# STEM development: A study of $6^{th}$-$12^{th}$ grade girls' interest and confidence in mathematics and science

by

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# DEDICATION

*This dissertation is dedicated to my family whose unconditional love and support have given me strength on this journey. Your wisdom and passion for life inspire me.*

*Nancy Heaverlo and Earl Iben*

*The Cavanaughs: Karen, Craig, Ian, Dylan, & Nolan*

*The Heaverlos: Craig, David, & Kristen*

*Chris Heaverlo*

*The Ridenours: Cherie, Brian, Courtney, & Brennia*

*And to Robyn Cooper for her unwavering love and support: to you I am forever grateful*

*In memory of my dad: Vernon Charles Heaverlo who remains with me always in spirit*

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## ABSTRACT

Researchers, policymakers, business, and industry have indicated that the United States will experience a shortage of professionals in the Science, Technology, Engineering, and Mathematics (STEM) fields. Several strategies have been suggested to address this shortage, one of which includes increasing the representation of girls and women in the STEM fields. In order to increase the representation of women in the STEM fields, it is important to understand the developmental factors that impact girls' interest and confidence in STEM academics and extracurricular programs. Research indicates that greater confidence leads to greater interest and vice versa (Denissen et al., 2007). This study identifies factors that impact girls' interest and confidence in mathematics and science, defined as girls' STEM development. Using Bronfenbrenner's (2005) bioecological model of human development, several factors were hypothesized as having an impact on girls' STEM development; specifically, the macrosystems of region of residence and race/ethnicity, and the microsystems of extracurricular STEM activities, family STEM influence, and math/science teacher influence. Hierarchical regression analysis results indicated that extracurricular STEM involvement and math teacher influence were statistically significant predictors for 6-12$^{th}$ grade girls' interest and confidence in mathematics. Furthermore, hierarchical regression analysis results indicated that the only significant predictor for 6-12$^{th}$ grade girls' interest and confidence in science was science teacher influence. This study provides new knowledge about the factors that impact girls' STEM development. Results can be used to inform and guide

educators, administrators, and policy makers in developing programs and policy that support and encourage the STEM development of 6-12th grade girls.

# CHAPTER 1

# INTRODUCTION

*"College majors are not found in blue and pink aisles, but some might as well be. Forty years ago, 75 percent of students studying to be elementary teachers were female. Today, 90 percent are female. Teaching is getting pinker. Only one in five engineers is female, two-thirds of physics majors are male, and a lower percentage of females are studying computer science today than a decade ago. These are the blue majors. Even when women break free of gender stereotypes, as they have in many math and science courses, too few actually find careers in science or math." (p. 2)*
*Sadker, Sadker, and Zittleman*
*Still Failing at Fairness (2009)*

For the last 50 years, many would say that the United States has been the world leader in science and technology providing its comparative advantage in the global economy. The United States has only 5% of the world's population yet employs one-third of the scientific and engineering researchers (Freeman, 2005). Students from across the globe flock to U.S. institutions to build their educational framework and collaborate with American researchers (Freeman).

Researchers, policymakers, business, and industry have indicated that the United States will experience a shortage of engineers as a result of retirements and a stagnant number of students entering postsecondary engineering programs, graduating with engineering degrees, and entering the workforce. The extent of the engineering shortage is disputed; however, it is clear that the share of scientists and engineers in the United States is decreasing rapidly (Freeman, 2005). Science, Technology, Engineering, and Mathematics (STEM) fields play a critical role in shaping our culture through innovation, creation, and problem solving. If the United States is to remain globally competitive it must improve technological literacy in the K-12 classroom and commit to a critical initiative of equitable education ensuring that all students develop the knowledge and skills to fully participate in society.

In 2005, a committee representing the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine was convened to examine the state of education, the workforce, the economy, and the global competitiveness of the United States and described their findings in an extensive report entitled *"Rising Above the Gathering Storm."* The report was drafted in response to a congressional request to create a list of the top 10 priority actions that federal policymakers could initiate to increase economic vitality, ensure prosperity, and improve the global competitiveness of the United States. Many of the recommendations in the original report were directly related to science and engineering (e.g., 10,000 Teachers, 10 Million Minds: Increase America's talent pool by vastly improving K–12 science and mathematics education.

Five years later, the committee from the National Academies was reconvened to examine the nation's progress on the recommendations from the 2005 report. Their assessment resulted in the recent publication, *Rising Above the Gathering Storm Revisited: Rapidly Approaching Category 5* (2010). Comments in regard to K-12 education made by the committee suggested that despite some valiant educational efforts during the previous five years, the public school system (14,000 systems) has improved very little, particularly in the areas of math and science. The report lists numerous facts that support their evaluation including:

- Sixty-nine percent of the U.S. public school students in fifth through eighth grade are taught mathematics by a teacher without a certificate in mathematics.
- Ninety-three percent of the U.S. public school students in fifth through eighth grade are taught the physical sciences by a teacher without a degree or certificate in the physical sciences.
- According to the ACT College Readiness report, 78 percent of high school graduates did not meet the readiness benchmark levels for one or more entry-level college courses in mathematics, science, reading, and English.
- The United States ranks 20$^{th}$ in high school completion rate among industrialized nations and 16$^{th}$ in college completion rate.
- The United States ranks 27$^{th}$ among developed nations in the proportion of college students receiving undergraduate degrees in science or engineering.
- Almost one-third of U.S. manufacturing companies responding to a recent survey say they are suffering from some level of skills shortages.

(National Academies, 2010, p. 7-11).

According to Bottoms and Uhn (2007), employers are looking for candidates who possess strong science, technology, engineering, and math backgrounds. As a result, schools are charged with ensuring that students are prepared for careers in STEM fields by providing rigorous math, science, and technology courses using experiential methodologies. Jeffers, Safferman, and Safferman (2004) note, “children lose interest in science and math when they do not see the connection to the real world around them” (p.

96). If the demand for engineers is accurate and the success of the global economy is critical, then it will be essential to engage underrepresented populations in the educational process to increase the number of women and ethnic minorities pursuing and persisting to a degree in STEM. The creations and advancements that emerge from science and engineering will drive the future economy and will result in the creation of jobs (*Gathering Storm, Revisited,* 2011).

"Scientists are made not born" (Burke & Mattis, 2007, p. 4) and the literature reveals numerous obstacles that girls encounter that influences that process while impacting their interest in science and mathematics education. Sadker, Sadker, and Zittleman (2009) suggested that the barriers girls encounter in their pursuit of STEM education and careers often begin early on in their academic experiences. Girls receive less encouragement at home and in the classroom than do boys who indicate an interest in STEM, there is a lack of female STEM role models, fewer STEM extra-curricular activities, societal gender role stereotypes, and a computing culture that supports male competence (AAUW, 2010; Andre, Whigham, Henderson, & Chambers, 1999; Herbert & Stipek, 2005; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Simpkins & Davis-Kean 2005). As a result, girls are beginning to opt out of science and mathematics courses in $6^{th}$-$8^{th}$ grades (Burke & Mattis, 2007).

According to the Iowa Department of Education, there were 510,916 students attending public and non-public schools during the 2008-2009 academic year in Iowa – a seven percent reduction from the previous year (Iowa Condition of Education Report, 2009). While this constitutes the $11^{th}$ consecutive year the state has experienced an overall decrease in enrollment, the percentage of minority (i.e., African American, Latino/a, etc.) students continues to rise. In 2009, the K-12 minority student population comprised 14.9% of the overall student population, an increase from 8.2% in the year 2000 (Iowa Condition of Education Report, 2000).

In Iowa, higher-level math courses include pre-calculus, calculus, trigonometry, statistics, and advanced placement mathematics. The Iowa Condition of Education Report (2009) indicated that 13,178 students enrolled in at least one higher-level math course with a greater percentage of female students (41.5%) enrolling than male students (38.4%). More females than males took chemistry (69.8% vs. 58.4%), however, there was a greater percentage of males who took physics (28.3% vs. 22.2%) than did the females. School districts with enrollments greater than 1,000 had the largest percentage of students taking higher-level math courses. Percentages of students taking chemistry and physics were highest in districts with enrollments larger than 2500 students (Iowa Condition of Education Report, 2009).

In 2008-2009, 81.2% of the graduating seniors in Iowa intended to pursue a postsecondary education. Of the graduating female students, 85.6% indicated that they were going to enroll at a postsecondary institution in comparison to 76.8% of the males (Iowa Condition of Education Report, 2009).

In order to address the under-representation of women in science and engineering, the Program for Women in Science and Engineering (PWSE) was established in 1986 at Iowa State University (ISU). The program is a centrally administrated academic program, reporting to the Office of the Executive Vice President and Provost. The mission of PWSE is to:

- *Create programs, share knowledge, and engage people to enhance the STEM educational experience for women.*
- *Create, offer, and maintain innovative undergraduate and outreach programs that engage a diverse audience of women and girls in an experiential and supportive learning environment in STEM.*
- *Share knowledge on innovative strategies, best practices, and research on the success of women in STEM with a broad range of individuals and organizations serving as partners in transforming the STEM educational experience for women.*
- *Engage a broader, more diverse group of women pursuing STEM careers.*

There are two areas of programmatic concentration within PWSE at ISU. One programmatic concentration focuses on outreach at the K-12 level. PWSE collaborates with programs across the state to offer experiential activities to stimulate the interest in STEM fields among Iowa youth. PWSE has two signature outreach programs that connect with over 9,000 K-12 students per year. The *Taking the Road Less Traveled Career Conference for $6^{th}$-$12^{th}$ Grade Girls* has reached nearly 52,000 girls, teachers, administrators, parents, and counselors since the first conference was offered back in 1987. There are currently six conferences offered per year and the format includes career information sessions typically led by professional women working in science, engineering, and other technical fields; hands-on activity sessions; tours of ISU labs and facilities; and special sessions for parents and educators. Another significant outreach program is *The Student Role Model Program*. The goal of this program is to generate interest and excite K-12 grade students about science and engineering through their involvement in hands-on activities and career discussions facilitated by undergraduate student role models. Student role models who are pursuing a degree in STEM visit classrooms, community organizations, and after school/summer programs throughout the state.

The second area of concentration for the Program for Women in Science and Engineering is the undergraduate program. PWSE supports undergraduate women in 62 STEM majors in four academic colleges: College of Agriculture and Life Sciences, College of Engineering, College of Human Sciences, and the College of Liberal Arts and Sciences. A few of the programs for undergraduate women include first and second year learning communities, transfer student learning community, leadership development, professional job shadow and networking opportunities. The primary purpose for the PWSE undergraduate programming is to increase the recruitment and retention of women in STEM majors.

## Statement of the Problem

It is well documented in the literature that if the United States is to remain globally competitive, it must increase the number of professionals entering the science and engineering pipeline (Bottoms & Uhn, 2007; Freeman, 2005; Jeffers et al., 2004; Sanoff, 2001). In order to address the shortfall of science and engineering professionals, efforts must be made to engage underrepresented populations specifically women and ethnic minorities. Workforce projections for 2018 by the U.S. Department of Labor indicated that nine of the 10 fastest growing occupations will require substantial science or mathematics education (National Science Board, 2010).

Research has shown that the gender gap in middle and high school math and science test scores and achievement are no longer statistically significant (AAUW, 2008; AAUW, 2010; COE, 2009; NCES, 2007) and while girls are performing as well as boys in math and science, there is a distinct loss in interest and lack of confidence in STEM areas that begin early on in their academic experience (AAUW, 1999; Fennema &

Sherman, 1978; James & Smith, 1985; White, 1992). During the last 20 years a great deal of research has focused on gender differences in science and mathematics. However, there is a lack of research specifically on 6$^{th}$-12$^{th}$ grade girls who have participated in the Taking the Road Less Traveled Career Conference to examine the factors that influence interest and confidence in science and mathematics. In addition, there is a void in the literature that has explicitly utilized Bronfennbrenner's (2005) bioecological theory of human development to investigate the factors at the microsystem and macrosystem levels that influence the math interest and math confidence and science interest and science confidence of 6$^{th}$-12 grade girls.

## Purpose

The purpose of this study was to understand the experiences that influence 6$^{th}$-12$^{th}$ grade girls' STEM development in Iowa by analyzing data from Iowa State University's Program for Women in Science and Engineering 2008-2009 Outreach Needs Assessment. Using Bronfenbrenner's (2005) bioecological model as a conceptual framework, this study explored the impact of specific environmental influences (e.g., family STEM influence, region of residence) on 6$^{th}$-12 grade girls' interest and confidence in science and mathematics. Understanding the factors that influence girls' interest and confidence in science and mathematics will inform strategies that may potentially increase participation in these areas for this population.

## Research Questions

The following research questions guided this study.

1. What are the background characteristics of the 6$^{th}$-12$^{th}$ grade girls who attended the spring 2009 *Taking the Road Less Traveled Career Conference?*

2. Is there a statistically significant difference between middle school girls' ($6^{th}$-$8^{th}$ grade) and high school girls' ($9^{th}$-$12^{th}$ grade) a) interest in math, b) interest in science, c) confidence in math, and d) confidence in science?
3. To what extent do race/ethnicity, region of residence, family STEM influence, extracurricular STEM activities, and math teacher influence predict *math interest* for middle school ($6^{th}$-$8^{th}$ grade) and high school girls ($9^{th}$-$12^{th}$ grade)?
4. To what extent do race/ethnicity, region of residence, family STEM influence, extracurricular STEM activities, and science teacher influence predict *science interest* for middle school ($6^{th}$-$8^{th}$ grade) and high school girls ($9^{th}$-$12^{th}$ grade)?
5. To what extent do race/ethnicity, region of residence, family STEM influence, STEM extracurricular STEM activities, and math teacher influence predict *math confidence* for middle school ($6^{th}$-$8^{th}$ grade) and high school girls ($9^{th}$-$12^{th}$ grade)?
6. To what extent do race/ethnicity, region of residence, family STEM influence, extracurricular STEM activities, and science teacher influence predict *science confidence* for middle school ($6^{th}$-$8^{th}$ grade) and high school girls ($9^{th}$-$12^{th}$ grade)?

## Theoretical Framework

This study was informed by Bronfenbrenner's (2005) bioecological theory of human development. Bronfenbrenner's theory provides a systemic, holistic view of the impact of specific contexts/environments that middle and high school (grades 6-12) girls interact in on a daily basis that may or may not impact STEM development. STEM development was defined in this study by the level of interest and confidence participants indicated in math and science.

Bronfenbrenner's (2005) model is a bioecological paradigm comprised of five evolving "systems" he classified as microsystem, mesosystem, exosystem, macrosystem, and the interactions between the individual and her or his environment over time (chronosystem). The classification of the five "nested" systems progresses from the layer or level closest to the individual to the outermost layer. Changes that occur in any one system will reverberate throughout each of the other layers. Bronfenbrenner (2005) defined the bioecological theory of human development as:

> the scientific study of the progressive, mutual accommodation, throughout the life course, between an active, growing human being and the changing properties of the immediate settings in which the developing person lives, as this process is affected by the relations between these settings, and by the larger contexts in which the settings are embedded. (p. 107)

Bronfenbrenner's theory emerged from Kurt Lewin's (1935) classical formula for human development:

B = f(PE) [Behavior is a joint function of person and environment]

What was missing from Lewin's model Bronfenbrenner suggested was the consideration for changes in an individual's biopsychosocial characteristics that occur over the life course. In order to accommodate for the changes, Bronfenbrenner replaced the "behavior" in Lewin's equation with the concept of "development" [Development = is a joint function of person and environment]. In this reformulation, Bronfenbrenner (2005) stated that "it was not the phenomenon of development that was the focus, but its outcome at a particular point in time" (p. 108). With that in mind, Bronfenbrenner's paradigm aligns quite well with this study as it provides a conceptual framework that looks at the potential factors impacting $6^{th}$-$12^{th}$ grade girls and their STEM development.

Figure 1.1 provides an illustration of the adaptation of Bronfenbrenner's (2005) bioecological model of human development using the variables identified in this study. Following figure 1.1 is a brief narrative explaining each system and how Bronfenbrenner's bioecological model provides a conceptual framework for this study.

**Microsystem**

The microsystem as defined by Bronfenbrenner is:

> a pattern of activities, roles, and interpersonal relations experienced by the developing person in a given face-to-face setting with particular physical and material features and containing other persons with distinctive characteristics of temperament, personality, and systems belief. (p. 148)

Bronfenbrenner (2005) suggested that systems at the micro level may include for example the developing person's home, school, or playground. For purposes of this study, microsystems for a $6^{th}$-$12^{th}$ grade girls' STEM development include family STEM influence, math and science teacher influence, and extracurricular STEM activities.

**Mesosystem**

A mesosystem includes the associations and processes that are occurring between two or more settings (microsystems) containing the developing individual (Bronfenbrenner, 2005). An example illustrating a mesosystem relevant to this investigation would be the interaction between the two microsystems of *parental STEM influence* and *math or science teacher influence*. Within the mesosystem, the connection

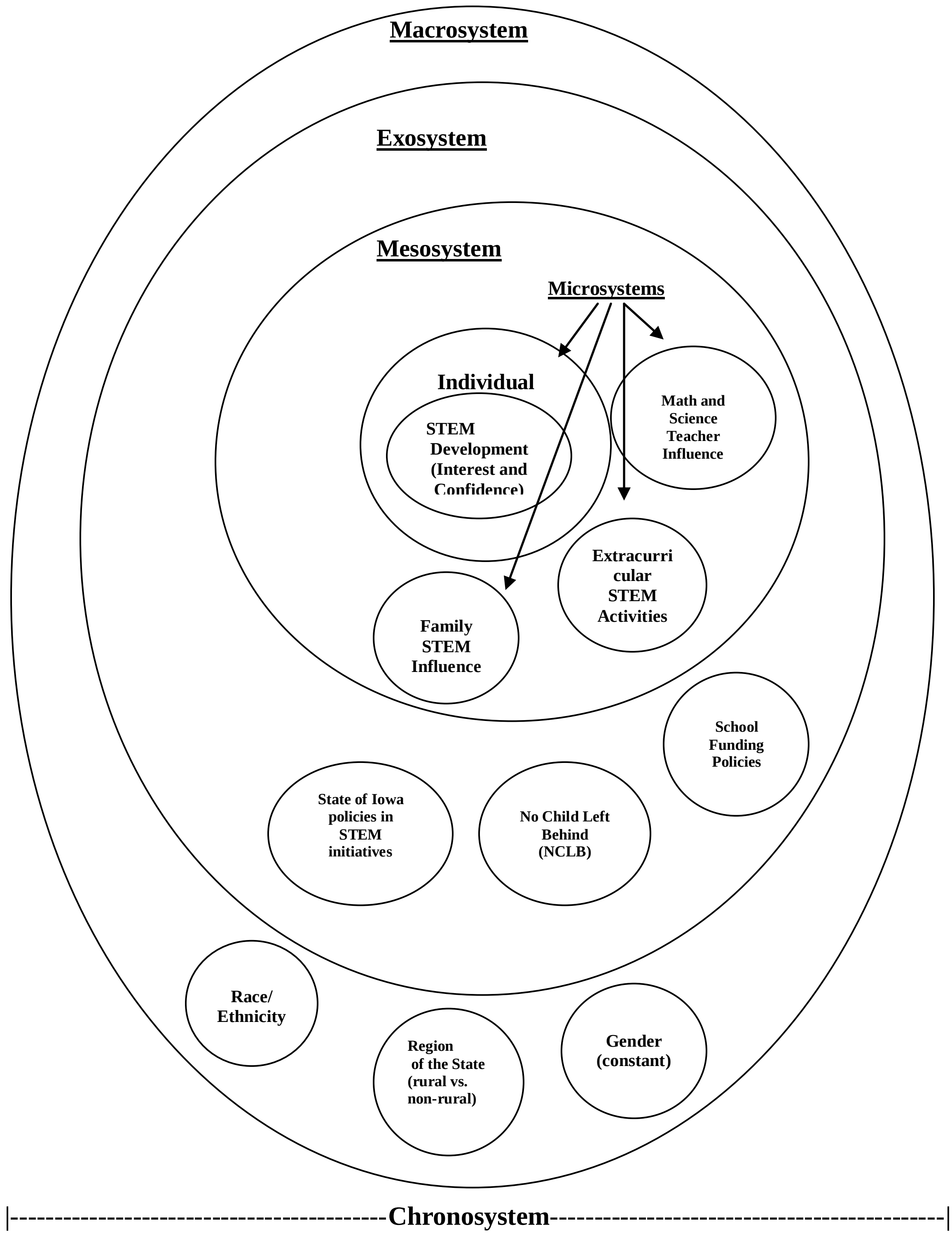


Figure 1.1 Girls' Interest and Confidence in Mathematics and Science – Adaptation of Bronfenbrenner's (2005) Bioecological Model

between microsystems can have a positive or negative effect on influencing an individual's STEM development.

**Exosystem**

The third layer of bioecological model is the exosystem in which the developing individual does not actively participate, but is influenced by the events and processes that occur between settings in the system. Bronfenbrenner (2005) explained that for a child, the influences might evolve from the relationship between the parent and the parent's workplace; for a parent, the linkages between the school and neighborhood group. In this study, potential relationships in the exosystem that may impact the STEM development of $6^{th}$-$12^{th}$ grade girls could include the state of Iowa's STEM initiatives funding and the school district's budget and funding policies.

**Macrosystem**

Bronfenbrenner (2005) defined the macrosystem as encompassing:

> the overarching pattern of micro-, meso-, and exosystems characteristic of a given culture, subculture, or other broader social context, with particular reference to the developmentally instigative belief systems, resources, hazards, lifestyles, opportunity structures, life course options, and patterns of social interchange that are embedded in each of these systems. The macrosystem may be thought of as a societal blueprint for a particular culture, subculture, or other broader social context. (pp. 149-150)

Bronfenbrenner further explained macrosystems as belief systems, social conduct, and economic resources that are passed on from generation to generation. Examples of macrosystems provided by Bronfenbrenner (2005) include social class, ethnicity, and region of residence (rural vs. urban). In this study, the macrosystem includes race/ethnicity, region of residence (rural vs. non-rural), and gender as variables used to assess the effects of the macrosystem on the individual's STEM development. However, the impact of gender is not measured in this study since all participants are females. Future studies in this line of inquiry could include similar frameworks with comparisons between males and females.

**Chronosystem**

The chronosystem is the final system in the bioecological model included by Bronfenbrenner to measure the temporal changes within an individual's environment. Bronfenbrenner described the chronosystem as:

> The individual's own developmental life course is seen embedded in and powerfully shaped by conditions and events occurring during the historical period through which the person lives. A major factor influencing the course and outcome of the human development is the timing of biological and social transitions as they relate to the culturally defined age, role expectations, and opportunities occurring throughout the life course. (p. 641).

The design in this study is cross-sectional rather than longitudinal therefore the influences of the chronosystem are not measured. There is potential to continue data collection and measure the chronosystem effect in a longitudinal study post-dissertation research.

## Significance of the Study

Bronfenbrenner (2005) stated that research designed to understand human development is essential for two purposes: "1) to understand the nature, strengths, and weaknesses of existing structures and strategies of socialization, and 2) far more importantly, to modify these forms and practices in ways that will enhance cognitive developmental processes" (p. 48).

This study is significant because it identifies factors that influence $6^{th}$-$12^{th}$ grade girls' interest and confidence in math and science. Identifying these factors increases our understanding of the STEM developmental experiences for $6^{th}$-$12^{th}$ grade girls in Iowa and in turn understanding their STEM developmental experiences as these experiences relate to interests and confidence in math and science helps to guide educational STEM practices and future opportunities.

This study will inform future STEM educational outreach activities initiated by programs like the Program for Women in Science and Engineering at ISU that are directed toward increasing the number of women and minorities into the fields of science, technology, engineering, and mathematics.

Also significant is the opportunity to impact professional development for in-service and pre-service teachers to include training on understanding the factors that influence interest and confidence and employing strategies that enhance and support girls' interest and confidence in science and mathematics.

## Definitions of Key Terms and Acronyms

This section provides definitions for key terms and acronyms used in this study.

**Confidence** – Anticipating a successful outcome (Pajares, 2006).

**Family STEM Influence –** For the purpose of this study, defined as at least one parent in a STEM career.

**Human development** – The process of progressively more complex reciprocal interaction between an active, evolving biopsychosocial human organism and the persons, objects, and symbols in its immediate external environment.

**Interest** – Relatively stable individual preferences (Hidi, 1990).

**PWSE** – Program for Women in Science and Engineering.

**STEM** – Science, Technology, Engineering, and Mathematics. In this dissertation, "STEM", "science, technology, engineering, and mathematics," and "scientific and engineering fields" are used interchangeably.

**STEM Development –** For the purpose of this dissertation, defined as interest and confidence in mathematics and science.

**TRLT –** Taking the Road Less Traveled Career Conferences for $6^{th}$-$12^{th}$ grade girls.

## Summary

This study seeks to inform educators, administrators, policy makers, and parents by identifying environments in the meso- and macrosystems that impact $6^{th}$-$12^{th}$ grade girls' interest and confidence in math and science. Specifically, building upon previous research this study introduces the concept of STEM development and attempts to increase understanding of factors that predict middle school and high school girls' interest and confidence in math and science (referred to as STEM development in this study). Identification of the influence of these environments on STEM development will increase awareness and serve to inform educators and policy makers in STEM development opportunities.

Chapter 2 provides a summary of the research that provided the theoretical framework for the regression models that informed this study.

Chapter 3 describes the quantitative methodology used in this study, philosophical assumptions, theoretical model and relationship to the variables in the study, sample and participant demographics, variables and instrumentation, data analyses, delimitations, and limitations.

Chapter 4 includes the results of the data analyses. Specifically, discussed are the results of the descriptive analyses, screening of data, independent samples *t*-tests, correlations, and regression results.

Chapter 5 summarizes the research and provides a discussion and conclusion based on the results addressed in chapter 4. Recommendations are made to inform policy and suggestions for future research are presented.

# CHAPTER 2

# LITERATURE REVIEW

*"By the age of 12, children have already formed firm beliefs about the subjects at which they excel and those at which they fail." (p. 7)*
*R. J. Burke*
*Women and Minorities in Science, Technology,*
*Engineering, and Mathematic: Upping the Numbers (2007)*

When proposing and testing Bronfenbrenner's conceptual model of human development as introduced in this study, it is essential to outline a solid theoretical base for the hypothesized regression models and connections between and amongst variables. This chapter includes an historical perspective of girls in STEM in addition to a rationale for each variable incorporated in the hypothesized regression models with concentration on the microsystems and macrosystem identified in chapter 1.

The review of the literature is divided into eight sections beginning with the historical perspective, local context, and followed by a review of independent factors influencing girls' interest and confidence in science and mathematics including the math and science teacher influence, involvement in Extracurricular STEM activities, family STEM influences, and region of residence.

Much of the previous quantitative research has focused on either secondary data analysis or the use of survey instrumentation (e.g., Bruyere, Billingsley, & O'Day, 2009; Else-Quest, Hyde, & Linn, 2010; Gilmartic & Aschbacher, 2006). According to Clewell and Campbell (2002), the theories used to trace the trajectory and progress of women in STEM fall into four main categories: "testing-based theories, biologically-based theories, social-psychological theories, and cognitive theories" (p. 255). Role-model theory has also emerged as a significant framework in which a girl's STEM development has been discussed (Gilmartin, Denson, Li, Bryant, & Aschbacher, 2007; MacDonald, 2000; Wallace & Haines, 2004; Zirkel, 2002). However, little is known about how aspects of these life segments combined in the day-to-day lives of middle and high school girls affect their interest and confidence in science and mathematics in particular. This study is unique in that it is informed by Bronfenbrenner's bioecological theory of human development which provides a systemic, holistic view of the impact of specific contexts/environments that middle and high school (grades 6-12) girls interact in on a daily basis that may impact their STEM development.

## An Historical Perspective

*"Here's how my 1960s high school chemistry class was taught: Boys were seated by the male teacher on the side of the room with the teacher's desk. Girls were seated on the far side of the room. Girls were told to be quiet and not cause trouble and they would not fail the class. When "dangerous" experiments were conducted, the boys went into the lab while the girls watched through the window" (p. 49).*
*Sadker, Sadker, and Zittleman*
*Still Failing at Fairness (2009)*

A lack of female representation in STEM fields is not a new dilemma in the United States. According to the American Association of University Women (AAUW) (2010), in the 1960s women made up a mere 1% of the engineers and 27% of the biologists. Forty years later, in 2000, 11% of the engineers were female and 44% were biologists. Although the percent of females employed in social science careers has almost reached parity, women still represent a very small percentage of those employed in the physical science careers including engineers, physicists, and chemistry fields (AAUW).

Explanations for underrepresentation by women in STEM fields have evolved over time. Early 20th century speculation by researchers suggested that less intelligence, creativity, and scientific ability evidenced by women, and mathematical superiority exemplified by males could be explained by genetic differences between the two genders (Benbow & Stanley, 1980; Cole, 1979; Graybill, 1975).

In 1995, Gerhard Sonnert proposed two models to explain the lack of female presence in the sciences. The Deficit Model posited that there were structural barriers in place at the system level (legal, political, and social) presenting women with fewer opportunities to advance professionally. Sonnert (1995) explained that the costs of a career in science outweighed the benefits for women due to access issues in higher education and inhibited research opportunities that restricted future career opportunities. The second model offered by Sonnert was the Difference Model suggesting that the explanation lies in the "deep-rooted" differences in outlook and goals between men and women. Sonnert further suggested that the challenges in professional achievement encountered by women are either innate or the result of gender-role socialization.

In 2000, the Commission on the Advancement of Women and Minorities in Science, Engineering, and Technology (CAWMSET) released their findings on the U.S. science, engineering, and technology (SET) labor force. Recognizing the omission of underrepresented populations, the commission called for a drastic change so the SET workforce more accurately represented the U.S. population and was inclusive of women, ethnic minorities, and persons with disabilities. As jobs requiring skills in science, technology, engineering, and mathematics continued to increase, the commission urged a nationwide call to action to increase the number of students in the STEM pipeline beginning at the elementary and middle school levels (AAUW, 2010).

Despite this call to action, young girls and women are still confronted with obstacles on their pathway to education and careers in STEM. From a lack of female role models and mentors, engrained societal gender stereotypes reinforced by friends, family, and community, lack of confidence due to internal feelings of inadequacy (Imposter Syndrome), to differential teaching practices in the classroom (Besecke & Reilly, 2006; Buck, Plano Clark, Leslie-Pelecky, Lu, & Cerda-Lizarraga, 2008; Buck, Leslie-Pelecky, & Kirby, 2002; Cleaves, 2005), there is no single or simple solution to this complex challenge. Whether it is a look into the past or contemplating the future, scientific exploration and technological innovation are deeply connected to the economic sustainability of the United States. Advancement in STEM is essential for national security, economic growth, health, and stability of the nation and this country's citizens (Burke & Mattis, 2007). The education system in the United States must begin to produce a larger and more diverse group of exceptional scientists and engineers in order to remain globally competitive (Clewell et al., 1992). Margolis and Fisher (2002) emphasized that the way to ensure competitiveness and maximize creativity and innovation in the STEM workforce is to attract and retain women.

## Local Context

Centrally located in America's upper Midwest, Iowa covers 55,896 square miles and is home to 3,007,856 people (U.S. Census Bureau, 2009). In 2008-2009, 510,916 students attended one of 362 public or 183 non-public K-12 school districts (Iowa Condition of Education Report, 2009). Iowa's post secondary institutions including 15 community colleges, 29 private, and three public institutions served 286, 891 students in which 60% enrolled were female (National Center for Education Statistics, 2008).

Agricultural business and industry has always been essential to the economy in Iowa whether it is crop production, food animal production, or helping to feed the world. In addition, the state of Iowa has become a national leader in the production of renewable energy. Iowa ranks first in the nation in the production of ethanol (Renewable Fuels Association, 2007), second in the production of biodiesel (Biodiesel Board, 2007) and third overall in wind energy capacity (Wind Energy Association, 2007). The state of Iowa leads the nation in terms of percentage of electricity from wind power, generating 14% of the state's power from the wind (U.S. Wind Industry Annual Market Report, AWEA, 2009).

According to the Iowa department of Economic Development, (accessed iowalifechanging.com) the innovation and development of this billion dollar industry has emerged from the scholars of Iowa's post-secondary institutions. For example, seven of the state's community colleges have partnered with Iowa State University, The University of Northern Iowa, and The University of Iowa to develop comprehensive wind energy training programs. In 2008, 40% of all students enrolled in STEM at the three public institutions were women. A modest increase from 2000 where women represented 37% of students enrolled in STEM.

The opportunities in STEM fields within the state continue to grow and support not only the economy in Iowa but play an integral role in national self-sustainability as well. The educational talent pool in Iowa is rich and diverse. It is evidenced by the expanding biofuels industry that there is a need to generate growth in the STEM pipeline by creating interest, developing confidence, and creating an awareness of the opportunities in those academic and professional fields.

## Microsystems for 6th-12th Grade Girls' STEM Development

In his theoretical model of human development, Bronfenbrenner (2005) described the microsystem as experiences and events that an individual encounters in a specific face-to-face environment with other persons having distinctive characteristics and belief systems present. The microsystems included in this study are the classroom environment (identified by math/science teacher influence), family STEM influence, and extracurricular STEM activities. Also examined is the extent to which these microsystems influence the STEM development of 6th-12th grade girls. Specifically, how these environments impact their interest and confidence in science and mathematics.

In the following subsections, the literature relating to middle and high school girls' interest and confidence in science and mathematics is reviewed in addition to the microsystems and the representing variables of classroom environment, family STEM influence, and extracurricular STEM activities.

### Interest in Mathematics and Science

*"A complex process that goes beyond intellectual preference for a body of knowledge."*
*Margolis & Fisher, 2002*

How students perceive their environments and the conceptual framework that is created from those experiences influences a student's interest and confidence in relation to that event or experience (Bronfenbrenner, 2005).

According to the report *Why so Few* released in 2010 by the American Association for University Women (AAUW), girls' interest and achievement in science, technology, engineering, and mathematics is affected by historical and invalid stereotypes that impact a girl's perception of their ability to perform well in those academic areas. There are two stereotypes that are prevalent in the literature: boys are better at math and science than girls and science and engineering careers are better suited for males (AAUW, 2010; Andre et al., 1999; Herbert & Stipek, 2005; Jacobs et al., 2002; Simpkins & Davis-Kean, 2005). Even subtle suggestions of gender stereotyping at home or in the classroom adversely affect a girl's confidence and therefore interest in considering or pursuing a career in STEM.

Parents and educators play a critical role in consciously alleviating gender stereotypes. Pajares (2006) suggested that interest and confidence are impacted by one's belief in their ability to do well on a specific task. Pajares also noted that many girls' are interested in mathematics and science, however in order for them to choose a trajectory toward a STEM career, it is essential for parents and educators to develop and reinforce belief in their ability to perform well.

**Confidence in Mathematics and Science**

*"Teachers cannot teach science until they understand and acknowledge who they are teaching science to. Subject-matter knowledge is essential but not sufficient for success in the classroom."(p.48)*
*R.H. Milner*
*Start Where You Are, But Don't Stay There (2010)*

Girls and boys begin to form opinions about their abilities as early as elementary school, and as they progress from sixth through twelfth grade and math becomes more challenging, students report receiving less support from their parents, teachers, and peers (Eccles, Wigfield, Harold, & Blumenfeld, 1993; Jones, How, & Rua, 2000). Both boys and girls appear to be equally motivated to do well academically, girls however, seem less confident that their endeavors will be successful (Huang & Brainard, 2001; Lantz & Smith, 1981). The gender gap in self-confidence begins to widen during high school when boys indicate higher levels of self-confidence and girls report higher levels of anxiety and lower levels of confidence about their abilities in science and mathematics courses. As student's beliefs that mathematics courses increase in difficulty, so too does their level of anxiety about their ability to do well (Beilock, Gunderson, Ramirez, & Levine, 2010; Fredericks & Eccles, 2002; Hyde, Fennema, Ryan, Frost, & Hopp 1990; McGraw, Lubienski, & Strutchens, 2006; Pajares & Miller, 1994).

A great deal of research has shown that lack of self confidence in one's ability to do mathematics is detrimental to the continuation of math studies (AAUW, 1998; Burke & Mattis, 2007; Fenema, 2000; Hannula & Malmivouri, 1996; Linn & Hyde, 1989; Sherman, 1982). Because the level of self-confidence a student has in high school is the strongest predictor for girls choosing to pursuit a STEM degree program in college, (Ethington 1998; Huang & Brainard, 2001), it is imperative that STEM outreach initiatives are introduced at the middle school level (Clewell, 2002).

Girls in particular have continued to experience low levels of confidence and this does not appear to have improved over the last 20 years (Burke & Mattis, 2007).

**Classroom Environment – Teacher Influence**

The K-12 classroom sets the educational foundation for the pathway to a STEM career. Exposure to hands-on activities and opportunities in science, technology, engineering and mathematics early on in a girl's academic experience is critical for cultivating interest in STEM (Baine, 2008). How a girl perceives those experiential opportunities is of equal importance. Boys more than girls tend to benefit from greater interaction with teachers whether it is positive reinforcement or negative attention due to behavioral issues (Jones Howe, & Rua, 2000). It is also suggested that boys have more opportunities in and out of the classroom to participate in activities that involve scientific tools and instruments which may lead to an increase in their confidence and ability to solve scientific problems (Jones, Howe, & Rua).

Gains in the last three decades in terms of girls' achievement in mathematics and science education demonstrate how critical learning environments are in encouraging abilities and interests (AAUW, 2010; NCES, 2000). According to Huang and Brainard (2001), the attention of researchers has increasingly turned to the affects that institutional climate has on a student's interest and confidence in science and mathematics abilities. They suggested that in addition to the affect that performance and experience has on self-confidence, the quality of teaching also plays a significant role in confidence levels.

It is well documented in the literature that girls have received less instructional time in the classroom, less help, and fewer challenges resulting in a lack of engagement, lower self-confidence, performance, and persistence in STEM courses (Burke & Mattis, 2007; Colbeck, Cabrera, & Terenzinin, 2001; Klein, 2004; Morozov, Kilgore, Yasuhara, & Atman, 2008; Sadker et al., 2009). During one particular professional development opportunity described by Sadker et al. teachers were stunned to look back at classroom videotapes and see themselves teaching subtle gender lessons. Sadker et al. reported observing hundreds of classrooms in which male students regularly monopolized classroom conversations, asked and answered more questions, received more praise, received help when perplexed, and were censured more sharply when they didn't follow rules. While usually unintentional, the micro-inequities that occur in the classroom and are not addressed continue to reinforce girls' as spectators in the classroom rather than engaged participants (Sadker et al.).

In their study on gender differences specifically in mathematics, Else-Quest, Linn, and Hyde (2010) found that girls will perform at the same level as boys in the classroom when there is representation from positive female role-models, they receive encouragement and the educational tools necessary to succeed.

**Extracurricular STEM Activities**

Extracurricular activities are an essential component of gender equity intercession according to the AAUW report Under the Microscope (2004). Many out of school activities (e.g., science and math clubs, 4-H, Mindstorm), provide girls with experiential learning and investigative opportunities in academic areas that are not part of the regular school day, but play an integral role in shaping interest and confidence in STEM courses and careers (Bruyere, Billingsley, & O'Day, 2009; Darke, Clewell, & Sevo, 2002). Woods (2002) studied the impact of extracurricular science activities and found that involvement affects interest in future science participation.

**Family STEM Influence**

Family is one of the most significant contexts of socialization in early childhood and adolescent development. Parental influence has been found to impact career preferences especially when it comes to non-traditional careers (Dryler, 1998).

Clewell and Anderson (1991) note that a lack of parental expectation and encouragement discourages girls' interest in science. Furthermore, family background and parental influence have been linked to mathematics achievement and attitudes toward mathematics coursework as well (Clewell & Anderson).

Gender stereotyping is imbedded in our culture and has been found to impact children's perceptions from an early age, on what career pathways are suitable for boys and girls (Adya & Kaiser, 2005). Subtle cues from parents, teachers, counselors, and peers about gender roles affects girls' interest in math and science and therefore limits opportunity and workforce talent (Adya & Kaiser). Results from a longitudinal study at the University of Michigan's Institute for Social Research (Davis-Kean, 2007) found that there is a positive correlation between a parent's attitude about their child's interest in math and the child's math achievement. Their study revealed when it comes to mathematics, parents provide a more supportive environment for their sons than their daughters. They also found that as a father's gender stereotypes increased, their daughter's interest in mathematics decreased whereas a boys' interest in mathematics increased with an increase in the father's gender stereotypes.

A review of the literature also indicates that girls are more likely to pursue a degree in science, technology, engineering, and/or mathematics if a parent is employed in a career involving STEM (AAUW, 2010, 2004, 1998; Burke & Mattis, 2007; Clewell, Anderson, & Thorpe, 1992; Corbett, Hill, & Rose, 2008; Jeffers et al., 2004).

**Macrosystem for 6$^{th}$-12$^{th}$ Grade Girls' STEM Development**

Bronfennbrenner (2005) described the macrosystem in his theoretical model of human development as the overarching pattern of micro-, meso-, and exosystem characteristics of a given society, culture, or subculture that constructs the developmental ideologies imbedded in each of these systems. The macrosystem in this study includes the region of residence (identified as rural vs. non-rural), race/ethnicity, and gender (a constant).

In the following subsections, the literature relating to middle and high school girls' interest and confidence in science and mathematics is reviewed in relation to the macrosystem and the representing variables of region of residence, and race/ethnicity.

**Region of Residence**

The state of Iowa is located in the Midwestern United States often referred to as the American Heartland. Although Iowa is perceived as being a very rural state, 61.1% of the 3,002,555 residents live in urban areas (Iowa Date Center, 2008). A shift in population from rural to urban living began early in the 20$^{th}$ century with an 8.5% increase in residents living in urban counties and a 4.2% decrease in rural counties (Iowa Data Center).

According to the Iowa Department of Education' Condition of Education Report (2009), more than two of every five districts in the state (45.6%) reported enrollments of less than 600 during the 2008-2009 academic year, serving 13% of the state's public school students. Similarly, the larger school districts (2,500 to 7,499 and 7,500 +) representing 8.8 % of the public schools within the state served nearly half (48.7%) of the public school district's students.

In general, the Iowa Department of Education (2009) indicates that the district enrollment numbers closely align with the urban/non-urban divide however, notes that there are a few exceptions of larger districts in more rural areas due to the increasing trend of combining districts (e.g., Aplington-Parkersburg and Clayton Ridge).

Access to resources remains one of the primary educational challenges to date in Iowa. There is a need within the state for an increase in the number of teachers certified to teach mathematics and science courses (e.g., physics, chemistry, advanced placement mathematics). Many teachers within the smaller school districts are being asked to teach outside their area of expertise. As discussed previously, the learning environment plays a critical role in girls' interest and confidence in science and mathematics. Clewell, Cabrera, and Terenzini (2001) noted that if an educator conveys a lack of confidence in teaching the content of a specific course, that lack of self-confidence can affect girls' interest and confidence in science and mathematics. Hiring teachers certified to teach more than one higher level class in math and science is an economic issue for smaller schools as well as a hiring and retention issue based on the salaries smaller districts are able to offer in comparison to larger districts (Wellenstein, Bloor, & Keshmiri, 2006).

Because urban areas are more populated as a result of the diverse business and industry sector, there may be fewer opportunities for girls from a rural school district to connect with female role models and professionals from business and industry (Wellenstein et al., 2006).

Hands-on, experiential STEM activities have been highlighted as a strategy to increase girls' interest in STEM fields (AAUW, 1998, 2004, 2010; Bottoms & Uhn, 2001; Burke & Mattis, 2007; Clewell, 2002; Corbett, Hill, & Rose, 2008). If a district has the money to purchase equipment and stock their labs, teachers are more prepared to provide interactive experiences than those districts without adequate funding for STEM resources.

**Race/Ethnicity**

Women of color are often faced with racism in addition to sexism in science (Fancsali, 2000). In terms of girls and STEM, the research investigating the relationship of gender and ethnicity is very limited according to Fancsali. It is much more common for data to be disaggregated by either by gender or race/ethnicity (Fancsali).

According to Gilmartin, Li, and Aschbacher (2006), the barriers are complex and involve both psychological and structural factors that are generally present in high school and make it more difficult for underrepresented minority groups and women to succeed in STEM fields. In addition, the pre-collegiate experiences and perceptions by race/ethnicity are less understood than are differences in experiences by gender.

In their study of 10$^{th}$ grade students in California, Gilmartin et al. (2006) found that parental support is to some extent a stronger positive predictor of a student's STEM interest than whether a parent has a STEM related job. In addition, their findings support the presence of role models indicating that a girls' science interest and career aspirations are influenced by racial/ethnic representation.

A national survey of 5$^{th}$-11$^{th}$ grade students and parents attitudes about science and mathematics was administered in 2001for the National Action Council for Minorities in Engineering (NACME). The data from that study revealed that interest in taking advance mathematics courses among minority girls (74%) was greater than that of nonminority girls (67%), however the availability of such courses was less at the minority student's schools (45%) than the availability at nonminority schools (52%).

**Summary**

There is a tremendous amount of literature (both current and historical) on the lack of females in STEM fields, potential reasons why, and strategies for inclusiveness. Although the achievement gap between girls and boys in science and mathematics has closed, boys and girls are performing equally well in both, there is still much we can learn about what may impact and/or influence $6^{th}$-$12^{th}$ grade girls' STEM development.

This study offers one perspective on factors that contribute to girls STEM development. It is unique in that it is informed by Bronfenbrenner's bioecological theory of human development that provides a systemic, holistic view of the impact of specific contexts/environments that middle and high school (grades 6-12) girls interact in on a daily basis.

# CHAPTER 3

# METHODOLOGY

The purpose of this study was to understand the experiences that influence $6^{th}$-$12^{th}$ grade girls' STEM development in Iowa by analyzing data from Iowa State University's Program for Women in Science and Engineering 2008-2009 Outreach Needs Assessment. Using Bronfenbrenner's bioecological model as a conceptual framework, this study explored the impact of specific environmental influences (e.g., parental STEM influence, region of residence) on $6^{th}$-12 grade girls' interest and confidence in science and mathematics. Understanding the factors that influence girls' interest and confidence in science and mathematics will inform strategies that may potentially increase participation in these areas for this population.

This chapter provides in depth information on the philosophical underpinnings of this research including an outline of the research questions, research design, methodological approach, setting, population and sample, data collection, instrumentation, variables, and data analysis. Chapter three concludes with the limitations and delimitations of the study

## Research Design

This study was undertaken with a quantitative approach using a survey research methodology with a postpositivist philosophical foundation. Creswell (2009) notes that postpositivism follows the tenets in the positivist tradition (i.e., scientific method), but recognizes that "we cannot be 'positive' about our claims of knowledge when studying the behavior and actions of humans" (p. 7). Phillips and Burbules (2000) identified the key assumptions of the postpositivist worldview as:

1. Absolute truth cannot be found, but knowledge is supported by the best evidence we have at the time.
2. Research is based on claims and warrants, and strong warrants are accepted until future research provides stronger claims.
3. Knowledge at a point in time is shaped by data, evidence, and rational consideration.
4. Research seeks to explain causal relationships with relevant and true statements.
5. Objectivity in research is essential, and researchers should examine methods and conclusions for any biases.

## Methodological Approach

A survey research methodological approach was used for this study. Groves et al. (2004) note that "A survey is a 'systematic' method for gathering information from (a sample of) entities for the purposes of constructing quantitative descriptors of the attributes of the larger population of which the entities are members" (p. 2). The survey research methodology was deemed appropriate for this study because the goal was to collect information from 6-12$^{th}$ grade girls regarding factors that may impact their interest and confidence in mathematics and science defined as their STEM development in this study. The survey instrument used for the data collected in this study was developed for a needs assessment conducted by the Iowa State University Program for Women in Science and Engineering K-12 Outreach Program during the 2008-2009 academic year.

The project team at the Research Institute for Studies in Education (RISE) in collaboration with the author designed the 47-item student survey instrument. A detailed description of the survey instrument can be found in the Survey Instrument section of this chapter.

## Research Questions

The following six research questions guided this quantitative study.

1. What are the background characteristics of the $6^{th}$-$12^{th}$ grade girls who attended the spring 2009 *Taking the Road Less Traveled Career Conference?*
2. Is there a statistically significant difference between middle school girls' ($6^{th}$-$8^{th}$ grade) and high school girls' ($9^{th}$-$12^{th}$ grade) a) interest in math, b) interest in science, c) confidence in math, and d) confidence in science?
3. To what extent do race/ethnicity, region of residence, family STEM influence, extracurricular STEM activities, and math teacher influence predict *math interest* for middle school ($6^{th}$-$8^{th}$ grade) and high school girls ($9^{th}$-$12^{th}$ grade)?
4. To what extent do race/ethnicity, region of residence, family STEM influence, extracurricular STEM activities, and science teacher influence predict *science interest* for middle school ($6^{th}$-$8^{th}$ grade) and high school girls ($9^{th}$-$12^{th}$ grade)?
5. To what extent do race/ethnicity, region of residence, family STEM influence, STEM extracurricular STEM activities, and math teacher influence predict *math confidence* for middle school ($6^{th}$-$8^{th}$ grade) and high school girls ($9^{th}$-$12^{th}$ grade)?
6. To what extent do race/ethnicity, region of residence, family STEM influence, extracurricular STEM activities, and science teacher influence predict *science confidence* for middle school ($6^{th}$-$8^{th}$ grade) and high school girls ($9^{th}$-$12^{th}$ grade)?

## Research Setting

The Program for Women in Science and Engineering (PWSE) at Iowa State University (ISU) provides programming to support and encourage girls and women to explore and pursue STEM education from pre-kindergarten through high school, Iowa's community colleges, and undergraduate levels at Iowa State. The PWSE Outreach Program serves over 9,000 students per year. One of PWSE's signature outreach programs is the *Taking the Road Less Traveled Career Conference for Girls (TRLT).* PWSE hosts six conferences per year for 6$^{th}$ - 12$^{th}$ grade girls, parents, teachers, and counselors on the Iowa State University campus. The conference format includes career exploration workshops and experiential activities facilitated by women in STEM fields from business, industry, or faculty positions; tours of ISU labs and facilities; and special sessions for educators and parents. The inaugural *Taking the Road Less Traveled Conference* occurred in 1987. Since that time the event has grown to six conferences per year and has reached over 50,000 students and teachers in the state of Iowa (PWSE 2008-2009 Annual Report).

During the 2008-2009 academic year, PWSE contracted with the Research Institute for Studies in Education (RISE) to conduct a comprehensive needs assessment of the PWSE outreach program. Data were collected from teachers, parents, and students at three different stages in the academic year. During the October 2008 TRLT conference series, focus groups were conducted with the parents of students who were in attendance at the conferences and teachers/educators who brought students to the conferences. The data from these focus groups helped to guide the development of the survey instrument utilized in this study. The second data collection stage took place during the three April 2009 TRLT conferences. The survey instrument was distributed in paper form to all students attending the conferences. The final stage of data collection included an online educator survey distributed to all math, science, and talented and gifted (TAG) teachers in the state of Iowa.

## Sample and Participants

The portion of the data collected and analyzed in this study is from the data collection that took place with students who attended the three April, 2009 TRLT conferences. The participants at the conference consisted of 885 middle school and 398 high school students for a total of 1,283 students from rural, urban and suburban Iowa. Seventy-nine percent of middle school girls ($n$ = 696) and 76% of high school girls ($n$ = 303) completed and returned the surveys for a 78% overall response rate. However, surveys that had missing responses to questions that were identified as measurement variables in this study were removed, resulting in a final sample size of $n$ = 871. Participants' ages ranged from 11 to 18 with a mean age of 13.86, $SD$ = 1.55. A frequency distribution of participant demographic characteristics is reported in Table 3.1.

Human Subjects approval was granted for the initial data collection and follow up with the Iowa State University Institutional Review Board indicated no further approval was needed for the data analysis in this study.

Table 3.1

*Frequency Distribution for Participant Demographics – Age, Ethnicity, Region, School Level, and Computer at Home, n = 871*

| | *n* | % of sample |
|---|---|---|
| Age *(n = 867)* | | |
| 11 | 35 | 4.0 |
| 12 | 131 | 15.1 |
| 13 | 219 | 25.3 |
| 14 | 233 | 26.9 |
| 15 | 102 | 11.8 |
| 16 | 91 | 10.5 |
| 17 | 45 | 5.2 |
| 18 | 11 | 1.3 |
| Race/Ethnicity *(n = 871)* | | |
| White | 731 | 83.9 |
| African American | 16 | 1.8 |
| Asian/Pacific Islander | 26 | 3.0 |
| Latina/Hispanic | 31 | 3.6 |
| American Indian/Alaskan Native | 8 | .9 |
| Bi-racial/mixed race | 44 | 5.1 |
| Other | 15 | 1.7 |
| Region of Residence *(n = 871)* | | |
| A rural area | 323 | 37.1 |
| A suburban area | 430 | 49.4 |
| An urban area | 118 | 13.5 |
| School Level *(n = 871)* | | |
| Middle School | 591 | 67.9 |
| High School | 280 | 32.1 |
| Computer Access at Home *(n = 871)* | | |
| Yes | 792 | 90.9 |
| No | 23 | 2.6 |
| Sometimes | 56 | 6.4 |

*Note.* Race/Ethnicity and Region of Residence are recoded into dichotomous variables for analysis. Coding is explained in greater detail under the variable section in this chapter.

## Survey Instrument

The Program for Women in Science and Engineering contracted with the Research Institute for Studies in Education (RISE) in the fall of 2008 to conduct a needs assessment for the outreach program. The author met with a team of researchers from RISE to discuss the outreach program's history, signature programs (e.g., Taking the Road Less Traveled Career Conference for Girls, and the Student Role Model Program), and purpose for the needs assessment. The information gained from the needs assessment was used to inform decisions regarding the educational outreach activities conducted by PWSE that are directed toward the awareness and exploration of STEM fields by girls (K-12) and women (community college transfer students). With content input from PWSE, the research experts at RISE designed the 47-item paper survey instrument used for data collection with the middle and high school girls attending the TRLT conferences.

Two versions of the 47-item survey instrument were developed, one for middle school girls (Appendix A) and the other for high school girls (Appendix B). The only difference between the two survey instruments, is in part 1, questions 1 and 3 of the survey instrument which asks participants to select the current math and science classes they are taking from a list of options. Because the option list of math and science classes were different for middle school and high school girls, two versions of the survey instrument were created. All other sections (described below) are exactly the same.

The survey instrument consists of 4 parts. Part 1, titled School Math and Science classes, inquires about the current math and science classes participants are taking, the gender of their math and science teachers, and 14 questions with a Likert-type response scale asking participants about their experiences in their math and science classes relative to teaching factors (e.g., my teacher encourages me to ask questions). In these 14 questions, participants were asked to select their level of agreement with each of the statements first for their math class and second for their science class with 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree.

In part 2, After School Activities, participants were asked to select from a list of afterschool activities in which they are currently involved. Participants were also asked to respond to an open-ended question about how many hours they spend in a one-week period (Monday through Friday) on these activities. Following assessment of current involvement in activities, participants were asked to identify those activities in which they would like to be involved (but are not currently involved). Through the use of an open-ended question, participants were asked to explain why they were not involved in the activities in which they would like to be involved.

Part 3, Program for Women in Science and Engineering, was subdivided into two sections. The first section asked participants to rate their level of interest and confidence in nine STEM-related activity and program areas. Interest was measured using a four-point Likert-type scale where 1 = no confidence (I don't think I do well in this activity area), 2 = slightly confident, 3 = confident, and 4 = very confident (I always do well and am comfortable in this activity area). The second section of part three asked participants to rate their interest level and potential attendance at a number of different types of activity/delivery methods (e.g., summer camp, workshops on the weekend). Interest was measured using the same interest scale in the first section of this part, and attendance was measured with a 1 = No, I would not attend a program or activity using this method, 2 = not sure, and 3 = Yes, I would attend a program or activity using this method.

Part 4, the final section of the survey, asked participants a series of demographic questions. Specifically, age, race/ethnicity, where they live (e.g., rural), whether or not they had access to a computer at home, their parents' occupations, and what they would like their occupation to be (if they had to choose right now).

## Variables

Through operationalizing Bronfebrenner's (2005) bioecological model (described in chapter 1) and using results from the survey described above, this study examined the impact of environmental factors on a participant's interest and confidence in mathematics and science. Independent variables indentified at the microsystem and macrosystem level were tested as potential predictors for their impact on $6^{th}$-$12^{th}$ grade girls' interest and confidence in science and mathematics. The model uses six independent variables including region of residence, race/ethnicity, family STEM influence, extracurricular STEM involvement, math teacher influence, and science teacher influence. The four dependent variables in the study are math interest, science interest, math confidence, and science confidence.

### Independent Variables

Measurement for each of the independent variables including region of residence, race/ethnicity, family STEM influence, extracurricular STEM involvement, math teacher influence, and science teacher influence are described below.

**Demographics.** Region of Residence and Race/Ethnicity were measured through participant responses to items on the survey. For the Region of Residence independent variable, participants selected Rural, Urban, or Suburban. Their responses were recoded into a dichotomous variable of rural (coded = 0) and non-rural (coded = 1) where urban and suburban make up the non-rural part of the variable.

Race/Ethnicity was measured by self-identification from the following options: White, African American, Asian/Pacific Islander, Latina/Hispanic, American Indian/Alaskan Native, Bi-racial/mixed race, and other. Because of the small number of participants in each race/ethnicity category, with the exception of White, this variable was recoded into a dichotomous variable of minority participants (coded = 0) and majority participants (coded = 1). The majority category was comprised of all White responses and the minority category included all other category responses (i.e., African American, Asian/Pacific Islander, Latina/Hispanic, American Indian/Alaskan Native, Bi-racial/mixed race, and other).

**Family STEM influence.** Family STEM influence was measured by recoding a variable in the dataset where participants responded to an open-ended question asking them to identify each parents' occupation. Recoding was done by assigning each of the parents' occupations to a STEM or non-STEM category, creating a dichotomous variable. If a participant had at least one parent who was employed in a STEM-type profession, they were coded as a 1, and when a participant did not have at least one parent employed in a STEM-type profession they were coded as a 0. Identification of STEM professions was addressed rather conservatively. For example, when a participant listed a parent as being employed at John Deere, it was not assumed that the parent was an engineer and thus this example was coded as a 0 (Non-STEM).

**Extracurricular STEM involvement.** In the survey, participants were asked to select from a list (see Appendix A or B) of afterschool activities in which they were currently involved. To measure participants' extracurricular STEM involvement a new variable was constructed that counts the number of STEM related afterschool activities in which a participant was involved. STEM related activities were identified as: math club, science club, 4H, Future Farmers of America (FFA), Girl Scouts, environmental outdoor club, Project Lead the Way, State Science Fair, and First Lego League.

**Math teacher influence.** The observed variable of *Math Teacher Influence* was measured by asking participants to rate their agreement with 14 statements regarding their math class, for example "I enjoy learning the material in this class," "We use technologies in class that help me learn," "My teacher creates a classroom environment that allows me to learn," "The assignments given help me learn the subject being taught," and "In class, we use a variety of classroom activities and resources that help me learn."

Each statement was assessed using a five point Likert-type score ranging from 1 = "strongly disagree" to 5 = "strongly agree." Through an exploratory factor analysis these statements were factored into a single construct that measured math teacher influence.

***Factor analysis for math teacher influence.*** An exploratory factor analysis was run on the 14 statements. Tabachnick and Fidell (2007) state a "factor analysis is a statistical technique applied to a single set of variables when the researcher is interested in discovering which variables in the set form coherent subsets that are relatively independent of one another" (p. 607). Tabachnick and Fidell go on to say that "when scores on factors are estimated for each subject, they are often more reliable than scores on individual observed variables" (p. 608). A principle component with a varimax rotation approach was used for the factor analysis, which yielded two factors with eigenvalues greater than one and explained 52% of the sample variation. A conservative approach of a .45 factor loading was used for acceptance of an item in interpretation of the factor. Tabachnick and Fidell state, "as a rule of thumb only variables with loadings of .32 and above are interpreted. The greater the loading, the more the variable is a pure measure of the factor" (p. 649). Kaiser's measure of sampling adequacy (KMO) was .94 and Tabachnick and Fidell note that "values of .6 and above are required for good FA" (p. 614).

From the original 14 survey items, nine items aligned to represent one factor and five items aligned to represent a second factor. Through interpretation of the aligned items it was determined to utilize only the first factor to create the factored variable – *math teacher influence* (eigenvalue = 6.30, variance explained = 45.0%). Table 3.2 reports the factor structure and loadings.

Table 3.2

*Factor Analysis for the Math Teacher Influence Construct*

| Item | Factor Loadings |
|---|---|
| Math Teacher Influence (α = .870) | |
| The assignments given help me learn the subject being taught | .760 |
| My teacher encourages my responsibility and effort. | .668 |
| I am comfortable asking questions in class. | .661 |
| My teacher encourages us to ask questions. | .643 |
| My teacher communicates high expectations. | .629 |
| I get helpful feedback from my teacher. | .629 |
| My teacher creates a classroom environment that allows me to learn. | .624 |
| My teacher asks questions that challenge me to think. | .516 |
| I enjoy learning the material in this class. | .498 |

**Science teacher influence.** The observed variable of *Science Teacher Influence* was measured by asking the participants to rate their agreement with the same 14 math teacher influence statements but in reference to their science teacher. Some of the 14 questions included: “My teacher encourages us to apply what we’ve learned to situations outside of class,” “My teacher encourages us to ask questions,” “My teacher communicates high expectations,” “I get helpful feedback from my teacher.” Each statement of agreement was assessed using the same five point Likert-type scale as reported in the math teacher influence construct. Through a factor analysis these 14 science teacher related statements were factored into one construct that measured science teacher influence.

***Factor analysis for science teacher influence.*** Similar to the math teacher influence variable, an exploratory factor analysis was run on the 14 survey science statements. A principle component with varimax rotation approach was used for the factor analysis, which yielded one factor with an eigenvalue greater than one and explained 46.7% of the sample variation. A conservative approach of a .45 factor loading was used for acceptance of an item in interpretation of the factor. From the original 14 survey items, all 14 items aligned to represent one factor – *science teacher influence* (eigenvalue = 6.54, variance explained = 46.7%). Kaiser’s measure of sampling adequacy (KMO) was .95. Table 3.3 reports the factor structure loadings.

Table 3.3

*Factor Analysis for the Science Teacher Influence Construct*

| Item | Factor Loadings |
|---|---|
| Science Teacher Influence (α = .909) | |
| I get helpful feedback from my teacher. | .789 |
| My teacher creates a classroom environment that allows me to learn. | .747 |
| My teacher encourages my responsibility and effort. | .738 |
| My teacher tells the class about resources that will help us learn about the subject we are studying, when appropriate. | .737 |
| The assignments given help me learn the subject being taught. | .723 |
| My teacher encourages us to ask questions. | .699 |
| My teacher asks questions that challenge me to think. | .696 |
| In class, we use a variety of classroom activities and resources that help me learn. | .693 |
| My teacher encourages us to apply what we've learned to situations outside of class. | .673 |
| My teacher communicates high expectations. | .646 |
| My teacher talks about possible careers in science, technology, engineering, and/or math. | .618 |
| I enjoy learning the material in this class. | .616 |
| We use technologies in class that help me learn. | .576 |
| I am comfortable asking questions in class. | .573 |

## Dependent Variables

The following sections explain how the dependent variables of math interest, science interest, math confidence, and science confidence were measured.

**Math interest.** Participants were asked to rate their level of interest in math using a four point Likert-type scale where 1= not interested, 2= slightly interested, 3 =

interested, and 4 = very interested. The higher the score the more interested a participant was in math.

**Science interest.** Participants were asked to rate their level of interest in science using a four point Likert-type scale where 1 = not interested, 2 = slightly interested, 3 = interested, and 4 = very interested. The higher the score, the more interested a participant was in science.

**Math confidence.** Participants were asked to rate their level of confidence in math using a four point Likert-type scale where 1 = no confidence (I don't think I do well in this activity area), 2 = slightly confident, 3 = confident, and 4 = very confident (I always do well and am comfortable in this activity area). The higher the score, the more confident a participant was in math.

**Science confidence.** Participants were asked to rate their level of confidence in science using a four point Likert-type scale where 1 = no confidence (I don't think I do well in this activity area), 2 = slightly confident, 3 = confident, and 4 = very confident (I always do well and am comfortable in this activity area). The higher the score, the more confident a participant was in science.

## Summary of Variables and Connection to Theoretical Framework

Table 3.4 provides a summary review of the variables used for analysis in this study and their connection to the theoretical framework, Bronfrenbrenner's bioecological model of human development that guides this study.

Table 3.4

*Connection to Theoretical Framework and Review of Measurement Variables*

| **System** | **Variable** | **Type** | **Description (Measured by)** |
|---|---|---|---|
| Macro | Gender | Constant | Not measured – held constant in this study |
| Macro | Race/Ethnicity | IV | Recoded to dichotomous variable: 0 = minority; 1 = non-minority |
| Macro | Region of Residence | IV | Recoded to dichotomous variable: 0 = rural; 1 = non-rural |
| Micro | Family STEM Influence | IV | Recoded from open-ended question on parents occupation: 0 =Non-STEM (neither parent has a STEM-based occupation), 1 = STEM (at least one parent has a STEM based occupation) |
| Micro | Extracurricular STEM Activities | IV | Number of STEM activities involved in |
| Micro | Math Teacher Influence | IV | Construct created based on factor analysis |
| Micro | Science Teacher Influence | IV | Construct created based on factor analysis |
| Micro (Individual) | Math Interest | DV | Likert-type measurement of math interest |
| Micro (Individual) | Science Interest | DV | Likert-type measurement of science interest |
| Micro (Individual) | Math Confidence | DV | Likert-type measurement of math confidence |
| Micro (Individual) | Science Confidence | DV | Likert-type measurement of science confidence |

*Note*. The Macrosystem is a combination of all microsystems, the exosystem is not measured directly in this study, and because this is a cross-sectional designed study the chronosystem cannot be measured.

## Data Analysis and Research Questions

The data were analyzed on several levels using both descriptive and inferential statistical analyses to address the research questions defined in this study. This section describes the analysis used to address each of the research questions.

### Descriptive Statistical Analysis

Using SPSS v.18 software, means, standard deviations, and frequencies were run and reported on all independent and dependent variables identified in Table 3.4. Descriptive statistics were used to answer research question 1 – What are the background characteristics of $6^{th}$-12th grade girls who attended the spring 2009 *Taking the Road Less Traveled Career Conference*?

### Inferential Statistical Analyses

Independent samples *t*-tests and multivariate analyses were conducted on the data to answer research questions two through six.

**Independent samples *t*-tests.** Four independent samples *t*-tests were conducted to answer research question two, whether there is a statistically significant difference between middle and high school girls' interest and confidence in mathematics and science. The four specific independent samples *t*-tests were:

*a) Is there a difference between middle school and high school girls' interest in math?*

*b) Is there a difference between middle school and high school girls' interest in science?*

*c) Is there a difference between middle school and high school girls' confidence in math?*

*d) Is there a difference between middle school and high school girls' confidence in science?*

**Multiple regression.** Multiple regression analyses with a sequential hierarchical approach were conducted to answer research questions three through six. Prior to running the regression analyses, two factor analyses were conducted to create the math teacher influence variable and the science teacher influence variable. The exploratory factor analyses for the construction of these two factors are explained in the prior section, under their respective variables, *math teacher influence* and *science teacher influence*. A correlation matrix was also constructed for all variables entered in the regression analyses, and data were screened to meet assumptions for regression analysis. Four regression models were designed to answer research questions 3 through 6 and they are further elaborated on in the following section.

Regression analyses are "statistical techniques that are used to make predictions based on correlations" (Gravetter & Wallnau, 2009, p. 563). Regression is based on a linear relationship and in simple regression the model equation can be expressed as:

$$Y=bX+a$$

Where $Y$ = is the predicted value of the dependent (outcome) variable, $b$ = the unstandardized regression coefficient, $X$ = the independent (predictor) variable, and $a$ = the intercept. In multiple regression, there is more than one independent (predictor) variable and thus the formula is adjusted to account for additional predictor variables.

$$Y = bX_1 + bX_2 + \ldots a$$

Where $X_1$ is the value of the first predictor variable, and $X_2$ is the value of the second predictor variable. Additional predictor variables can be added to the equation as long as minimum sample requirements are accounted for. Tabachnick and Fidell (2007) suggest a minimum sample size based on the following equation:

$$8m + 50 = n$$

Where $m$ = the number of independent (predictor variables). In this study, the maximum number of predictor variables used in a regression model is five. Inserting five to replace $m$ in the above equation and conducting the calculation produces a minimum sample size of $n = 90$. In this study, the sample size is $n = 871$ which is greater than 90, thus fulfilling Tabachnick and Fidell's (2007) minimum sample guidelines.

**Regression Models and Theoretical Connection**

In this section each research question that was analyzed using a multiple regression statistical technique is described and the resulting regression model equation is shown.

A sequential hierarchical approach was used for the regression analysis. In this approach, IVs enter the equation in an order determined by the researcher (Tabachnik & Fidell, 2007). It was determined that the sequential hierarchical regression approach was the best method to account for the specific influence of each of the systems identified in Bronfenbrenner's model. Independent variables were entered in two blocks for each of the four different regression models (math interest, science interest, math confidence, science confidence). The first block entered contained the variables identified in the macrosystem – region of residence (rural, nonrural) and race ethnicity (majority, minority). Theoretically, the macrosystem variables were entered into the regression analyses first because of the broad overarching influence that Bronfenbrenner (2005) noted they have on an individual's development. The goal by entering the macrosystem variables in the first block was to determine the extent to which the macrosystem variables alone predict the dependent variables of STEM development (math interest, science interest, math confidence, science confidence). Variables at the macrosystem level are ones in which it is often difficult to invoke change because they are deeply imbedded in societal structures and societal influence (Bronfenbrenner). The macrosystem variables were entered in the first block to account for their predictive value first in determining how much variance can be accounted for by these macrosystem variables. Changes made at this level would have to be addressed on a national basis.

State, local, and individual change can be made more easily for the variables in the second block, those identified as the microsystems. Specifically, family STEM influence, extra-curricular STEM activities, and math or science teacher influence depending upon which dependent variable is entered into the equation. For example, if the regression model is statistically significant for the microsystem, it is much easier to effect change by providing more opportunities for girls to participate in extracurricular STEM activities or developing professional development opportunities for teachers that focus on the their development in the items identified in the math and teacher influence factors. Following are the regression models for each of the dependent variables.

**Regression model for math interest – research question three.** To what extent does race/ethnicity, region of residence, family STEM influence, extracurricular STEM activities, and math teacher influence predict *math interest* for middle school ($6^{th}$-$8^{th}$ grade) and for high school (9-12th grade) girls? Research question three was answered by running a sequential hierarchical regression analysis on the following model where *math interest = macrosystems (race/ethnicity + region of residence) + microsystems (family STEM influence + extracurricular STEM activities + math teacher influence factor).*

**Regression model for science interest – research question four.** To what extent does race/ethnicity, region of residence, family STEM influence, STEM extracurricular activities, and science teacher influence predict *science interest* for middle school ($6^{th}$-$8^{th}$ grade) and for high school (9-12th grade) girls? This research question was answered by running a regression analysis on the following model where *science interest = macrosystems (race/ethnicity + region of residence) + microsystems (family STEM influence + extracurricular STEM activities + science teacher influence factor)*.

**Regression model for math confidence – research question five.** To what extent does race/ethnicity, region of residence, family STEM influence, STEM extracurricular activities, and math teacher influence predict *math confidence* for middle school ($6^{th}$-$8^{th}$ grade) and for high school (9-12th grade) girls? This research question was answered by running a regression on the following model where *math confidence = macrosystems (race/ethnicity + region of residence) + microsystems (family STEM influence + extracurricular STEM activities + math teacher influence factor).*

**Regression model for science confidence – research question six.** To what extent does race/ethnicity, region of residence, family STEM influence, STEM extracurricular activities, and science teacher influence predict *science confidence* for middle school (6$^{th}$-8$^{th}$ grade) and for high school (9-12th grade) girls? This research question was answered by running a regression on the following model where *science confidence = macrosystems (race/ethnicity + region of residence) + microsystems (family STEM influence + extracurricular STEM activities + science teacher influence factor).* Figure 3.1 provides a visual depiction of the regression models respective to each dependent variable.

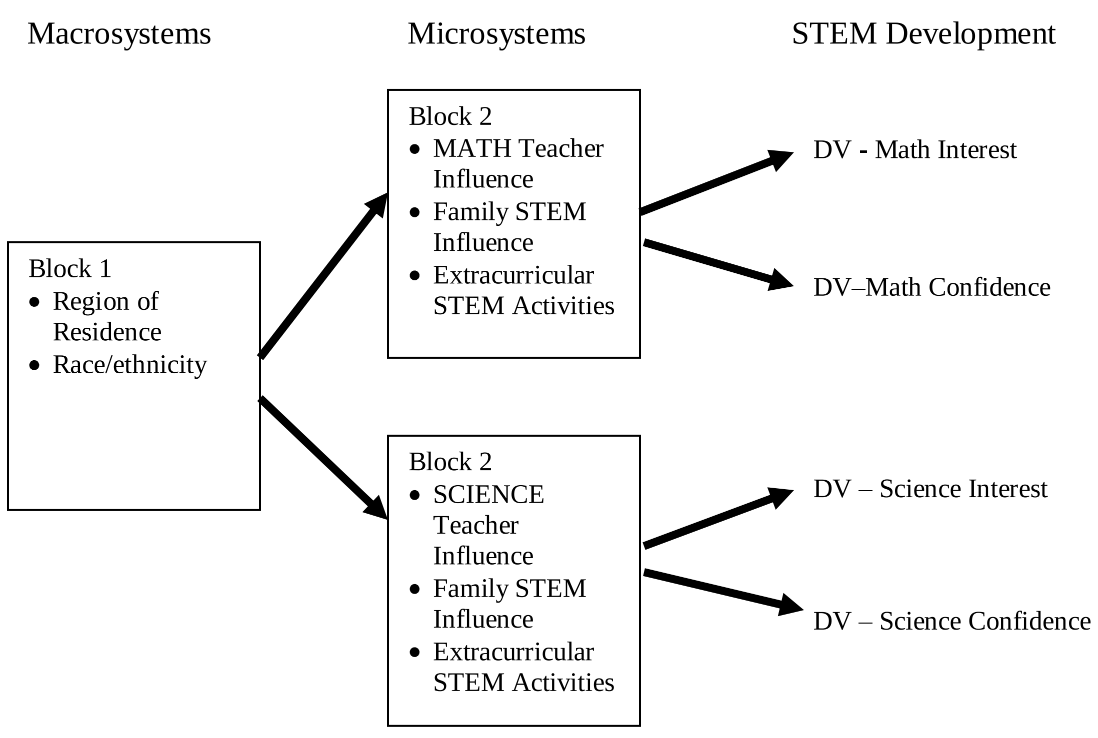


Figure 3.1. Visual Model of Sequential Hierarchical Regression Analyses

## Delimitations

This study was delimited to a specific group of students: 6th through 12th grade girls from rural, urban, and suburban Iowa school districts who attended one of three April 2009 Taking the Road Less Traveled Career Conferences sponsored by Iowa State University's Program for Women in Science and Engineering.

## Limitations

This dissertation employs a cross sectional design and therefore captures information from one specific point in time. Future research should include capturing data at multiple points throughout girl's middle and high school years to better understand their experiences and STEM development over time.

Some might suggest that a second limitation of this study is its focus on girls only without a causal-comparative approach (i.e., control group) using boys. However, the focus of this study is only to determine the factors that influence girls' development (interest and confidence) in STEM and whether or not there is a difference between girls and boys in their STEM development is not the goal of the study, thus a control group design was not necessary. What is important is what factors influence girls in their STEM development. If, in future research, it is deemed that these same factors also influence boys, or does not influence boys, it does not detract from the purpose and goals of this study.

## Summary

This chapter describes the methodological approach used in this research study. Philosophical assumptions, research design and questions, independent and dependent variables, as well as results from factor analyses conducted for the math and science teacher influence constructs were reviewed. Additionally, details were provided on how the data were analyzed to address each of the research questions. The chapter closed with a discussion on the delimitation and limitations of the study. Chapter 4 presents the results of the data analyses.

# CHAPTER 4

# RESULTS

The purpose of this study was to understand the experiences that influence $6^{th}$-$12^{th}$ grade girls' STEM development in Iowa by analyzing data from Iowa State University's Program for Women in Science and Engineering 2008-2009 Outreach Needs Assessment. Using Bronfenbrenner's bioecological model as a conceptual framework and a review of the literature on girls' in STEM, variables (e.g., parental STEM influence, region of residence) were identified and hypothesized as having potential influences on $6^{th}$-12 grade girls' interest and confidence in science and mathematics.

This chapter reports results of the data analysis, which in turn provides answers that address the six research questions. The chapter is divided into six sections. The first section describes the procedures used to screen the data and ensure that assumptions of data normality were met in order to conduct data analyses. The second section reports results for the descriptive statistics conducted on all demographic variables and all independent and dependent variables. The third section reports the correlations between all independent and dependent variables, which is required reporting for multiple regression analysis. The fourth section describes the results for the independent samples *t*-tests conducted to answer research question two. The fifth section reveals the sequential (hierarchical) regression analyses conducted to answer research questions three through six. The sixth, and final section, applies the results reported in prior sections and answers each of the six research questions identified in chapters one and three.

## Data Screening and Assumptions of Normality

Prior to conducting descriptive and inferential statistical analyses, data were screened for outliers and missing values. Results of data screening revealed no outliers or missing values for independent or dependent variables. Further screening was then conducted to assess whether the variables met assumptions of normality. Screening variables to ensure that data are distributed normally is a precursor to conducting most inferential statistical analyses. This study used independent samples *t*-tests and multiple regression (MR) analyses, both require that assumptions of data normality are not violated.

Kline (2011) states that "the statistical assumptions of MR are stringent, probably more so than many researchers realize" (p. 23). Kline identifies these assumptions as:

> 1. Regression weights reflect linear relations only. If there are curvilinear relations, then values of regression weights will underestimate predictive power.
> 2. Statistical tests of MR assume that the residuals are normally distributed and have uniform variances across all levels of the predictors.
> 3. It is assumed that the scores on the predictors are perfectly reliable (no measurement error). This assumption is necessary because there is no direct way in MR to represent less-than-perfect score reliability for the predictors. (p. 23)

One method suggested by Kline (2011) for assessing data normality is to review the skew and kurtosis index scores for each variable used in the regression analysis. Kline explains that absolute values for skew values greater than 3.0 can be described as extremely skewed and for kurtosis values "absolute values from about 8.0 to over 20.0 of this index are described as indicating 'extreme' kurtosis" (p. 63). Results of the data screening for the independent and dependent variables are reported in Table 4.1. A review of the skew and kurtosis index scores revealed that none of the independent and dependent variables in this study exhibit extreme non-normal data thus fulfilling the assumption of data normality for independent sample *t*-tests and multiple regression analysis.

Table 4.1

*Assessment of Normality for Variables in the Model (n = 871)*

| Variables | Skew | SE of Skew | Kurtosis | SE of Kurtosis |
|---|---|---|---|---|
| Region of Residence (1 = NonRural) | -.536 | .083 | -1.717 | .166 |
| Race/Ethnicity (1 = Majority) | -1.851 | .083 | 1.428 | .166 |
| Family STEM Influence (1 = STEM) | .749 | .083 | -1.442 | .166 |
| Extracurricular STEM Activities | 1.628 | .083 | 2.744 | .166 |
| Math Teacher Influence | -.983 | .083 | .905 | .166 |
| Science Teacher Influence | -.984 | .083 | 1.184 | .166 |
| Math Interest* | -.426 | .083 | -.591 | .166 |
| Science Interest* | -.654 | .083 | -.513 | .166 |
| Math Confidence* | -.652 | .083 | -.218 | .166 |
| Science Confidence* | -.638 | .083 | -.252 | .166 |

*Dependent Variables

## Frequencies and Descriptive Statistic Analyses

Descriptive analyses and frequencies were run for all variables in this study as well as participants' demographic background information. Tables 4.2 and 4.3 report the math and science classes that participants were taking at the time of data collection.

Table 4.2

*Frequencies for Participants' Math Classes by Middle School and High School*

| Class | N | | % | |
|---|---|---|---|---|
| | MS | HS | MS | HS |
| General Math | 315 | -- | 53.30% | -- |
| Pre-Algebra | 79 | -- | 13.37% | -- |
| Algebra I | 143 | 59 | 24.20% | 21.07% |
| Algebra II | 7 | 62 | 1.18% | 22.14% |
| Geometry | 28 | 80 | 4.74% | 28.57% |
| Pre-Calculus/Advanced Math | -- | 29 | -- | 10.36% |
| Calculus I | -- | 9 | -- | 3.21% |
| Calculus II | -- | 2 | -- | .71% |
| Pre-Integrated Math | 6 | -- | 1.06% | -- |
| Integrated Math | 4 | 26 | .68% | 9.29% |
| Statistics | -- | 5 | -- | 1.79% |
| Trigonometry | -- | 8 | -- | 2.86% |
| Other | 9 | -- | 1.52% | -- |
| *Total* | *591* | *280* | | |

*Note.* Percentages are within +/- .2% due to rounding

Participants were enrolled in a wide assortment of math classes that reflects the range of middle school to high school math offerings (6$^{th}$ grade through 12$^{th}$ grade). The top three math classes for middle school participants were general math (53.30%), algebra I (24.20%), and pre-algebra (13.37%). The top three math classes for high school participants were geometry (28.57%), algebra II (22.14%), and algebra I (21.07%).

Table 4.3

*Frequencies for Participants' Science Classes by Middle School and High School*

| Class | N | | % | |
|---|---|---|---|---|
| | MS | HS | MS | HS |
| Earth Science | 175 | 23 | 29.61% | 8.21% |
| General Science | 127 | 23 | 21.49% | 8.21% |
| Life Sciences | 100 | -- | 16.92% | -- |
| Physical Science | 56 | 30 | 9.48% | 10.71% |
| Biology | 25 | 114 | 4.23% | 40.71% |
| Anatomy and Physiology | 18 | 9 | 3.05% | 3.21% |
| Chemistry | 20 | 64 | 3.38% | 22.86% |
| Physics | -- | 15 | -- | 5.36% |
| Other | 70 | 2 | 11.84% | .71% |
| *Total* | *591* | *280* | | |

*Note.* Percentages are within +/- .2% due to rounding

Similarly participants reported a diverse assortment of science classes for their current enrollment. The top three science classes reported by middle school participants were earth science (29.61%), general science (21.49%), and life science (16.91%). Approximately 11% of middle school participants selected the "other" option for their science class. Middle school participants' explanations for "other" included a number who reported "integrated science" for their math class and a high number of participants who cited specific class curriculum that was being taught at the time instead of the course title. The top three science classes reported by high school participants were biology (40.71%), chemistry (22.86%), and physical science (10.71%).

Table 4.4 identifies the gender of participants' math and science teachers. Participants reported higher numbers for female math teachers (59.53%) than male math teachers (40.47%). Higher numbers were also reported for female science teachers (63.51%) than male science teachers (36.49%).

Table 4.4

*Gender Breakdown for Participants' Math and Science Teachers*

| Class | Female | | Male | |
|---|---|---|---|---|
| | N | % | N | % |
| Math Teacher *(n = 850)* | 506 | 59.53% | 344 | 40.47% |
| Science Teacher *(n = 844)* | 536 | 63.51% | 308 | 36.49% |

Table 4.5 describes the results of the descriptive analyses, reporting the range (minimum and maximum values), mean, and standard deviation values for each variable in the study. Table 4.5 also notes the scales for each variable for ease in interpretation of mean scores. The mean age of participants was $M$ = 13.86, $SD$ = 1.55.

Table 4.5

*Descriptive Statistics for Demographic Data, IV, and DV Variables (n = 871)*

| Variables | Min | Max | *Mean* | *SD* |
|---|---|---|---|---|
| Age | 11 | 18 | 13.86 | 1.55 |
| School Level (1=High School) | 1 | 2 | 1.68 | .47 |
| Computer Access[a] | 1 | 3 | 1.15 | .51 |
| Region of Residence (1=NonRural) | 0 | 1 | .63 | .48 |
| Race/Ethnicity (1=Majority) | 0 | 1 | .84 | .37 |
| Family STEM Influence (1=STEM) | 0 | 1 | .32 | .47 |
| Extracurricular STEM Activities[b] | 0 | 4 | .48 | .73 |
| Math Teacher Influence | 11 | 45 | 36.81 | 6.09 |
| Science Teacher Influence | 19 | 70 | 56.83 | 9.22 |
| Math Interest[c] | 1 | 4 | 2.87 | .90 |
| Science Interest[d] | 1 | 4 | 3.08 | .91 |
| Math Confidence[c] | 1 | 4 | 3.10 | .84 |
| Science Confidence[d] | 1 | 4 | 3.17 | .80 |

[a]Scale: 1 = Yes, 2 = No, 3 = Sometimes
[b]Scale: 0 = 0activities, 1 = 1activity, 2 = 2 activities, 3 = 3 activities, and 4 = 4 activities
[c]Scale: 1 = not interested, 2 = slightly interested, 3 = interested, 4 = very interested
[d]Scale: 1 = no confidence, 2 = slightly confident, 3 = confident, 4 = very confident

## Correlations

Examining bivariate correlations can assess the degree that variables are linearly related as well as detect the existence of mutlicollinearity between two variables.

Tabachnick and Fidell (2007) state that “when variables are multicollinear or singular, they contain redundant information and they are not all needed in the same analysis” (p. 83). Any bivariate correlation above .90 is considered to be multicollinear (Tabachnick & Fidell). The strength of the relationship between two variables is determined by the correlation coefficient. Green and Salkind (2008) note that whether the relationship is large or small depends upon the discipline. “However, for the behavioral sciences, correlation coefficients of .10, .30, and .50 irrespective of sign, are, by convention, interpreted as small, medium, and large coefficients, respectively” (Green & Salkind, p. 259).

Pearson correlation coefficients were computed among all independent and dependent variables, resulting in 45 correlation coefficients that are represented in Table 4.6. Based on the results, it was determined that there were no instances of multicollinearity between variables. However, when several correlations are computed, Green and Salkind (2008) suggest using a Bonferonni approach to control for a Type 1 error. The Bonferonni approach requires dividing .05 (general accepted significance level) by the number of computed correlations (Green & Salkind). A correlation is not determined significant unless its $p$ value is less than the corrected significance level. Using the Bonferonni approach, .05 was divided by 45 to determine the new significance level at .0011. Using .0011 as the revised and conservative significance level, 17 of the 45 correlations were deemed significant. These 17 significant correlations are noted with an asterisk (*) in Table 4.6.

Table 4.6

*Correlation Matrix – All Independent and Dependent Variables (n = 871)*

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Region of Residence (1 = NonRural) | -- | | | | | | | | |
| 2 | Race/Ethnicity (1 = Majority) | -.19* | -- | | | | | | | |
| 3 | Family STEM Involvement (1 = STEM) | .04 | .01 | -- | | | | | | |
| 4 | Extracurricular STEM Activities | -.21 | .08 | -.02 | -- | | | | | |
| 5 | Math Teacher Influence | .02 | .05 | -.05 | .01 | -- | | | | |
| 6 | Science Teacher Influence | .04 | -.05 | .01 | -.02 | .39* | -- | | | |
| 7 | Math Interest | .05 | .04 | .01 | .13* | .34* | .16* | -- | | |
| 8 | Math Confidence | .04 | .03 | .02 | .07 | .30* | .14* | .59* | -- | |
| 9 | Science Interest | .02 | -.02 | .05 | .06 | .14* | .39* | .26* | .18* | -- |
| 10 | Science Confidence | .05 | -.03 | .01 | .06 | .14* | .37* | .20* | .33* | .60* |

*Note*: * $p < .0011$ Bonferonni adjustment for multiple correlations to minimize chances of a Type 1 error.

Of the 17 statistically significant correlations, and using Green and Salkind's (2008) interpretation of the correlation coefficient, two were considered to have a large (high) relationship, six were considered to have a medium (moderate) relationship, and nine were considered to have a small (low) relationship. The following subsections describe the statistically significant correlations based on strength of relationship (coefficient) size.

**High Correlations**

Two correlations were considered large based on Green and Salkind's (2008) recommendations for interpreting the size of the correlation coefficient. Analysis indicated a high positive correlation relationship between math interest and math confidence ($r = .59$, $p < .0011$). This suggests that participants who reported higher scores in math interest also reported higher scores in math confidence. A similar high correlation relationship existed between science interest and science confidence ($r = .60$, $p < .0011$). This also reveals that participants who reported higher scores in science interest also reported higher scores in science confidence.

**Moderate Correlations**

Six correlations were considered to be statistically significant medium (moderate) relationships (Green & Salkind, 2008). The variable math teacher influence correlated significantly with science teacher influence ($r = .39$, $p < .0011$) revealing that participants who reported higher scores for their math teacher influence also reported higher scores for their science teacher influence. Science teacher influence correlated significantly with science interest ($r = .39$, $p < .0011$) indicating that participants who reported higher scores for science teacher influence also reported higher scores for an interest in science. Similar to science interest, science teacher influence also correlated significantly with science confidence ($r = .37$, $p < .0011$). The variables of math teacher influence and math interest were statistically significant at the moderate level ($r = .34$, $p < .0011$).

Participants who reported higher scores on the math teacher variables reported a positive relationship (higher scores) on the math interest variables. Similarly, math teacher influence was also statistically significant with math confidence ($r = .30$, $p < .0011$). Finally at the moderate level, analysis revealed a statistically significant correlation between math confidence and science confidence ($r = .33$, $p < .0011$).

**Low Correlations**

Nine correlations were considered to be statistically significant; however, the relationships were low. Analysis revealed a significant relationship between math interest and science interest ($r = .26$, $p < .0011$) indicating that participants who reported a higher math interest score also reported a higher science interest score. Two other statistically significant relationships were between math interest and science confidence ($r = .20$, $p < .0011$) and science interest and math confidence ($r = .18$, $p < .0011$). Both of these were positive relationships suggesting that as participants reported higher scores on one variable, they also reported higher scores on the second variable. Region of residence was significantly correlated with race/ethnicity ($r = -.19$, $p < .0011$). Since both of these variables are dichotomous, the analysis revealed that between race/ethnic categories, greater numbers of majority participants indicated being from a rural area than minority participants.

Several of the correlations between the teacher influence variables and math/science interest and confidence were statistically significant at a low level relationship. Math interest was statistically significant with science teacher influence ($r = .16$, $p < .0011$) and science interest was statistically significant with math teacher influence ($r = .14$, $p < .0011$). Furthermore, science confidence with statistically significant with math teacher influence ($r = .14$, $p < .0011$) and math confidence was statistically significant with science teacher influence ($r = .14$, $p < .0011$). All four of these correlations were positive, revealing that participants who scored higher on one variable in the relationship also scored higher on the second variable. Finally, math interest produced a statistically significant relationship with extracurricular STEM activities. This reveals a relationship between participants who indicated higher scores on math interest with involvement in more extracurricular STEM activities.

## Independent Samples *t*-tests

Four independent samples *t*-tests were conducted to determine if there was a difference between middle school girls and high school girls and their interest and confidence in math and science. If results of the independent samples *t*-tests indicated a statistically significant difference between these two groups (middle school and high school) then the groups would be separated and multiple regression analyses would be run on each group separately. If results indicated there was no statistically significant difference between these two groups then both groups could be combined as one sample for each regression analyses. The four specific independent samples *t*-tests conducted were:

*a) Is there a difference between middle school and high school girls' interest in math?*

*b) Is there a difference between middle school and high school girls' interest in science?*

*c) Is there a difference between middle school and high school girls' confidence in math?*

*d) Is there a difference between middle school and high school girls' confidence in science?*

According to Green and Salkind (2008), there are three assumptions that the data must meet prior to conducting an independent samples *t*-test. These assumptions are:

1. The test variable is normally distributed in each of the two populations.
2. The variances of the normally distributed test variable for the populations are equal.
3. The cases represent a random sample from the population, and the scores on the test variable are independent of each other. (Green & Salkind, p. 176)

Prior data screening (described in the first section of this chapter) at the onset of data analysis ensured that assumptions 1 and 3 were met. When conducting the independent samples *t*-tests, Levene's test for equality of variances was interpreted and indicated that variances between the two samples were equal thus meeting assumption 2.

Analysis of the four independent samples *t*-tests indicated that none of the four independent samples *t*-tests produced statistically significant results. Specifically, an independent samples *t*-test was conducted to determine if there was a difference between middle school girls and high school girls and their interest in math. Results revealed the test was not significant, $t(869) = -1.61$, $p = .11$. A second independent samples *t*-test was conducted to see if there was a difference between middle school girls and high school girls and their confidence in math. Results were not significant, $t(869) = -1.50$, $p = .13$, indicating there was not a statistically significant difference between the two groups and their confidence in math. A third and fourth independent samples *t*-tests were conducted to determine if there was a difference between middle school girls and high school girls and their interest in science and their confidence in science. Results revealed that there were no statistically significant differences between these two groups in their interest in science, $t(869) = 1.72$, $p = .09$, or their confidence in science, $t(869) = -.176$, $p = .86$. Table 4.7 provides a summary review of results for the independent samples *t*-tests.

Table 4.7

*Independent Samples t-tests – Summary of Results (n = 871)*

| | Middle School Girls | | High School Girls | | | | | Confidence Intervals | |
|---|---|---|---|---|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* | *t* | *df* | *p* | Lower | Upper |
| Math Interest | 2.91 | .90 | 2.80 | .90 | -1.61 | 869 | .11 | -.23 | .02 |
| Science Interest | 3.05 | .91 | 3.16 | .89 | 1.72 | 869 | .09 | -.02 | .24 |
| Math Confidence | 3.13 | .83 | 3.04 | .86 | -1.50 | 869 | .13 | -.21 | .03 |
| Science Confidence | 3.17 | .81 | 3.16 | .05 | -0.18 | 869 | .86 | -.12 | .10 |

*Note.* Levene's test for equal variances was not significant, indicating that variances were assumed equal.

## Multiple Regression Analyses

A sequential hierarchical regression approach was used to determine whether the independent variables were statistically significant predictors of the dependent variables. Four sequential hierarchal regression analyses were conducted. There were two blocks for each regression analysis. The first block included the macrosystem variables of regions of residence and race/ethnicity. The second block included the microsystem variables of math or science teacher influence, family STEM influence, and extracurricular STEM activities. Because results of the independent samples *t*-tests showed no statistically significant differences between middle school and high school girls' interest and confidence in math and science, there was no division of these groups in the regression analyses. The following sections report the results for the regression analyses on each of the dependent variables.

**Math Interest**

A sequential hierarchical regression analysis was conducted on the dependent variable of math interests. Based on Bronfenbrenner's (2005) bioecological model of development, the independent variables were grouped into two blocks, macrosystems and microsystems. Table 4.8 reports the blocks in which the variables are entered in the regression analysis, the unstandardized regression coefficients (*b*), the standard error for the unstandardized regression coefficient (*SE b*), standardized regression coefficients (β), and the variance ($R^2$) explained for each model (block).

**Macrosystems math interest (model 1).** Results for the regression analysis indicated that for block 1, neither of the macrosystem variables for significant predictors of math interest, region of residence, race/ethnicity) were statistically significant predictors for math interest, $F(2, 868) = 2.05$, $p = .13$.

**Macrosystems and microsystems math interest (model 2).** Adding the microsystem variables, math teacher influence, family STEM influence, and extracurricular STEM activities in block 2 to the hierarchical regression analysis produced results for the full model. In the full model, $F(5,865) = 28.03$, $p < .001$, math teacher influence ($\beta = .340$, $p < .001$) and extracurricular STEM activities ($\beta = .128$, $p <$

.001) were statistically significant predictors of math interest, accounting for 14% ($R^2$ = .139) of the variance in math interest.

Table 4.8

*Hierarchical Regression Coefficients for Math Interest (n = 871), $R^2$ = .139*

| Variable blocks | *b* | *SE b* | β |
|---|---|---|---|
| Macrosystems (block 1) | | | |
| Constant | 2.703 | .093 | |
| Region of Residence | .108 | .064 | .058 |
| Race/ethnicity | .120 | .084 | .049 |
| Macrosystems and Microsystems (block 2 – full model) | | | |
| Constant | .790 | .191 | |
| Region of Residence | .140 | .061 | .075 |
| Race/ethnicity | .061 | .079 | .025 |
| Math Teacher Influence | .050 | .005 | .340*** |
| Family STEM influence | .034 | .061 | .018 |
| Extracurricular STEM Activities | .170 | .040 | .138*** |

*Note*[1]. *$R^2$ = .005 for block 1; .139 for block 2 – full model*
*Note*[2]. * $p < .05$, ** $p < .01$, *** $p < .01$

**Science Interest**

Similar to the dependent variable math interest, science interest included the same two blocks, with one exception. In block 2, the math teacher influence variable was replaced with the science teacher influence variable.  Table 4.9 reports the blocks in which the variables are entered in the regression analysis, the unstandardized regression coefficients (*b*), the standard error for the unstandardized regression coefficient (SE *b*), standardized regression coefficients (β), and the variance ($R^2$) explained for each model (block).

Table 4.9

*Hierarchical Regression Coefficients for Science Interest (n = 871),* $R^2 = .163$

| Variable blocks | *b* | *SE b* | β |
|---|---|---|---|
| Macrosystems (block 1) | | | |
| Constant | 3.109 | .094 | |
| Region of Residence | .023 | .065 | .012 |
| Race/ethnicity | -.048 | .085 | .085 |
| Macrosystems and Microsystems (block 2 – full model) | | | |
| Constant | .803 | .191 | |
| Region of Residence | .013 | .061 | .007 |
| Race/ethnicity | -.009 | .078 | -.004 |
| Science Teacher Influence | .039 | .003 | .396*** |
| Family STEM influence | .107 | .060 | .055 |
| Extracurricular STEM Activities | .053 | .040 | .043 |

*Note*[1]. $R^2$ = .001 for block 1; .163 for block 2 – full model
*Note*[2]. * $p < .05$, ** $p < .01$, *** $p < .01$

**Macrosystems science interest (model 1).** Results of the regression analysis indicated that for block 1, none of the macrosystem variables (region of residence, race/ethnicity) were statistically significant predictors for science interest, $F(2, 868) = .265$, $p = .78$.

**Macrosystems and microsystems science interest (model 2).** Adding block 2 to the regression analysis produced results for the full model. In the full model, science teacher influence ($\beta = .396$, $p < .001$) was the only statistically significant predictor of science interest, accounting for 16% ($R^2 = .163$) of the variance in science interest, $F(5, 865) = 33.70$, $p < .01$.

**Math Confidence**

A sequential hierarchical regression analysis was conducted on the dependent variable of math confidence. Results were similar to those for the dependent variable of math interests. Table 4.10 reports the blocks in which the variables are entered in the regression analysis, the unstandardized regression coefficients (*b*), the standard error for the unstandardized regression coefficient (*SE b*), standardized regression coefficients (β), and the variance ($R^2$) explained for each model (block).

**Macrosystems math confidence (model 1).** Results of the regression analysis indicated that for block 1, none of the macrosystem variables (region of residence, race/ethnicity) were statistically significant predictors for math confidence, $F(2, 868) = 1.290$, $p = .28$.

**Macrosystems and microsystems math confidence (model 2).** Adding block 2 to the regression analysis produced results for the full model. In the full model, math teacher influence ($\beta = .303$, $p < .001$) and extracurricular STEM activities ($\beta = .078$, $p < .05$) were the only statistically significant predictors of math confidence, accounting for 10% ($R^2 = .10$) of the variance in math confidence, $F(5, 865) = 19.463$, $p < .01$.

Table 4.10

*Hierarchical Regression Coefficients for Math Confidence (n = 871), $R^2$ = .101*

| Variable blocks | *b* | *SE b* | β |
|---|---|---|---|
| Macrosystems (block 1) | | | |
| Constant | 2.980 | .087 | |
| Region of Residence | .084 | .060 | .048 |
| Race/ethnicity | .081 | .079 | .036 |
| Macrosystems and Microsystems (block 2 – full model) | | | |
| Constant | 1.418 | .182 | |
| Region of Residence | .093 | .058 | .054 |
| Race/ethnicity | .036 | .075 | .016 |
| Math Teacher Influence | .042 | .004 | .303*** |
| Family STEM influence | .064 | .058 | .036 |
| Extracurricular STEM Activities | .089 | .038 | .078* |

*Note*[1]. *$R^2$ = .031 for block 1; .101 for block 2 – full model*
*Note*[2]. * $p < .05$, ** $p < .01$, *** $p < .01$

**Science Confidence**

The regression analysis for science confidence included the same two blocks as the analysis for science interest. Table 4.11 reports the blocks in which the variables are entered in the regression analysis, the unstandardized regression coefficients (*b*), the standard error for the unstandardized regression coefficient (*SE b*), standardized regression coefficients (β), and the variance ($R^2$) explained for each model (block).

Table 4.11

*Hierarchical Regression Coefficients for Science Confidence (n = 871),* $R^2$ *= .138*

| Variable blocks | *b* | *SE b* | β |
|---|---|---|---|
| Macrosystems (block 1) | | | |
| Constant | 3.160 | .082 | |
| Region of Residence | .082 | .057 | .050 |
| Race/ethnicity | -.052 | .075 | -.024 |
| Macrosystems and Microsystems (block 2 – full model) | | | |
| Constant | 1.329 | .176 | |
| Region of Residence | .080 | .054 | .048 |
| Race/ethnicity | -.022 | .070 | -.010 |
| Science Teacher Influence | .031 | .003 | .361*** |
| Family STEM influence | .029 | .054 | .017 |
| Extracurricular STEM Activities | .054 | .035 | .050 |

*Note*[1]. $R^2$ *= .004 for block 1; .138 for block 2 – full model*
*Note*[2]. * $p < .05$, ** $p < .01$, *** $p < .01$

**Macrosystems science confidence (model 1).** Results of the regression analysis indicated that for block 1, similar to the previous three models, none of the macrosystem variables (region of residence, race/ethnicity) were statistically significant predictors for science confidence , $F(2, 868) = 1.526$, $p = .22$.

**Macrosystems and microsystems science confidence (model 2).** Adding block 2 to the regression analysis produced results for the full model. In the full model, science teacher influence ($\beta = .361$, $p < .001$) was the only statistically significant predictor of science confidence, accounting for 14% ($R^2$ = .138) of the variance in science interest, $F(5, 85) = 27.698$, $p < .01$.

## Answers to Research Questions

Each of the six research questions is answered in this section using results from the data analyses presented in this chapter.

### Research Question 1 – Background Characteristics

*What are the background characteristics of the 6th-12th grade girls who attended the spring 2009 Taking the Road Less Traveled Career Conference?*

Of the 871 participants in the sample, 591 (67.9%) were middle school students and 280 (32.1%) were high school students. Participants ranged in age from 11 to 18 with the mean age of participants at 13.86, *SD* = 1.55. The majority of participants identified as White (83.9%), followed by Bi-racial/mixed (5.1%), Latina/Hispanic (3.6%), Asian/Pacific/Islander (3.0%), African-American (1.8%), American Indian/Alaskan Native (.9%), and other (1.7%). Approximately 91% of participants had access to a computer at home with 49% living in a suburban area, 37% in a rural area, and 14% in an urban area.

Participants attended more math and science classes taught by female teachers (59.53%, 63.51%) respectively, than math and science classes taught by male teachers (40.47%, 36.49%). Participants were enrolled in a wide range of math classes, the most identified math class was general math (35.48%) and the most identified science class was earth science (22.62%).

Less than half of the participants (32.0%) identified at least 1 parent who had a STEM-type occupation. More than half of the participants (63.3%) were not involved in any extracurricular STEM activities. Slightly more than 27% were involved in one extracurricular STEM activity, followed by 7.1% in two STEM activities, 1.7% in three STEM activities, and .3% in four STEM activities.

**Research Question 2 – Difference between Groups**

*Is there a statistically significant difference between middle school girls' ($6^{th}$-$8^{th}$ grade) and high school girls' ($9^{th}$-$12^{th}$ grade) a) interest in math, b) interest in science, c) confidence in math, and d) confidence in science?*

The answer is no. Results for each of the independent samples *t*-tests revealed no statistically significant differences between middle school girls and high school girls' interest in math interest in science, confidence in math, or confidence in science. Because there were no statistically significant differences between middle school girls and high school girls in any of the four independent samples *t*-tests, the middle school and high school groups were combined for the hierarchical regression analyses on each of the dependent variables of math interest, science interest, math confidence, and science confidence.

**Research Question 3 – Math Interest**

*To what extent do race/ethnicity, region of residence, family STEM influence, extracurricular STEM activities, and math teacher influence predict math interest for middle school ($6^{th}$-$8^{th}$ grade) and high school girls ($9^{th}$-$12^{th}$ grade)?*

Results for the hierarchical regression analysis revealed that there were no macrosystem variables (race/ethnicity, region of residence) that were statistically significant predictors for math interest. However, two of the microsystem variables, math teacher influence and extracurricular STEM activities were statistically significant predictors for middle and high school girls' interest in math. This suggest that the more middle school or high school girls view their math teacher as adhering to the 9-items listed under the math teacher influence construct (e.g., The assignments given help me learn the subject being taught, My teacher encourages my responsibility and effort, I am comfortable asking questions in this class, etc.) the greater their interests will be in math. Also, the more middle school or high school girls participate in extracurricular STEM activities (e.g., math or science club, Project Lead the Way, Environmental club) the greater their interest will be in math.

**Research Question 4 – Science Interest**

*To what extent do race/ethnicity, region of residence, family STEM influence, extracurricular STEM activities, and science teacher influence predict science interest for middle school ($6^{th}$-$8^{th}$ grade) and high school girls ($9^{th}$-$12^{th}$ grade)?*

Results for the hierarchical regression analysis for the dependent variable science interest revealed that the only macro- or microsystem variable that was a statistically significant predictor for science interest was science teacher influence. This suggest that the more middle school or high school girls view their science teacher as adhering to the 14-items listed under the science teacher influence construct (e.g., I get helpful feedback from my teacher, My teacher creates a classroom environment that allows me to learn, and My teacher encourages my responsibility and effort, etc.) the greater their interests will be in science.

**Research Question 5**

*To what extent do race/ethnicity, region of residence, family STEM influence, STEM extracurricular STEM activities, and math teacher influence predict math confidence for middle school ($6^{th}$-$8^{th}$ grade) and high school girls ($9^{th}$-$12^{th}$ grade)?*

Similar to the results for question 3 and 4, there were no macrosystem variables that predicted girls' confidence in math. The microsystem variables of math teacher influence and extracurricular STEM activities were statistically significant predictors for math confidence. Once again, this suggest that the more middle school or high school girls view their math teacher as adhering to the 9-items listed under the math teacher influence construct (e.g., The assignments given help me learn the subject being taught, My teacher encourages my responsibility and effort, I am comfortable asking questions in this class, etc.) the greater their confidence will be in math. Also, the more middle school or high school girls participate in extracurricular STEM activities (e.g., math or science club, Project Lead the Way, Environmental club) the greater their confidence will be in math.

**Research Question 6**

*To what extent do race/ethnicity, region of residence, family STEM influence, extracurricular STEM activities, and science teacher influence predict science confidence for middle school ($6^{th}$-$8^{th}$ grade) and high school girls ($9^{th}$-$12^{th}$ grade)?*

As was the case for questions 3, 4, and 5 there were no macrosystem variables that were statistically significant predictors for girls' confidence in science. However, the microsystem variable of science teacher influence was a statistically significant predictor for girls' confidence in science. Indicating that the more middle school or high school girls view their science teacher as adhering to the 14-items listed under the science teacher influence construct (e.g., I get helpful feedback from my teacher, My teacher creates a classroom environment that allows me to learn, and My teacher encourages my responsibility and effort, etc.) the greater their confidence will be in science.

## Summary

This chapter presented results for the data analyses. Data were analyzed and determined to meet assumptions of data normality. Frequencies and descriptive data were reported for background characteristics of the participants in the study. Seventeen correlations between variables were described. Independent t-tests results revealed no statistically significant differences between middle school and high school girls in their interest in math and science as well as their confidence in math and science. Hierarchical regression analyses results showed that math teacher influence and extracurricular STEM activities were statistically significant predictors for the dependent variables of math interest and math confidence. For the dependent variables of science interest and science confidence, the only statistically significant predictor variable was science teacher influence. A discussion of the results and recommendations for practice and future research are presented in chapter 5.

# CHAPTER 5

# DISCUSSION, CONCLUSIONS, AND IMPLICATIONS

*"I know my daughter loves math and science but a lot of her friends are like, 'Oh, I hate math.' Well they liked it the year before so I don't know."*

*"I think that girls in our school don't really think it's cool to be in the advanced math or science."*
*-Iowa parents on challenges for young women pursuing STEM interests,*
*PWSE Outreach Needs Assessment, 2009-2010*

In this chapter, the results presented in chapter 4 are discussed within the context of the conceptual framework and current literature. The chapter opens with a summary of the study, followed by a discussion of results as noted above, then, implications for policy and practice are presented along with recommendations for future research. The chapter concludes with my final thoughts on the study.

## Summary of the Study

Chapter 1 described the importance of the study and grounded the problem being addressed in the literature. This study is significant because it sought to identify the variables that influence $6^{th}$-$12^{th}$ grade girls' STEM development, reflected by their interest and confidence in mathematics and science. By understanding what variables impact girls' interests and confidence in mathematics and science, resources can be better directed toward promoting their STEM development. By increasing the number of girls who are pursuing STEM degrees and careers, it is hoped that these numbers will help to fill the void that exists with declining numbers of professionals in the STEM areas. Chapter 1 also presented Bronefenbrenner's (2005) bioecological theory of human development and in particular how Bronfenbrenner's model provided the conceptual framework for this study.

Chapter 2 began with an historical perspective of the literature describing the environment for women in STEM fields and how that environment has evolved over time. In addition, a local perspective was presented on the importance of STEM in Iowa and the impact these fields have on the economy at the state and national levels. Information was also presented in chapter 2 that described the microsystems (based on Bronfenbrenner's model) included in this study and the relevant literature relating to middle and high school girls' interest and confidence in science and mathematics including teacher influence, extracurricular STEM activities, and family STEM influence. These contexts/environments are unique in that girls' interact with them on a daily basis. In addition, region of residence (i.e., rural, urban, and suburban) and race/ethnicity were examined as part of the macrosystem of the Bronfenbrenner's bioecological theory of human development to determine their impact on $6^{th}$-$12^{th}$ grade girls' interest and confidence in science and mathematics.

Chapter 3 described the methodological approach used in this study. The philosophical assumptions, research design and research questions, independent and dependent variables along with the results from the factor analyses conducted for the math and science teacher influence constructs were presented as well. In addition, details were provided on how data were analyzed to address each of the research questions. The chapter concluded with a discussion on the delimitations and limitations of the study.

Chapter 4 presented the results of the analyzed data. Both descriptive and inferential statistics were performed to provide answers to the six research questions. At the conclusion of chapter 4, each research question was listed and answered based on the results of the analyses.

In the following section and subsections of this chapter (chapter 5) a discussion of the research results is presented relating them within the context of the conceptual framework and current literature.

## Discussion of the Results

One strategy that has been suggested as a solution in responding to the decreasing numbers of scientists and engineers in the United States is to increase the number of those populations who are currently underrepresented in the STEM fields (Starobin, Laanan, & Burger, 2010; Starobin & Laanan, 2008). Girls and women make up one of these underrepresented groups in the STEM disciplines. For one to show interest in a discipline, there must be some level of affirmation to that discipline. To increase the number of girls pursuing STEM fields, it is important to find successful strategies that encourage their interest and affirm their confidence in the areas of science and mathematics. Denissen, Zarrett, and Eccles (2007) found in their study of 1000 children between the ages of 6-17 that "individuals generally felt competent and interested in domains where they achieve well, and were interested in domains where they perceive their personal strengths" (p. 430). In their study of $7^{th}$-$12^{th}$ grade students, Koller and Baumert (2001) found that those who were highly interested in mathematics chose to enroll in higher level courses and that boys more than girls chose the advanced placement mathematics classes. Koller and Baumert also noted for 7-$10^{th}$ grade students that those who were high achievers also conveyed a higher level of interest.

While it is disputable as to whether the United States is still a world leader in STEM fields, it is important to note that achievement scores in mathematics and science for U.S. students (both girls and boys) have dropped significantly in comparison to other countries (PISA, 2009). Table 5.1 and 5.2 present the mean mathematics and science achievement scores, respectively, for 15 year olds from around the world. According to data from the Program for International Student Assessment (PISA) (2009), assessment results revealed that U.S. students ranked 33 in world rankings in mathematics achievement scores and 23 in science achievement scores. Furthermore, for the 31 countries ranking higher than the United States in mathematics achievement, only two of the countries (Shanghai-China and Sweden) had girls scoring higher than boys did. In science achievement, girls fared a bit better than they did in mathematics achievement. Of the 22 countries ranking higher than the United States in science scores, girls in 13 of these countries scored higher than boys did. According to Denissen et al. (2007), if interest is related to achievement and that perceived strength is related to interest, then increasing the interest and confidence levels for girls in mathematics and science will in turn increase the achievement scores for girls in these areas. The focus of this study was to determine which factors contribute to the interest and confidence for 6-12$^{th}$ grade girls in mathematics and science. Results revealed that of the five independent variables identified within the macro- and microsystems, *family STEM influence, extracurricular STEM activities, teacher influence, race/ethnicity, and region of residence,* only *teacher influence* was a significant predictor for both mathematics interest and confidence and science interest and confidence. Additionally, for math interest and confidence *extracurricular STEM activities* was a significant predictor. In the following sections, results for each of these independent variables will be discussed in greater detail.

Table 5.1
*World Rankings based on Math Achievement Scores of 15 year-olds*

| World Rank | Country | Mean Math Achievement Score[1] | Mean Math ACHIEVEMENT Score[2] | | |
|---|---|---|---|---|---|
| | | | Girls | Boys | Diff |
| 1 | Shanghai-China | 600 | 601 | 599 | +1 |
| 2 | Singapore | 562 | 559 | 565 | -6 |
| 3 | Hong-Kong China | 555 | 547 | 561 | -14 |
| 4 | Korea | 546 | 544 | 548 | -4 |
| 5 | Chinese Taipei | 543 | 541 | 546 | -5 |
| 6 | Finland | 541 | 539 | 542 | -3 |
| 7 | Liechtenstein | 536 | 523 | 547 | -24 |
| 8 | Switzerland | 534 | 524 | 544 | -20 |
| 9 | Japan | 529 | 524 | 534 | -10 |
| 10 | Canada | 527 | 521 | 533 | -12 |
| 11 | Netherlands | 526 | 517 | 534 | -17 |
| 12 | Macao-China | 525 | 520 | 531 | -11 |
| 13 | New Zealand | 519 | 515 | 523 | -8 |
| 14 | Belgium | 515 | 504 | 526 | -22 |
| 15 | Australia | 514 | 509 | 519 | -10 |
| 16 | Germany | 513 | 505 | 520 | -10 |
| 17 | Estonia | 512 | 508 | 516 | -8 |
| 18 | Iceland | 507 | 483 | 491 | -8 |
| 19 | Denmark | 503 | 495 | 511 | -16 |
| 20 | Slovenia | 501 | 501 | 502 | -1 |
| 21 | Norway | 498 | 495 | 500 | -5 |
| 22 | France | 497 | 489 | 505 | -16 |
| 22 | Slovak Republic | 497 | 495 | 498 | -3 |
| 24 | Austria | 496 | 486 | 506 | -20 |
| 25 | Poland | 495 | 493 | 497 | -4 |
| 26 | Sweden | 494 | 495 | 493 | +2 |
| 27 | Czech Republic | 493 | 490 | 495 | -5 |
| 28 | United Kingdom | 492 | 482 | 503 | -21 |
| 29 | Hungary | 490 | 484 | 496 | -12 |
| 30 | Luxembourg | 489 | 479 | 499 | -20 |
| 31 | United States | 487 | 477 | 497 | -20 |

*Note 1&2: Rankings are based on inclusion of both OECD countries and non-OECD, Data from 2009 PISA Assessment*

Table 5.2

*World Rankings based on Science Achievement Scores for 15 year-olds*

| World Rank | Country | Mean Science Achievement Score[1] | Mean Science ACHIEVEMENT Score[2] | | |
|---|---|---|---|---|---|
| | | | Girls | Boys | Diff |
| 1 | Shanghai-China | 575 | 575 | 574 | +1 |
| 2 | Finland | 554 | 562 | 546 | +16 |
| 3 | Hong-Kong China | 549 | 548 | 550 | -2 |
| 4 | Singapore | 542 | 542 | 541 | +1 |
| 5 | Japan | 539 | 545 | 534 | +11 |
| 6 | Korea | 538 | 539 | 537 | +2 |
| 7 | New Zealand | 532 | 535 | 529 | +6 |
| 8 | Canada | 529 | 526 | 531 | -5 |
| 9 | Estonia | 528 | 528 | 527 | +1 |
| 10 | Australia | 527 | 528 | 527 | +1 |
| 11 | Netherlands | 522 | 520 | 524 | -4 |
| 12 | Chinese Taipei | 520 | 521 | 520 | +1 |
| 12 | Germany | 520 | 518 | 523 | -5 |
| 12 | Liechtenstein | 520 | 511 | 527 | -16 |
| 15 | Switzerland | 517 | 512 | 520 | -8 |
| 16 | United Kingdom | 514 | 509 | 519 | -10 |
| 17 | Slovenia | 512 | 519 | 505 | +14 |
| 18 | Macao-China | 511 | 512 | 510 | +2 |
| 19 | Poland | 508 | 511 | 505 | +6 |
| 19 | Ireland | 508 | 509 | 507 | +2 |
| 21 | Belgium | 507 | 503 | 510 | -7 |
| 22 | Hungary | 503 | 503 | 503 | nd |
| 23 | United States | 502 | 495 | 509 | -14 |

*Note 1&2: Rankings are based on inclusion of both OECD countries and non-OECD. Data from 2009 PISA Assessment*

**Macrosystems**

Based on a review of the literature, two variables at the macrosystem level were hypothesized at the onset of this study as having an influence on 6-12$^{th}$ girls' interest and confidence in mathematics and science. Neither of these two variables, race/ethnicity or region of residence, were statistically significant predictors of 6-12$^{th}$ girls' interest or confidence in mathematics or science.

**Race/Ethnicity.** While race/ethnicity was not a statistically significant predictor for interest or confidence in mathematics or science in this study, several studies have suggested that in some cases minority students have demonstrated a stronger interest in STEM than their white peers (Anderson & Kim, 2006; Bruyere, Billingsley, & O'Day, 2009; Hanson, 2009; Wenner, 2003). The encouraging news is that for the girls in this study there were no differences in interest and confidence levels in math and science between race/ethnicity groups; however, it is important to note that a great deal of researchers have noted that when it comes to science, minority students experience unique barriers (Anderson & Kim, 2006; Bruyere, Billingsley, & O'Day, 2009; Hanson, 2009; Wenner, 2003).

In her book *Swimming Against the Tide,* (2009) Hanson indicated that African American girls not only fight the gender barrier, but find that racism is often an even greater obstacle. Even though some girls expressed interest in science, Hanson found that young African American girls often felt unwelcome in science, and that "the science education system is structured in a way that favors white middle-class males" (p. 5). Hanson goes on to say that:

> When gender and skin color are the major factors determining who will do science, a considerable amount of scientific talent is lost. The implications for this talent loss for scientific discovery and advance are considerable. The implications are also great for the young people who are denied access to science since they

> will not be involved in the creation of policies and technologies that will guide us through the next century. (p. 6)

Whitman Brown (2002) also suggested when science is taught in the traditional manner, that the science, engineering, and math pathways are not inclusive of students of color. Educators including administrators, teachers, and counselors along with some parents have eliminated STEM career options for some underrepresented students as they progressed through their educational experiences (Whitman Brown). In her study, Whitman Brown noted seven variables or themes that were factors in Hispanic students' participation in science and mathematics:

> 1) support of their family members;
> 2) high ability student;
> 3) interactive curriculum;
> 4) pre-college coursework that prepared them for rigorous math and science courses in college;
> 5) teachers that showed an interest in and a desire for the students to learn;
> 6) small class size; and
> 7) living in a small community where there is usually a commitment to "place and being not found in a larger city." (p.143)

This last variable/theme that Whitman Brown identified, living in a small community, may be one reason that race/ethnicity was not a significant predictor in this study such that most communities and school districts in Iowa are relatively small and students may be more likely to find that "place and being" that Whitman Brown refers too.

While race/ethnicity was not a significant predictor of 6th-12th grade girls' interest and confidence in science and mathematics in this study, the demographics of Iowa continue to become more diverse. If future research finds that race/ethnicity is a significant factor in determining girls' interest and confidence in science and mathematics, it will be essential to determine what can and should be done to address the issue.

**Region of Residence.** Results of this study indicated that region of residence was not a statistically significant factor influencing the STEM development of the 6th-12th grade girls who participated in this study. Although considered a Midwestern, agricultural state, only 38.9% of Iowa's residents live in rural areas (Iowa Data Center, 2008). Chapter 2 of this study outlined access issues (e.g., lack of resources, educators teaching upper level science and math courses that they are not certified to teach) present in some of the smaller school districts that may influence girls' interest and confidence in science and mathematics.

In order to generate interest in science and mathematics among rural high school girls in the state of Washington, Ginorio, Huston, Frevert, and Seibel (2002) implemented the Rural Girls in Science (RGS) program that served American Indians, Latinas, and Whites. While their afterschool program did cultivate interest among some of the (RGS) participants, they encountered several challenges along the way. Ginorio et al. (2002) noted that if the girls came from families that were very traditional in their values and beliefs, then their interest in science may not have been reinforced because it was not perceived by the parents as gender appropriate. Furthermore, educators within the rural school districts expressed concern over a lack of resources and a decrease in flexibility due to the implementation of state standards. While the students perceived their teacher to be the most influential aspect of their educational experience, the teachers were not in charge of setting policy or allocating budgets. Counselors stated that they were able to spend very little time mentoring the average student with an interest in science and college aspirations because their time was consumed with the brightest students and those with the greatest behavioral challenges (Ginorio et al.). While their initial goal was to increase an interest in science, Ginorio et al. found that in order for the girls to remain engaged and persist in science, programs must have the support of policy makers, administrators, educators, and families.

Some of the barriers that emerged from the Ginorio et al. (2002) study have also been found in urban school districts as well. In addition to issues involving race, class, and gender equity, a lack of resources, student engagement, academic achievement, and educators teaching in areas in which they are not certified – specifically upper level science and mathematics courses are all challenges experienced in many urban school districts (Atwater & Lee, 2006; Barton, 2001; Fraser-Abder, Emdin, 2010; Knapp & Plecki, 2001).

The results of this study indicate that whether a family lives in a rural or non-rural area does not significantly impact the STEM development of $6^{th}$-$12^{th}$ grade girls who participated in this study. These findings are reinforced by the literature citing the cultural and academic challenges found within both rural and non-rural regions. The result indicating that region of residence is not a statistically significant predictor is important (and perhaps encouraging) because region of residence lies within the macrosystem of the conceptual model used for this study. According to Bronfenbrenner

(2005), the macrosystem consists of systems that are embedded within a culture or subculture and making changes as these levels are particularly difficult. In other words, it is not likely that in order to advance girls' interest and confidence in mathematics and science, policy would be developed to dictate where a female student lives or attends school.

## Microsystems

Three microsystems were hypothesized as impacting 6-12th grade girls' STEM development. Each microsystem is addressed in the following subsections.

**Math/Science teacher influence.** Results of this study indicated that teacher influence was a statistically significant predictor of STEM development. Specifically, math teacher influence was a predictor for math interest and confidence and science teacher influence was a significant predictor for science interest and confidence for the girls 6-12th grade girls who participated in this study.

The participants in this study were asked to rate their agreement with 14 items describing the teaching characteristics and classroom dynamics for their math and science teachers, individually. Results of a factor analysis revealed that for participants' responses based on their math teacher nine of the 14 items loaded on one construct. A second factor analysis was conducted for the same items using the participants' reflections on their science teachers, in this case all 14 of the items loaded. For a more detailed review of the factor analysis results, please refer to chapter 3.

Because the construct of math teacher influence was a significant predictor for girls' interest and confidence in math and the construct of science teacher influence was a significant predictor for girls' interest and confidence in science, it is valuable to review those items that led to the development of the teacher influence factors. There were nine items in common that loaded for both the math and the science teacher influence constructs. These items are:

- My teacher creates a classroom environment that allows me to learn.
- My teacher encourages my responsibility and effort.
- The assignments given help me learn the subject being taught.
- My teacher encourages us to ask questions.
- My teacher asks questions that challenge me to think.
- My teacher communicates high expectations.
- I get help from my teacher.
- I am comfortable asking questions in class.
- I enjoy learning the material in the class.

Additional five items for science teacher influence include:

- My teacher tells the class about resources that will help us learn about the subject we are studying, when appropriate.
- In class, we use a variety of classroom activities and resources that help me learn.
- My teacher encourages us to apply what we've learned to situations outside of class.
- My teacher talks about possible careers in science, technology, engineering, and/or math.
- We use technologies in class that help me learn.

Since the teacher influence construct was a significant predictor, the results of this study suggest that by focusing on encouraging and developing each of these items in a teacher's pedagogy and classroom environment, it is possible to advance girls' interest and confidence in the areas of mathematics and science. A synthesis of the common items, suggest that for the girls' in this study who reported higher interest and confidence in math and science, their teachers encouraged their responsibility and challenged them within a supportive environment that inspired active engagement in their learning.

Progress during the last 30 years in terms of girls' academic achievement in science and mathematics has demonstrated how critical positive learning environments are in generating interest and growing abilities (AAUW, 2010). In addition to students' performance, Huang and Brainard (2001) found that the pedagogical skills of the classroom teacher are instrumental in developing students' confidence.

A synthesis of the additional five items that loaded for the science teacher influence construct, demonstrates the effect that hands on activities have in promoting girls' interest and confidence in science. Specifically, science teachers who used a variety of classroom activities, encouraged application of concepts learned in class to outside activities, and provided additional resources that helped students learn the activities were significant in advancing girls' interest and confidence in science. When hands-on activities are used in the science classroom, it is important to find those activities that are engaging for both male *and* female students. Weber and Custer (2005) suggest that activities that are inherently appealing to boys should be developed to ensure they are gender-balanced in order to overcome the disparity in topical interest.

In order to increase participation and engage girls in the classroom, Sadker et al. (2009) note that the mirco-inequities that often take place, while often unintentional, must be addressed. Issues that reinforce the chilly climate experienced by girls in some science and math classes include receiving less instructional time, fewer challenges, reinforcement of gender stereotypes, and differential feedback and encouragement to name a few (Burke & Mattis, 2007; Hanson, 2009).

According to Bronfenbrenner's bioecological model, the classroom environment designated in this study as Math/Science Teacher Influence is also a microsystem that has a strong influence on the developmental trajectory of a child. Bronfenbrenner (2005) noted that changes can be made to or within the microsystem system that have a positive impact on the developmental experiences of the child. In this case, professional development opportunities for current and pre-service educators to create an awareness and understanding of the subtle cues and implicit biases that impact $6^{th}$-$12^{th}$ grade girls' interest and confidence in science and mathematics. Educators must ensure that instructional styles meet the diversity of learning styles within the classroom (Hanson, 2009). Introducing girls to hands-on science, technology, engineering, and mathematics activities early on in their educational experience is critical for cultivating interest in STEM (Baine, 2008).

Results of this study provide detailed information on teaching skills that positively impact girls' interest and confidence in mathematics and science. The identification of these skills can be used to improve science and mathematics teaching, which Sevo (2009) notes as critical to improving science literacy and increasing the number of students with a STEM workforce trajectory.

**Extracurricular STEM involvement.** Formal science education has traditionally been identified as the pathway for developing scientific literacy among the U.S. youth (Bruyere, Billingsly, & O'Day, 2009). However, Bruyere et al. noted that science achievement can also be enhanced through Informal Science Education (ISE) activities such as after-school programs, visits to museums, nature centers, etc. Assessment of the after school programs in Bruyere et al.'s study suggested that the ISE activities were successful in part because they catered to different learning styles and took place in a comfortable learning environment.

The 2004 AAUW report *Under the Microscope* also emphasized the importance of extracurricular (informal learning environments) STEM activities indicating that they play a crucial role in developing interest in STEM areas because the outside of normal class time activities are generally self-selected which means that students who choose to participate often have a fundamental interest or curiosity about the subject area or activity being explored.

The results of this study indicated that extracurricular STEM involvement was a statistically significant predictor of math interest and math confidence. Extracurricular STEM involvement was not, however, significant in predicting science interest and confidence. Accordingly, the AAUW (2010) report *Why so Few?* stated that "extra-curricular STEM activities with a specific focus on increasing interest and confidence are rare" (p. 2) and of the programs that do exist, many of them concentrate on science rather than mathematics. In their research on outreach programs, Anderson and Gilbride (2003) determined that participating in an outreach program with a STEM focus significantly increased girls' interest in pursuing engineering as a career.

If, as mentioned in chapter 2 of this study, girls' achievement in mathematics is affected by the confidence they have to successfully complete a task, and that involvement in extracurricular STEM activities has a positive impact on their interest and confidence in mathematics, it would be beneficial to create more opportunities for girls to engage in extracurricular STEM activities – specifically activities that involve mathematics concepts which connect content to real world issues. Hosting the events in a comfortable learning environment and ensuring that the activities are facilitated by a positive, female role model are two additional aspects that have been previously described as strategies to successfully engaging girls in STEM (see chapter 2) that when addressed may serve to increase their interest and confidence in STEM activities (e.g., AAUW, 2010: Andre et al., 1999; Herbert & Stipek, 2005; Jacobs et al., 2002; Simpkins & Davis-Kean 2005).

In this study, extracurricular STEM involvement was not a significant predictor for girls' interest and confidence in science; whereas, it was a significant predictor for girls' interest and confidence in mathematics. The lack of congruence for extracurricular STEM involvement in not being a predictor for both math and science, could be due to the fact that there are more opportunities for girls to participate in science extracurricular activities in Iowa (e.g., 4H, FFA, Project Lead the Way, Environmental Clubs) than there are for math extracurricular activities. However, as demonstrated through the results of this study when opportunities for extracurricular activities relating to math are offered their impact is significant in developing girls' interest in math, suggesting the need to further fund and provide math-type extracurricular activities.

**Family STEM influence.** Parents are often unaware of career opportunities in STEM fields, especially those in engineering. However, there is a great deal of research indicating that parents have a strong influence on their child's academic choices and experiences which directly or indirectly influences career aspirations (Bachman, Hebl, Martinez, & Rittmayer, 2009; Dryler, 1998; Halpbern, et al., 2007; Hanson, 2009; Starobin & Laanan, 2005).

In this study, family STEM influence was determined by whether a participant had a parent whose occupation was identified within the STEM fields. Participants in this study listed their parents' occupations and each occupation was then coded as STEM or non-STEM. A conservative approach was used to identify STEM-based careers based on the 2009 Iowa Board of Regents report, *Women and Minorities in STEM programs at Iowa's Public Universities*. Results of the hierarchical regression analysis indicated that a parent's employment in a STEM career was not a statistically significant predictor of the $6^{th}$-$12^{th}$ grade girls' interest and confidence in science and mathematics. These findings are contrary to previous research focusing on parental influences (e.g., Corbett, Hill, & Rose, 2008; Davis-Kean, 2007; Gilmartin, Li, & Aschbacher, 2006; Mannon & Schreuders, 2007). One reason family STEM influence may not have been significant in this study is the conservative means in which the STEM careers were coded. For example, a participant who indicated that a parent "worked at John Deere" – a company that employees a large number of engineers – as well as a number of other professionals who would not be deemed as falling into a STEM-type career (e.g., administration, factory workers, etc.), was not coded in the data analysis as a STEM career. It may have been possible, but was not assumed that the parent was an engineer, and within the conservative coding scheme this person was categorized as non-STEM.

In their 2003 study of 1057 high school students, Anderson and Gilbride (2003) found that the majority of students listed parents and family members as influencers of their future career choice. Anderson and Gilbride also noted that female students with a parent who is an engineer were more than twice as interested in an engineering career as were female students without a parent who is an engineer, and that interest is further increased if the engineer in the family is female.

Bronfenbrenner (2005), in his bioecological model, described a microsystem as experiences and events that an individual encounters in a specific face-to-face environment with other persons having distinctive characteristics and belief systems present, and provided the example of family as one type of microsystem. Bronfenbrenner also stated that the microsystems have the strongest influence and impact on a child. In other words, the behaviors and beliefs of the parents influence the behavior of the child. Teachman and Paasch (1998) also described the family as a micro-social environment that shapes the educational experiences that children have and the future occupations they choose by the values, attitudes, aspirations, and expectations they convey through socialization and role modeling. According to Gilmartin, Li, and Aschbacher (2006), it is not enough to have a family member who works in a STEM field. Gilmartin et al. found that girls can pick up on mixed messages about their roles and view of mathematics from subtle and not so subtle societal cues.

While family STEM influence in this study was not a predictor of girls’ interest and confidence in science and mathematics, previous research as noted in this section has demonstrated that parents play a critical role in shaping the educational experiences and therefore the career trajectory of their children. Parental awareness of the impact they have and strategies for encouraging their daughter's interest in science and mathematics can be provided through parental STEM educational opportunities and enhanced communication of such opportunities.

## Conclusion

This study sought to provide information that would help to address the significant problem of the underrepresentation of girls in STEM-programs and career fields by seeking to identify variables within the development trajectory of girls' that impact their interest and confidence in mathematics and science. Bronfenbrenner's (2005) model of bioecological human development was used to guide the identification of variables in the developmental trajectory; specifically, the macro- and microsystems that impact girls' STEM development. In review, only two of the microsystems hypothesized at the onset of this study as having an impact on girls STEM development, *math teacher influence* and *extracurricular STEM involvement*, were found to be statistically significant predictors for 6-12$^{th}$ grade girls' interest and confidence in mathematics. And only one of the microsystems, *science teacher influence*, was found to be a statistically significant predictor for 6-12$^{th}$ grade girls' interest and confidence in science. None of the hypothesized macro-systems, *race/ethnicity* or *region of residence*, were significant predictors. What is most encouraging about the results of this study is that for the microsystems identified as predictors of girls' interest and confidence in mathematics and science (i.e., teacher influence and extracurricular activities), it IS possible to make changes and foster development in these areas through policies, education, and practice that will help to advance girls' interest and confidence in mathematics and science; whereas, implementing change at a macro-level is much more difficult to organize, implement, and successfully achieve.

## Implications for Policy and Practice

Understanding the factors that influence 6th-12th grade girls' interest and confidence in science and mathematics is essential for addressing the persistence of girls in science and mathematics classes in order to increase the representation of girls and women pursuing STEM degrees, and ultimately the STEM workforce. The findings of this study provide several implications for policy and practice.

It is clear that science and mathematics classroom experiences and extracurricular STEM activities impact the educational trajectory of 6th-12th grade girls STEM development. The quantitative results illustrate the influence that science and mathematics teachers and extracurricular STEM activities have on the science interest and confidence, and math interest and confidence of 6th-12 grade girls in Iowa. As mentioned in chapter 2, girls begin to form opinions about their abilities as early as elementary school. As they progress through the K-12 pipeline and math and science courses become more rigorous, the confidence girls have in their ability to perform well in those courses decreases (Huang & Brainard, 2001). Because there is often a positive correlation between confidence in one's ability to perform well and interest level (Denissen et al., 2007), it is essential to implement strategies that will foster and reinforce girls' interest and confidence in science and mathematics.

At the programmatic level for PWSE, and program similar to PWSE, the results of this study may inform future outreach efforts including professional development opportunities for pre-service and in-service teachers, counselors, administrators, and parents that include 1) understanding the factors that influence girls' interest and confidence in science and mathematics and, 2) strategies to support and grow their STEM development. The results of this study also reinforce the important role that extracurricular STEM activities like the *Taking the Road Less Traveled Career Conferences* have on girls' STEM development.

The broader impacts resulting from this study includes recommendations that may be used in any learning environment by educators, administrators, and parents.

**Recommendations**

Based on the results of this study, the following strategies are recommended toward encouraging, developing, and facilitating girls' interest and confidence in mathematics and science:

1. Communicate high expectations while providing support for meeting those expectations.
2. Provide opportunities that encourage creativity and innovation.
3. Encourage a positive learning environment, where questions are encouraged and girls feel comfortable asking questions.
4. Discuss possible career opportunities in STEM.
5. Provide additional resources to encourage further exploration (for parents as well as students).

   *Example Resources:*

   a. Engineer Your Life – www.engineeryourlife.org
   b. Girl Start – www.girlstart.org

c. Scitable by nature Education – www.nature.com/scitable
d. Figure This! – www.figurethis.org
e. WEPAN Knowledge Center – www.wepanknowledgecenter.org

6. Share what extracurricular STEM opportunities are available for girls in STEM

   *Example Activities:*

   a. Math and Science clubs
   b. Environmental clubs
   c. Taking the Road Less Traveled Career Conference for Girls
   d. 4-H, Future Farmers of America (FFA)
   e. State Science Fair
   f. Project Lead the Way
   g. First Lego League

7. Create a connection between classroom content and real world applications.
8. Evaluate the physical presence of math and science classrooms (posters, bulletin boards, displays, etc.). Make certain it is representative of the diversity within the class – at a minimum.
9. Develop assignments that encourage students to share interests that have personal relevance.
10. Determine what kinds of STEM extracurricular opportunities currently exist in the school district and community. If there are gaps in availability of programs or diversity in programs then develop programming to meet the needs based on interests.

11. Review curriculum and use examples that are free of gender bias and traditional stereotypes.

## Recommendations for Future Research

This study contributes to the existing literature on the underrepresentation of girls pursuing STEM areas of study by examining the factors that influence $6^{th}$-$12^{th}$ grade girls' interest and confidence in science and mathematics.

The use of Bronfenbrenner's bioecological model of human development to investigate the factors that influence the STEM development of $6^{th}$-$12^{th}$ grade girls is unique to this study. While examining relationships within and between these nested systems, future research might consider investigating the impact of STEM professional development on student engagement in the classroom. Also of interest would be exploring whether there are differences between public, parochial, and magnet schools in the STEM development of students. Examining the impact of factors that are situated within the exosystem (No Child Left Behind, State STEM initiatives, for example) and how they influence the classroom environment and STEM development may be appropriate for future examination as well.

Additional research should be conducted that follows the same research design used in this study, but with a longitudinal approach thus addressing Bronfenbrenner's (2005) chronosystem which was not accounted for in this study. The results of this study were achieved through a cross-sectional design and determining the "developmental" factors that contribute to girls' interest and confidence in mathematics and science might be better served through a longitudinal study that measures these factors throughout their adolescent developmental trajectory.

This study focused only on 6-12$^{th}$ grade girls and the factors that influence their interest and confidence in mathematics and science. Since the goal of this study was to identify the impact of those factors only on girls' interest and confidence in mathematics and science, there were no gender comparisons made with 6-12$^{th}$ grade boys or control groups used in the research design. However, since dismal U.S. academic achievement scores for both girls *and* boys were addressed earlier in this chapter, it would be beneficial to conduct a similar study to determine if the same factors identified in this study were also significant predictors for boys' interest and confidence in mathematics and science. Research identified earlier in this chapter supported a link between a student's interest and confidence and achievement scores.

Similar studies should also be conducted in different regions of the country. Results of this study revealed that region of residence was not a significant predictor of interest and confidence in math and science. However, it is possible that these results were not significant because Iowa is a fairly homogenous state with minimal to at most medium variations between rural and non-rural state demographics and resources. Similar studies in other regions of the country would help to determine whether the results of this study are unique to Iowa and its demographics or if the macrosystem, region of residence, is not a universal significant predictor for girls' interest and confidence in mathematics and science.

Although the influence of peers was outside the scope of this study, previous research has suggested the important role that peers have on whether girls' pursuit and persist in STEM fields (Clewell, 2002; Sadker et al., 2009; Stake & Nickens, 2005).

Future research might include the influence of peers at the microsystem level of human development.

## Final Thoughts

The lack of girls and women pursuing and persisting in STEM fields is a complex issue that begins with experiences early on in a girls' academic journey. This study illuminates the important role that math and science teachers, along with extracurricular STEM activities, have on girls' interest and confidence in mathematics and science. However, it is not the teachers alone who are responsible for addressing this issue. It is also apparent in the literature that parental awareness and support are a critical part of the STEM development equation. What I find particularly encouraging within the results of this study is that positive outcomes regarding girls' interest and confidence in mathematics and science can be impacted through professional development opportunities for educators, parental awareness of STEM resources and STEM careers, and evaluating and adding extracurricular STEM activities based on girls' interest in participating.

It is not enough however for change to take place at the microsystem levels alone. State and federal agencies have indicated that increasing the number of girls and minorities in STEM is a priority in order to address new and emerging issues that require a growing and diverse pool of scientists and engineers. As a result, reports and initiatives have been generated to illustrate the pathway to STEM; however, to implement the recommendations made by these reports it is imperative that monetary resources are consistently available.

Not every girl will choose a STEM career, but she should have the opportunity to make that decision by knowing what is available to her. And should she desire to pursue a STEM field, her STEM developmental path should be cultivated, reinforced, and supported.

# APPENDIX A. MIDDLE SCHOOL SURVEY INSTRUMENT

**MIDDLE School Student Questionnaire – TRLT Conference 2009**
**Part I – School Math and Sciences Classes**

1. The math class I am currently taking is: (if your class is not listed please select other and write the name of the class)

_______General

_______Algebra I

_______Algebra II

_______Geometry

_______Other_______________________________________

2. My math teacher is:

_______Female

_______Male

3. The science class that I am currently taking is:

_______ Earth Science

_______ Other _______________________________________

4. My science teacher is:

_______Female

_______Male

For the next set of questions, using the scale below, please circle the number that matches your level of agreement with each statement. You should have two answers for each question. One answer that reflects your agreement with the statement as it relates to your math class and one answer that reflects your agreement with the statement as it relates to your science class.

**Scale: 1=Strongly Disagree, 2=Disagree; 3 = Neutral; 4 = Agree, and 5=Strongly Agree**

| | **Statements** | **Math Class** | | | | | | **Science Class** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | I enjoy learning the material in this class. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 6 | We use technologies in class that help me learn. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 7 | My teacher creates a classroom environment that allows me to learn | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 8 | The assignments given help me learn the subject being taught | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 9 | In class, we use a variety of classroom activities and resources that help me learn | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 10 | My teacher encourages us to apply what we've learned to situations outside of class. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 11 | My teacher encourages us to ask questions. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 12 | I am comfortable asking questions in class. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | My teacher communicates high expectations. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 14 | My teacher encourages my responsibility and effort. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 15 | My teacher asks questions that challenge me to think. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 16 | I get helpful feedback from my teacher. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 17 | My teacher tells the class about resources that will help us learn about the subject we are studying, when appropriate. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 18 | My teacher talks about possible careers in science, technology, engineering, and/or math. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |

Using the same scale as above, please answer the following question.
19. Our school counselors talk about possible careers in science, technology, engineering, and/or math?
**1 2 3 4 5**

**Part II – After School Activities**
20. I am involved in the following activities (please check all that apply).

________Math Club

________Science Club

________Academic clubs other than math and science
(e.g., Debate, language)

________Band/Music

________Theatre and/or Arts Clubs

________Sports/Athletic teams

________4-H

________Future Farmers of America (FFA)

________Church group

________Girl Scouts

________ Environmental/Outdoor Club

________Volunteering

________Civic groups (e.g., Key club)

________ Student council

________Project Lead the Way

________State Science Fair

________First Lego League

________ Other (please list) ______________________________

21. In a one-week period (Monday through Friday), how many hours do you spend in these activities? ____ _______________

22. From the list below please check all activities that you **would like** to be involved in, but are currently **NOT** involved (please check all that apply):

_______None, I am involved in all the activities I want to be

_______Math Club

_______Science Club

_______Academic clubs other than math and science
(e.g., Debate, language)

_______Band/Music

_______Theatre and/or Arts Clubs

_______Sports/Athletic teams

_______4-H

_______Future Farmers of America (FFA)

_______Church group

_______Girl Scouts

_______ Environmental/Outdoor Club

_______Volunteering

_______Civic groups (e.g., Key club)

_______ Student council

_______Project Lead the Way

_______State Science Fair

_______First Lego League

_______ Other (please list) _____________

23. For any of the activities you selected above, please explain why you are not involved in those that you selected

**Part III – Program for Women in Science and Engineering**
**The Program for Women in Science and Engineering provides a number of after-school and in-school activities and programs for students in grades Kindergarten through 12. We'd like to know more about what you are interested in to help us plan these activities and programs.**

For the next set of questions, you will be using the scales below, please circle the number that matches your level of agreement. You should have two answers for each question. One answer that reflects your level of **INTEREST** in each activity area and one answer that reflects your level of **CONFIDENCE** in that activity area. For example, if you love math activities you would circle a "4" under the INTEREST column. If you think you do very well and are comfortable doing math related activities, you would circle a "4" under the CONFIDENCE column. If you struggle with math related activities or don't think you do well, you might circle a "1" or "2."

| | | **INTEREST LEVEL** | | | | | **CONFIDENCE IN MY SKILLS** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Activity/Program Areas** | 1=Not interested | 2=Slightly Interested | 3= Interested | 4=Very Interested | | 1=No confidence, I don't think I do well in this activity area | 2= Slightly confident | 3=Confident | 4=Very confident, I always do well and am comfortable in this activity area |
| 24 | Math | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 |
| 25 | Science | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 |
| 26 | Computer | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 |
| 27 | Environment/Outdoors | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 |
| 28 | Problem Solving | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 |
| 29 | Creativity and Design | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 |
| 30 | Space/Astronomy | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 |
| 31 | Health | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 |
| 32 | Engineering | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 |

**Now we'd like to know more about the different ways in which you would like to participate in activities relating to the areas above.**

For this next set of questions, you will be using the scales below, please circle the number that matches your level of agreement. You should have two answers for each question. One answer that reflects your level of **INTEREST** with the specific participation method and one answer that reflects how **likely you would be to attend** an activity that is conducted using that method. For example, if you love attending summer camps you would circle a "4" under the interest column. If you are pretty sure you would attend a summer camp sponsored by PWSE at ISU, you would circle a "4" under the ATTEND column. If you are unsure whether you would attend you might circle a "2."

| | | **INTEREST LEVEL** | | | | | **ATTENDANCE** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Activity/Program Delivery Methods** | 1=Not interested in programs or activities using this method | 2=Slightly Interested | 3= Interested | 4=Very Interested in programs or activities using this method | | 1=No, I would not attend a program or activity using this method | 2= Not sure | 3= Yes, I would attend a program or activity using this method |
| 33 | Summer Camps | 1 | 2 | 3 | 4 | | 1 | 2 | 3 |
| 34 | Online Programs | 1 | 2 | 3 | 4 | | 1 | 2 | 3 |
| 35 | Workshops after school – at my school | 1 | 2 | 3 | 4 | | 1 | 2 | 3 |
| 36 | Workshops after school – at Iowa State University | 1 | 2 | 3 | 4 | | 1 | 2 | 3 |
| 37 | Workshops on the weekends – at Iowa State University | 1 | 2 | 3 | 4 | | 1 | 2 | 3 |
| 38 | Workshops after school – at my local community college | 1 | 2 | 3 | 4 | | 1 | 2 | 3 |
| 39 | Workshops on the weekends – at my local community college | 1 | 2 | 3 | 4 | | 1 | 2 | 3 |

**Part V – Demographics**

**40. My age is: _________**

**41. What is your race/ethnicity:**

________Caucasian

________African American

________Asian/Pacific Islander

________Latina/Hispanic

________American Indian/Alaskan Native

________Bi-racial/mixed race

________Other_________________________

**42. I live in:**

_______A rural area (e.g., you live in the country)

_______A suburban area (e.g., you don't live in the country or the city)

_______An urban area (e.g., you live in the city like downtown Des Moines, not the suburbs of Des Moines)

_______I don't know

**43. I have access to a computer at my home?**

_______Yes

_______No

_______Sometimes

**44. I have access to a computer that is connected to the internet at my home?**

_______Yes

_______No

_______Sometimes

**45. IF YOUR MOTHER IS CURRENTLY EMPLOYED, what is her current occupation/job? ______________________________________**

**46. IF YOUR FATHER IS CURRENTLY EMPLOYED, what is his current occupation/job? _______________________________________**

**47. If I had to decide right now, I would say my occupation/job will be? ______________________________________________**

# APPENDIX B. HIGH SCHOOL SURVEY INSTRUMENT

**HIGH School Student Questionnaire – TRLT Conference 2009**
**Part I – School Math and Sciences Classes**

1. The math class I am currently taking is: (if your class is not listed please select other and write the name of the class)

_______Algebra I

_______Algebra II

_______Statistics

_______Geometry

_______Trigonometry

_______Pre-Calculus/Advanced Math

_______Integrated Math

_______Calculus I

_______Calculus II

_______Other___________________________________

2. My math teacher is:

_______Female

_______Male

3. The science class that I am currently taking is:

_______ Biology

_______Chemistry

_______Earth Science

_______Physics

_______Other ___________________________________

4. My science teacher is:

_______Female

_______Male

For the next set of questions, using the scale below, please circle the number that matches your level of agreement with each statement. You should have two answers for each question. One answer that reflects your agreement with the statement as it relates to your math class and one answer that reflects your agreement with the statement as it relates to your science class.

**Scale: 1=Strongly Disagree, 2=Disagree; 3 = Neutral; 4 = Agree, and 5=Strongly Agree**

| | **Statements** | **Math Class** | | | | | | **Science Class** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | I enjoy learning the material in this class. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 6 | We use technologies in class that help me learn. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 7 | My teacher creates a classroom environment that allows me to learn. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 8 | The assignments given help me learn the subject being taught. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 9 | In class, we use a variety of classroom activities and resources that help me learn. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 10 | My teacher encourages us to apply what we've learned to situations outside of class. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 11 | My teacher encourages us to ask questions. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 12 | I am comfortable asking questions in class. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 13 | My teacher communicates high expectations. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 14 | My teacher encourages my responsibility and effort. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 15 | My teacher asks questions that challenge me to think. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 16 | I get helpful feedback from my teacher. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 17 | My teacher tells the class about resources that will help us learn about the subject we are studying, when appropriate. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 18 | My teacher talks about possible careers in science, technology, engineering, and/or math. | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |

Using the same scale as above, please answer the following question.

19. Our school counselors talk about possible careers in science, technology, engineering, and/or math?
**1 2 3 4 5**

**Part II – After School Activities**

20. I am involved in the following activities (please check all that apply).

________Math Club

________Science Club

________Academic clubs other than math and science

(e.g., Debate, language)

________Band/Music

________Theatre and/or Arts Clubs

________Sports/Athletic teams

________4-H

________Future Farmers of America (FFA)

________Church group

________Girl Scouts

________ Environmental/Outdoor Club

________Volunteering

________Civic groups (e.g., Key club)

________ Student council

________Project Lead the Way

________State Science Fair

________First Lego League

________ Other (please list) ____________________________

21. In a one-week period (Monday through Friday), how many hours do you spend in these activities? ____ _______________

22. From the list below please check all activities that you **would like** to be involved in, but are currently **NOT** involved (please check all that apply):

________None, I am involved in all the activities I want to be

________Math Club

________Science Club

________Academic clubs other than math and science
(e.g., Debate, language)

________Band/Music

________Theatre and/or Arts Clubs

________Sports/Athletic teams

________4-H

________Future Farmers of America (FFA)

________Church group

________Girl Scouts

________ Environmental/Outdoor Club

________Volunteering

________Civic groups (e.g., Key club)

________ Student council

________Project Lead the Way

________State Science Fair

________First Lego League

________ Other (please list) ____________________________

23. For any of the activities you selected above, please explain why you are not involved in those that you selected

**Part III – Program for Women in Science and Engineering**
**The Program for Women in Science and Engineering provides a number of after-school and in-school activities and programs for students in grades Kindergarten through 12. We'd like to know more about what you are interested in to help us plan these activities and programs.**

For the next set of questions, you will be using the scales below, please circle the number that matches your level of agreement. You should have two answers for each question. One answer that reflects your level of **INTEREST** in each activity area and one answer that reflects your level of **CONFIDENCE** in that activity area. For example, if you love math activities you would circle a "4" under the INTEREST column. If you think you do very well and are comfortable doing math related activities, you would circle a "4" under the CONFIDENCE column. If you struggle with math related activities or don't think you do well, you might circle a "1" or "2."

| | | **INTEREST LEVEL** | | | | | **CONFIDENCE IN MY SKILLS** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Activity/Program Areas** | 1=Not interested | 2=Slightly Interested | 3= Interested | 4=Very Interested | | 1=No confidence, I don't think I do well in this activity area | 2= Slightly confident | 3=Confident | 4=Very confident, I always do well and am comfortable in this activity area |
| 24 | Math | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 |
| 25 | Science | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 |
| 26 | Computer | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 |
| 27 | Environment/Outdoors | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 |
| 28 | Problem Solving | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 |
| 29 | Creativity and Design | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 |
| 30 | Space/Astronomy | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 |
| 31 | Health | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 |
| 32 | Engineering | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 |

**Now we'd like to know more about the different ways in which you would like to participate in activities relating to the areas above.**

For this next set of questions, you will be using the scales below, please circle the number that matches your level of agreement. You should have two answers for each question. One answer that reflects your level of **INTEREST** with the specific participation method and one answer that reflects how **likely you would be to attend** an activity that is conducted using that method. For example, if you love attending summer camps you would circle a "4" under the interest column. If you are pretty sure you would attend a summer camp sponsored by PWSE at ISU, you would circle a "4" under the ATTEND column. If you are unsure whether you would attend you might circle a "2."

| | | **INTEREST LEVEL** | | | | | **ATTENDANCE** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Activity/Program Delivery Methods** | 1=Not interested in programs or activities using this method | 2=Slightly Interested | 3= Interested | 4=Very Interested in programs or activities using this method | | 1=No, I would not attend a program or activity using this method | 2= Not sure | 3= Yes, I would attend a program or activity using this method |
| 33 | Summer Camps | 1 | 2 | 3 | 4 | | 1 | 2 | 3 |
| 34 | Online Programs | 1 | 2 | 3 | 4 | | 1 | 2 | 3 |
| 35 | Workshops after school – at my school | 1 | 2 | 3 | 4 | | 1 | 2 | 3 |
| 36 | Workshops after school – at Iowa State University | 1 | 2 | 3 | 4 | | 1 | 2 | 3 |
| 37 | Workshops on the weekends – at Iowa State University | 1 | 2 | 3 | 4 | | 1 | 2 | 3 |
| 38 | Workshops after school – at my local community college | 1 | 2 | 3 | 4 | | 1 | 2 | 3 |
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**Part V – Demographics**

**40. My age is: _________**

**41. What is your race/ethnicity:**

_______Caucasian

_______African American

_______Asian/Pacific Islander

_______Latina/Hispanic

_______American Indian/Alaskan Native

_______Bi-racial/mixed race

_______Other________________________

**42. I live in:**

_______A rural area (e.g., you live in the country)

_______A suburban area (e.g., you don't live in the country or the city)

_______An urban area (e.g., you live in the city like downtown Des Moines, not the suburbs of Des Moines)

_______I don't know

**43. I have access to a computer at my home?**

_______Yes

_______No

_______Sometimes

**44. I have access to a computer that is connected to the internet at my home?**

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_______Sometimes

**45. IF YOUR MOTHER IS CURRENTLY EMPLOYED, what is her current occupation/job? _____________________________________**

**46. IF YOUR FATHER IS CURRENTLY EMPLOYED, what is his current occupation/job? ______________________________________**

**47. If I had to decide right now, I would say my occupation/job will be? _______________________________________________**

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