to say the following:

> I think a lot of people, if they know all the different things you can do with STEM…that the world needs more STEM majors, and I think it would be very valuable to expose people in [this] county to stuff like that.

A male STEM major explained that the school needs to expose students to all areas of STEM careers and go beyond just math and science, the STEM courses taught in the school. His suggestion was as follows:

> Mainly exposing students equally to all four rather than just science and math. And then giving a seminar or presentation about what you could do with each field such as job opportunity, salary and stuff like that, that a lot of people make their decisions on what they want to do based on mainly whether they can get a job, whether they would like doing it or if they would get paid enough to live the life style that they would want to live. So more of a focus overall rather than just on science and math.

A male non-STEM major said the school could "bring back students who have really interesting STEM jobs to speak to current students and talk about who they work for, what they do." He believed that this would have a positive impact on high school students because they would be "able to see where a STEM career can lead, then it could really improve the opinion and the, I guess, the possibility in the high school students' minds of a career in STEM." A male STEM major stated that starting STEM career exposure before high school was important. He suggested a STEM day with guest speakers and hands-on activities could "spark the interest of younger kids."

Female students expressed similar concerns about a lack of exposure to STEM careers in high school. A female STEM major stated that "there wasn't ever like a class

or anything like that that would teach you about career options." Another female STEM major said, "There was never a time when someone was like 'these are different things you could go into.'" She stated that students' career understanding was limited to only the careers that were in common in their rural community. A non-STEM major echoed the belief of STEM majors as she stated that the high school "didn't really show us any fields as careers." Like the male students who believed the school's focus was on graduation and not what comes after graduation, a female non-STEM major said the following:

> I feel like in high school it really wasn't so much of a priority. You're just trying to get them out of high school I felt like was more of a priority than focusing on what could you do with a science degree, what could you do with a math degree.

As the male participants did, the female participants provided suggestions on ways the school could improve exposure to STEM careers.

A female STEM major expressed her belief that exposing students to all aspects of STEM would help students better understand STEM career options. She said the following:

> So just exposing students to the STEM fields and what careers you can focus on in the STEM field. So it's not just geeky science. There is so much more in the STEM field that you can focus on and that is important in the world. So show students the relevance and the career options in the STEM field.

A female non-STEM major suggested the school have a "career fair where people can talk to people who do other occupations just to get people's minds going and you know 'maybe I should look into this more' and that would help expose people to other things."

A female non-STEM major suggested inviting STEM professionals to talk to students. She said the following:

> Maybe like finding people that work in STEM or another field that's not agriculture and inviting them to come talk to students and be like "hey, here's an actual person that's in that field doing stuff, doing really cool stuff" and talk to them about it. I think giving students a tangible person to focus on instead of abstract like there's people doing this but here's an actual person doing this. I think that would help.

Another non-STEM female mentioned the need to expose students to careers other than agriculture, which is the dominant industry in the area. She said, "I think a lot of what I heard about was in agriculture…so learning stuff beyond that whether it's in STEM or not" would be beneficial. A female non-STEM major suggested that there should be a position devoted to career counseling. She said the following:

> I feel like they need to have somebody especially for seniors who kinda like, guides them, at least gives them an idea, helps you develop the idea of "oh I might want to be this, oh I might want to be this" instead of getting to college and being like "crap, there's tons of different careers I can have, what do I want to do?" So I don't, I mean, I don't know if, if I had it my way someone, that would be their full time job, to like obviously you have a graduation coach and I really don't know what that is. I'm thinking that's for people who fall behind and need to have that extra push to graduate. But have someone who, or get a teacher who volunteer to do it. To meet with seniors or seniors who are really serious about wanting to try to, and emphasize when you get to college you're going to have to

> choose a major and the major you might be thinking about now might not be the same but you have to have an idea you know of kinda what you want to do with your life. That would've helped me.

The suggestions offered by the female students were similar to those offered by the male students. Both agree that teachers should incorporate STEM careers into their classes and that the school should host career fairs, STEM days, and guest speakers to promote STEM careers.

Improved STEM experiences in college theme. The second theme is that being from a rural area caused a lack of STEM experiences in high school but that STEM experiences in college were better than in high school. A male non-STEM major said the following about being from a rural area:

> I absolutely think it had a great impact on my STEM experience because I think growing up in a rural area being prominently agricultural based region of Georgia we really didn't teach the math, the technology, the engineering and the math all of that mathematical based stuff because around here it's just not that important.

Participants noted that being a rural area impacts the types of jobs that high school students can envision themselves doing. A male non-STEM major said the following:

> Well, obviously the engineering was not really offered here probably because we live in a rural area versus if you were in Atlanta or a major city that might possibly be offered. So that was one way that we were affected.

Similarly, another male non-STEM major said the following about his exposure to STEM in high school:

> I don't think that there was as much, and especially, and when we look around at our parents' jobs, they don't focus on this kind of stuff. You don't see many mechanical engineers around [here]. Though when people don't, students don't see that as a real option for them to do in the future. So they are probably not interested in doing it in high school.

Lack of access to STEM courses was a concern that was expressed. There was a belief that the students from their rural high school had less exposure to some STEM courses than students in urban areas had. A male non-STEM major said, "I had less exposure to…computer science classes." He discussed taking AP courses in biology and chemistry but believed that had he been in a more populated area he might have been able to take them earlier in high school so that he could have built a stronger STEM foundation early in his high school career. He said, "If I weren't in a rural area I probably would have been able to go straight into the AP Biology and AP Chemistry and get a much more in-depth exposure earlier, in my 9th and 10th grade years especially."

Female students had similar views of the lack of exposure to STEM in their rural community. A female STEM major described how her college experience made her realize that rural students had less exposure to STEM. She said the following:

> I was a biology major so we participated in STEM things like STEM night where we went to elementary schools, we had a STEM fair this big thing in college where all of the community came to. And nothing like that happened here and I think it is because it's rural. So that's what I would say that cities have an advantage over rural. They have things outside of the things they learn in school.

A female non-STEM major stated that because agriculture is a large industry in the community, the STEM focus was limited only to science as it can be applied to agriculture. She said the following:

> I think growing up in a rural area there was a lot more, what's the word, like they push more of the science like ag stuff because that's what everybody does here so that's what you understand and that's what a lot of people are going to be doing because that's what we do here.

A female STEM major continued with the idea that the emphasis on agriculture in her rural community impacted her STEM exposure when she said, "I don't think our high school did expose us to the STEM concepts or the STEM fields as a career option just because this community in general is more agricultural based."

College STEM experiences tended to be described positively by participants. They described their experiences related to STEM as being stronger than they had in high school. More resources, more opportunities to learn about STEM topics that they were not exposed to in high school, and more information about STEM careers were all examples of the increased STEM exposure in college that interviewees cited.

A male STEM major said that at his college "there were plenty of STEM fairs, networking events, and career fairs" that allowed students to gain exposure to STEM. Another male STEM major said that having professors who are actively engaged in research provided him with a strong exposure to STEM. He said of having professors who discussed their research, "It kind of opens [students'] eyes to like what you can do with this degree, what kind of jobs you can get, what all stuff you can get into as a career option." An additional male STEM major pointed out that colleges have more resources

available for exposing students to STEM than high schools do. He said, "I just think the difference in college is they have a lot more resources but you know they do a good job of providing you with more information than say I got in high school." Another male STEM major explained that there are more opportunities to learn about STEM in college than in high school. He said, "There is a lot more opportunity in college to broaden your knowledge in each of these [STEM fields] even if you are not a science major or a math major." A male non-STEM major discussed how the college curriculum allows students the option to take STEM classes to find out if they have an interest in those areas. He said the following:

> You have the flexibility in your curriculum to explore those majors early on and so if you come in with any consideration of doing STEM then chances are you're able to get any exposure that you want. So in high school if I wanted to give engineering a try I can't go out and take mechanical engineering class. In college anybody can choose to take ME [Mechanical Engineering] 101 and a lot of people do choose to take it and they get pretty good exposure. So me personally I feel like I've had a really good exposure.

The consensus of the male participants was that their college STEM exposure was strong in college. This was true among STEM and non-STEM majors alike.

Female interviewees had similar views about college STEM exposure. A female STEM major said that her exposure to STEM in college was "definitely more so than in high school." Similar to the male STEM major who stated that having professors who conducted research resulted in strong STEM exposure, a female non-STEM major said that her college "is a research institution so there's a lot of people doing research in

science, technology, engineering, and math," which led her to conclude that her college provided her with a strong STEM exposure. A third female non-STEM major explained that professors in her STEM classes exposed students to STEM careers because "at the end of the class our professors would say that if this is something you're interested in you could do this as a major or a minor." A female non-STEM major discussed that technology is a focus of her public relations classes but that in college it is up to the student to seek out exposure to STEM. She said the following:

> Technology has always been stressed in my field, or in my classes, but I feel like when I started out in college, in college it's kind of up to you. It's more like you have to be active, not the teacher exposing you.

Another female non-STEM major explained that her exposure to STEM in college has come from both professors and other students. She said, "You meet other people [who are STEM majors] and also I feel like the advisors and the teachers and all really talk to you like you know this is what we have here, this is what your options are." Like their male counterparts, the female participants believed that their college did a good job of exposing them to STEM.

Summary of STEM Experiences perceptions. The STEM experiences of the interviewees tended to be different from high school to college. While the participants were not critical of the quality of the STEM content they learned in high school, they tended to believe that their exposure to STEM outside of the time spent in their STEM classes was lacking and that their exposure to STEM careers was practically non-existent. They often cited the rural effect as a reason for their lack of exposure to STEM. In college, the students spoke more favorably of their exposure to STEM as they had

professors who were conducted research in STEM fields, received career advisement from professors, and were able to take a wider variety of STEM classes than in high school.

Evolving Perceptions Category. The Evolving Perceptions category consisted of questions related to how college students view STEM and how these views have changed since high school. The questions from the interview protocol that comprised the Evolving Perceptions category were as follows: Questions 19, 20a, 20b, 21a, 21b, 22, 23a, 23b, 24a, 24b, 25, 26, 27, 28, 29, 30, 31, 32, 33, and 34. These questions can be found on the interview protocol (see Appendix E). The theme that emerged from this set of questions was one of more positive perceptions of STEM. With only a few exceptions, male and female students both reported more positive perceptions of STEM since high school.

More positive STEM perceptions theme. Students tended to speak of improving perceptions of STEM due to gaining a better understanding of the value of STEM and seeing where learning about STEM can lead. Several participants mentioned that knowing students who were STEM majors made them more aware of STEM and led to their improved perceptions. A male non-STEM major said the following about his perception of science:

> I think that they have definitely improved as far as science just because I've gotten to know a lot of science majors through various organizations and I kind of have a new appreciation of how difficult it can be and…I also understand now the different types of careers that are possible through science majors.

Another male non-STEM major spoke of his improved appreciation for science being a result of meeting science majors while in college. He said of his perceptions of science, "I can definitely appreciate it more, and I look at people who know how the world works in that way and am amazed that they understand it." A male non-STEM major discussed how his perception of science has improved since high school because he sees more value in it now than he did then. He said the following:

> I like reading articles about new drugs that are being done to cure certain diseases, so I think my perception has improved versus in high school when I thought, "Why am I learning about rocks? Why am I learning about what reacts with what?" So I think it's improved. I actually took interest in that after high school.

A male STEM major described how, as he has learned science at a higher level in college than in high school, he has come to enjoy it more. He said the following:

> My perceptions have definitely improved. I always liked biology but I really hated chemistry because, well I thought it was just boring memorization. It was general chemistry so you had to memorize the periodic table and there was a pretty good bit of math involved. You know, a lot of formulas and stuff and I didn't really like math and I didn't really like general chemistry like we took in high school. But as I've gotten more into like advanced chemistry I find it more interesting than like basic chemistry.

Male participants' views of science have become more positive as they have taken more advanced classes and as they have begun to see the value of science.

Perceptions of engineering have tended to improve as a result of participants learning more about engineering. Growing up in a rural area where few people are

employed as engineers led the students to have limited exposure to engineering while in high school. A male STEM major said the following:

> I didn't really have many perceptions of engineering in high school but since I've gotten to college I've met a lot of people who are engineering majors in my college and in my classes and my perception has improved from what it was.

Another male STEM major stated that gaining increased exposure to STEM has improved his view of engineering. He said, "As I've taken more STEM classes my perception tends to get better and better." A male engineering major described how writing assignments for his English class have caused his perception of engineering to improve during college. He said the following:

> I'd say they have improved because last semester I had an English professor, all the papers I had to write were based on, like all the papers the students wrote were based on their major or their field or whatever. So I had to write five or six papers on engineering and different projects. I had to write a research paper and I kinda, I did a lot of research on fuel cell cars and it kinda sparked my interest in alternative fuel sources and stuff like that.

Another participant described how having friends who were engineering majors caused his perceptions of engineering to improve. A male non-STEM major said that he "just happened to be good friends with people who are in these [engineering] classes." A non-STEM major said that seeing what his engineering major friends were learning made his perception of engineering improve. He said, "[I] just never understood it [engineering] in high school as much as I do now."

Participants also spoke of STEM in general and most shared that their perceptions of STEM have improved since high school. A male STEM major explained that seeing connections between the STEM fields in college led his perceptions to improve. He said he is "more interested in math and technology than I was just because I see how it all kind of relates." Another male STEM major explained that he learned more about STEM careers in college than he did in high school. Seeing where STEM can lead him caused his perceptions to improve since high school. He said that in college he **"**got to explore different things" which stands in contrast to high school where he said that "you learn the material and don't really focus on the career path you will take." He went on to point out that focusing in on a course of study made him appreciate STEM in college. He said, "Having a more focused curriculum gave me more insight into science which made me decide that was what was right for me." A male non-STEM major discussed how his improved STEM perceptions in college were due to gaining more awareness of the career opportunities in STEM. He said the following:

> They've probably improved and the improvement is a direct result of being more aware of STEM careers. Having a lot of friends that are going to work at start-ups or going to work at you know Big Tech, whether that's Facebook, Apple, Google, et cetera, or even friends that are going to work in the technology divisions of financial services companies. Learning about those career opportunities and the culture in technology especially or the STEM areas vs the culture of the financial services that I'm going to work in makes that career look really favorable and sort of makes me wonder if I should've pursued a STEM career.

Similarly, another male non-STEM major described how having friends who are STEM majors impacted the improvement of his perceptions of STEM. He said the following:

> Since I've been in college and I've been exposed to all these types of different engineering and science and technology, a lot of my friends are computer science majors and all that type of stuff, I think that like I said I have a new appreciation for the types of people that do enjoy doing these types of things because I know for a fact that I would not be very good at those kinds of things.

A male non-STEM major explained that his improved STEM perceptions are because he knows "so much more as like the different types of science, technology, engineering, math and the careers available." Learning how the STEM fields are connected, gaining more knowledge of STEM careers, and having friends who are STEM majors led to improved perceptions of STEM from high school to college for most of the male interviewees.

Female participants had similar views of how their STEM perceptions have changed since high school. Female students spoke specifically about their improved perceptions of science since high school. A female STEM major who is an aspiring doctor said that learning that there is a need for physicians in rural areas like her hometown made her feel more strongly about STEM. She said the following:

> I realize there's a big, for where I'm going, shortage of physicians especially in rural areas. But overall I've also heard that STEM is very lacking, people majoring in those fields. So that's also made me more passionate, getting people to be interested in science.

Other female interviewees pointed to the differences in the course offerings in college compared to high school as the reason for their improved perceptions of science. A female STEM major said her perceptions of science have improved because she has "taken more classes that have gone more in depth than in high school." The depth of the college courses led to her improved perceptions. Similarly, a female non-STEM major said, "In high school you kind of get a baseline understanding and then in college you can…go more in-depth into one and just really understand it more and see what it is all about." A female non-STEM major discussed the variety of course offerings in college. She said the following:

> I think it's improved because we have more, in college, I have more options. It wasn't you have to take biology in ninth grade. It was I can take these different classes. I took in college for instance, my sciences were weather and climate and forestry. So it was like completely opposite of biology whereas those were more to my personality. And so I think I learned more in the sciences than just biology and physics. There was more to it and so I think it definitely improved since high school.

As someone who grew up on a farm, she found that the weather and climate and the forestry courses she took as her science classes were more relevant to her. Other participants mentioned gaining a better appreciation for science as they have learned about the relevance of it. A female STEM major said her perceptions of science have "improved overall because I do have a greater appreciation of science" because "I do see the relevance in science" after taking college science courses. A female non-STEM major discussed how her perceptions have improved because she sees that there is a need

for people with a science background to pursue careers that are necessary to society, such as medicine. She said, "I know there's a need for people to have a career in science so in that sense I guess it has improved because we need people to have careers in science." Realizing that science is relevant and that it is needed in many careers was one of the causes of improved perceptions.

Several female students discussed their improved perceptions of engineering. A female non-STEM major mentioned that college exposed her to more which led to improved perceptions. She said her perceptions improved by "getting out of the rural area, just getting out of here and seeing what there is to be brought with engineering and seeing the need for it too." A female STEM major said, "I already had a high opinion of engineering, but I feel that it is so gone up because it is more exciting for me now." A non-STEM major said her perceptions of engineering improved since high school because before college she "just didn't know what it was." Meeting fellow college students who are majoring in engineering led to some female participants' improved perceptions of engineering. A female STEM major said that working with an engineering major led to her improved perceptions. She said the following:

> To me also realizing it's not too different than what I do. Their research is not very different than what I do. It's still very structured and that kind of thing. Just realizing that we have a lot in common.

A female non-STEM major said her perceptions of engineering had improved as a result of having a roommate who is majoring in engineering. She said, "I have a lot more respect [for engineering] seeing [my roommate] dealing with it and kind of learning what

it's about and it's not just a bunch of math." More exposure to engineering in college was the primary reason for the improvement in female participants' perceptions.

In describing how the overall perceptions of STEM have evolved since high school, female interviewees tended to speak of gaining more exposure to STEM in college that led them to better understand its relevance and the opportunities available to STEM majors. A female non-STEM major said that her perceptions of STEM careers improved in college because "there's a lot more information out there than what there was in high school." Similarly, a female non-STEM major said her perceptions have improved because she has "met more people that have different opinions and I've learned taking different classes and learned more about it and gained more respect for it." A female non-STEM major discussed that gaining more exposure to STEM led to her improved perceptions of STEM careers. She said the following:

> I've actually learned a lot more in the technology field in college and right now I'm in charge of a whole database where I'm interning at. They're all looking to me because they are like "oh you know about this program." I feel like there's a lot more that I just didn't know about in high school that's out there.

When asked why her perceptions of STEM careers have improved, a female STEM major responded as follows:

> I think just knowing more about them. Also like realizing if you are an engineering major how many options you have. Same thing with math. There's tons of things you can do with math. And I've actually had friends who are both engineering and math majors so I've talked to them. Technology I actually worked with a girl and she sat their programming for her homework. I just think

knowing more about them helped me gain appreciation for the field they're going into.

Understanding the relevance of STEM was identified as a reason for improved perceptions of STEM careers. In response to a question about whether her perceptions of STEM careers have changed, a female STEM major said the following:

> Absolutely improved, because I guess I didn't see the relevance in high school. I know it existed, but now in college I've been more than aware of the STEM field and then going into education I've gone into schools where they are STEM schools and they are focusing on engineering and technology, everything. So I see the importance of the STEM field and just being more exposed to it. My perception has definitely improved.

Speaking about STEM perceptions in general, a female STEM major explained that her perceptions "have definitely improved because overall it's relevant." Another female STEM major said that STEM is "growing and expanding and there is just so much that is exciting to see coming." A female non-STEM major said her perceptions of STEM have improved because she has "learned more about things that are happening in those fields and the things you can do in them." Seeing STEM as a field that is relevant has led to improved perceptions of STEM for female college students, whether or not they are STEM majors.

Summary of Evolving Perceptions. STEM perceptions have generally improved for the female participants. They pointed specifically to improved perceptions of science, engineering, and STEM careers. The improvement was due to gaining more exposure to STEM both in their classes and through friends, seeing the relevance of STEM, and

learning about the career opportunities in STEM. It is important to acknowledge that changed perceptions may be a result of maturity from high school to college rather than other factors. However, the overwhelming conclusion from interviewees was that they were not presented with STEM role models or STEM career information in high school, which lends support for considering how such information might be offered. As was described in the Rural Effect category, the lack of STEM role models and the lack of information about STEM careers in high school was perceived to be a function of the rural setting in which the participants grew up.

Chapter Summary

The two research questions, while focusing on two different groups, were related in that they both were designed to further understanding of the perceptions of STEM held by students from a rural area. The high school participants' perceptions were gauged quantitatively through the STEM Semantics Survey and qualitatively through two open ended questions that participants responded to in writing. The college participants' perceptions were determined primarily through an analysis of transcripts derived from an interview of the participants. Because the STEM Semantics Survey was given to the college participants in order to generate interview questions, it is worth noting the similarities and differences between the high school and college participants.

For both the high school and college students, Technology was rated most favorably. Mathematics and Engineering were the two areas rated least favorably for both groups with Mathematics being rated least favorably for college participants and Engineering being rated least favorably for high school participants. The low rating for Engineering was consistent with some of the concerns expressed by the college students.

Having few female role models in engineering was a concern described in the Gender category of interview questions. Also in the Gender category, college students believed that female students' improving perceptions of engineering was largely due to more exposure to the field than in high school. This perception was consistent with the STEM Semantics Survey results that showed that the female college participants had more favorable perceptions of engineering than the female high school participants. Engineering was mentioned in the STEM Experiences category as well. College students noted that engineering courses were not offered at their rural high school. It was also explained that their rural community had few engineers so students had limited exposure to engineering while in high school.

College participants pointed to the agricultural economy in their community as a reason that they believe they were not exposed to STEM in high school as much as they perceive others from more populated areas were. The rural effect was discussed prominently by the college participants but was perceived as less important among the high school participants. While some high school students said that growing up in a rural area had a negative impact on their STEM perceptions, almost as many said it had no impact. Others stated that growing up in a rural area had a positive impact on their STEM perceptions. These differences among the high school participants stood in contrast to the college participants who were more unified in their belief that their STEM perceptions were shaped by a lack of exposure to STEM during high school.

Of the five scales on the STEM Semantics Survey, two had more favorable ratings given by the college students than the high school students. The two were Engineering and Careers in STEM. Comments made by the college participants during

the interviews corroborate these quantitative results. The more positive perception of engineering among the college participants than the high school participants was perceived to be due to the high school offering no engineering courses and the community lack of engineering role models. A commonly held perception described in the STEM Experiences category was that participants were not exposed to STEM careers while in high school. College students described their colleges as doing a better job of exposing them to STEM careers than their high school did. They pointed to networking activities, professors discussing the implications of their research, access to a wider range of STEM courses, and meeting other students in STEM fields as ways in which they gained exposure to STEM careers in college.

The MANOVA results for the first research question indicated a significant difference in STEM perceptions held by the female and male high school students. Qualitative findings for the college participants tended to show consistent responses among females and males. The gender difference between the high school students found quantitatively and the consistency in the responses between male and female college students seen qualitatively was an interesting contrast.

Chapter 4 presented descriptive statistics for the high school and the college participants responses to the STEM Semantics Survey, the results of the MANOVA to determine if female and male high school students had significant differences in STEM perceptions, and a discussion of the themes generated through the interviews of the college participants with supporting evidence provided in the participants' words. In Chapter 5 each component of the study will be summarized. Then, the study's findings

and their implications, the limitations of the study, and suggestions for future research are presented.

Chapter V

SUMMARY AND DISCUSSION

A concern about the dearth of Americans pursuing careers in STEM has been well-documented in the national media and in academic literature. A *USA Today* article described a lack of Americans pursuing college majors in STEM as a national security threat (Levy & Plucker, 2015). Another *USA Today* article urged the business community to encourage people from under-represented groups, including women, to become involved in STEM education (Elias, 2011). United States Presidents included references to the importance of STEM education in their State of the Union Addresses (Bush, 2006; Obama, 2011). With more people needed to pursue college majors and careers in STEM, attracting more people, including women, to STEM fields has become a priority (Alvarez et al., 2010; Morganson et al., 2010).

Understanding the perceptions students have about STEM will enable policy makers, educators, and the business community to develop strategies for encouraging more young people to pursue college majors and careers in STEM. Understanding STEM perceptions is at the heart of this study. Delving deeper into the subject of STEM perceptions, the study was conducted in order to better understand the effect that growing up in a rural area had on the perceptions held by students. With a rural setting as the backdrop of the study, high school students from a rural part of southern Georgia and recent graduates of that school were the participants who helped to shed light on the

STEM perceptions held by students and the impact growing up in a rural area had on their perceptions.

Overview of the Study

The conceptual underpinnings of the study are social efficiency ideology of preparing students for important societal roles such as the students' careers (Knoll, 2009) and the idea that students from rural areas lack cultural capital (Hopkins, 2005). With career decisions about STEM being made based on perceptions of STEM, it was important to understand the perceptions that students hold. With little research available on the effect being from a rural area has on STEM perceptions, this study was framed within a rural context. Waters et al. (2008) found a wealth of research on mathematics education but little on rural mathematics education. The researchers called for more research on the rural effect as it pertains to mathematics. In the present study their concern about mathematics education was applied more broadly to STEM education.

The perceptions that students from one high school in rural south Georgia had of STEM were examined in this study. The first research question focused on high school seniors enrolled in Advanced Placement mathematics courses because they are the type of students who have the academic background necessary to major in a STEM field in college. The high school seniors completed a questionnaire to gauge their perceptions of STEM and to determine what impact they believe growing up in a rural area had on their perceptions. The second research question focused on college students who graduated from the same rural high school that the participants from the first research question attended. The college students completed a questionnaire to gauge their perceptions of

STEM and took part in an interview to further explain their perceptions and the effect growing up in a rural area had on their perceptions of STEM.

The first research question was as follows: How are the STEM perceptions of twelfth-grade female students enrolled in an advanced mathematics course in a rural high school similar to and different from the STEM perceptions of twelfth-grade male students enrolled in an advanced mathematics course in a rural high school? The second research question was as follows: How did attending a rural high school impact the STEM perceptions of female and male college students? These questions guided the research to determine the impact of attending a rural Georgia high school on the perceptions of STEM held by male and female students.

Review of the Literature

The importance of STEM education has been the subject of academic literature in recent years. Williams (2011) described the STEM initiative instituted by government officials in the United States and the United Kingdom. Moskal and Skokan (2011) espoused the belief that STEM education is critical to maintaining America's economic competitiveness. Dave et al. (2010) predicted a shortage of STEM professionals in the United States. A lack of interest in STEM by American students was documented by Perry (2010) and Brett (2007). An underrepresentation of women in STEM was documented by Alvarez et al. (2010).

Gender Differences. Understanding the differences in the perceptions of STEM held by males and females has been the focus of several studies. While achievement in science and mathematics is similar between male and female students (Campbell et al., 2000; Else-Quest et al., 2010, Hargreaves et al., National Center for Educational

Statistics, 1988; Preckel et al., 2008), studies have found that male students generally have more favorable perceptions of science and mathematics than female students (Barmby & Defty, 2006; Beghetto, 2007; Bhanot & Jovanovic, 2009; Brandell & Staberg, 2008; Britner, 2008; Britner & Pajares, 2006; Correll, 2001; Hargreaves et al., 2008; Kurtz-Costes et al., 2008; Miller et al., 2006; Preckel et al., 2008; Selimbegovic et al., 2007; Watt, 2008). Mixed results were found in studies about gender differences regarding interest in science. Some found that females had less interest in science (Barmby & Defty, 2006; Beghetto, 2007; Miller et al., 2006). Other studies found interest in science to be equally low among male and female students (Masnick et al., 2010; Sorge, 2007). The literature also suggested that female students have lower self efficacy with respect to science than male students (Barmby & Defty, 2006; Bhanot & Jovanovic, 2009; Britner, 2008; Britner & Pajares, 2006).

As with science, differences in views of mathematics between male and female students have been described in academic literature. Females have been found to be less interested in mathematics than males (Brandell & Staberg, 2008; Preckel et al., 2008) and have lower self-efficacy with respect to mathematics (Correll, 2001; Hargreaves et al., 2008; Watt, 2008). The stereotype of science and mathematics as male fields was revealed to have a negative impact on female students' perceptions of science, mathematics, and careers in those fields (Brandell & Staberg, 2008; Selimbegovic et al., 2007).

The literature also showed gender differences in perceptions of STEM held by college students. Starobin and Laanan (2008) found that female STEM majors did not believe that a degree in engineering was a major they could pursue. The researchers

noted that the students were unaware of what engineering entailed and that they needed more support to realize that engineering was an option. Hartman and Hartman (2008) revealed that female engineering majors perceived a lack of female role models in engineering and viewed STEM was not a feminine major. Similarly, Nosek and Smyth (2011) found an association between women's' view of mathematics as a male dominated field and negative views of mathematics. Career interests were studied by Su et al. (2009), who found that males tended to be more interested in objects and females were more interested in people. The implication was that hands-on jobs and working with things appealed more to males, while people-oriented jobs were more liked by females.

Rural Effect. The literature related to the impact growing up in a rural area can have on STEM perceptions was limited. Waters et al. (2008) revealed that comparing the paths taken by rural and non-rural students who are strong mathematics students was a study that needed to be conducted. Hopkins (2005) explained that rural students have less available cultural capital, which she explained were enrichment activities outside of the regular school curriculum. Having difficulty attracting STEM teachers, employing few district level administrators with a mathematics and science background, and having few jobs in the community requiring mathematics knowledge were identified as challenges that rural school districts face (Blanton & Harmon, 2005; Dessoff, 2010). A qualitative study of the perceptions of mathematics held by citizens in a rural area was conducted by Lucas and Fugitt (2009). They found that many residents explained that jobs in their area did not require high levels of mathematics knowledge.

Methods

A questionnaire and interviews were used in this mixed-methods study to provide data for answering the two research questions. The questionnaire results were analyzed with a MANOVA and independent samples *t* test. Interview data were coded to develop themes.

Setting and Participants. Two groups of students were the participants in the study. A group of students from a high school in a rural part of south Georgia made up one group and a group of college students who graduated from that same rural high made up the second group. Fifty high school students and 35 college students participated in the study. Thirty percent of the high school participants were males, 68% were females, and 2% did not provide their gender. The racial make-up of the males was as follows: 5 Hispanic and 10 White. The racial make-up of the females was as follows: 3 Hispanic, 25 White, 1 Black, 1 Native American, 1 Hispanic/White, 1 White/Native American, one Other, and 1 who did not provide a response. The high school participants were twelfth graders enrolled in Advanced Placement mathematics courses or a Move on When Ready College Algebra/Trigonometry course. Students with strong mathematics abilities were deemed to be the most capable of majoring in a STEM field in college.

The 35 college students who participated in the study represented 14 different colleges. Eight of the participants were STEM majors. Of the 35 participants who completed the STEM Semantics Survey, 49% were male and 51% were female. The racial make-up of the males was as follows: 1 Hispanic, 13 White, one Black, and 2 Asian. All 18 female participants were White. Twenty of the 35 college student participants were interviewed. Of the 20 participants who were interviewed, 45% were

male and 55% were female. The race of the male interview participants was as follows: 1 Hispanic, 2 Asian, and 6 White. All 11 of the female interviewees were White.

The setting of the study was a rural part of south Georgia with an economy that is based largely on agriculture. The high school from which the college students were graduates and which the high school students attended is the only high school in the county. The school district's website indicated that almost 75% of the district's students were classified as Economically Disadvantaged, all students in the district received free breakfast and lunch through a U.S. Department of Agriculture program, and 7% of the students were served through the migrant education program. The county where the high school was located had a per capita income that was more $8,000 less than the state average ($16,972 compared to $25,427). The percentage of adults with a bachelor's degree was half that of the state (12.9% compared to 28.3%).

Instrumentation. The STEM Semantics Survey (see Appendix C) was given to the high school participants to gauge their perceptions of STEM on five scales. The scales were Science, Technology, Engineering, Mathematics, and Careers in STEM. Each scale included five adjective pairs where an adjective was paired with its opposite. Participants rated their perception with a number between 1 and 7. Reverse coding was used when necessary in order to make higher ratings represent more positive perceptions on for each adjective pair. Included with the STEM Semantics Survey were two open-ended questions that asked participants what could be done to improve the STEM perceptions of high school students and what impact growing up in a rural area had on their STEM perceptions.

The STEM Semantics Survey was also given to the college participants to gauge their perceptions of STEM. The high school and college participants' results from the STEM Semantics Survey were used to develop an interview protocol, which was used with a subset of college students. Twenty college students were interviewed to gain a deeper understanding of their STEM perceptions and the role that growing up in a rural area had on their perceptions. The interview protocol was used to ask a standardized set of questions of all participants, but follow-up questions were asked as needed.

Procedures and Data Analysis. Fifty high school seniors in advanced mathematics classes at the rural high school were given the STEM Semantics Survey, which gauged perceptions on five scales, and two additional open-ended questions developed by the researcher. The quantitative results were reverse coded when necessary so that higher numbers represented more favorable perceptions. The qualitative results were coded in order to identify themes. Scale reliability was established for each scale and the results of the five responses on each scale were summed for each participant. Thus, the summed scale scores could range from seven to 35 for each of the five scales. Descriptive statistics for each scale were calculated. Independent samples *t* tests and MANOVA were the inferential statistics procedures were used to determine if perceptions of STEM differed by gender. The data from the two open-ended questions given to the high school participants were coded so that themes could be established.

A group of 35 college students, who graduated from the same rural high school that the high school participants attended, was given then the STEM Semantics Survey. Results of the survey were analyzed using SPSS and were used to develop interview questions. As with the high school students, descriptive statistics for each scale were

calculated. An independent samples *t* test and MANOVA were the inferential statistics procedures were used to determine if perceptions of STEM differed by gender.

A sub-set of the college participants were interviewed using an interview protocol that was informed by the quantitative data collected from the high school and college participants. Twenty students participated in the interviews, which were recorded and transcribed by the researcher. The transcripts were analyzed to determine broad categories and more specific themes that were present in the qualitative data.

Summary of Findings

For this mixed-methods answers to two research questions were sought. The first research question asked: How are the STEM perceptions of twelfth-grade female students enrolled in an advanced mathematics course in a rural high school similar to and different from the STEM perceptions of twelfth-grade male students enrolled in an advanced mathematics course in a rural high school? The second research question asked: How did attending a rural high school impact the STEM perceptions of female and male college students? The results of the study are described next.

Research Question 1. The first research question was examined quantitatively with the STEM Semantics Survey and to a lesser degree it was examined qualitatively with two open-ended questions developed by the researcher. Presented first are the results of the STEM Semantics Survey. Then, the open-ended questions are discussed.

STEM Semantics Survey for high school students. Results of the administration of the STEM Semantics Survey to the high school students showed that Technology and Science were the scales with the highest ratings and Mathematics and Engineering had the lowest ratings. Inferential statistics were used to determine if male and female high

school seniors in the rural school had differing perceptions of STEM. Male respondents gave higher ratings than the female respondents on all categories except Mathematics. The result of the MANOVA revealed that male high school students had statistically significantly more favorable STEM perceptions than female high school students, Wilks' $\lambda = .67$, $F\ (8, 86) = 2.38$, $p = .023$, partial eta squared =.18.

Each of the five scales was then analyzed using an independent samples *t* test. The Engineering category had the biggest difference between male and female students. Male high school students were found to have perceptions of Engineering that were statistically significantly more favorable than female high school students, $t(47) = -3.85$, $p < .001$.

As reported and cited above, literature included studies that found male students have more favorable perceptions of science and mathematics than female students. The findings from the present study indicated that females had more positive perceptions of mathematics than males and that males had more positive perceptions of science than females, but neither of these difference was statistically significant. Thus, the present study had findings that were not consistent with the results of previous studies.

Open-ended questions for high school students. The high school participants provided written response to two open-ended questions. The first question was as follows: What can be done (if anything) by the school and/or community to increase interest in the areas of science, technology, engineering, and mathematics? More hands-on activities, more relevance with a career focus, more technology use, broader STEM course offerings, and more outside of school activities were the typical responses given by the participants. Having more hands-on activities in STEM classes and showing how

STEM is relevant and necessary for careers were the ideas that were provided the most. The responses to the first open-ended question were similar for male and female students.

The second question was as follows: In what ways (if any) does attending high school in a rural area impact your perceptions of science, technology, engineering, and mathematics? The two most common responses were in opposition to each other. The most frequent response was that living in a rural area caused students to be less exposed to STEM because STEM jobs were less prevalent where they live than in more populated areas. However, almost as many participants said that being from a rural area did not impact their STEM perceptions or that their community's agricultural focus positively impacted their STEM perceptions. The responses to the second open-ended question were similar for male and female respondents.

Research Question 2. The second research question was primarily designed to be answered qualitatively through interviews of the college student participants. Results from the STEM Semantics Survey for both the college student group and the high school student group were used to develop the interview questions. Presented first are the results for the college students' STEM Semantics Survey followed by a discussion of the interview data.

STEM Semantics Survey for college students. The result of the administration of the STEM Semantics Survey to the college participants showed that the Technology scale and Careers in STEM scale had the most favorable perceptions of the five categories, while Engineering and Mathematics had the least favorable perceptions. Inferential statistics were used to determine if male and female college students who attended the rural high school had differing perceptions of STEM. While the male high school

students had more favorable perceptions of four of the five scales than high school females, the female college students had more favorable perceptions of three of the five scales than college males. Female college students rated Science, Mathematics, and Careers in STEM higher than males.

Interview data. The data from the interviews of the subset of college participants were organized into six categories: Rural Effect, Gender, Obstacles to STEM, College Major and Career Interest, STEM Experiences, and Evolving Perceptions. While the interview questions had a category of questions related to the impact of growing up in a rural area on STEM perceptions, reviewing the data showed that the idea of ruralness was woven into all categories. The idea of a rural effect was the umbrella under which the other categories stood.

Rural Effect category. A lack of exposure to STEM and a lack of resources for STEM in rural areas was the overall theme that emerged from the Rural Effect category. The limited exposure to STEM and lack of resources devoted to STEM impacted the way the students perceived STEM. The responses from the college student participants centered around limited access and less rigor in their high school STEM classes compared to college classmates, less exposure to STEM outside of the classroom setting, and a culture in their rural community that did not value STEM largely due to the low number of STEM jobs in the area.

Concern related to limited access to and less rigor in their high school STEM classes compared to their college classmates was expressed by STEM majors as well as those who are not STEM majors. The interviewees used the term "basic" to describe the STEM classes they took in high school and they contrasted them with their college

classmates from larger areas who they perceived to have had more access to more advanced STEM content. This theme emerged as participants described their perceptions of their high school STEM classes. Science lab activities were thought to be less advanced and to include less integration of technology than lab activities of students in more populated areas. A participant explained that her computer class at the rural high school consisted of learning about Microsoft PowerPoint, whereas her college friends from non-rural areas took computer programming classes in high school. It was also mentioned that the rural high school did not have any of the engineering courses that their college peers from more populated areas were able to take.

Another concern expressed by the college students was that because they attended high school in a rural area, they had less exposure to STEM outside of the classroom setting than those who attended high school in a populated area. The participants believed that more populated areas have an advantage over rural areas when it comes to developing positive perceptions of STEM in young people. Participants explained that there were few opportunities for them to explore STEM in their rural community beyond what was taught in their courses. One of the interviewees spoke about the STEM outreach she did while in college that exposed young people to STEM topics. She lamented that nothing like that was done in her hometown.

A final concern mentioned by participants regarding the impact ruralness had on their STEM perceptions was that members of their rural community did not value STEM. A STEM major stated his belief that "the culture of a rural area placed less emphasis on..STEM." The concern that the community does not value STEM centered largely on

the idea that the rural community's economic base was not tied to STEM. Interviewees said that a lack of STEM jobs in their community made STEM less valued.

The Rural Effect category captured many of the foundational ideas that were described throughout the interviews. A lack of exposure to STEM in the school and in the community, as well as a sense that their rural community did not value STEM, were the prevailing perceptions of the participants. These perceptions provided an important contextual background for rest of the study.

Gender category. The Gender category produced two themes: (a) the idea that a gender stereotype exists in STEM fields and (b) more STEM exposure in college leads female students to improved perceptions of engineering and STEM careers. These themes were discussed both by participants who majored in STEM and those who did not. The rural effect was also present in the Gender category as students described limited job options in their community (the stereotypical female jobs of nurse and teacher, for example) and the lack of STEM role models for women in their rural community. The lack of STEM role models exacerbated the perception that STEM is a male dominated field.

STEM as a field that is stereotypically male was a perception held by the college students. Participants said that this male stereotype might serve as a deterrent to females entering STEM fields. They described the way in which early childhood experiences could play a role in continuing to give life to this stigma. A female participant described the differing ways in which she and her twin brother played as children. Her brother was interested in building things while she spent her time playing with dolls. Another said

that in her experience, she did not think parents of young children tended to encourage young girls to become engineers.

While the participants believed that gender stereotype in STEM continues to exist, there was a belief that the female participants' STEM perceptions, especially bout engineering and STEM careers, had improved since high school as a result of receiving more exposure to STEM in college. A female STEM major said, "I feel like we're limited in high school, the things we know about engineering versus college, especially as a girl." Her belief was echoed by others who believed that female college students learned that engineering was a broad field that consisted of "more than just building things," as verbalized by one participant. Going to college and meeting other females who were interested in engineering was viewed as a reason for female students' improved perceptions of engineering.

This idea that more exposure to the field of engineering could cause perceptions to improve in college was similarly discussed with respect to careers in STEM. Having few STEM professionals to serve as inspirational role models for females was believed to be exacerbated in the rural area because there are so few STEM professionals in the community. Interviewees spoke about the limited jobs available to women in their rural community, but also noted that going to college exposed the female participants to STEM careers. A participant spoke about the way the female participants' worldview may have changed from high school to college as they were more exposed to females who were in STEM fields.

Obstacles to STEM category. The lack of STEM professionals in America led to the need to determine students' perceptions of the obstacles that exist to pursuing college

majors and careers in STEM. The themes that emerged from the interviews of the college participants were (a) STEM coursework is challenging causing students to be intimidated by it, (b) their K-12 educational experiences did not prepare them for their college STEM classes, and (c) their rural community lacked STEM resources and exposure to STEM for students. The third theme showed that the rural effect described earlier was intertwined throughout the students' commentary.

Participants described how students are often intimidated by college STEM courses. This view that STEM is difficult was identified by the participants as an obstacle to getting more people interested in STEM. Interviewees said that STEM was perceived as being difficult, that students were fearful of STEM classes, and that STEM classes were viewed by college students as "weed out" classes.

The second theme from the Obstacles to STEM category was that the participants' perceived that their school experiences prior to college did not adequately prepare them for STEM classes in college. The college students' perception that their high school experiences did not prepare them for college STEM courses was consistent with the view that STEM is difficult. Participants stated that they believed their college peers had a stronger foundation in STEM than they did and had more exposure to complicated material earlier in their academic career.

The third theme, a lack of STEM resources and lack of STEM exposure as an obstacle to STEM, was consistent with the perceptions described in the Rural Effect category. Interviewees described having less access to STEM courses, especially engineering and computer programming, than their college peers from more populated

areas. They also expressed the perception that their community's largely agricultural economy with few STEM jobs resulted in a lack of exposure to STEM for students.

College Major/Career Interest category. Two themes emerged from the College Major/Career Interest category: (a) college mathematics and science classes were enjoyed by participants and (b) perceptions of the impact of high school STEM classes on choice of college major and career were varied. These themes were important to consider due to the shortage of people entering STEM fields as careers. Thus, it was useful to learn about the perceptions students had of their college majors and potential career.

STEM and non-STEM majors both reported liking their college mathematics and science classes. Students spoke of the ever-changing nature of science as a reason they enjoyed their college science classes. Science was perceived as a growing field where there is always something new to learn. Mathematics courses were viewed as relevant to the participants' area of interest. For example, a business major described how relevant mathematics was in his major. Another participant described how important mathematics was in computer programming.

The second theme that emerged about college major and career choice was that there were varying perceptions of the role high school STEM classes had on the participants' choice of college major and career. The perception that their high school STEM classes had a positive impact on their choice of major and career was held by 13 participants. Five students said their high school STEM classes had a negative impact on their choice of major and career and two believed that there was no impact. Not surprisingly, all STEM majors declared that their high school STEM classes had a positive impact on their choice of college major and career. They spoke specifically of

science and mathematics classes influenced their decision to major in a STEM field. Some non-STEM majors also said that their high school STEM classes positively impacted their choice of major and career. They spoke of biology and anatomy classes that made them interested in nursing and math classes that made them interested in a numbers-oriented business major. Those who said their high school STEM classes had a negative effect stated that it was because the classes led them to believe that STEM was not an area of strength or because the participants did not gain an understanding of what career options were available in STEM through their high school STEM classes. Some interviewees said that their STEM classes made them realize that STEM was not for them. One said that he wished he had learned more about STEM careers in high school and another said that if a course in computer programming had been offered in his high school, he might have pursued a computer science or engineering major in college rather than business.

The themes of enjoying college mathematics and science classes and of varying perceptions of the impact high school STEM experiences had on the choice of college major and career were prominent. The rural effect was present in the perceptions held by participants regarding their choice of college major and career as evidenced by the comment by the participant who said that he might have chosen a major in computer science or electrical engineering if his rural high school had offered a computer science class. Also, several participants explained that they did not understand what career opportunities were available for STEM majors. These beliefs were consistent with the participants' perception that their rural community lacked jobs in STEM fields which led them to not have positive perceptions of STEM careers.

STEM Experiences category. The STEM Experiences category focused on high school and college experience, both in and out of the classroom setting. From this category, two themes emerged: (a) rural high school students' STEM experiences did not expose them to STEM careers and (b) being from a rural area resulted in a lack of STEM exposure in high school but that exposure to STEM increased in college. The rural effect described earlier was strongly represented in these themes.

The interviewees expressed their belief that they did have experiences related to STEM careers while they were in high school. Participants said that the focus was on graduation and choosing a college rather than on what careers were available to students. The participants expressed that their rural community had few people in STEM careers to serve as role models in those careers. Participants suggested that teacher include careers in STEM as part of their classroom experiences and that STEM professionals should be brought in as guest speakers.

The second theme that emerged from the STEM Experiences category was that though was a lack of STEM experiences in high school, STEM exposure was greater in college. Students expressed the perception that STEM was not important to their rural community and that this led to reduced exposure to STEM. A STEM major explained that being from a rural area impacted her STEM exposure when she said, "I don't think our high school did expose us to the STEM concepts or the STEM fields as a career option just because this community in general is more agricultural based." Interviewees also described a lack of computer programming classes and having no community STEM activities as examples of the reduced STEM experiences they received in high school compared to what they believe to be the case in more populated areas.

The participants believed that their STEM experiences improved from high school to college. They found that their college had more resources available to devote to STEM than their high schools and that students had more options for STEM classes than in high school. Having a wider variety of STEM classes from which to choose showed students that STEM is a broader field than they realized in high school. The students also explained that learning about the STEM research taking place at their college gave them more STEM experiences than they had in high school.

Evolving Perceptions category. The theme that was established in the Evolving Perceptions category was one of more positive perceptions of STEM developing after high school. The participants spoke of their improved perceptions of STEM being a result of gaining a better grasp of the value of STEM and seeing where learning about STEM can lead. Students mentioned that their perceptions of STEM in general improved in college and they discussed improved perceptions of science and engineering specifically.

When speaking of the improvement in their perceptions of STEM in general, participants spoke of the increased knowledge of STEM careers. The students explained that in high school you focused more on the academic content, but in college there was more emphasis on where the academic content can lead you in terms of a career. One of the participants mentioned that she learned more about technology in college which led to an internship in which she was put in charge of a database. She said, "I feel like there's a lot more that I just didn't know about in high school that's out there." Learning more about where STEM leads was a commonly cited reason for the participants' improved perceptions of STEM.

Seeing the relevance of science was a reason given for the students' improved perceptions of science since high school. Understanding that science was relevant came from their college science classes and from meeting other students who were majoring in science. Interviewees said that knowing people who understand science and knowing people who want to use science for the betterment of society made them appreciate the relevance of science.

Perceptions of engineering improved as a result of learning more about what engineering entails. With few engineers in their rural community, participants had limited exposure to engineering while in high school. They said that in high school they never really understood what engineering was but after meeting engineering majors in college they have a better appreciation for it.

Discussion of Findings

Two research questions were studied in order to better understand the perceptions students who grew up in a rural area have of STEM. Understanding these perceptions is important due to the demand for STEM professionals in the United States, the role gender was found to play in STEM perceptions in previous studies, and the educational challenges faced by students and educators in rural areas. The first research question was directed at determining similarities and differences between the STEM perceptions held by female and male high school students from a rural high school. The second research question was designed to determine the impact attending a rural high school had on the STEM perceptions of college students. A discussion of the findings of is presented here.

High School Students' STEM Perceptions. Perry (2010) and Brett (2007) documented a lack of interest in STEM by American students. Consistent with their

research, the students in the current study had particularly low favorability ratings of Mathematics, Engineering, and Careers in STEM. The mean ratings (out of 35 possible points) were 24.41 for Mathematics, 22 for Engineering, and 25.44 for Careers in STEM. Science and Technology fared better with favorability ratings of 28.27 and 28.33, respectively.

Though ratings by males and females were similar in some categories, further analysis of data did show some differences by gender. Male high school participants rated four of the five categories of the STEM Semantics Survey more favorably than females. Only Mathematics was rated more favorably by females than by males. For Science, the mean rating was 27.58 for females and 29.43 for males. For Mathematics, the mean rating was 24.68 for females and 23.00 for males. For Engineering, the mean rating was 18.74 for females and 29.00 for males. For Technology, the mean rating was 27.12 for females and 30.79 for males. For Careers in STEM, the mean rating was 24.44 for females and 27.07 for males. The result of a one-way MANOVA showed a significant difference in the overall STEM perceptions held by female and male high school students. The perceptions of STEM held by the high school participants were a function of gender, as evidenced by the statistically significant result of the MANOVA.

Previous studies regarding gender differences in science gave mixed results, with some indicating that female high school students had more unfavorable views than males (Barmby & Defty, 2006; Beghetto, 2007; Miller et al., 2006) and others finding the views of males and females to be equally unfavorable with regard to science (Masnick et al., 2010; Sorge, 2007). In this study, female participants' mean science rating was lower than the males' mean rating (27.59 compared to 29.43), but the difference was not

statistically significant, based on the results of an independent samples *t* test. It should also be noted that science received the highest rating among females of the five categories that were rated and was second highest among the males. This proved consistent with the college participants involved in the study who tended to speak positively of both their high school and college science classes. The details of the college students' discussions about science are discussed in the section addressing college students' perceptions.

The female respondents' higher favorability rating for mathematics was surprising considering the literature that indicated lower views of mathematics held by females (Brandell & Staberg, 2008; Preckel et al., 2008). In the present study, female high school participants perceived mathematics more positively than did male (24.68 compared to 23) though the difference was not statistically significant based on the results of an independent samples *t* test. This finding may signal a positive change in the previously reported gender differences in male and female high school students' perceptions of mathematics.

High school females' perceptions of engineering followed those in studies of college students which revealed that females tended to view engineering in a negative light. Starobin and Laanan (2008) found that female STEM majors had limited knowledge of what engineering involved and believed that it was not a major that they could pursue. While Research Question 1 of the present study focused solely on high school students, it was interesting to find that a negative perception of engineering was held by the female high school participants. The difference between the female and male perceptions of engineering for the high school participants (18.74 compared to 29) was

statistically significant, based on the results of an independent samples *t* test. The reason for the unfavorable perception of engineering held by high school females were explored in the interviews with college students that are discussed in the college student sections.

Technology received the highest rating overall from the high school students in the study. Among the five categories rated by the high school participants, it had the most favorable ratings among the males and had the second most favorable ratings among the females. The term "technology" was not defined and it could be argued that students had varying beliefs about what the term means. Considering that the students were born near the turn of the 21st century, it was not surprising that technology was rated highest among the five categories. With technology permeating all facets of daily life, the participants in the study would be considered digital natives. According to Prensky (2001), digital natives are people who have been surrounded by digital technology their entire lives. Digital native are able to easily learn how to use new technologies and can skillfully acclimate to them (Berman & Hassell, 2014). The fact that technology was viewed most favorably was consistent with the status of the participants as digital natives. In the present study, it was found that males had a more favorable perception of technology than females (30.79 compared to 27.12). Results of an independent samples *t* test indicated no difference in the perceptions of technology held by female and male students. The fact that all students, male and female, were considered to be digital natives supported the conclusion that there was no significant difference in perceptions by gender.

Prior studies showed that a belief that mathematics and science were male-dominated fields had a negative impact on female students' views of those careers

(Brandell & Staberg, 2008; Selimbegovic et al., 2007). In the present study, it was found that females had lower perceptions of careers in STEM than males (24.44 compared to 27.07). The female ratings were lower than those of males but not by a statistically significant amount, based on the results of an independent samples *t* test.

Two open-ended questions developed by the researcher accompanied the STEM Semantics Survey. The first question was: What can be done (if anything) by the school and/or community to increase interest in the areas of science, technology, engineering, and mathematics? Responses were consistent among male and female participants. Male and female participants both pointed to the need for STEM classes to have more hands-on activities and the need for students to be shown that STEM is relevant for many careers.

The perception that STEM classes should have more of a hands-on focus was consistent with the assertion by Schaffhauser (2016) that STEM courses should be taught with a student-centered application approach. The hands-on focus suggested by the high school students was supported by U.S. Secretary of Education John King Jr.'s (2016) article in *USA Today* in which he calls for more hands-on instruction that promotes collaboration, problem solving, and engagement. King wrote that the concept of "making" as an instructional strategy would improve student engagement, teach students to solve problems, and inspire students to succeed in STEM.

The perception that it was important for students to learn about the relevance of STEM for careers was echoed by the college students who were interviewed. The college participants described their high school STEM experience as lacking a career component which led them to not understand what STEM careers entailed. The college

students also said that not having many STEM professionals in their rural community limited their exposure to STEM and led them to have little knowledge of STEM careers.

The second open-ended question was the initial step to understand the role growing up in a rural area had on students' STEM perceptions. The second question was as follows: In what ways (if any) does attending high school in a rural area impact your perceptions of science, technology, engineering, and mathematics? The rural effect was studied more fully with the college student interviews, but it was interesting to gain a sense of how high school students viewed the rural effect. There were varying views of the degree of the impact that growing up in a rural area had on the high school participants' STEM perceptions. The most frequent response, that living in a rural area caused them to be less exposed to STEM because STEM jobs are less prevalent where they live than in more populated areas, was consistent with the finding of the study by Lucas and Fugitt (2009). Other students disagreed with this idea and stated that attending high school in a rural area either had no impact or a positive impact on their perceptions of STEM. The college participants, who will be discussed in the next section of Chapter 5, tended to believe that attending high school in a rural area shaped their perceptions of STEM. As with the first open-ended question, responses were similar for males and females.

The findings of the data from the high school students shed light on the perceptions that students from a rural area had of STEM and on relationship between the high school students' gender and their STEM perceptions. These results add to the literature about the differences in STEM perceptions held by female and male students, specifically rural students. Studies focusing on STEM perceptions held by rural students

were limited so these results provide some insight into the STEM perceptions and the role gender plays in helping to explain perceptions for that group of students.

College Students' STEM Perceptions. To better understand the perceptions that students had about STEM, college students who had attended the same high school as the high school student participants were interviewed. The context of a rural setting was incorporated into the study due to a lack of research on the STEM perceptions held by rural students. Research Question 2 asked: How did attending a rural high school impact the STEM perceptions of female and male college students? The interview questions fell into six categories and the discussion of the findings are organized by those categories. In each of the categories, attending a rural high school had a profound impact on the students' STEM perceptions. The Rural Effect category described the role ruralness had on perceptions. The subsequent categories focused on other aspects of the students' STEM perceptions but the rural effect was present in each of them. Presented next is the discussion of each of the six categories: Rural Effect, Gender, Obstacles to STEM, College Major/Career Interest, STEM Experiences, and Evolving Perceptions.

Rural Effect. The theme that emerged from the Rural Effect category was that there is a lack of exposure to STEM and a lack of resources for STEM in rural areas. The participants identified their rural upbringing as a fundamental element which influenced how they perceived STEM. The rural effect was not limited to this one category of interview questions. Rather, the idea of a rural effect was found throughout the categories and was an important contextual factor that impacted the students' perceptions of STEM.

The participants' perception that attending a high school in a rural community led to a lack of exposure to STEM and a lack of resources for STEM was consistent with the literature. Consistent with Hopkins' (2005) assertion that students in rural schools lack the cultural capital of students in urban schools, participants expressed the feeling that urban students were closer to more STEM opportunities and that their schools provided a greater STEM focus. They perceived that they had missed out on STEM-related opportunities. These views were important because they established the idea that because they attended a rural high school, the students had limited exposure to STEM. Receiving limited exposure to STEM led the students to have a more shallow understanding of the STEM fields, which may have led to lower perceptions of the fields than if they had received more exposure.

Dessoff (2010) and Blanton and Harmon (2005) explained the difficulty rural school districts have attracting high quality teachers to teach STEM classes. Their research was important to this study because if high quality STEM teachers are not available in rural areas, then the STEM perceptions held by students from those rural areas would likely suffer. The concern about the quality of the STEM education received in their rural high school was questioned by participants. Students speculated that the STEM classes in their rural high school were not as good as those at high schools in larger areas. Participants noted that the best teachers might choose a non-rural school, that students from non-rural areas seemed to have a better basic understanding of STEM subjects, that STEM classes in non-rural schools seemed to include more technology, and that STEM-related courses, such as computer programming and engineering, were not available to them.

A lack of STEM jobs in their community was cited as a reason the participants believed that STEM exposure was lacking for them. The students spoke of the agricultural economy in their rural community. While it can be argued that there is a scientific component to agriculture, the participants tended to view the jobs in their community as not emphasizing STEM. It should be noted that few jobs of the agricultural jobs in the community involved the research component that would be found in a university or corporate agriculture setting. College students perceived that the "culture of a rural place" resulted in less emphasis on STEM classes or careers, and that students from more populated areas would be more likely to be pushed toward a STEM major. These views that their rural area placed less value on STEM was likely a result of having few STEM jobs in their rural area. This perception was evidenced by the participant who said that the jobs held by the parents of his high school peers were not STEM jobs. Similarly, other participants said that it is uncommon to find engineers, people with a mathematics background, or technology oriented jobs in their rural community. Having few STEM role models in their community helped lead students to the perception that they received less exposure to STEM than students from more populated areas.

The notion of a rural effect on the perceptions of STEM held by the participants was important to acknowledge. This idea permeated the discussions the interviewees had about their STEM perceptions. The rural effect they described was consistent with the literature describing the challenges rural districts face with regards to STEM and the literature addressing the lack of cultural capital available in rural areas.

Gender. The themes of a gender stereotype existing in STEM and of more exposure to STEM in college leading female students to improved perceptions were found as a result of analysis of the interview data. These themes are worthy of discussion because they helped to shed light on the perceptions of STEM held by students. The rural effect was found to exist in this category due to the lack of female STEM role models that existed in the rural community where the college participants grew up.

Studies have shown that STEM fields were viewed as stereotypically male (Hartman & Hartman, 2008; Nosek & Smyth, 2011; Starobin & Laanan, 2008). Results of the Draw-A-Scientist studies conducted by Chambers (1983) seem to still be borne out today as evidenced by the college student participants who declared that gender stereotypes had an impact on their STEM perceptions. The implication of the stereotype of STEM as a male field was described by participants as "a stigma . . . that might just deter females," and that it is "for boys." Interviewees noted that this stereotype contributes to the less favorable perceptions of STEM subjects and careers. Participants discussed that, even as young children, boys built and destroyed while girls played with dolls. This discussion of STEM being viewed as male field was worthy of discussion because of the implications this view might have on the students' perceptions. The participants not only found this stereotype to still exist but also described the negative implications it had.

This stereotype was thought to be exacerbated for rural students because they have so few STEM role models in their communities. As was described in the previous section, few jobs in the students' rural community were STEM jobs so few STEM

professionals lived in the community. It follows that there would be few female STEM professionals available to promote STEM to female students.

It should be noted that interviewees found that females received more exposure to STEM in college, which led to improved perceptions of STEM, especially in engineering and STEM careers. Participants had complained that their high school science lab assignments lacked technology, computer classes did not teach programming, and engineering classes were non-existent were explained. Those complaints stand in contrast to the college environment described by participants, who noted that colleges have extensive course offerings and exposure to STEM content and careers, and females have increased interest in technology and engineering. This view supports the theme that more exposure to STEM in college resulted in improves perceptions by females. Interviewees felt it was possible to overcome "that more narrow mindset" from high school and that seeing other female students pursuing STEM studies helped them to develop more positive perceptions and to see possibilities. More exposure to STEM leading to better perceptions of engineering and STEM careers was consistent with the impact that the rural effect had on participants. In an area with few engineers and others in STEM careers, male or female, it made sense that females would develop improved perceptions with more exposure.

The themes of gender stereotypes of STEM fields and increased STEM exposure in college leading to improved perceptions of engineering and STEM careers for female college students impacted the STEM perceptions held by students. These views could not be separated from the idea that being from a rural area impacted the interviewees' views on gender as they relate to STEM. The rural effect informed the participants'

STEM perceptions involving the gender stereotype and the idea that more STEM exposure in college led to improved perceptions for females.

Obstacles to STEM. Themes of the difficulty of STEM, inadequate STEM preparation for college, and the rural effect leading to a lack of resources and exposure to STEM were the themes that emerged in this category. These obstacles to STEM suggested by the students were worth considering due to the concern that not enough people are interested in pursuing STEM fields as careers. As the third theme suggests, the impact of being from a rural area was again an important factor influencing the perceptions held by students.

The perception that STEM courses are thought of as difficult could impact students' desire to enter those fields. This notion was supported participant responses in the study. Participant statements included noting that the science, technology, and engineering coursework "sounds really hard" and a participant concluded that this perception might "scare people away." The implication of the view that STEM is difficult is that some people who are capable of finding success and enjoyment in STEM fields may opt against it because of the belief that it is hard and the perhaps erroneous belief that they would not be successful in STEM. Several STEM majors viewed STEM classes out "weed out" classes.

The idea that STEM is difficult was consistent with the second theme that emerged from the interviews. Participants described their preparation for college STEM classes as inadequate. They described science labs that lacked technology and computer classes where they did not learn programming. They also pointed out that they believed their college classmates had more advanced classes in high school than they did, and

participants believed that their preparation for college STEM classes was contingent on how hard their high school classes were. The students perceived that their high school STEM preparation was not as strong as the preparation of other college students.

This lack of preparation tied in with the third theme of a lack of STEM exposure and resources. This finding was consistent with the idea that having few STEM jobs in a rural area resulted in less STEM exposure, and with the difficulties rural school districts face with regard to STEM. These rural issues should not be overlooked when considering the perceptions about STEM that students have taken with them to college.

College Major/Career Interest. Two themes emerged were from this category. The themes were that many participants expressed an enjoyment of mathematics and science classes in college and that there were widely varying views about the impact the participants' high school STEM classes had on their choice of college major and career. These themes were important to uncover in order to have a better understanding of students' perceptions of STEM career options.

The idea that college mathematics and science classes were enjoyed was interesting because it does stand in some contrast to the study Masnick et al. (2010) that showed unfavorable views of science among college students and the study by Sorge (2007), which found that attitudes toward science become more negative over time. This theme was also surprising because mathematics was rated least favorably by the college students on the STEM Semantics Survey. These findings may be the result of students comparing their college classes to their high school classes, so that relative to their high school mathematics and science classes, they found their college classes to be enjoyable.

College students described the hands-on nature of some of their STEM classes and learning about the relevance of STEM as reasons they enjoyed their mathematics and science classes. This college perspective was consistent with the comments high school participants provided in the open-ended question about their views on how to increase interest in STEM. The high school respondents described a desire for more of a hands-on approach to their STEM classes and for more focus on the relevance of STEM for careers. These were exactly what the college participants mentioned when they described their enjoyment of their college mathematics and science courses. For example, the college students talked about learning about the research their professors were doing in STEM fields, the interactive nature of a physics class, seeing the relevance of mathematics in business, applying mathematics concepts to computer programming, and using science concepts in their pursuit of a degree in a medical field. High school students seemed to be saying that they desired the types of STEM classes that the college participants were provided.

College participants reported widely varying perceptions of the impact their high school STEM classes had on their college major. Tyson et al. (2007) found that high school course taking of calculus and physics was a factor in students majoring in STEM in college. In another study it was found that enrollment in trigonometry, precalculus, and calculus in high school was found to be associated with STEM enrollment in college (National Center for Educational Statistics, 2009). While specific high school courses were not discussed in the current study, most participants indicated that high school STEM courses had a positive impact on their choice of college major. These students

spoke of specific STEM classes in high school as having a large impact on their choice of major.

Five of the 20 interview participants commented that their STEM classes had a negative impact on their choice of career in the sense that they made them realize that their strengths or area of interest were not in a STEM field. This notion was supported by comments about a lack of success in high school STEM classes creating a lack of confidence that it was possible to do well in a STEM major or STEM college classes. Participants also pointed out that not learning about STEM careers while in high school led to them to not major in a STEM field. Interviewees made comments about not being exposed to STEM careers and how they were then unable to picture themselves in that line of work.

College students also noted that stronger high school courses (e.g. computer programming instead of learning word processing and PowerPoint) might encourage high school students to consider STEM courses and careers. A lack of exposure to some STEM areas in high school, computer science and engineering were commonly mentioned, in their rural high school may lead some students away from STEM majors and careers. These student responses again point to the rural effect that has permeated the study. As discussed by Dessoff (2010) and Blanton and Harmon (2005), recruiting STEM teachers is difficult and this situation may be particularly true in specialized fields like computer science and engineering. Furthermore, the lack of cultural capital in the rural community limited exposure to STEM outside of school. With no STEM-oriented activities that exist in larger communities with science museums, high tech businesses, and universities, students who are not exposed to computer programming or engineering

in the school will likely get no exposure at all. Thus, attracting rural students into STEM majors could prove difficult.

These themes merited discussion because they impact the perceptions rural students have of STEM. The interviewees provided valuable insight into their views of their college mathematics and science classes. It was interesting to see the connection between the high school participants' desires for their STEM classes and the college students' expressions that they were experiencing some of the high school participants' desires in their college classes. Gaining knowledge of the role the college students' high school STEM classes had on their choice of college major and career has important implications for educators.

STEM Experiences. Two themes that emerged from interview questions about the participants' STEM experiences. They were the idea that participants lacked experiences with STEM careers in high school and the belief that being from a rural area caused a lack of STEM exposure in high school but that STEM exposure in college improved. As with the previous categories, the rural effect influenced the participants' discussion about their STEM experiences.

Lacking experience with STEM careers in high school was discussed by the students as a high school issue where the school did not do enough to promote STEM careers. There was also some discussion though about exposing students beyond the typical careers found in their community. This factor was significant because, as has been discussed before, STEM jobs are not the norm in the rural community where the participants grew up.

Incorporating career discussions into STEM classes, hosting career fairs, inviting guest speakers to discuss STEM careers, and having a staff member whose focus was on career guidance were suggestions given for providing STEM careers experiences for students. With few STEM professionals in their rural area, it was up to the school to explicitly teach students about STEM careers. The students believed that the school was not doing a good enough job in that regard. Students believed it was important to show the relevance of STEM careers. This finding was consistent with the high school participants who said that their school should focus more on making STEM relevant in order to increase interest in STEM so that students see it is not "just geeky science" and that STEM careers have importance in the world. This idea that STEM is broad and important to society was echoed by other participants and important for educators to note. Participants also explained that it was important to expose students to careers that were not common in their rural community. With agriculture as the dominant local industry it was not surprising to find that most of the careers they learned about were in the agriculture industry.

The second theme associated with students' STEM experiences was the view that being from a rural area caused a lack of STEM experiences in high school but that STEM experiences in college improved. As noted previously, students indicated that they did not receive much information about STEM careers in school. Within responses to questions related to STEM experiences, respondents again pointed to the lack of local professionals in STEM careers leading to lack of opportunity for STEM experiences. Comments about having little knowledge of STEM careers because those careers are not common in their community pointed to the rural effect that permeated this study.

While the participants mentioned a lack of STEM experiences in high school, they did speak of increased experiences in college. The students pointed to colleges having more resources, providing more opportunities to learn about STEM topics, and more readily exposing students to STEM careers as ways in which their colleges provided more experiences with STEM than their high schools. This revelation was important because it provides high schools with an opportunity to learn what colleges do to expose students to STEM so that high schools could attempt to replicate them. While not having a university in the rural community would make it difficult for the high school to form a partnership, there could be some long distance learning opportunities that could enhance the high school students' exposure to STEM.

The themes from the STEM Experiences category provided valuable insight into the concerns students had about their high school exposure, the role their rural community had on their STEM experiences, and ways that colleges are providing STEM experiences. These insights could be used by rural high schools to improve the STEM exposure they provide to students. Increased experience could result in increased achievement in STEM and more interest in pursuing a college major and career in STEM.

Evolving Perceptions. Participants reported more positive perceptions of STEM from high school to college. These evolving perceptions were important to understand because they point to ways in which high schools in rural areas could attempt to improve the STEM perceptions of their students. Participants identified gaining a better understanding of the value of STEM and seeing where learning about STEM can lead as sources of their evolving perceptions since high school. Learning about the relevance of STEM was lacking in high school but that area improved once the students were in

college. This finding was consistent with the high school participants who wrote in the open-ended question that their high school should show the relevance of STEM.

The idea that the relevance of STEM should be emphasized was expressed by students who wanted to see connections between what they were studying in high school and relevant and interesting real world ideas and events. Interviewees also noted that connections and relationships between STEM fields improved their perceptions. High schools could consider emphasizing the relevance of STEM and the connections between STEM fields to students.

The interviewees also discussed that learning more about where STEM can lead contributed to their improved perceptions. This result is consistent with comments described in an earlier section where the participants discussed the need to learn more about STEM careers in high school. Their desire to learn more about STEM careers was realized in college, which led to improved perceptions of STEM. The finding that participants' STEM perceptions improved as a result of learning where majoring in a STEM field could lead was an important revelation because it showed the value of career education in high school.

Again the rural effect is a factor in the evolving perceptions of STEM. Rural districts with limited STEM resources in the school and community, that have difficulty attracting STEM teachers, and that have few STEM role models to draw on in the community could have a particularly difficult time exposing students to STEM careers. Consistent with the rural community described by Lucas and Fugitt (2009) where most residents did not believe advanced mathematics was required for jobs in their community, many rural communities face the challenge of showing students the relevance of STEM

when few STEM jobs exist in their community. The evolving perceptions of the students in the current study indicated that showing the relevance of STEM is important for rural students.

Implications of Findings

The findings of this study should serve as a call to action for STEM teachers and school leaders at both the K-12 level and at the post-secondary level. The need for more people to enter STEM fields has been well-established, so it is paramount that educators provide a path to STEM for their students. The results of this study shed light on the perceptions that students in a rural area held about STEM.

Results of the examination of the rural high school students' STEM perceptions indicated that female and male students from a rural high school had STEM perceptions that were statistically significantly different. This difference was driven by males having a significantly more favorable perception of engineering. The implication of this result is that educators must work to improve the perceptions female students have regarding engineering. High school students involved in the study suggested that their high school STEM classes should have more of a hands-on component where students are actively engaged in problem solving, collaboration, and critical thinking. This recommendation could lead to improved perceptions of engineering for female students, as well as providing engaging content for all students. Educators should also be aware that research findings indicated that women tend to be more oriented toward careers dealing with people than do males (Miller et al., 2006; Su et al., 2009). Thus, engineering needs to be presented as more than an object-oriented career. Female students who have limited exposure to engineering could result in females not realizing that there is a human side of

engineering and that there a many ways in which engineering can impact the greater good. This knowledge could appeal to female students.

Educators in rural districts face a difficult challenge because there are typically few engineering professionals in rural areas. This concern was noted by the college students who were a part of this study. With few engineering jobs in their rural community, it was difficult for them to envision a career in engineering. Female students likely feel this effect as they do not have many female engineering role models. This view is consistent with the study by Hartman and Hartman (2008) who found that female engineering majors identified a lack of female role models as an area of concern. The implication of this finding is that educators in rural areas should seek out partnerships, perhaps long distance alliances, with female engineers.

The ability to connect with others in real time through technology makes forming alliances with engineers from a different community less daunting than in the past. In rural areas where few STEM role models exist and where a lack of cultural capital make exposure to engineering difficult, technology could be used to bring the exposure into the classroom. This exposure could take the form of a female engineer talking to students via Skype or a similar technology. A virtual tour of a high tech manufacturing facility could show students that engineering is more than designing bridges. Using the internet to explore the work engineers do to bring clean water to the developing world could expose female high school students to the helping nature of engineering.

The rural high school the participants attended did not offer any courses in engineering. Many of the college students interviewed mentioned that their college friends from larger areas had engineering courses or magnet programs emphasizing

STEM in their school districts. An implication of this study is a need for rural school districts to consider offering engineering courses as electives or to incorporate engineering modules into existing classes. The Georgia Department of Education has engineering courses as part of their Career, Technical, and Agriculture Education department. Additionally, Project Lead the Way offers a curriculum for a set of hands-on engineering courses that could be implemented. School leaders should looks for ways to implement engineering courses and concepts in their schools.

Universities should also view the results of the inquiry into rural high school students' perceptions from this study as a call to action. Universities can play a role in encouraging female students to consider engineering as a career option. More outreach to rural communities is needed to show female high school students what engineering is and show them that it is a broad field worthy of their consideration. It was interesting to note that the female college students involved in the study rated engineering higher than the female high school students. The college students said that learning more about what engineering entailed was a reason for their improved perception. Universities with engineering programs could increase their outreach to students in rural school districts to encourage more female students to take an interest in engineering.

The examination of rural college students' STEM perceptions identified the rural effect as an influential factor in the way in which college students from a rural area perceive STEM. The primary implication is that educators must look beyond the contextual factors of race, gender, and socioeconomic status that are typically studied and to take into consideration the rural effect. It is also important to acknowledge that rural communities lack cultural capital, that lacking cultural capital impacts students' STEM

perceptions, and that schools and communities must work to overcome this lack of cultural capital.

The college students who participated in the study identified a lack of exposure to STEM and a lack of resources for STEM in rural areas as a concern. The implication of this finding is that school districts must seek out resources to expose students to STEM. This exposure could come with increased expenses. Adding engineering and computer programming classes to the school's course offerings have a cost associated with them. However, other solutions have minimal costs. Seeking out partnerships in the community or looking for long distance partnership with people and organizations in larger communities where STEM professionals and organizations are more readily available could be undertaken for little cost. College students suggested STEM nights as a way to provide more exposure to STEM for rural students in all grades. Rural schools could seek out the help of a university to help spearhead such an event. The university could provide its expertise and its connections within the STEM community to find willing partners to support such an event. Having guest speakers come to the school to discuss their STEM careers was a suggestion provided by participants of the study. College students mentioned guest speakers, career seminars, and professors discussing their research as ways their colleges exposed them to STEM. In a rural area with few STEM professionals, these approaches could be difficult to implement, however technology could provide the link to STEM professionals. As discussed earlier, STEM professionals could interact with students via Skype or a similar platform.

A low-cost way to provide more STEM course offerings is to seek out online courses. Many states offer accredited virtual schools. Students in rural schools who want

to take a computer programming course, a class that students in the study said they wish had been offered at their rural high school, could take the course online through their state's virtual school. For example, during the fall semester after this paper is completed (Fall 2016), this state's virtual school is offering 34 courses in the area of career, technical, and agricultural education, including engineering, computer science, digital design, and other similar courses. There are extensive other content offerings, including Advanced Placement courses in all areas. The virtual school option is one that should be explored and used by rural schools. Another low-cost approach to providing more STEM exposure is to engage students in STEM-related clubs. Students in this study explained that they did not have many opportunities to engage in STEM activities outside of class.

From the Gender category it was found that college students see STEM fields as predominantly male. STEM's stigma as a male dominated field should be combated by providing more exposure to female STEM professionals. This exposure should be provided for both male and female student, and could be accomplished by providing more of a career element in STEM classes. This element was something participants, both high school and college students, suggested. Spotlighting females who make contributions to the STEM fields could show students that females are in fact engaged in STEM activities. Those spotlighted could be figures of historical importance to their respective fields or they could be current STEM practitioners. Identifying former female students who went into a STEM career or even current college students majoring in STEM could serve as much-needed role models. Learning from these former students could be in the form of a question and answer session (in person or long distance),

through personal written communications such as a pen pal or a blog, or by interacting through social media.

Themes of the difficulty of STEM, inadequate STEM preparation for college, and the rural effect leading to a lack of resources and exposure to STEM were the themes that emerged from the Obstacles to STEM category. An implication is that rural issues contributed to the participants' concerns that STEM is challenging and that they were not adequately prepared for college STEM classes. Schools must work to overcome the issues of limited resources devoted to STEM and difficulty in attracting teachers in STEM fields. Universities must also work to encourage more students to pursue careers in teaching STEM in rural schools and they must work to provide adequate resources for these potential former STEM teachers.

The College Major/Career Interest category produced themes of an expression of enjoyment of mathematics and science classes in college and of widely varying views about the impact the students' high school STEM classes had on their choice of college major and career. The implication of these results is that colleges are taking positive approaches in their mathematics and science classes that should be continued and replicated in high schools. Partnerships between colleges and high schools could be an avenue for an exchange of best practices in mathematics and science.

The implication of the findings from the STEM Experiences category includes the previously mentioned need for rural schools to seek partnerships to expose students to STEM careers. Students' lack of knowledge of what these careers entail would make students more likely to consider a STEM field as a career. Partnerships to overcome the

rural effect of having few STEM role models in the community must be developed in order to generate more exposure to STEM careers for students in rural areas.

The Evolving Perceptions category showed that students' perceptions of STEM were improving from high school to college. The implication is that educators should continue with efforts to improve the perceptions students have regarding STEM. Showing the relevance of STEM was deemed to be especially important for the rural students in this study. Educators should work to show students how STEM relates to the world around them, how STEM can be used to make a positive impact on the world, and how each of the STEM fields is connected. While the challenges of adequately engaging students in learning about STEM and exposing students to STEM careers is difficult for educators in rural areas, having students identify their STEM perceptions as improving provides hope for educators that their efforts are needed and have the potential to be effective.

Limitations

The findings of the study are limited for several reasons. The generalizability of the study is limited because the study focuses on students from one rural high school. The study should be thought of as a snapshot of the perceptions held by students from one school at one particular moment in time. Other rural schools and communities may have contextual factors that make them different from the school and community from which this study's participants were drawn. Increasing the number of participants would create a more reliable data set. The number of participants is also a limiting factor in the study. Another limiting factor is that the high school participants were all drawn from the same graduating class. Previous and subsequent graduating classes could have had

perceptions that were different from the perceptions of the participants due to factors that are specific to their graduating class.

A limiting factor of the college students' results was that only a subset of those college students who completed the STEM Semantics Survey was interviewed. Those who were interviewed volunteered to participate in the interview and were not chosen at random. The college student participants who were not interviewed could have expressed different views about STEM than the views of those who were interviewed. Another limiting factor is that of the bias of the researcher. Because the participants in the study were current or former students, they could have been influenced by the fact that the researcher was their current or former teacher.

Future Research

Future research is needed in a variety of areas that were a part of this study. More research is needed on the impact rural effect might have on the perceptions students have about STEM fields and careers. Thus, a broader study of students from various rural locales is warranted. Additionally, studies that seek to determine if perceptions differ by the type of locale (urban, rural, suburban) would add to the literature on the perceptions of STEM held by students from rural areas. Research examining the role socio-economic status plays in the perceptions students hold about STEM is warranted. In keeping with the need for more research on STEM within a rural context, a study of the resources available to students in rural areas, both in schools and in communities, is necessary. Similarly, a study of the obstacles to STEM to determine if obstacles are perceived differently by students from various locales (urban, rural, suburban) would add to the literature. More research is needed to understand how rural college students come to

decisions about what college major and career to choose in light of the limited variety of careers they may have been exposed to in the rural communities where they grew up.

In the current study, it was found that college students had STEM perceptions that evolved from high school to college. Future research is needed to determine the reason for these evolving perceptions. A long term study regarding the changes in STEM perceptions over time for students from a rural area would be useful. Through the current study it was found that female and male high school participants had significantly different perceptions of STEM. A qualitative study designed to understand the nature of these differences and to determine whether maturity is a significantly contributing factor, would add to the literature on STEM perceptions.

Conclusion

STEM is an important area of education that contributes to America's economy and to the identity of the United States as a center for innovation. The United States economy needs more STEM professionals to sustain its place in the world. Developing more STEM professionals is more than just an economic concern, though. STEM can provide for the common good for American society in the form of solutions to environmental concerns or the development of treatments to cure diseases. STEM can provide technological innovations that bring enjoyment and connectedness to people. STEM can bring a sense of wonder to people and provide an avenue for continued learning in the form of the type of cutting edge research being conducted at universities. Finally, STEM can reopen the exploration of galaxies and the universe, which was evident in the landing of American astronauts on the moon, and can provide the expertise for further space exploration.

Because of the importance of STEM, it is necessary that the perceptions young people have about STEM be studied. In this study, using a rural setting as a lens through which to view STEM, the STEM perceptions held by students from a rural area were analyzed quantitatively and qualitatively. High school students rated science, technology, engineering, mathematics, and STEM careers using the STEM Semantics Survey. Engineering and mathematics were found to be the least favorable areas. It was found that there was a statistically significant difference in the STEM perceptions held by female and male students. Results of independent samples *t* tests identified that gender differences in engineering drove the results of those statistical tests. Male high school students had significantly more favorable perceptions of engineering than female high school students.

College students were interviewed to understand their perceptions of STEM and to determine what impact attending high school in a rural area had on their perceptions. The rural effect played an important role in the way the students perceived STEM. Six categories of interview questions was part of the study. Those categories were labeled Rural Effect, Gender, Obstacles to STEM, College Major/Career Interest, STEM Experience, and Evolving Perceptions. While the idea of a rural effect was in its own category, it was found to permeate the other categories as well.

From each category, themes emerged. A lack of exposure to STEM and a lack of resources for STEM in rural areas was the theme that emerged from the Rural Effect category. The Gender category produced the themes of a gender stereotype existing in STEM fields and that more STEM exposure in college leads female students to improved perceptions of engineering and STEM careers. Themes of the difficulty of STEM,

inadequate STEM preparation for college, and the rural effect leading to a lack of resources and exposure to STEM were the themes that emerged in the Obstacles to STEM category. From the College Major/Career Interest category the themes that developed were of college mathematics and science classes being enjoyed by students and the idea that the perceptions of the impact of high school STEM classes on choice of college major and career were varied. The two themes that emerged from the STEM Experiences category were that participants lacked exposure to STEM careers in high school and the belief that being from a rural area caused a lack of STEM experiences in high school but that STEM exposure in college improved. In the Evolving Perceptions category the theme of more positive perceptions of STEM from high school to college emerged. The idea of a rural effect extended to all of the themes, so it was clear that ruralness impacted the college students' perceptions of STEM.

The study adds to the research on STEM perceptions and on the impact that being from a rural area has on those perceptions. Studies specific to STEM perceptions held by rural students are limited. Thus, this study was needed in order to add to the literature on the topic of STEM perceptions held by students from a rural area. Research-based conclusions have been made available to the research school, and those findings may generalize to other schools in rural settings. Based on the findings, potential actions that could address the issues have been noted. Seeking remedies to the identified issues may provide rural students with opened doors to STEM courses and careers. Opening doors to STEM may provide students with the spark needed to ignite an interest in STEM.

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APPENDIX A:

Institutional Review Board Approval

Institutional Review Board (IRB)
for the Protection of Human Research Participants

NEW PROTOCOL APPROVAL

PROTOCOL NUMBER: IRB-03045-2014 **RESPONSIBLE RESEARCHER:** Ben Pitchford

PROJECT TITLE: Difference in Male and Female Student Perceptions of STEM from a Rural Georgia High School

APPROVAL DATE: 6/23/14 **EXPIRATION DATE:** 6/22/15

LEVEL OF RISK: ☒ Minimal ☐ More than Minimal

TYPE OF REVIEW: ☒ Expedited Under Catetory/ies :6 & 7 ☐ Convened (Full Board)

APPROVAL: This research protocol is **approved** as presented. If applicable, your approved consent form(s), bearing the IRB approval stamp and protocol expiration date, will be mailed to you via campus mail or U.S. Postal Service unless you have made other arrangements with the IRB Administrator. Please use the stamped consent document(s) as your copy master(s). Once you duplicate the consent form(s), you may begin participant recruitment. **Please see Attachment 1 for additional important information for researchers.**

COMMENTS: NONE

Lorraine Schmertzing 6/23/14

Lorraine Schmertzing, EdS., IRB Chair Date

Thank you for submitting an IRB application.
Please direct questions to irb@valdosta.edu or 229-259-5045.

Form Revised: 12.13.12

APPENDIX B:

School Permission

Colquitt County High School

Stephanie Terrell, Principal

1800 Park Ave.
Moultrie, GA 31768

Phone: 229-890-6141 -:- Fax: 229-890-6166
Website: http://colquitt.k12.ga.us/cchs

February 3, 2014

Dear Mr. Pitchford:

I have reviewed your request for permission to collect data at Colquitt County High School for your doctoral dissertation regarding the perceptions students hold about science, technology, engineering, and mathematics. You have my permission to collect data at Colquitt County High School. If I may be of assistance, please do not hesitate to contact me.

Sincerely,

Stephanie Terrell

Stephanie Terrell
Principal

COLQUITT COUNTY HIGH SCHOOL WELCOMES PARENTAL INVOLVEMENT

APPENDIX C:

STEM Semantics Survey

STEM Semantics Survey

Gender: M / F

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.

ID: _____ **School:_____**	Use the assigned ID or the year and day of your birthday (ex: 9925 if born on the 25th day of any month in 1999.

Instructions: Choose one circle 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

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

APPENDIX D:

STEM Perceptions Open-Ended Questionnaire

STEM Perceptions
Open-Ended Questionnaire

ID: _____

School: Colquitt County High School

Please answer the following questions to the best of your ability. Any question that you do not want to answer may be left blank if you so choose.

1. Age? _____ 2. Gender? _____ 3. Race? _____

4. Do you plan to attend college after graduating from high school? YES or NO

If you answered "yes" to #4 please answer #5-#6.

5. What college do you plan to attend?

6. What do you plan to major in?

If you answered "no" to #4 please answer #7.
7. What are your career plans for after high school?

All students please answer #8-#9.
8. What can be done (if anything) by the school and/or the community to increase interest in the areas of science, technology, engineering, and mathematics?

9. In what ways (if any) does attending high school in a rural area impact your perceptions of science, technology, engineering, and mathematics?

APPENDIX E:

College Student STEM Perceptions Interview Protocol

College Student STEM Perceptions Interview Protocol

These questions comprise the initial standardized open-ended questions. Follow up questions will be asked of individual participants based on answers given to the standardized open-ended questions.

High School

1. Describe the STEM classes you took in high school.

2a. Describe the STEM experiences (if any) you had in high school that were outside of the classes you took (example: math team, science fair, GHP, etc).

2b. If you had STEM experience in high school, how did these STEM experiences impact your choice of college major or career? (Example: math team, science fair, GHP, etc)

3. In what ways (if any) did growing up in a rural area impact your high school experience?

4. In what ways (if any) did growing up in a rural area impact your high school STEM experience?

5. Describe any adults you interacted with in high school (other than your teachers) that you view as a STEM role model.

College/Career

6. Describe what made you interested in your college major.

7. Tell me about your favorite classes you have had since you have been in college.

8. Have you ever changed your major? If so, what other major(s) did you have prior to your current one? If so, what led you to change?

9. What career do you intend to pursue when you graduate?

10. Where do you see your career five years after graduation?

11. What impact (if any) did your STEM classes in high school have on your choice of major and career?

If a STEM major, answer number 12. If not, move to number 13:

12. What is it about STEM that appeals to you?

13. What led to your decision to not major in a STEM field?

14. What impact (if any) did growing up in a rural area have on your choice of major and on your career plans?

15. Describe any adults you have interacted with since high school that you view as a STEM role model.

Access/Obstacles

16. Do you believe students from your rural high school have the same access to STEM classes, activities, and resources (both in the school and in the community) as students who attended high school in non-rural areas? Explain why you answered as you did.

17a. Do you believe there are any obstacles to pursuing a career in STEM that students face? Explain why you answered as you did.

17b. If you believe so, do you believe the obstacles are different for students from a rural high school than for students from high schools in more populated areas? Explain why you answered as you did.

17c. If you believe so, do you think the obstacles are different for female and male students?

18. Is there anything that can be done to encourage more students to pursue college majors or careers in STEM? Explain why you answered as you did.

Response to Quantitative Data from HS Seniors

Explanation: The next set of questions was developed after analyzing the results of the STEM Semantics Survey which was given to high school seniors last year. T his is the same survey that you recently completed.

19. Data collected using the STEM Semantics Survey from last year's seniors at your high school indicate that male and female students have different perceptions of engineering. Female students view it more unfavorably. To what do you believe the difference can be attributed?

20a. Data collected using the STEM Semantics Survey from last year's seniors at your high school indicate that engineering is viewed the least favorably overall among science, technology, engineering, and math. Why do you believe this to be the case?

20b. Do you believe that being from a rural area has any impact on this result?

21a. Data collected using the STEM Semantics Survey from last year's seniors at your high school indicate that math is viewed the second least favorably overall among science, technology, engineering, and math. Why do you believe this to be the case?

21b. Do you believe that being from a rural area has any impact on this result?

Response to Quantitative Data from College Students

Explanation: The next set of questions was developed after analyzing the results of the STEM Semantics Survey which was recently given to college students. This is the same survey that you recently completed.

22. Data collected using the STEM Semantics Survey from graduates of your high school indicate that male and female students have different perceptions of engineering. Female students view it more unfavorably. To what do you believe the difference can be attributed?

23a. Data collected using the STEM Semantics Survey from graduates of your high school indicate that math is viewed the least favorably overall among science, technology, engineering, and math. Why do you believe this to be the case?

23b. Do you believe that being from a rural area has any impact on this result?

24a. Data collected using the STEM Semantics Survey from graduates of your high school indicate that engineering is viewed the second least favorably overall among science, technology, engineering, and math. Why do you believe this to be the case?

24b. Do you believe that being from a rural area has any impact on this result?

25. When comparing the results of the STEM Semantics Survey which was given to last year's high school seniors from your high school and to current college students from your high school, it was found that male and female college students both rated math and science less favorably than the high school students. To what do you attribute this?

26. When comparing the results of the STEM Semantics Survey which was given to last year's high school seniors from your high school and to current college students from your high school, it was found that female college students rated engineering more favorably than the high school students. To what do you attribute this?

27. When comparing the results of the STEM Semantics Survey which was given to last year's high school seniors from your high school and to current college students from your high school, it was found that male college students rated engineering less favorably than the male high school students. To what do you attribute this?

28. When comparing the results of the STEM Semantics Survey which was given to last year's high school seniors from your high school and to current college students from your high school, it was found that the high school males rated science more favorably than females but the opposite is true for the college students. To what do you attribute this?

29. Do you believe your perceptions of science have improved, worsened, or remained the same since high school? Explain why you answered as you did.

30. When comparing the results of the STEM Semantics Survey which was given to last year's high school seniors from your high school and to current college students from your high school, it was found that high school males rated perceptions of STEM careers more favorably than females, but the opposite is true for the college students. To what do you attribute this?

31. Do you believe your perceptions of STEM careers have improved, worsened, or remained the same since high school? Explain why you answered as you did.

32. When comparing the results of the STEM Semantics Survey which was given to last year's high school seniors from your high school and to current college students from your high school, it was found that while males viewed engineering more favorably than females for both the high school group and for the college group, the mean difference in the male and female perceptions for college students was half that of the high school students. To what do you attribute this?

33. Do you believe your perceptions of engineering have improved, worsened, or remained the same since high school? Explain why you answered as you did.

34. Do you believe your perceptions of STEM in general have improved, worsened, or remained the same since high school? Explain why you answered as you did.

35a. How well do you believe your high school exposed you to STEM concepts and STEM fields as a career option?

35b. What suggestions do you have (if any) for ways your high school could improve in this regard?

36a. How well do you believe your college has exposed you to STEM concepts and STEM fields as a career option?

36b. What suggestions do you have (if any) for ways your college could improve in this regard?