EINSTEIN GIRLS: EXPLORING STEM CAREERS, INTEREST, AND IDENTITY IN AN ONLINE MENTORING COMMUNITY

By

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To my husband Noel, daughter Rachael, and son Jordan-You are my inspiration for life. To my Dad, Uncle Bill, and Kathy-You are my inspiration for STEM. To the Einstein Girls past, present, and future-You are my inspiration for this project.

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ISL	ILS refers to informal science learning and can be used to supplement traditional science education programs. These often take place outside of school and may include, but are not limited to, after-school programs, summer camps, off-site field trips, and science museum visits. Quality ISL programs should utilize the best practices of inquiry-based learning, problem-solving, peer collaboration, hands-on training, career exploration, and interactions with practicing scientists, engineers, and other experts.
OMC	OMC refers to an online mentoring community. Online mentoring is defined as a relationship between a mentor and a protégé which provides learning, advising, encouraging, prompting, and modeling. Online mentoring is accomplished through the Internet and can connect mentors with protégés from any place at any time.
SCLE	SCLE refers to a student-centered learning environment. This type of environment is designed to provide self-directed interactive activities that enable the participants to address their unique learning interests and needs. In an SCLE, the participants engage in complex open-ended problem contexts enriched with resources, technology tools, and scaffolding among the members and make meaning and construct knowledge while engaged in authentic and real-world activities.
STEM	STEM is an acronym that refers to science, technology, engineering, and mathematics.

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The purpose of this project was to create and study an online mentoring community that connected fifth and sixth grade girls and female STEM mentors. The project was designed to give girls who were interested in science the chance to communicate online with women who were successful STEM professionals. The community provided the girls a venue to ask the women questions about their careers, their interests, and their science identities. Through this venue the girls were able to explore various STEM careers, be exposed to role models, and potentially increase their interest in science for the future.

Mentoring has been shown to have a positive impact on girls and help improve their attitudes toward science and interests in STEM. The project examined the nature of the online mentoring process as well as the participants' perceptions of the opportunities and constraints of the community. The girls were members of an after-school academy and the mentoring took place through the Internet using a secure educational social networking program. The program spanned a four-week period between April and May 2013.

The main purpose of this study was formative since online mentoring is a relatively new area of research. This investigation produced detailed accounts of activities between the girls and the mentors. Findings revealed that the participants approached the community uniquely and explored many aspects of career exploration, STEM interest, and science identity. The participants also identified what they perceived as the opportunities afforded by the community as well as the constraints posed by the community.

The research represented by this study was practitioner research with the work connecting theory with practice. The knowledge gained through the intentional reflection on and study of the Einstein Girls online mentoring community was useful in the production of knowledge that is transformative for the researcher’s professional practice and transferable to other settings. The results of this study are most applicable to online mentoring programs with similar contexts and demographics, but are also applicable to other online mentoring communities. Findings from this study have direct implications in the design and operation of future online mentoring programs.

CHAPTER 1
ENCOURAGING GIRLS IN STEM

Introduction

Science, technology, engineering, and mathematics, which are collectively known by the acronym STEM, represent the achievements that reflect the power of imagination, drive the market, and constitute critical aspects of the future economy, job creation, and global competitiveness (Beede et al., 2011; Carnevale, Smith, & Melton, 2011; National Research Council [NRC], 2011). Innovation, knowledge, creativity, and competition are at the heart of the U.S. economy and require the development of sufficient science and mathematics talent (Beede et al., 2011; Carnevale et al., 2011; Hill, Corbett, & St. Rose, 2010). STEM permeates nearly every aspect of modern American life and represents the key to meeting many of our most urgent challenges. The principal driving force of the future U.S. economy and accompanying creation of jobs will be innovation, largely derived from advances in science and engineering (National Academy of Sciences [NAS], 2012).

In addition, an increasing number of jobs will require knowledge of science and technology (NRC, 2011). According to the National Science Foundation (NSF, 2010), a key strategy for the United States is the cultivation of a world-class, broadly inclusive science and engineering force and an expansion of the scientific literacy of all citizens. U.S. Department of Labor workforce projections for 2018 show that a majority of the fastest-growing occupations will require a minimum of a bachelor's degree and significant scientific training (Hill et al., 2010). The demands for STEM competencies will be especially important in healthcare, professional, and business services (Carnevale et al., 2011). A report from the U.S. Department of Commerce demonstrates that growth in STEM-related fields was three times faster than non-related fields over the past ten years, and that these American workers command higher wages than their non-related counterparts (Langdon, McKittrick, Beede, Khan, & Doms, 2011). The U.S. must continue development of scientific talents to meet the needs of a changing economy and society.

Over the past half-century, data from the NSF, the NRC, the RAND RaDiUS database, the U.S. Census Bureau, and the U.S. Bureau of Labor Statistics have indicated significant shortages of scientists and engineers in the United States (Butz et al., 2003; Carnevale et al., 2011; NAS, 2007; 2012; NSF, 2006b; 2010; 2011a; 2012). Such shortages affect the competitiveness and growth of the U.S. as well as our long-term economic and national security (Butz et al., 2003). Our universities are not producing enough professionals to successfully fill and compete in global science and technology markets (Butz et al., 2003; Carnevale et al., 2011; NRC, 2011; NSF, 2012; Tai, Liu, Maltese, & Fan, 2006). As a result, the U.S. has come to rely increasingly on imported talent in research laboratories, software development houses, and product design centers (Carnevale et al., 2011; NRC, 2011; NSF, 2010; Tai et al., 2006). Infusions of talent are no longer a supplement, they are a necessary part of our American enterprise. The value of imported talent is evident in an increasingly competitive and innovative marketplace, as our dependence reflects weaknesses and vulnerabilities that cannot be overlooked. There are not enough American college students majoring in science and technology disciplines, causing a measureable gap between open STEM positions and qualified graduates to fill those positions (Carnevale et al., 2011; NSF, 2010). A concerted effort is underway to encourage a new generation of STEM innovators by identifying and developing America's human resources (NSF, 2010).

The NSF (2010) calls for a "collective commitment to excellence in education and the development of scientific talent" (p. 1) to ensure the long-term prosperity for our country. Too many of America's "best and brightest young men and women go unrecognized and underdeveloped" (NSF, 2010, p. 1). This is a key reason for the shortage of scientists and engineers in the U.S. The STEM workforce is crucial to American global competitiveness and innovative capability, yet women are underrepresented in related careers relative to their position in the overall labor market (Beede et al., 2011; Butz et al., 2003; Carnevale et al., 2011; Halpern et al., 2007; Hill et al., 2010; NSF, 2011b). There are a number of supporting studies that document the shortage of women in some STEM occupations, such as those requiring engineering and technology skills (Beede et al., 2011; Butz et al., 2003; Carnevale et al., 2011; Halpern et al., 2007; Hill et al., 2010; Lawrence & Mancuso, 2012; NSF, 2006b; 2011b; 2012). While women make up about half of the U.S. workforce they make up approximately 25 percent of the science and engineering labor market (Beede et al., 2011; Halpern et al., 2007; NSF, 2006c). Women have made gains over the past several years in terms of science and technology employment, but are still underrepresented in some key occupations such as engineering, computer science, and mathematics (Beede et al., 2011; Carnevale et al., 2011; Hill et al., 2010; Lawrence & Mancuso, 2012; NSF, 2011b).

A number of researchers have questioned why women are still underrepresented in some STEM areas (American Association of University Women [AAUW], 1992; 1994;

Baker & Leary, 1995; Barton, Tan, & Rivet, 2008; Brickhouse, Lowery, & Schultz, 2000; Brotman & Moore, 2008; Halpern et al., 2007; Hill et al., 2010; Jones, Howe, & Rua, 2000; Jovanovic & Steinbach King, 1998; Kahle & Lakes, 1983; NAS, 2012; Papadimitriou, 2004; Sadker & Sadker, 1994; Weinburgh, 1995). The underrepresentation of women in related jobs may be attributable to educational factors, social and cultural factors, and intrapersonal factors (Beede et al., 2011; Hill et al., 2010; NAS, 2012). The shortage of women in STEM professions translates to an untapped opportunity to expand related employment in the U.S. (Beede et al., 2011; NSF, 2007; Purcell, 2012).

To remain competitive in a changing global economy, the U.S. needs to broaden participation by encouraging more women to enter the STEM pipeline (NAS, 2007; NRC, 2011; NSF, 2006a; 2010; 2011b). Since most STEM careers require a related degree, emphasis should be made on attracting females into the pipeline when they are young, well before the time they enroll in college and choose majors (Committee on Equal Opportunities in Science and Engineering [CEOSE], 2004; Maltese & Tai, 2010; Purcell, 2012; Tai et al., 2006). The NRC (2011) has recommended improved K-12 science and technology education in the U.S. to encourage more girls to choose related college trajectories and careers.

There appears to be a correlation between K-12 education and the development of women STEM professionals (Building Engineering & Science Talent [BEST], 2004; NAS, 2012; Purcell, 2012). The NAS (2012) maintains that the most pressing challenge facing the U.S. educational system is to provide opportunities for all students for learning. The NAS (2007) encourages our schools to provide students with exemplary

K-12 science and mathematics curriculum modeled on world-class standards. The NRC (2011) submits specific goals for K-12 STEM education, including strategies to broaden the participation of women in related fields and the workplace.

In addition to quality K-12 education, the NSF (2010) outlines recommendations to prepare for the next generation of innovators, which suggests our schools "cast a wide net" (p. 3), encouraging more girls to become STEM leaders. The U.S. Department of Education published a practice guide that "formulates specific and coherent evidence-based recommendations that educators can use to encourage girls in the fields of math and science" (Halpern et al., 2007, p. 1). Both documents recommend strategies designed to encourage more girls in science and mathematics. Some of the strategies include: fostering a supportive educational environment sparking initial curiosity and encouraging long-term interest, utilizing high-quality informal enrichment programs which stimulate interest, exposing girls to female role models who have succeeded in science and technology careers, and expanding school computer infrastructures to connect girls with STEM mentors in the scientific research community (Halpern et al., 2007; NSF, 2010).

Girls May be Encouraged into STEM through K-12 Education

Women majoring in STEM fields at the university level must become interested in science and mathematics early on since these majors require the rigor of upper-level high school courses (Purcell, 2012). For girls to take demanding science and mathematics courses in high school, advanced-level prerequisite courses are usually taken during the middle school years. Therefore it is apparent that girls need to become interested in science and STEM early on, well before entering high school. This may help encourage girls to enroll in rigorous science and mathematics courses, better preparing them for STEM majors and careers (Halpern et al., 2007; Hill et al., 2010; NRC, 2011; Purcell, 2012; UMass Donahue Institute, 2011).

Girls in upper elementary and middle school are at a critical point in their scientific, technical, and mathematical development (Reis & Graham, 2005). According to a number of sources, gender differences in science interest are minimal during the elementary school years but appear to increase during middle school and high school, with girls becoming increasingly less interested in science than boys (AAUW, 1994; 2004; Andre, Whigham, Hendrickson, & Chambers, 1998; Archer et al., 2010a; Archer, DeWitt, Dillon, Osborne, & Wong, 2010b; Blue & Gann, 2008; DeWitt et al., 2010; Farland-Smith, 2009; Hill et al., 2010; Koenig & Hanson, 2008; NAS, 2012; NRC, 2011; Purcell, 2012; Reis & Graham, 2005; Skamp & Logan, 2005). Specifically, young girls have been shown to demonstrate an interest in science and positive attitudes towards science at age 10, but show declines in both by age 14 (Archer et al., 2010a; Archer et al., 2010b; DeWitt et al., 2010). By this age, Tytler (2010) says a girl's interest in the study of science has been largely formed and the implication is that intervention after this point in their schooling may become increasingly more difficult.

Science identity has also been explored as a factor of how, why, and when girls engage in science (Archer et al., 2010a; Barton et al., 2008; Brotman & Moore, 2008; DeWitt et al., 2010; Farland-Smith, 2009). Science identity describes one's proficient performance in scientific practices with deep thinking, knowledge, understanding, and engagement in science (Brickhouse et al., 2000; Carlone, 2004). Farland-Smith (2009) stated that science identity refers to someone who "recognizes oneself and gets recognized as 'a science person' by others" (p. 415). She also maintained that "middle school girls are especially vulnerable as they are constructing their own identities" (p. 415). Kahle (1990) added that middle school is the time when some girls develop negative feelings towards science and science classes. This may cause some girls to no longer consider certain STEM fields, such as engineering, as a potential career.

It is important for schools and teachers to encourage an interest for girls in science as early as possible, since their interest may decline during the transition to middle school. An excellent science program that begins strong at the elementary school level may form an essential foundation, stimulating girls' subsequent interest in science. This may influence them to select the demanding courses in science and mathematics needed to succeed in middle school, high school, college, and in their careers (NRC, 2007; NSF, 2010; Purcell, 2012). In addition, informal and enrichment programs may encourage more girls in STEM. Girls may benefit from exposure to female scientific role models through mentoring opportunities (Halpern et al., 2007; NSF, 2010; Purcell, 2012). Involving girls in informal science, enrichment, and mentoring programs may also influence them to pursue science and mathematics trajectories in school and in college (Afterschool Alliance, 2011; Brotman & Moore, 2008; Farland-Smith, 2009; Heilbronner, 2009; Jovanovic & Steinbach King, 1998; Koenig & Hanson, 2008; Maltese & Tai, 2010; NAS, 2012; NRC, 2011; Patrick, Mantzicopoulos, & Samarapungavan, 2009; Tai et al., 2006; Vanmali & Abell, 2009). Perhaps Purcell (2012) framed the argument best when she said, "As a country, we stand to gain a lot by exposing young girls to STEM fields and encouraging those who are interested to follow their hearts and minds" (p. 17).

Problem of Practice

For the past 21 years, I have directed a science enrichment laboratory-based program as a part of my professional practice. Science enrichment is offered to students from grades three through six as a part of a Lower School that serves students from grades Pre-Kindergarten through six. The Lower School is a PK-6 division of a PK-12 private college-preparatory independent day school in an urban city in Florida. In a typical school year over 500 students participate in my enrichment program. Since the school services students from grades Pre-Kindergarten through twelve, I have the unique opportunity to follow the progress of many former students from the time they leave my program until they graduate from high school and enter college.

In 2006, I enrolled in the Educational Specialist program at the University of Florida's College of Education. It was there I first began to consider the need to encourage more girls into science and STEM. During the first course in the program I was asked to find my passions as an educator by moving through a series of exercises designed to explore my teaching strategies, practices, curriculum, and beliefs as a teacher-inquirer (Dana & Yendol-Silva, 2003). I thought about the many young girls I knew in my enrichment classes who were interested in science and saw themselves as science persons (Farland-Smith, 2009). Some of these same girls lost interest in science and no longer considered themselves as science persons as they moved through middle school and into high school. In addition, several parents talked with me about their desire to have extra science opportunities for their daughters outside of school to keep them interested and engaged in science. Two questions kept coming to mind: Why were so many girls losing interest in science and no longer considering themselves as science persons as they transitioned from elementary school to middle and high school? What could I do to help encourage a long-term interest and identity for these girls in science?

Einstein Girls

In 2009, I took the first step in answering these questions and formed an after school program for girls in fifth and sixth grade which I called Einstein Girls. This program was one of the school's after-school academy offerings. The after-school academy was designed to provide students enrolled in the Lower School a number of enriching opportunities for the exploration of academics, athletics, and arts. The goal of the Einstein Girls program was to use research-based strategies to develop the interests of more girls in science and STEM. My aim was to encourage girls in STEM before they reached the age when interest in science and science identity showed the tendency to decline. I envisioned girls working together with me after school in groups with others of similar background and looked for unique activities that appealed to their interests. Academy meetings included activities that allowed girls to work in laboratories, participate in scientific research, learn about STEM careers, and receive face-to-face (F2F) mentoring from successful female STEM professionals. They also participated in an online community using a school-based social media program.

Einstein Girls has been a part of the after-school academy for four years. During that time I have been building a strong network of girls interested in science (current and former Einstein Girls). This group functions as a student-centered learning environment (SCLE), where students are provided with self-directed and real-world activities which enable them to address their unique learning interests and needs (Land, Hannafin, & Oliver, 2012). In addition, a growing group of female STEM professionals has become involved with the Einstein Girls, acting as guest speakers and occasionally as mentors. While encouraging all underrepresented individuals in STEM should be the ultimate goal, the focus of this specific program was on encouraging fifth and sixth grade girls to continue their pursuits of STEM through their schooling years and college, and perhaps direct them into a related career.

Online Mentoring Community

The Einstein Girls continued to meet during the spring semester of 2013 with a new element added to the program. The Einstein Girls expanded their school-based online community to include female STEM professionals as mentors. This community functioned as an online mentoring community (OMC). Previous experiences indicated the girls were positively engaged while participating in the online community and that the format appealed to their social networking interests. During the spring semester, the OMC consisted of 19 fifth and sixth grade Einstein Girls, one former Einstein Girl student assistant, and six female mentors. These mentors represented various branches of STEM fields and were known by me and purposefully selected by me from our school community. I served as owner and director of the community.

Purpose of Project

There is a large body of research devoted to K-12 science education but very little research devoted to K-12 STEM education. I used K-12 science education research to inform much of this project but used the terms science and STEM interchangeably throughout the project. The purpose of this capstone project was to examine in depth the nature of the online mentoring process, the discussions that took place between the girls and female STEM mentors, and the themes that emerged from the discussions. Special focus was placed on career exploration and the establishing or strengthening of interest in STEM and science identity for the mentees. This project also explored the participants' perceptions of the opportunities and constraints surrounding the online mentoring process. The following research questions guided this capstone project:

1. RQ 1: What is the nature of the online mentoring process--with special focus on mentees' career exploration, interest in STEM, and their science identities?
2. RQ 2: What are the participants' perceptions of the opportunities and constraints surrounding online mentoring?

Research Design

A qualitative research design was used to frame this study for both questions. Qualitative research was chosen in efforts to collect descriptive data to gain insight into the nature of the online mentoring community and the mentees' perceptions of the community (Gay, Mills, & Airasian, 2009). To answer the first research question, I examined two aspects of the online mentoring process: the participation in the OMC by the community members and a thematic analysis of the online discussions. I completed an examination of the discussions that took place between the girls and the mentors. Numerical data contained within the online community program were examined to determine the frequencies of participation for each of the community members. Transcripts of conversations that took place in the online community site were evaluated to determine the levels of participation for community members. The interactions that took place between the students and the mentors were also analyzed and classified.

Secondly, I explored the themes that emerged from those discussions using a thematic analysis of the online transcripts of the mentor-mentee discussion threads collected during April and May 2013. The discussion threads related to the mentors' careers, their interest in STEM, and their science identities. Each message contained in a discussion thread representing a writer's thoughts served as a unit of data analysis

(Garrison, Anderson, & Archer, 2001). These transcripts were analyzed using an a priori codebook developed from a variety of sources, including existing research and theories as well as my own experiences and observations (see Appendix A). This method is also known as 'theoretical' thematic analysis by Braun and Clarke (2006) since is "driven by the researcher's theoretical or analytical interest in the area, and is thus more explicitly analyst-driven" (p. 84). This method was used to identify and analyze patterns or themes within the data, and used to "code for a quite specific research question" (Braun & Clarke, 2006, p. 84). As the data analysis progressed, codes were subsequently modified, added, merged, or deleted during the analysis using the constant comparison method (Corbin & Strauss, 2008). An audit trail was established to allow any outsider to "examine the processes of data collection, analysis, and interpretation" (Gay et al., 2009, p. 377). The data collection and data analysis processes are described in greater detail in Chapter 4.

To analyze the second research question, I returned to the relevant posts of the online transcripts and purposefully selected individual girls to interview. Two types of girls were interviewed: those who seemed interested in the online mentoring process and those who did not seem interested in the online mentoring process. In this way I was able to determine their perceptions of both the opportunities and the constraints surrounding the online mentoring process. I used transcripts from seven completed interviews collected from the selected mentees during May 2013. The interviews followed a semi-structured format, which allowed me to explore issues by asking probing questions and following hunches (Maltese & Tai, 2010). The interviews took place at school and were video recorded and transcribed. I also conducted a focus group with the six mentors. The purpose of the focus group was to gather evidence related to the perceptions of the opportunities and constraints surrounding the online mentoring process from the perspective of the mentors. The focus group followed a semi-structured format. The mentors were asked questions about the mentoring process during the group setting and were free to talk with the other group members. The focus group took place at school and was video recorded and transcribed. The data collection and data analysis processes for the interviews and the focus group are described in greater detail in Chapter 4.

Trustworthiness of Research

Lincoln and Guba (1985) proposed the four criteria of credibility, transferability, dependability, and confirmability to evaluate the trustworthiness of interpretive research and to insure the rigor of research. Credibility is the “adequate representation of the social world under study” (Bradley, 1993, p. 436). Efforts to increase the credibility of this study included prolonged observation and engagement of the girls and member checking of interview transcripts by the participants (Lincoln & Guba, 1985). Transferability relates to the application of the researcher’s work to another context (Zhang & Wildemuth, 2009). Rich descriptions of the project and data sets were provided to allow future researchers to make judgments about the findings’ transferability to other settings (Zhang & Wildemuth, 2009). Dependability is the “coherence of the internal process and the way the researcher accounts for changing conditions in the phenomena” (Bradley, 1993, p. 437). This means the findings of the study are consistent and may be reproduced. I provided a clear description of the design of the OMC as well as of the methods employed by this study. Confirmability is the “extent to which the characteristics of the data, as posited by the researcher, can be confirmed by others who read or review the research results" (Bradley, 1993, p. 437). I kept coding manuals and an audit trail throughout the project. I also kept a researcher journal where I recorded observations and reflections. In addition, a colleague acted as an outside observer during the focus group. She kept notes during the meeting and also completed a member check of the final transcript and the results of the project.

Researcher's Subjectivity

This research represents practitioner research and as the principal investigator for this project, my knowledge and experience in the fields of science education and online mentoring are inherently subject to bias when conducting my research. Although attempts were made to exclude thoughts and feelings, these may have an effect on the analysis and interpretation of my results. I utilized member checking and an outside observer to limit the potential subjectivity that may have influenced my results.

Significance of Research

The practice of online mentoring has potential to support the growth of individual students, guiding them and providing them positive influences in STEM as well as in many other areas. Research has indicated that mentoring is effective at inspiring students as they work towards their career goals (Long & Close, 2012). There is research that assesses the effectiveness of mentors when working with mentees in the business world or higher education (Bierema & Merriam, 2002; Blake-Beard, Bayne, Crosby, & Muller, 2011; Garrison et al., 2001; Penny & Bolton, 2010; Simonsen, Luebeck, & Bice, 2009) and research assessing the effectiveness of mentors when working with mentees in online mentoring communities (Burgstahler, 2006; Dorner, 2012). Halpern et al. (2007) noted there is little research matching female STEM mentors and role models with K-12 girls.

The AAUW recommends exposing girls to successful female role models and mentors as a prescriptive measure for future success in STEM (Halpern et al., 2007; Hill et al., 2010). Online mentoring communities provide a way to accomplish this measure. This area of research and practice is formative and the results of this study were specific to the Einstein Girls program. However, the findings from this study have direct implications in the design and operation of similar programs.

Limitations

The student participants were members of the Einstein Girls program who chose to be a part of the group as well as a part of the research study. As such, the number of student participants was relatively small (n=20). The girls were members of a private school population and shared a common bond of interest in science; this may not be typical for the average fifth or sixth grade girl. The number of female STEM mentors was also small (n=6) and purposefully limited. This allowed student participants the opportunity to receive specific information from various mentors within the community. Since this was not a longitudinal study, it was not possible to follow the Einstein Girls' schooling and career paths to determine whether or not they became STEM professionals themselves.

Organization of the Study

The study was organized into seven Chapters represented in Table 1-1. Chapter 1 provides an overview of the capstone project and identifies the purpose and research problem. Chapter 2 provides an introduction to STEM and STEM occupations as well as STEM majors in college. Chapter 2 also reviews the research on K-12 STEM education and includes a discussion on several factors that influence girls' interest in STEM and science identity. Chapter 3 offers a literature review that examines the context of the Einstein Girls through the theoretical framework of the program. Chapter 4 presents the two research questions the capstone project seeks to answer and includes a description of the data collection process and the data analysis procedure. Chapter 5 outlines the results of the capstone project, and discusses the nature of the online mentoring process and the participants' perceptions of the OMC. A discussion of the study is included in Chapter 6, and Chapter 7 presents the implications of the study and suggestions for future research.

Table 1-1. Dissertation format

Chapter	Title	Summary
1	Encouraging girls in STEM	Introduction to project, description of problem of practice, and overview of project
2	Current status of STEM	Introduction to STEM and STEM occupations, STEM majors in college, K-12 STEM education, and factors influencing girls' interests in STEM
3	Literature review	Review of research and literature examining the context of the Einstein Girls OMC project through the theoretical framework of the program
4	Methodology: A qualitative analysis of the OMC	Description of context of capstone project including descriptions of data collection and analysis procedures
5	Results	Results of RQ 1 and 2
6	Discussion	Discussion of RQ 1 and 2
7	Implications and conclusions	Presents implications and suggestions for future research

CHAPTER 2
CURRENT STATUS OF STEM

Introduction

The purpose of Chapter 2 is to provide an overview of the current status of STEM occupations and education in the U.S. Chapter 2 examines the current status of women in STEM occupations and STEM education and reviews the research and literature related to girls and their science education and other science experiences. Chapter 2 concludes with a discussion of several factors that may affect the participation of girls in STEM.

What is STEM?

The acronym STEM refers to science, technology, engineering, and mathematics. The U.S. government defines STEM in a variety of ways, but usually uses the term to refer to the physical, biological and agricultural sciences; computer and information sciences; engineering and engineering technologies; and mathematics (Hill et al., 2010). In the report *Broadening Participation in America's Science and Engineering Workforce*, the CEOSE (2004) stated that the local and global challenges of the new millennium resound with a call for the best minds to come together to apply and advance areas of STEM to deal with the growing complexity of the technological world. For the U.S. this means that ongoing and future leadership depends on the development of science and technology talents of all of its citizens, keeping in line with the National Defense Act of 1950, which set forth the mission to "promote the progress of science; to advance the national health, prosperity and welfare; and to ensure the national defense" (NSF, 2011a, p. 2).

Over a half a century ago during World War II, President Franklin Roosevelt posed the question to the U.S. Office for Science Research and Development: "Can an effective program be proposed for discovering and developing scientific talent in American youth so that the continuing future of scientific research in this country may be assured on a level comparable to what has been done during the war?" (Roosevelt, 1945, p. 1). After the war, the U.S. began a collective, coordinated, and sustained effort to recruit and educate the best and brightest that would become a new generation of innovators and leaders in science and engineering (NSF, 2010). Concern about the ability of the U.S. to be competitive in the global economy has urged a strengthening of the pipeline into these fields (NAS, 2007; NRC, 2011; NSF, 2006a; NSF, 2010; NSF, 2011b). The National Science Board (NSB) believes that to guarantee the long-term prosperity of the U.S., there must be a renewal of our commitment to excellence in education and the development of scientific talent (NSF, 2010). The call of the NSB is to develop new STEM innovators who can become leaders and creators for our society (NSF, 2010). In addition, the NSB calls for a commitment to equity and diversity and seeks to cast a wider net in finding and developing the leaders of tomorrow (NSF, 2010).

STEM Occupations

The U.S. Department of Commerce Economics and Statistics Administration (ESA) defines STEM occupations as those professions that include science, technology, engineering and mathematics positions as well as the professional and technical support occupations in the fields of life and physical sciences, computer science, engineering, and mathematics (Beede et al., 2011). Occupations of social sciences, behavioral sciences, and health sciences are usually not included in these definitions (Carnevale et al., 2011; Hill et al., 2010) but are included in this project. The ESA lists 50 specific occupations in STEM and estimates that between four and five percent of the nation's workforce is employed in these occupations (Beede et al., 2011; Hill et al., 2010; NRC, 2011). The ESA divides STEM occupations into four categories: Computer and math, which represents approximately 47 percent of related employment; engineering and surveying, which represents approximately 33 percent of related employment; life and physical sciences, which represents approximately 12 percent of related employment; and STEM managerial occupations, which represents approximately 8 percent of related employment (Beede et al., 2011).

An increasing number of jobs at all levels require knowledge of STEM (Carnevale et al., 2011; NAS, 2012; NSF, 2010). According to the NSF (2010), a key strategy for the future success of the U.S. is the cultivation of a world-class science and engineering force and an expansion of the scientific literacy of all citizens. However, after more than fifty years of unchallenged dominance in these fields our country is starting to lose ground to other nations (Lemonick, 2006). Numerous alarms are sounding regarding imminent shortages of scientists and engineers in the U.S. (Butz et al., 2003; Carnevale et al., 2011; Lemonick, 2006; NSF, 2010). Employers in many industries are concerned that job applicants lack needed STEM-related skills to succeed, and that international students are filling an increasing portion of elite positions in the U.S. (NAS, 2012). The NAS (2007) report *Rising Above the Gathering Storm* reiterated the alarm and indicated that in the 21st century, educated and motivated people and ideas are necessary for the creation of innovations that will sustain the nation's prosperity. The U.S. cannot afford to rely on a narrow and decreasing population segment to provide technical expertise that is the foundation of our nation's security, prosperity, and quality of life. A vigorous and thriving STEM workforce is essential to America's global competitiveness and innovative capability (NAS, 2007; NRC, 2011; NSF, 2006a; NSF, 2010; NSF, 2011b).

Women in STEM Occupations

A number of researchers have studied the effect of gender differences in the achievement and participation in science (AAUW, 1992, 1994, 2004; Beede et al., 2011; Butz et al., 2003; CEOSE, 2004; Halpern et al., 2007; Hill et al., 2010; Lawrence & Mancuso, 2012; NAS, 2012; NRC, 2006; NSF, 1994; 2006a; 2011b). These researchers have offered explanations for the underrepresentation of women in some related fields. The STEM workforce is crucial to the U.S. global competitiveness and innovative capability, yet women are vastly underrepresented in related jobs despite making up nearly half of the U.S. workforce and half of the college-educated workforce (Beede et al., 2011; Halpern et al., 2007; NSF, 2006b; NSF, 2012). This has been the case over the past decade, even as women with college degrees have increased their percentage in the overall workforce (Beede et al., 2011) and the overall proportion of STEM bachelor's degrees awarded to women as increased over the past four decades (Hill et al., 2010). According to the ESA, the proportion of women compared to men working in STEM fields remained constant at 24 percent between 2000 and 2009 (Beede et al., 2011). The NSF (2012) states that female scientists and engineers are employed in different professions than are men, with more women in the social sciences (53%) and biological and medical sciences (51%) and less women in engineering (13%) and computer and mathematical sciences (26%). In addition, the representation of women in STEM occupations has varied over time, with a decline in computer and math jobs (from 30 percent to 27 percent since 2000) and a rise in other STEM jobs (Beede et al., 2011). While the field of engineering represents the second largest STEM job group, only about one out of seven engineers is female (Beede et al., 2011). Men are more likely than women to have a job in a STEM field than women regardless of educational achievement (Beede et al., 2011; NSF, 2012).

Even when women choose STEM degrees, their typical career paths diverge significantly from their male counterparts. Approximately 40 percent of men with STEM degrees work in related jobs, whereas only about 26 percent of women with STEM degrees work in related jobs (Beede et al., 2011; NSF, 2012). Participation of women in STEM has grown over the years, but progress has been slow and uneven for women studying related fields in college and choosing related career paths (Beede et al., 2011; CEOSE, 2004; Halpern et al., 2007; NSF, 2012). While there have been great strides over the past several decades, in spite of the progress fewer females than males are entering the workplace pursuing careers in engineering, computer science, and the physical sciences (Halpern et al., 2007; NSF, 2012). Since women appear to be underrepresented in these jobs, this translates into an untapped opportunity to expand related employment in the U.S. When female students opt out of these areas they shut the door to a growing job market and lose many scientists and engineers (Huebner, 2009).

STEM Majors in College

Most STEM careers require a degree in the field (Beede et al., 2011). The ESA identifies STEM undergraduate degree fields as computer science and mathematics, engineering, and life and physical sciences, and defines STEM degree holders as those whose undergraduate major was in a STEM field. They do not include business, health care, or social science majors in their definition (Beede et al., 2011) but are included in this project. The NSF (2006b) defines STEM undergraduate and graduate degrees as biological and agricultural sciences, chemistry, computer science, earth, atmospheric, and ocean sciences, engineering, mathematics, and physics.

Data from the NSF, the U.S. Census Bureau, the U.S. Bureau of Labor Statistics, the NRC, and the RAND RaDiUS database indicate significant shortages of scientists and engineers in the United States (Butz et al., 2003). A RAND Corporation study published in 2003 concluded that the U.S. is falling behind competitor nations in awarding science and engineering degrees (Butz et al., 2003). The proportion of high school students in the U.S. that choose to graduate in STEM degrees in college is lower than in many other countries (NRC, 2007). In 2007, over one third of science and engineering graduate students were international, with more than 70 percent of those students remaining in the U.S. after earning their degrees (NRC, 2011). By using data obtained through the NSFWebCASPAR database, Tai et al. (2006) were able to compare the trends in the percentages of Ph.D.'s awarded in science and technology fields to U.S. citizens, permanent residents, and non-citizens. The downward trend in doctorates awarded to U.S. citizens is clearly evident. The physical sciences and engineering are at particular risk, with declines in the number of doctorates awarded in these fields over the past decade (Tai et al., 2006).

Women in STEM Majors

A number of researchers have written about women pursuing STEM majors in college (AAUW, 1992, 1994, 2004; Beede et al., 2011; Butz et al., 2003; CEOSE, 2004; Halpern et al., 2007; Hill et al., 2010; Lawrence & Mancuso, 2012; NAS, 2012; NRC, 2006; NSF, 1994; 2006a; 2011b). In evaluating the current status of women in STEM fields, it is useful to examine the extent to which workers in these jobs have related degrees. In 2004, women earned 58 percent of all bachelor's degrees and 59 percent of all master's degrees (NSF, 2011b). Women earned 45 percent of all doctoral degrees, but less than one-third of these degrees were awarded in chemistry, computer sciences, engineering, math, or physics (NSF, 2011b).

Among STEM majors in college, women hold a disproportionately low share of related undergraduate and graduate degrees, particularly in engineering (Beede et al., 2011, Halpern et al., 2007). The NSF (2006b) reports the percentages of engineering doctorates earned by women in 2004 were the lowest in the subfields of mechanical engineering (11.1 percent), aeronautical engineering (11.9 percent), and electrical engineering (13.5 percent). In their report, Carnevale et al. (2011) conclude that the current education system is not producing enough students proficient in STEM to meet the demands of related occupations.   Broadening participation in STEM includes encouraging more women to enter the pipeline.

K-12 STEM Education

The NAS (2007) released a report warning that U.S. students were losing ground to international students in STEM education. When compared to global measures of science and mathematics achievement, U.S. students are continuing to perform below average (NRC, 2007). Perhaps even more alarming is the fact that these performances decline as the students move from elementary school through high school (NRC, 2007). The U.S. is slipping behind other industrialized nations in K-12 science measures resulting in a "generation of American students who rank far behind their peers from other countries in their mastery of science and mathematics" (Kays, 2012, p. 37). According to the *2010 Program for International Student Assessment* report, the science scores of 15-year-old students from the U.S. ranked 17th out of 34 compared to other industrialized countries (Kays, 2012). Only ten percent of 8th graders from the U.S. met the *Trends in International Mathematics and Science Study* international benchmark in science compared with 25 percent in China and 32 percent in Singapore (NRC, 2011). There are reasons to be concerned about the state of STEM learning in the U.S. in light of these statistics.

In their report *Why So Few? Women in Science, Technology, Engineering, and Mathematics*, Hill et al. (2010) found that the transition between high school and college is a critical time when many interested young women tend to turn away from a STEM major and career path. To address these challenges, one of the recommendations of the NAS (2007) report focused on ways to increase the U.S. STEM talent pool by improving K-12 science and mathematics education. In their report *Preparing the Next Generation of STEM Innovators: Identifying and Developing Our Nation's Human Capital*, the NSF (2010) recommended that K-12 education focus on "excellent STEM instruction that will inspire and excite those who might pursue STEM careers" (p. 6). The NAS (2007) recommended utilizing high-quality teaching with world-class curricula, standards, and student learning assessment as a starting point for improved STEM instruction. There is a concerted effort for improvements in K-12 science education that includes the identification of the science students need to know and the development of K-12 science standards that will better prepare students for college and STEM careers (NRC, 2011).

In addition, the NRC (2011) identified three goals for K-12 STEM education that "reflect the types of intellectual capital needed for the nation's growth and development in an increasingly science- and technology-driven world" (p. 4). While one of the goals is designed to increase STEM literacy for all students, the other two goals are designed to increase the participation of underrepresented groups, including women, into STEM majors in college and related careers in the workforce (NRC, 2011).

K-12 Science Learning for Girls

Researchers have gathered data documenting participation of girls in K-12 science (Barton et al., 2008; Brotman & Moore, 2008; Papadimitriou, 2004). The traditional body of research aimed at recognizing and overcoming flaws and deficits in science education experiences of girls (Brickhouse et al., 2000; Papadimitriou, 2004). Equity, accommodation, and social concern are also themes of research (Rennie, 1998). In addition, another current approach considers the epistemology, or the nature of knowledge, as it relates to science and the science education of girls (Papadimitriou, 2004). Brotman and Moore (2008) recommended strategies designed to engage more girls in science. The goal of the strategies was to increase the number of students who pursue degrees and careers in STEM as well as encourage more participation of women in those fields (NRC, 2011).

Achievement for Girls in Science

To increase the participation of girls in STEM, Levin, Sabar, and Libman (1991) proposed an increase in their science achievement during the K-12 years. There have been gains in achievement for girls over the past few decades and some studies have shown that girls and boys are achieving at science and mathematics at a comparable level (AAUW, 2004; Barton et al., 2008; Brotman & Moore, 2008; Catsambis, 1995; Gilbert & Calvert, 2003; Greenfield, 1996; Halpern et al., 2007; Heilbronner, 2009; Hill et al., 2010; Huebner, 2009). Achievement is often quantitatively measured in terms of school test scores and grades (AAUW, 1992; Barton et al., 2008; National Center for

Education Statistics, 2004), standardized test scores (AAUW, 1992; Halpern et al., 2007), course preferences (AAUW, 2004; Papadimitriou, 2004), and course selection (AAUW, 2004; Halpern et al., 2007; Papadimitriou, 2004). These achievement indicators are valuable in statistical analyses but they do not always tell the full story, since these increases have not been accompanied by a corresponding flow of girls into some upper-level high school science courses, STEM college majors and careers (Papadimitriou, 2004).

Barton et al. (2008) made the case that “research is also needed that moves beyond girls as a homogeneous population and beyond achievement as the only marker of success” (p. 72). Maltese and Tai (2010) concurred, saying “it seems logical that factors other than achievement influence students’ decisions to persist in their study of science” (p. 670). To better understand the nature of the science education experience for girls, other issues that interact with achievement and participation need to be considered such as educational factors, social and cultural factors, and intrapersonal factors (Kahle & Lakes, 1983; Papadimitriou, 2004).

Factors that May Affect Girls’ Participation in STEM

There are many factors that may affect participation of girls in STEM. These factors may be multi-faceted and difficult to study (Beede et al., 2011; Hill et al., 2010; NAS, 2012). The following factors are included in this paper: educational factors, social and cultural factors, and intrapersonal factors.

Educational Factors

Educational factors may affect girls’ participation in STEM. Educational factors include, but are not limited to, the equitable treatment of girls in the science classroom (AAUW, 1992, 1994; Baker & Leary, 1995; Barton et al., 2008; Brotman & Moore, 2008;

Sadker & Sadker, 1995) and curriculum and pedagogy of science classrooms (AAUW, 1992; Brotman & Moore, 2008; Halpern et al., 2007). In their review of literature, Brotman and Moore (2008) found that some inequities exist in the science education experience of girls. Girls were often found to be treated differently in the science classroom than boys. Boys sometimes received more praise, attention, instruction, and feedback from a teacher than girls and were called on more often in class than girls (AAUW, 1992; 1994; Sadker & Sadker, 1994). Boys were found to dominate over girls in science classrooms, especially when handling and manipulating lab equipment during an experiment (Jovanovic & Steinbach King, 1998; Kahle, Parker, Rennie, & Riley, 1993). Brotman and Moore (2008) documented instances where girls were portrayed differently than boys in some science textbooks. Strategies to overcome these barriers include improved teacher education and teacher training, and a change in the curriculum and pedagogy to include attentiveness to the interests, experiences, and learning styles of both boys and girls (AAUW, 1994; Brotman & Moore, 2008).

Social and Cultural Factors

Factors of culture and society may effect girls' participation in STEM (Lawrence & Mancuso, 2012). Social and cultural factors may include, but are not limited to, gender, race, ethnicity, and socioeconomic status (AAUW, 1992; 1994; Baker & Leary, 1995; Barton et al., 2008; Brickhouse et al., 2000; Brotman & Moore, 2008; Jones et al., 2000; Kahle & Lakes, 1983). The field of study is immense in nature, reaching into the areas of sociology, psychology, and philosophy (Brotman & Moore, 2008), and is beyond the scope of this background report. According to various researchers, differences in science participation for girls may be attributed to many factors including, but not limited to, socialization (Erwin & Maurutto, 1998; Farenga & Joyce, 1999; Kahle & Lakes, 1983), social interactions (Papadimitriou, 2004; Schibeci, 1984), stereotypes (AAUW, 1992; Sadker & Sadker, 1994), and family structure (Schibeci, 1984). Parents, peers, ethnicity, race, and socioeconomic status help shape and establish gender roles, which in turn may impact the participation of girls in science (Brickhouse et al., 2000; Lawrence & Mancuso, 2012; Papadimitriou, 2004). Social and cultural factors often interact in multifaceted and powerful ways with educational experiences and intrapersonal factors to influence the participation in science for the individual (Brickhouse et al., 2000).

Intrapersonal Factors

Intrapersonal factors may also have an effect on girls' participation in STEM. Intrapersonal factors include, but not limited to, a girl's interest in science (AAUW, 1994; 2004; Barton et al., 2008; Brotman & Moore, 2008; Halpern et al., 2007; Jones et al., 2000), science identity (AAUW, 1994; Barton et al., 2008; Brickhouse et al., 2000; Brotman & Moore, 2008), perception of science (AAUW, 1994; Baker & Leary, 1995; Barton et al., 2008; Brickhouse et al., 2000; Brotman & Moore, 2008; Halpern et al., 2007; Jones et al., 2000; Jovanovic & Steinbach King, 1998), and attitude towards science (AAUW, 1994; Barton et al., 2008; Brotman & Moore, 2008; Jones et al., 2000; Kahle & Lakes, 1983). These intrapersonal factors cause a girl to construct meaning and understanding of science based on her own perceptions, attitudes, interests, and identity. As with the other factors, these factors interact with educational experiences and social and cultural factors to influence the participation in science for the individual. The following sections describe several intrapersonal factors that may influence participation in science for girls.

Science interest and STEM interest

Science interest and STEM interest are constructs that may influence the decision one makes to participate and persist in the study of science (Maltese & Tai, 2010). Interest in science may be defined as the state of wanting to know or learn about something, or to excite one's curiosity about a topic or set of topics. For some it may be a general curiosity about how things work, for others it may be an enjoyment of the surrounding world, and for others the source of interest may come from intrinsic interests or extrinsic experiences (Maltese & Tai, 2010). Regardless of the source, having an interest in science is one of the most important reasons students say they choose to pursue a science trajectory in school (Lindahl, 2007).

When to encourage an interest. Tai et al. (2006) make the case that to create a scientific job force, interest in science and STEM must be encouraged in the pre-college years and as early as possible. They found that young adolescents who planned on careers in science were more likely to graduate from college with a degree in science. Based on data from over 3300 participants, they found that it was essential to develop early interest and emphasize encouragement for the exploration of sciences. Their study suggested that close attention should be paid to children's early exposure to science and that there was a direct correlation between this exposure and the pursuit of science in college. Several other studies highlight he importance of igniting an interest in science and STEM for students in their K-12 years to increase the numbers choosing to enter STEM fields (Halpern et al., 2007; Hill et al., 2010; Maltese & Tai, 2010; NAS, 2012; Wigfield, Eccles, Schiefele, Roser, & Davis-Keen, 2006).

In particular, it is important that girls become interested in science and STEM early on before entering high school so they will enroll in the kinds of courses that will prepare them for STEM majors and careers (Halpern et al., 2007; Hill et al., 2010; NRC, 2011; UMass Donahue Institute, 2011). In their report *Encouraging Girls in Math and Science*, Halpern et al. (2007) maintain that girls are “more likely to choose courses and careers in math and science if their interest in these fields is sparked and cultivated throughout the school years” (p. 8). For this reason, approaches in science education need to be made interesting and motivating for girls (Hill et al., 2010; Maltese & Tai, 2010; Tai et al., 2006; Wigfield et al., 2006).

Some say that encouraging an interest in science and STEM for girls needs to take place in middle or high school (Burkam, Lee, & Smerdon, 1997; Barton et al, 2008; Cleaves, 2005) but others suggest that the encouragement needs to take place earlier to engage them more meaningfully and support them in long-term learning opportunities (CEOSE, 2004; Maltese & Tai, 2010; NRC, 2011; NSF, 2010; Reis & Graham, 2005; Tai et al., 2006). In their study of sources of early interest in science, Maltese & Tai (2010) looked at the interaction of the timing, the source, and the nature of scientists’ early interest in science. The scientists they worked with were both male and female individuals with experience in either a chemistry or physics PhD program. Approximately 30% of the scientists indicated that their interest in science began in middle school or high school. Both men (68%) and women (66%) reported being interested in science before middle school, indicating the timing to be during their K-5 years (early) or always (Maltese & Tai, 2010). This research emphasizes the importance of creating an interest for both males and females as early as possible.

Young girls have been shown to exhibit interest in science at age 10 with the interest declining sharply by age 14 (Archer et al., 2010a; Archer et al., 2010b; DeWitt et al., 2010). At this point their interest in the study of science has been largely formed and life aspirations established (Tytler, 2010). Gender differences in interest towards science were minimal during the elementary school years but increased from middle school upward (AAUW, 1994; AAUW, 2004; Andre et al., 1998; Archer et al., 2010a; Archer et al., 2010b; Blue & Gann, 2008; DeWitt et al., 2010; Farland-Smith, 2009; Hill et al., 2010; Koenig & Hanson, 2008; NAS, 2012; NRC 2011; Reis & Graham, 2005; Skamp & Logan, 2005). According to Blue & Gann (2008), girls steadily lose interest in science over the course of their schooling. They stated that children enter Kindergarten with an interest for science but exhibit a decline as they progress through their K-12 years. In their study of nearly 2000 girls, they conclude that the fourth and fifth grades are the critical school years for encouraging girls in science. Jones et al. (2000) concurred, and noted that the sixth grade is the defining year for science engagement with girls. The implication is that intervention after this point in schooling may become increasingly more difficult.

It is important to cultivate interest in science for girls as early as possible since interest declines for some girls during the transition into middle school. Ideally this should happen in the primary grades and extend throughout the elementary grades. Research has shown that children enter school with a great capacity for learning science (NRC, 2007). Children are natural inquirers, and often act like scientists by posing questions, seeking answers, and using science processes (McCormack, 2010). Many early childhood specialists indicate the need for science to even be included in the primary school programs, stating that early science experiences are essential for children to help them develop an interest in science (Eshach & Fried, 2005; Tytler, 2010). Research confirms the need for the inclusion of quality science instruction at the elementary level to capture the interests of young girls (Brotman & Moore, 2008; Jovanovic & Steinbach King, 1998; Maltese & Tai, 2010; NAS, 2012; Patrick et al., 2009; Tai et al., 2006; Vanmali & Abell, 2009).

Sources of interest. While sources of interest in STEM and science may come from a girl's science education experience, it may also come from outside of the traditional schooling experience. For example, the source of interest may come from an individual's own intrinsic interests or extrinsic experiences (Maltese & Tai, 2010). Maltese and Tai (2010) studied graduate students and scientists in physics and chemistry to determine the initial experiences that sparked their interest. They believed that "aspirations and career choices are a result of the complex interplay of person, environment, and behavior" (Maltese & Tai, 2010, p. 672). They considered both the nature of the experience and the source of the experience. They found that the nature of the experience was often intrinsic, with many of the instances relating to activities done at home, such as reading science books, trying home experiments, or playing with electronics. For females, the source of the experience was school (52%), self (24%), and family (24%). Jones et al. (2000) concurred, saying that "there is growing evidence that science experiences impact science career selection" (p. 182).

In the report *Under the Microscope: A Decade of Gender Equity Projects in the Sciences*, the AAUW (2004) found that many gender equity intervention projects to encourage more girls in STEM disciplines "involved extracurricular informal learning activities" (p. iii). These kinds of outside activities are important in encouraging girls' interest and achievement in science (Kahle & Lakes, 1983). Some evidence suggests that extracurricular informal learning opportunities such as informal science learning (ISL) programs can increase girls' interest in STEM courses and careers (AAUW, 2004). ISL programs will be discussed in further detail in Chapter 3. When girls are given the opportunity to see science inside and outside of the regular classroom as interesting and relevant to their lives, they may be more inclined to choose STEM for a career.

Science identity

Identity is difficult to define but usually refers to a social category expressed by the attributes, expected behaviors, or socially distinguished features of an individual. Archer et al. (2010a) discusses the lens of identity, drawing on the "theoretical framework that views identity as an embodied and a performed construction that is both produced by individuals and shaped by their specific structural locations" (p. 617). Using this framework, science identity describes one's proficient performance in scientific practices with deep thinking, knowledge, understanding, and engagement in science (Brickhouse et al., 2000; Carlone, 2004). In addition, science identity often means that someone recognizes themself as a science person and gets recognized that way by others (Farland-Smith, 2009).

The identities of students are shaped by social and cultural factors such as gender, race, ethnicity, and socioeconomic status (Archer et al., 2010a; Brickhouse et al., 2000). In much of the recent science literature, the role of identity has been explored in girls' participation and learning of science (Brotman & Moore, 2008). Brickhouse et al. (2000) used the framework of situated cognition to say that girls learn science as they see their complex identities coinciding with their pursuit of science or as compatible with scientific identities. They posited that once a girl decides what kind of person she is and wants to be, then she can engage in the types of activities that make her a part of similar communities. They believed that identity formation is essential to learning since how and why a person learns connects to who they are becoming in their own lives.

Tan and Barton (2007) added that the construction of identity requires the participation with others of similar backgrounds since identity is constructed socially within community of practices. Lave and Wenger (1991) agreed that students develop their identities through the engagement with practices of a dynamic community, such as a science class or an after-school science program. For the members of such a community, learning science becomes a process of becoming to be, and of forging of identities (Farland-Smith, 2009). Wenger (1998) views identity as a core outcome of human development. Brickhouse et al. (2000) have linked identity formation as a critical dimension of how and why students engage in science. Barton et al. (2008) used the lenses of practice and identity to describe their research in girls' science identities. The idea of practice was grounded in the sociocultural perspectives on learning (Lave & Wenger, 1991). They believed that science learning is an embodied activity. They said it is "not just about what the learners know but also how what they know is a part of a larger system of activity, feeling, value, and performance" (Barton et al., 2008, p. 74). For them, science learning moves beyond the memorization of content into the realm of participation in science-related communities and feel that issues of identity are central to making sense of science practices (Barton et al., 2008).

Perception of science

The perception of science is an area where consistent differences have emerged between boys and girls (Halpern et al., 2007). Some studies have found that girls may perceive science as difficult to understand and oftentimes uninteresting and boring

(Brotman & Moore, 2008; Jones et al., 2000). Many girls underestimate their ability to succeed in science and mathematics (AAUW, 1994; Brotman & Moore, 2008; Halpern et al., 2007; Papadimitriou, 2004; Sadker & Sadker, 1994). Jovanovic and Steinbach King (1998) found in one study that girls felt less certain about their science abilities at the end of a school year than they did at the beginning. They hypothesized that the girls believed they became better in other subjects than in science as the school year progressed (Jovanovic & Steinbach King, 1998).

In their research on girls' engagement with science, Brickhouse et al. (2000) describe common perceptions about science. Stories by girls say that "girls are alienated by science. Science is masculine, competitive, objective, impersonal--qualities that are at odds with our images of what girls are" (p. 441). Some girls believe that science is a domain that belongs to males and that they cannot "do" science (Brickhouse et al., 2000; Farenga & Joyce, 1999; Jones et al., 2000; Kahle & Lakes, 1983). Some students have been found to identify certain courses as masculine, such as chemistry, mathematics, and physics, and certain courses as feminine, such as biology, art, and language (Farenga & Joyce, 1999). These types of perceptions may influence the course selection process for girls, which in turn may influence eventual college majors and careers (AAUW, 1992).

Attitudes toward science

The term attitude refers to the feelings one has towards something and generally refers to likes and dislikes (Koballa, 1988). The development of a positive attitude towards science is an important goal of science education (Koballa, 1988). In general, girls have less positive attitudes towards science than do boys (Baker & Leary, 1995; Catsambas, 1995; Jovanovic & Steinbach King, 1998; Kahle & Lakes, 1983; Osborne, Simon, & Collins, 2003; Weinberg, 1995). In addition, it has been found that attitudes toward science decline as girls grow older and move from the elementary grades to the middle school and high school grades (Jones et al., 2000; Osborne et al., 2003; Simpson & Oliver, 1990). Girls have been shown to exhibit positive attitudes towards science at age 10, but exhibit less positive attitudes as the move through their early teens (Archer et al., 2010a; Archer et al., 2010b; DeWitt et al., 2010; Jones et al., 2000). Catsambis (1995) believes that a girl's attitude towards science affects her career decisions more than her achievement in science. When these girls have less favorable attitudes towards science they may be less likely to enroll in advanced high school courses. This may in turn translate into less interest in science careers for these girls (Catsambis, 1995; Papadimitriou, 2004).

The relationship between attitude toward science and achievement in science for girls is complex and largely uninvestigated (Papadimitriou, 2004) and is difficult to separate from the other factors previously discussed. According to Weinberg (1995) "The conflicting results from different studies makes it difficult to determine whether, in general, there are gender differences in student attitudes toward science, or whether there are gender differences in correlations between attitudes toward science and achievement in science" (p. 389). There are many multi-faceted factors that may affect the participation of girls in STEM (Beede et al., 2011; Hill et al., 2010; NAS, 2012). Regardless of the reasons for the underrepresentation of females in STEM, efforts are being made to encourage girls' interest in related areas.

Summary

Ambitious efforts are being made to "cast a wide net" (NSF, 2010, p. 3) to encourage more students into STEM careers, with girls in particular being targeted

(CEOSE, 2004; Halpern et al., 2007). Early exposure to science is important, since interest in science often begins to blossom in elementary school and may strongly influence future career plans (Eshach & Fried 2005; NSF, 2010; Tai et al., 2006). Girls should be provided with a variety of excellent K-12 educational programs that spark an initial interest and encourage a sustained interest in STEM.

The NRC wrote a practice guide outlining several strategies designed to encourage girls in science and mathematics (Halpern et al., 2007). These strategies were based on experiments, review of literature studies, correlational studies, trends, and longitudinal studies (Halpern et al., 2007). Mentoring is a recommended strategy and is the focus of this capstone project. The project was designed to create and carry out an online mentoring community which connected the Einstein Girls with successful female STEM professionals. Chapter 3 presents a review of research and literature examining the context of the Einstein Girls OMC project through the theoretical framework of the project.

CHAPTER 3
LITERATURE REVIEW

Introduction

The purpose of Chapter 3 is to provide a brief description of the Einstein Girls program and the online mentoring community that was a part of the program. It will also describe the theoretical framework that informed the designs of the Einstein Girls and the online mentoring community. The need to encourage more girls into science and STEM was documented in Chapter 2. Researchers have studied issues related to gender and science education for decades and have recommended several strategies designed to engage more girls into STEM during K-12 years. The Einstein Girls was created as a program to address some of the issues related to girls and STEM utilizing recommended strategies.

Theoretical Framework for the Einstein Girls Program

Grounded design is defined by Hannafin, Land, and Oliver (1999) as "the systematic implementation of processes and procedures that are rooted in established theory and research in human learning" (p. 102). Grounding design is based on primary assumptions that form the foundation of any notion of the teaching and learning process. Assumptions for learning are always assumed and cannot be proven either true or false; assumptions for learning lead to goals, strategies, and essences of instruction (Duffy & Cunningham, 1996). I created the Einstein Girls program in 2009 as a response to a perceived need. I noted that several of my female students who were interested in science and saw themselves as a science person would lose that interest and identity as they transitioned from the Lower School (grades PK-6) to the Middle School (grades 7-8) and the Upper School (grades 9-12). I wondered why a decline in interest often took place and considered ways I could encourage a long-term interest and identity for these girls in science. The Einstein Girls was created to answer some of these questions and as an attempt to encourage more girls into the STEM pipeline. I utilized the informal science learning framework to design and create the program.

The Einstein Girls as an Informal Science Learning Program

Informal science learning (ISL) is one of the strategies recommended to facilitate an interest in and an engagement of students in STEM (AAUW, 2004; NRC, 2009). This strategy is also recommended to help build a pipeline of incoming majors and future professionals badly needed in the U.S. workforce. With the emphasis on scientific literacy for national success in the 21st century, some educators and policy-makers looked outside the traditional science setting for ways to attract and retain more students in the STEM areas (Hussar, Schwartz, Boiselle, & Noam, 2008). The NSF described informal science learning as voluntary and self-directed learning motivated by curiosity, exploration, intrinsic interests, and social interaction (AAUW, 2004). This strategy focuses on the prospect of providing students with enriching out-of-school activities, such as after-school academies, summer camps, off-site field trips, and science museum visits. The NSF (2010) posits that quality ISL programs would utilize best practices of inquiry-based learning, problem-solving, peer collaboration, hands-on training, career exploration, and interactions with practicing scientists, engineers, and other experts. Informal science learning settings are well positioned to encourage and develop young girls' interests in STEM and STEM topics (AAUW, 2004; Hill et al., 2010; Hussar et al., 2008).

In 1999, the Board of the National Association of Research in Science Teaching (NARST) established the Informal Science Education Ad Hoc committee to focus on the positioning of informal science learning (Dierking, Falk, Rennie, Anderson, & Ellenbogen, 2003). The committee recommended that science learning should include more than the experiences that take place during the school day and encouraged the establishment of outside-of-school learning opportunities for students (Dierking et al., 2003). The NSF recommends that informal science learning involves projects designed to increase interest in, engagement with, and understanding of STEM by students through self-directed learning experiences (Friedman, 2008). ISL projects typically offer an environment where inquiry can occur in a more casual and test-free setting, allowing participants to focus on the experiences (Hussar et al., 2008). These experiences may be more personally and contextually relevant than those that are driven primarily by tests and required curriculum (Noam, Biancarosa, & Dechausay, 2003). Schwartz and Noam (2007) found indications that ISL programs can increase students' interest in science and their scientific knowledge. In addition, they found a correlation between participation in ISL programs and the increase of selection of science-related majors in college.

Benefits of ISL programs

There are beneficial reasons to utilize ISL strategies to supplement traditional science education programs. The variety of programs available utilizing ISL are nearly limitless even though many of the programs share similar goals (Friedman, 2008). Since they happen outside of the school, ISL programs can serve a wide population of students and can allow students to meet on a regular basis. In addition, the experiential nature of ISL programs has been shown to foster the interest in science for girls (AAUW, 2004; Hussar et al., 2008). Much of the research on encouraging girls in science focuses on exposing girls to science through ISL utilizing extra-curricular clubs, summer camps, and science-related activities (Anderson, Lucas, & Ginns, 2003; Farland-Smith, 2009; Halpern et al., 2007; Heilbronner, 2009; Koenig & Hanson, 2008; Reis & Graham, 2005; Stake & Mares, 2005). Maltese & Tai (2010) found in their study of Ph.D. scientists that participation in science activities outside of school played a significant positive role for girls in the development of their initial interest in science. Conversely, Jovanovic and Steinbach King (1998) found a direct correlation between the lack of exposure to science-related activities outside the classroom and the lack of interest in science for girls.

Science learning strands

The Committee on Learning Science in Informal Environments was formed to evaluate evidences of science learning across age groups, settings, and time, and to identify six strands of science learning that articulate science-specific capabilities supported by informal environments (NRC, 2009). Four of these strands are grounded in the four strands developed for K-8 science learning in the *Taking Science to School: Learning and Teaching Science in Grades K-8* report by the NRC (2007). Two additional strands are identified in the book *Learning Science in Informal Environments: People, Places, and Pursuits* (NRC, 2009) that are unique to informal learning environments. These strands describe what participants do "cognitively, socially, developmentally, and emotionally in these settings" (NRC, 2009, p. 4). Strand 1 says that "learners in informal settings experience excitement, interest, and motivation to learn about phenomena in the natural and physical world" (NRC, 2009, p. 4) and Strand 6 states that "learners in informal environments think about themselves as science learners and develop an identity as someone who knows about, uses, and sometimes contributes to science" (NRC, 2009, p. 4).

These strands represented an important consideration in the design and implementation of the Einstein Girls after-school academy. Strand 1 was significant since the program offered a rich science environment that was designed to tap into prior interest and experience. Membership in the Einstein Girls program was voluntary so it was assumed that the participants demonstrated a prior interest in science, leading them to join the group. Many of the participants have been in the group for multiple semesters and several participated in other ISL opportunities at the school such as Future Problem Solvers and Odyssey of the Mind. Strand 6 was significant to the program in that it addressed the processes by which participants built on interest and the development science learning identities. Many members shared that they saw themselves as science persons and joined Einstein Girls specifically to meet friends and improve relationships with others of similar interests. Several indicated an interest in pursuing science trajectories through middle school and high school, and considered a STEM major in college and a related career in the future.

The Einstein Girls program

The Einstein Girls academy was a curricular innovation I created in 2009 to promote science and STEM learning in an informal, after-school setting. The program was designed to utilize best practices of science learning, problem-solving, peer collaboration, hands-on training, career exploration, and interactions with practicing scientists, engineers, and other STEM experts (NSF, 2010). The Einstein Girls academy met in my science lab and had access to science equipment and materials, including 24 iMac computers, 4 iPads, 8 microscopes, 16 stereoscopes, digital cameras, digital microscopes, models, and various lab supplies. We also were given access to school computer labs and science labs at the Upper School as well as the school's 42-acre lakefront campus.

Last year I completed a program evaluation of the Einstein Girls and determined based on the various data collected that the program was a successful example of a local informal science learning program for the past four years. I found that the ISL arena was uniquely well-suited to provide experiences that helped the girls make personal connections to science, explore STEM careers, and expand their interests and identities in science. My program and similar programs gave girls the time to investigate topics more deeply and participate in inquiry-based real-world STEM learning (Afterschool Alliance, 2011). By providing an opportunity to learn about STEM in a fun and relaxed atmosphere, the program sparked and encouraged girls' interests in STEM topics (AAUW, 2004).

Other successful ISL programs

Other ISL programs were designed and implemented which helped girls connect science learning with their own lives (Afterschool Alliance, 2011; Friedman, 2008; NSF, 2010; Schwartz & Noam, 2007). These programs were designed utilizing research-based best practices for encouraging STEM interest in girls; some are listed in Appendix B. These and similar ISL programs may exist at the local level (e.g. Girls at the Center, Girls in Science, Girlstart, Techbridge), or have an outreach at the national level (e.g. aspire2inspire, Sally Ride Science). Several programs have a web presence and in many cases are web-based (e.g. Engineer Girl, National Girls Collaborative Project). Some offer information on how to start an after-school STEM club (e.g. The GEMS Club, Great Science for Girls). Based on evaluations of programs around the country, the Afterschool Alliance posits that the best STEM-focused ISL after-school programs increase students' interest and enrollment in the STEM subjects as well as the future pursuit of STEM careers (Afterschool Alliance, 2011). By identifying the research-based practices from some of the best programs available, an after-school STEM club for girls can be started at a school, summer camp, or youth program that may bring STEM alive for girls, encourage a long-term interest in STEM, enrollment in STEM subjects, and encourage STEM majors in college.

Koenig and Hanson (2008) described an ISL program known as "Girls in Science" (GIS) created for girls entering middle school. The program offers participants real-world applications of science and information on STEM careers. The GIS clubs meet after school several times during the year. During the meetings, invited female scientists present career fields and conduct an experiment with the participants. One weekend each year the GIS club visits a local university for a showcase of women sciences. The GIS model has gained interest and other clubs are being implemented around the country (Koenig & Hanson, 2008). Techbridge is another ISL program that introduces girls in grades 5 through 12 to STEM topics through a variety of after-school and summer activities (Cohn, 2009). Launched in Oakland, California by Chabot Space & Science Center in 2000, Techbridge encourages girls to explore fields where women have traditionally been underrepresented. As of 2009, Techbridge has worked with a total of 2,500 girls in 30 area schools. The project receives funding from the NSF, corporate, and private foundations (Cohn, 2009).

Challenges of ISL programs

Without funding from outside sources, ISL programs may be difficult to initiate and maintain. ISL programs may also find themselves at the forefront of budget cuts. Volunteers are often used to work with the programs. This may require a significant commitment of time and resources and some are unwilling to be involved. While ISL programs offer valuable opportunities to inspire interest in STEM, such programs alone are insufficient for effective science learning and are most effective when combined and coordinated with formal education (NSF, 2010). Since much of the research on ISL programs is descriptive, future research agendas should include independent external evaluations on the designs and outcomes of ISL programs (Anderson et al., 2003; NSF, 2010). Time should be devoted to designing specific interventions backed by strong evidence-based and data-driven studies. Qualitative data may better suited to analyzing the deeper layers of science learning taking place in informal science learning programs and a review of literature is needed (Schwartz & Noam, 2007). Evaluations should be designed to provide the education community knowledge that can be generalized to build better interventions, thus increasing the knowledge base of best practices (NSF, 2010).

Other Theories that Inform the Einstein Girls Program

Several theories of learning that share many common beliefs and assumptions form the structural framework of the Einstein Girls program. They are based on similar ontology and epistemology, what Jonassen & Land (2012) called “willful, intentional, active, conscious, constructive practice that includes reciprocal intention-action-reflection activities” (p. ix). The overarching theoretical framework of constructivism was the grounding assumption in which the Einstein Girls program was situated. This assumption provided the framework for additional theories that informed the organization the program, the goals of the program, the strategies for the program, and the methods of instruction for the program. The additional theories that informed the program will be further described in terms of the social and cultural nature of the group (social constructivism), the group as a student-centered learning environment (learning community), the group as an online learning community, and the group as a social community (situated learning).

Constructivism

The term constructivism has become an accepted expression for a wide diversity of views which Duffy and Cunningham (1996) theorize “focuses on the cultural embeddedness of learning” or cognition (p. 174). The theory states that learners construct knowledge based on their own experiences, perspectives, conceptions, and social interactions. As a learner experiences something new it is internalized through past experience or knowledge constructs that have been previously established (Robinson, Molenda, & Rezabek, 2008). For effective learning to occur, the theory of constructivism dictates that learning needs to take place within a meaningful and authentic situation in which experience and knowledge are shared and adapted collectively (von Glaserfeld, 1984).

Constructivism as a learning theory has a long history in education and philosophy (Duffy & Cunningham, 1996). John Dewey (1916, 1938) was a proponent of the restructuring of education to meet the changing needs of the society and was an advocate for learning by doing (Duffy & Cunningham, 1996). In the book *Democracy in Education* (1916), Dewey discusses knowledge as that which “furnishes the means of understanding or giving meaning to what is still going on and what is to be done” (p. 166). Dewey (1916) put forth that knowledge is “the method by which one experience is made available in giving direction and meaning to another” (p. 168).

Jerome Bruner (1966, 1971) focused on learning as a function of the activity of the learner and said the discovery process must be personally relevant to the learner

(Duffy & Cunningham, 1996). He believed that knowledge was not based in the content of the learning but in the activity of the learner during the discovery process (Duffy & Cunningham, 1996). Vygotsky (1962, 1978) focused on both the social and cultural situated context of cognition and emphasized the social origins of cognition (Duffy & Cunningham, 1996).

Several recent philosophers have offered epistemological grounding for modern constructivist leanings, including Kuhn, Wittgenstein, and Rorty (Duffy & Cunningham, 1996). According to Duffy and Cunningham (1996), these philosophers hold a similar argument that knowledge is a “construction by individuals and is relative to the current context (community)” (p. 172). Since about 1990 there have been significant changes in learning theory in history, most notably a shifting from theories of behaviorism and cognitivism towards contemporary sociocultural, situated, and constructivist notions of learning (Jonassen & Land, 2012).

Jonassen and Land (2012) described three fundamental changes in thinking that are reflective of this shift. First they noted that learning involves the making of meaning rather than a transmission of knowledge. Learners interact with others and with artifacts of their worlds and try to make sense of those interactions, thus making meaning out of the dissonance between what is known and what is desired to be known (Jonassen & Land, 2012). This dissonance guarantees at least some ownership of the knowledge by the learner (Jonassen & Land, 2012). Secondly, they noted that the more contemporary learning theories focus on the social nature of the meaning making, and that learning is a process of social negotiation among the participants of an activity (Jonassen & Land, 2012). Finally the third change focused on the locus of meaning making. As learners engage in social communities or communities of practice, individuals' beliefs and knowledge about the world are influenced by that community, their culture, their values, and their beliefs (Jonassen & Land, 2012). Constructivist learning is then defined through the changes in one's relation to the cultures in which one participates, as Duffy and Cunningham (1996) note "with the gradual transformation of one's means of constructing one's world as a function of the change in membership in that culture" (p. 178).

ISL and constructivism

Anderson et al. (2003) proposed that the constructivist view of learning can inform the research and interpretation of research data of ISL. Much of informal science learning research has been descriptive and lacks a theory base (Anderson et al., 2003). As mentioned before, constructivism states that learners construct knowledge based on their own experiences, perspectives, conceptions, and social interactions (Robinson et al., 2008). As a learner experiences something new it is internalized through past knowledge constructs that have been previously established (Robinson et al., 2008). For effective learning to occur, constructivism dictates that learning needs to take place within a meaningful and authentic situation in which experience and knowledge are shared and adapted collectively (von Glaserfeld, 1984; 1995).

Martin (2001) stated that "learning in science occurs best when approached from a constructivist point of view" (p. 184). Learners attach meaning to new experiences based on the familiarity and knowledge they bring to their learning environments (Martin, 2001). Scott (1987) defines a constructivist approach in science instruction where students are active learners who come to science experiences readily having ideas about natural phenomena which they use to make sense of everyday experiences. In an ISL setting, learners build upon their prior knowledge and active involvement in the construction of new knowledge (Anderson et al., 2003).

Social constructivism

Vygotsky observed that learners developed mental abilities through social interactions with adults, thus learning the habits of mind of their culture (Robinson et al., 2008). He termed his theory a sociocultural approach to learning since he placed significance in the social and cultural influences on his theory (Robinson et al., 2008). This sociocultural approach is also known as social constructivism. In a social constructivist approach of knowledge construction, Duffy and Cunningham (1996) noted the emphasis is placed on the “socially and culturally situated context of cognition” (p. 175) and` how learning takes place as individuals participate in the shared endeavors of others. According to this theory, learning is a process of acculturation as an actively constructing learner is participating in culturally organized practices (Duffy & Cunningham, 1996). During this participation, the learner is applying prior experience and knowledge to new experiences that usually involves some element of emotion and feeling (Falk & Dierking, 1997). This definition situates the process of learning in the physical, social, and personal contexts of the learner (Anderson et al., 2003).

During social learning, learners work towards an understanding of their own knowledge through engagement and ownership in tasks that are meaningful to the learner. This was apparent in the Einstein Girls meetings, as girls were observed engaged in the activities and were able to take ownership of the activities by suggesting areas of study of interest to them. Vygotsky (1978) created the term “zone of proximal development” (ZPD), which focuses on the encouragement and advancement of individual learning. Vygotsky (1978) defines the ZPD as “the distance between the actual developmental level of a child as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (p. 86). Cole (1985) described the ZPD as a place where culture and cognition are co-created. A zone of proximal development therefore describes a form of community cognition where the members of the community provide support for one another for learning (Duffy & Cunningham, 1996).

Support for learning is known as "scaffolding" and is necessary for success in the learning environment. The ZPD is described in terms of the affordances or scaffolding of the learning environment and may include the support of the individual members, a teacher or a mentor (a more experienced "other"), of artifacts within the environment, the history of the members, or the cultural context of the environment (Duffy & Cunningham, 1996). The ZPD and scaffolding together are viewed as a learning environment designed to support the growth of the learner (Duffy & Cunningham, 1996).

Student-centered learning environment

The Einstein Girls program functioned as a student-centered learning environment which was designed to provide interactive activities that enable the participants to address their unique learning interests and needs (Land et al., 2012). As such, the environment facilitated student-directed learning as the participants engaged in complex open-ended problem contexts enriched with resources, technology tools, and scaffolding among the members (Land et al., 2012). The design framework for a SCLE was based on the previously-described constructivist-inspired views of learning (Jonassen, 1991), in which learners made meaning and constructed knowledge while engaged in authentic and real-world activities.

Several key features of a SCLE were assumed in the design of the Einstein Girls after-school program as well as the online mentoring community. These assumptions included the nature of the learning with the learner at the center of defining meaning, the participation in real-world tasks and sociocultural practices, and the significance of everyday experiences in making meaning (Hannafin & Land, 1997). In the Einstein Girls program, an overarching focus was to support the participants in the active construction of meaning. The program connected the students with female STEM mentors online, enabling them to ask questions, receive support, and learn about the building of the science identity. In addition, activities and inquiries were designed that were meaningful to the students and allowed them to make choices and pursue individual interests, thus taking greater control of their own learning (Land et al., 2012). The program utilized problem contexts, such as engineering design problems and environmental research projects, and computer tools to enhance the visualization of science concepts. These were designed to link everyday experiences and build upon what the participants already knew. By allowing participants to make connections to real-world contexts, their learning was enriched and allowed the development of meaningful and long-lasting interests as well as the formation of a dynamic learning community (Land et al., 2012).

Learning communities

A learning community is made of a group of learners who work together, build relationships that create a mutual commitment and belonging, and are involved in a collected effort of understanding (Gunawardena et al., 2009; Land et al., 2012). The notion of such a community generates widespread significance in a variety of contexts, whether in organizational behavior, higher education, or pre-college education

(Luppicini, 2003). Within this framework, learning communities are considered to be curricular structures that connect various disciplines around a central question or theme and encourage shared inquiry among students and faculty (Luppicini, 2003). In such a community, students are provided with opportunities to share ideas, elaborate on their own thoughts, and consider the ideas of others.

Bielaczyc and Collins (1999, p. 271) categorize four features of learning communities: (a) areas of varied expertise are facilitated and encouraged; (b) goals are designed to increase the collected knowledge of the community; (c) learning how to create new knowledge is emphasized; and (d) technologies for sharing what is learned are key to the success of the community. The community may exist in a F2F environment, an online environment, or a combination of both. Palloff and Pratt (1999; 2004) were early authors to describe creating a community in an online environment and encouraged the utilization of social networking tools to facilitate the communication within the community (Hill, 2012).

The social constructivist approach to teaching and learning provides is the framework that provides the order of a learning community (Akyol & Garrison, 2011). Hill (2012) says this perspective “emphasizes the interdependence of the individual learner and context is which s/he is learning” (p. 273). The ZPD and scaffolding are essential to the success of a learning community as the interactions between learners enable the community to form within a particular context (Hill, 2012). The Einstein Girls together functioned as a successful learning community, which in the spring of 2013 became an online learning community.

Online learning communities

The notion of a learning community has expanded into a global view, as new technologies are changing the concept of community. The Internet enables communities to go beyond physical boundaries present in face-to-face (F2F) communities and provides members a platform for world-wide sharing, teaching, and learning (Howland, Jonassen, & Marra, 2012), thus creating online learning communities. Online learning communities may also be known as virtual learning communities, social networks, collaborative networks, or by other names. The *2010 Horizon Report* (Johnson, Smith, Levine, and Haywood, 2010) discusses online communities or collaborative environments as self-contained online spaces for collaboration, exchange of ideas, and knowledge sharing. Such spaces give students the opportunity to build knowledge in their own way, work creatively, and learn from others who possess a wide range of expertise and experiences. Web 2.0 tools and social software that support the construction of communities offer unlimited potential by providing the bonds to connect students in their group with one another, selected outside experts, and online information sources (Howland et al., 2012; Richardson, 2006).

Online learning communities happen when the participants share interests they have in common. Howland et al. (2012) recommend that emphasis be placed on the social and cognitive contributions of a group of learners with one another by collaboration and support of each other towards learning goals. Online tools allow for the effective building of community through online conversations and dialogue (Jonassen, Howland, Moore, & Marra, 2003). Online learning communities may provide learners with the opportunities to collaborate with others in a complex, dynamic network of collaborating contributors, functioning together to become more capable of learning (Howland et al., 2012). The Einstein Girls functioned as an informal social and cultural online learning community when they connected with one another and with the female STEM mentors through the Internet. Together the participants pursued the common themes of career exploration, science interest and science identity.

An online community scaffolds learning and may provide a supportive social context where learning can occur. By being a part of a community, participants' feelings of isolation are reduced and feelings of connectedness are magnified. Beginning learners and expert learners work together in a community providing an increasing sense of mutual effort on behalf of the community by sharing ideas, developing knowledge, and appreciating multiple perspectives. This gives the context that scaffolds the learning of the participants. In addition, cooperative learning strategies that are utilized during learning community interaction have also been found to increase the academic skills, social skills, and self-esteem among school children (Riel, 1990). Small group investigations or team projects improve instruction and learning which fosters pro-social patterns of peer interactions and relationships among the members (Riel, 1990).

Social constructivist theory can be used to examine the value of various technology applications for online learning community building (Gunawardena et al., 2009). According to social constructivist theory, an individual's understanding of the world arises from their own shared construction of the world. An online learning community can facilitate the construction of knowledge through the participants' online interactions within the community as the online environment scaffolds learning and provides a supportive social context where learning can occur (Turvey, 2006). Beginning learners and expert learners work together in a community providing an increasing sense of obligation and mutual effort on behalf of the community. This gives the context that scaffolds the learning of the participants and is agreement with Dewey's (1938) theory that the learning by an individual is the consequence of the interaction of their personal interests, their experiences, and their social worlds. It is also in agreement with Vygotsky's (1978) social constructivist thesis that interaction between people and within individual minds is fundamental for personal cognition development (Jung & Latchem; 2011).

While there is evidence that a sense of community can be created online (Garrison, 2007), the community group members may lack the social interactions afforded by F2F communities. This may require more time to develop social relationships as members may be unfamiliar with others and isolated from others (Koh & Hill, 2009). The lack of social interaction may impact group formation, group dynamics, and individual and group learning (Koh & Hill, 2009). Other challenges such as communication problems, distrust, disagreement, and unwillingness to participate may prove detrimental to an online learning community (Chen, Chen, & Kinshuk, 2009).

The National Girls Collaborative Project (NGCP) provided capacity-building topical webcasts that assisted girl-serving organizations (NGCP, 2008). One of their programs was known as "Girl Game Company" and was funded by the NSF. The program was a project-based, design-based learning approach in which games were placed in an imaginary science-based online community for preteens. The project utilized the online community to deal with environmental and social issues, allowing the girls to work together in an online learning community (NGCP, 2008). Other online learning platforms such as Edmodo, Edublogs, ePals, and ThinkQuest are available for teachers and students to collaboratively create learning projects together (Howland et al., 2012).

During the spring of 2013, the Einstein Girls and the female STEM mentors formed an online learning community. The community utilized the social networking program Edmodo that connected the student participants with the female STEM mentors. By utilizing the network, participants asked questions of the mentors, got information from the mentors, and were encouraged by the mentors, building up the community nature of the group. The Einstein Girls participants functioned as the beginning learners and the female STEM mentors served as the expert learners. During the online interactions, all of the community members interacted and increased the strength of the community.

Situated learning

The theory of situated learning maintains that learning as it normally occurs is a function of activity, context, and culture in which it occurs (i.e., it is situated). These activities are seen as authentic, and have embedded within them the working practices and culture of the real world. This contrasts with many learning activities within the classroom which involve knowledge that is out of context and abstract. In traditional instruction, “the learner’s cognitive activity is centered on the development of strategies for determining what the text and the teacher are signaling as important” (Duffy & Cunningham, 1996, p. 184). They recommend that involving learners in “cognitive and metacognitive activities that involve the authentic use of information” (p. 184) is essential to situated learning.

Learning needs to be understood as a social process and in order to make sense of learning the sociocultural context needs to be examined (Rogoff, Turkanis, & Bartlett, 2002). Social interaction is a central component of situated learning as learners become involved in a community which embraces certain behaviors and beliefs to be acquired (Ganley, 2011; Lave & Wenger, 1991; Wenger, 1998; Wenger, McDermot, & Snyder, 2002). Falk & Dierking (1997) suggests that learning is strongly influenced by setting, social interaction, and individual beliefs, knowledge, and attitudes. Data indicate that a community brings for the participants a greater sense of belonging, connectedness, and meaningful relationships, and may ensure better academic preparation (Lave & Wenger, 1991; Wenger, 1998; Wenger et al., 2002).

The Einstein Girls and Mentoring

Penny and Bolton (2010) define a mentor as a “trusted friend, a counselor, or a teacher” (p. 17). The mentor is usually a more experienced person (expert, old-timer) who gives advice and help to a less experienced person (newcomer, peripheral participant). O’Neill, Wagner, and Gomez (1996) define an effective mentoring relationship as one that is “characterized by a richness of interdependence between two people” (p. 42). Mentoring may be used in a broad sense to include the responsibility of role model, coach, guide, tutor, or advisor (O’Neill & Harris, 2000; Penny & Bolton, 2010). The idea of mentoring itself dates back to the ancient work *The Odyssey* by the Greek poet Homer. In the poem, Odysseus' son Telemachus is given direction by a wise sea captain named Mentor about how to cope with the difficulties associated with the long absence of his father since the Trojan War. The term mentor is used to describe individuals in a wide variety of relationships in educational and business communities.

Traditionally, mentoring is often associated with workplace relationships, with a more experienced mentor helping raise up a younger protégé. For the purposes of this literature review, mentoring in education will be the focus. O'Neill (1998) separated traditional mentoring relationships into two broad categories which are termed natural mentoring and formal mentoring. Natural mentoring relationships represent those where the mentors and mentees come together by either personal affiliation or chance opportunities, and are often present in the workplace (O'Neill, 1998). Formal mentoring relationships are oftentimes the result of the initiative of a school, a business, or a non-profit organization. According to O'Neill (1998), empirical research on mentoring is sprinkled throughout the literature on business, teacher training, adult development, nursing, and various other fields. The research is often somewhat lacking in agreement and difficult to conduct (O'Neill, 1998).

Theoretical Grounding for Mentoring

The theoretical grounding for mentoring, while not well defined, is often included under the broader category of learning theories, specifically cognitive apprenticeship and constructivist/socio-cultural theories (Ehrich, Hansford, Tennent, 2001). Cognitive apprenticeship provides a theoretical framework for the process of helping novices become experts through one-on-one guidance and is grounded in mentoring, coaching, and modeling. Cognitive apprenticeships are situated within the social constructivist model and suggest students work together on projects modeled in real-world situations (Collins, Brown, & Holum, 1991). The perspective of constructivism maintains that learning is a process of active construction. The construction of ideas takes place during social interactions with other people (Weinburgh, 2007). Vygotsky (1962) submitted that the construction of new meaning is most often facilitated by a more knowledgeable person, such as a teacher, an older student, or a mentor. The use of mentoring in K-12 education incorporates social constructivist methods as students construct their knowledge and scaffold personal meanings through social interactions with their mentors (Penny & Bolton, 2010). The use of mentoring in the K-12 classroom fits well into the framework of constructivist methods of classroom teaching as well as in informal learning environments (Penny & Bolton, 2010). Mentoring relationships provide social interactions, the ZPD, and scaffolding of the learning environment between the member and the more experienced expert.

Cognitive apprenticeship

Cognitive apprenticeship, defined by Robinson et al. (2008), provides "a theoretical framework for the process of helping novices become experts through one-on-one guidance" (p. 34). The theory of cognitive apprenticeship is grounded in the work of Resnick (1987) and Brown, Collins, and Duiguid (1989), and moved apprenticeships from the area of physical job skills to the realm of the development of cognitive skills (Duffy & Cunningham, 1996). Lave and Wenger (1991) examined the entire sociocultural context in which the learner is a part. They also discussed an apprenticeship as being a part of the legitimate peripheral participation theory with an apprentice assuming the responsibilities over time in the community. The learner becomes a part of the community of practice and begins to assume responsibilities in the community (Duffy & Cunningham, 1996). All the parts of the community, the culture, the experts, and the artifacts, afford the scaffolding for the learner as s/he assumes the responsibilities (Duffy & Cunningham, 1996). Another way to view a cognitive apprenticeship is through a mentoring relationship that involves a relationship between a mentor and a mentee. The next section discusses the mentoring, the theoretical framework of mentoring, and how mentoring was accomplished in the Einstein Girls online mentoring community.

Mentoring functions

O'Neill (1998) further describes formal mentoring relationships according to the two functions the relationships provide to the protégé by the mentor. The two classes are career mentoring and psychosocial mentoring (Kram, 1985; O'Neill, 1998). These functions have been described by Schockett, Yoshimura, Beyard-Tyler, and Haring-Hidore (1983) and have been supported by further research (O'Neill, 1998). While most of the mentoring research relates to higher education and adult settings, these functions may also inform mentoring in K-12 settings. A mentor offers a mentee the career functions of sponsorship, exposure, visibility, coaching, and protection (O'Neill, 1998). In a similar fashion, the mentor offers a mentee the psychosocial functions of role modeling, acceptance, confirmation, counseling, and friendship (O'Neill, 1998). Several of these functions were observed in the OMC of the Einstein Girls and female STEM mentors and informed parts of the a priori codebook (see Appendix A) used to evaluate RQ 1.

The Einstein Girls were given the opportunity for exposure to a variety of STEM careers. They were able to communicate with real STEM professionals and explore various careers and career paths. They could ask specific questions about their careers and questions about their educational pathways. They received information on pursuing advanced degrees in STEM from a medical doctor, a veterinary surgeon, a woman with an Ed.D., an engineer, and two women with Ph.D.'s. The girls also talked about their interests in STEM and their science identities with the mentors. They were able to ask the women about the timing, the source, and the nature of their interest in science.

They were able to ask questions about science identity. The girls were able to find out what drew the women to science, how their surroundings shaped them, and ways they could encourage their own science identities.

Mentoring models

There are several models for mentoring that can be used in formal and informal educational settings, such as traditional one-to-one mentoring, group mentoring, team mentoring, peer mentoring, and online mentoring (NMP, 2005). In the book *Creating an E-Mentoring Community*, Burgstahler (2006) stated that, when working with young people, mentors “can help their protégés explore career options, set academic and career goals…” (p. 4), She also stated that mentoring may help their protégés “…strengthen interpersonal skills, achieve higher levels of autonomy, and develop a sense of identity and competence” (p. 4). Mentors may provide a significant contribution to a student’s educational experience by providing a positive influence as they begin to seriously consider future career options (Long & Close, 2012). Mentoring is seen as a strategy that can help young people of all circumstances realize their potential (NMP, 2005). Sjaastad (2012) investigated the extent STEM students said they were inspired or motivated in their educational choices by individuals. His research looked for a suitable theoretical framework to study the “influence of significant persons on STEM-related educational choices” (p. 1616). Maltese and Tai (2010) also considered the sources of early interest in science in their research. They asked Ph.D. scientists who they attributed with initiating their early interest. Several of the scientists responded that an “extraordinary teacher” (p. 678) or other significant person provided that initial spark of interest in science.

Mentoring and girls in science

Mentoring and role models have shown to have a positive impact on female students and help improve their attitudes towards science (Weber, 2011). Mentors can convey to girls positive images of women in STEM and girls who find mentors from within the scientific community are more likely to pursue their interests in science (NRC, 2006; Weber, 2011). The AAUW recommends exposing girls to successful female role models and mentors as a prescriptive measure for future success in STEM (Hill et al., 2010). A mentoring relationship between a girl and a science mentor may offer the spark of encouragement needed to encourage towards STEM areas.

Mentoring programs can help female students develop an interest in STEM and help them persist in their studies of STEM (Blake-Beard et al., 2011; Burgstahler, 2006; Farland-Smith, 2009; Halpern et al., 2007; Wasburn & Miller, 2004). Female STEM mentors can be paired or grouped with girls to offer advice, guidance, and answer questions about their careers. These mentors can teach girls that struggles and successes in STEM are normal and that becoming good in science and mathematics takes hard work (Halpern et al., 2007). A mentor may provide a protégé an example as a role model, offer motivation, give career advice, and provide moral support. Science mentors for girls may be scientists (Farland-Smith, 2009; Halpern et al., 2007; Heilbronner, 2009; Koenig & Hanson, 2008; Vanmali & Abell, 2009), graduate students (Buck, Clark, & Beeman-Cadwaliader, 2008; Cohn, 2009; Penny & Bolton, 2010), professors and teachers (Reis & Graham, 2005; Weber, 2011), or older peers (Cohn, 2009; Karcher, 2008; Reis & Graham, 2005). Mentors may be utilized in both F2F and online scenarios. The students receiving mentoring may be in elementary school

(Karcher, 2008; Penny & Bolton, 2010; Ryan, Whitaker, & Pinckney, 2002), middle school, or high school.

Girls can benefit from extra motivation and encouragement as well as career advice and inspiration they may receive from STEM mentors. These relationships may be advantageous for girls as they move through their pre-college schooling as they consider interest areas and career paths. In a discussion on the specific need for girls to have mentors, Eschevarria (1998) said that girls reach a point in their development when "they must construct their individual identities by moving away from mothers and fathers" (p. 1), and that "external support from a nonparental female role model is an essential-and far too frequently ignored-requirement for healthy development in girls and young women" (p. 7).

Challenges associated with mentoring

There are several unique challenges that are inherent with mentoring. Setting up mentoring relationships for girls may be difficult as it may be problematic to recruit mentors who are willing to commit the time and resources needed to build mentoring relationships. Mentors often report lack of time and lack of training as obstacles to mentoring (Ehrich et al., 2001). Strategies for recruiting mentors may include using school, university, and community resources, obtaining assistance from older girls pursuing STEM, and visiting local chapters of professional societies and companies. In addition, school hours alone may not provide adequate opportunities for girls to be exposed to role models, as mentoring may be better suited to out-of-school time (Halpern et al., 2007). Another challenge relates to the research available on mentoring. A few promising studies have been found that demonstrate the effect of mentoring programs in increasing the number of minority students pursuing advanced degrees in STEM (Maton & Hrabowski, 2004; Summers & Hrabowski, 2006). While some descriptions and evaluations are available in the literature of mentoring programs involving adolescents, there is little research available on elementary school mentoring programs (Ryan et al., 2002) or on the effectiveness of mentoring programs with girls.

Online Mentoring

The increased interest in mentoring in educational environments has encouraged an interest in online mentoring (Penny & Bolton, 2010). Online mentoring is defined as "a computer mediated, mutually beneficial relationship between a mentor and a protégé which provides learning, advising, encouraging, promoting, and modeling, that is often boundary-less, egalitarian, and qualitatively different than traditional face-to-face mentoring" (Bierema & Merriam, 2002, p. 214). This type of mentoring may also be known as virtual mentoring, telementoring, electronic mentoring, or e-mentoring (Harris, 2011; O'Neill, 1998; Penny & Bolton, 2010). Online mentoring provided an innovative way to connect the Einstein Girls with female STEM mentors through the Internet and social networking. Prior to the spread of the Internet, mentors would have to come to a school or outside meeting place to interact with their mentees in F2F settings (Penny & Bolton, 2010). In addition, the time and cost commitments were often prohibitive, often making F2F mentoring difficult to accomplish (Langley, 2008). By utilizing the Internet, there is a reduction in time commitment for the mentor volunteers to maintain a significant involvement in the lives of the mentees. In addition, online mentoring allows for more lengthy and intellectual discussions between the parties (O'Neill, 1998).

The models previously mentioned for mentoring in formal and informal educational settings may also be used in an online setting, such as traditional one-to-one mentoring, group mentoring, team mentoring, and peer mentoring (NMP, 2005).

Online mentoring may be accomplished using synchronous and asynchronous communication through email, websites, discussion boards, collaborative environments, social networks, or other emerging technologies (Johnson et al., 2010; Langley, 2008; O'Neill et al., 1996). Computers and web-enabled devices allow for a wide variety of experiences and activities that can support learning outside of the classroom through mentoring. Through the use of mentoring framed in the cognitive apprenticeship model, participants are further assimilated into the culture by interactions with the other participants and with the experts.

Much of the research on online mentoring communities is focused on learning in higher education settings (Blake-Beard et al., 2011; Dorner, 2012; Hung & Tan, 2004; Muldoon & Wijeyewardene, 2012; Simonsen et al., 2009) or the fields of business and engineering (Blake-Beard et al., 2011; Langley, 2008). While there is not a large body of research available on online mentoring in K-12 settings, such programs have great potential for "impact on the lives of a broad spectrum of school children" (O'Neill, 2011, p. 15). According to Harris (2011), online mentoring is one of the "oldest and most educationally beneficial forms of social/educational networking" (p. 2). There have been successful Internet-based mentoring projects used in K-12 settings. For example, the Electronic Emissary Project (EEP) matched subject matter experts (SME) from different disciplines with K-12 students and teachers (Harris, 2011; Harris, O'Bryan, & Rotenberg, 1996; Sanchez & Harris, 1996). The EEP is an Internet-based online mentoring service and resource that helps locate and match mentors and mentees in order to assist in curriculum-based information exchanges between students, teachers, and SMEs. Researchers and teachers have been designing online mentoring programs for close to two decades, yet the potential for such spaces has yet to be tapped (Harris, 2011; O'Neill, 2011).

There have been some successful online mentoring groups that utilized group chat sessions for communication or through an established network. As a part of the Women@NASA website, the network aspire2inspire targeted middle school girls considering education and careers in STEM (Sohn, 2011). The website features four Twitter feeds for girls to communicate with the women highlighted in the videos. Penny and Bolton (2010) describe another online mentoring program that involves synchronous and asynchronous electronic communication through social media, e-mail, discussion boards, blogs, and wikis. These types of systems support and facilitate online mentoring relationships allowing students to be mentored by role models or subject-matter experts (O'Neill & Harris, 2000; Penny & Bolton, 2010).

Edmodo

For this project, the Einstein Girls and female STEM mentors were connected online through a program known as Edmodo (see Figure 3-1). Edmodo is a free social networking program that provides a communication platform for educational use. It is a private platform, meaning the content is not available to the general public. This makes Edmodo a safe and secure instrument that can be used in schools to connect a community of individuals for sharing ideas and collaboration (Anderson, 2010). My school has used Edmodo with students in grades 7 and 8 for student-to-teacher communication and student-to-student collaboration in both English and social studies courses. We have an official school site which allows all of the networks to be managed by the technology department. Teachers can create and manage their own accounts simply by registering and creating an account within the Edmodo website. The program features a simple, user-friendly, and intuitive interface that offers a safe and managed environment.

Figure 3-1. Welcome to Edmodo screenshot.

The Einstein Girls online mentoring community

The Einstein Girls program offered the participants opportunities for online mentoring with the female STEM mentors through Edmodo during the months of April and May of 2013. I decided to use the team mentoring model within an online setting. The team mentoring model involved “several adults working with small groups of young people, with an adult-to-youth ratio no greater than one to four” (NMP, 2005, p. 12). The team mentoring allowed students to interface with STEM professionals as well as one another. By using the online mentoring community, the girls were able to talk with the female STEM professionals about their careers in STEM and the pathways that led them to their careers. In addition, they were able to ask the women about the timing, the source, and the nature of their interest in science. They were also able to ask questions of the women regarding the science identity. They were able to find out what drew the women to science, how their surroundings shaped them, and how girls could encourage a science identity in themselves. Through the online mentoring project, the girls were able to worked forge a sense of connectedness, culture, identity, and belonging with one another and the female STEM mentors.

CHAPTER 4
METHODOLOGY: A QUALITATIVE ANALYSIS OF THE ONLINE MENTORING COMMUNITY

Introduction

The purpose of this capstone project was to create an online mentoring community among fifth and sixth grade girls and female STEM mentors, to examine in depth the nature of the online mentoring process that took place within the community, and to determine the participants' perceptions of the opportunities and the constraints of the community. The project sought to answer two research questions. The first question centered on understanding the nature of the online mentoring process, with special focus on mentees' career exploration, interest in STEM, and science identities. The second question sought to gain insight into the perception of the participants regarding both the opportunities afforded by the community and the constraints associated with the community.

A qualitative research design was used to frame the first research question utilizing the collection of descriptive data to gain insight into the complex nature of the OMC (Gay et al., 2009) as well as a thematic analysis of the online discussions. Descriptive data contained within the online community site were examined to determine the frequencies of participation for each of the members. The types of interactions that took place between the students and the mentors were also analyzed and classified. In addition, the transcripts of the discussions that took place in the community were evaluated to determine the participation approaches by the members. A thematic analysis of the online discussions was also completed. The design process for this analysis was documented from the perspectives of the mentors and the students. I used Braun and Clark's (2006) theoretical thematic analysis framework of qualitative data analysis along with an a priori codebook which was developed before the program began.

The project also explored the participants' perceptions of the opportunities and constraints surrounding the online mentoring process. To analyze the second research question, a qualitative research methodology was also used. I interviewed seven Einstein Girls for the project to explore their perceptions of the online mentoring process using a semi-structured interview format (see Appendix C). I also conducted a focus group with the mentors to find out their perceptions (see Appendix D). I completed a member check with 12 of the 13 participants. Table 4-1 summarizes the two research questions, the data collection methods, and the data analysis process for this project.

Table 4-1. Research design for capstone project

Research question	Data collection	Data analysis
RQ 1: What is the nature of the online mentoring process--with special focus on mentees' career exploration, interest in STEM, and their science identities?	Online transcripts of student and mentor discussions Researcher journal	Frequencies of participation for each member Participation approach for each member Types of interactions identified and classified Thematic analysis of discussion topics using a priori codebook Researcher journal for additional insights into nature of online mentoring process
RQ 2: What are the participants' perceptions of the opportunities and constraints surrounding online mentoring?	Interviews of seven Einstein Girls Focus group with six mentors Researcher journal	Coding of categories relating to participants' perceptions through CCM Researcher journal for additional insights into participants' perceptions

Design of Online Mentoring Community

New forms of community are emerging as our traditional assumptions about learning are being transformed by opened-ended processes of communication though the Internet (Jenkins, 2006). According to Harris (2011) students "are drawn so powerfully to multiple forms of networked communication" (p.1), and when used for educational purposes an online communication network may be used to "capitalize upon students' attractions to social networking" (p. 1). An online community may facilitate the construction of knowledge through the participants' online interactions within the community (Turvey, 2006) as the online environment scaffolds learning and provides a supportive social context where learning can occur. Beginning learners and expert learners work together in a community providing an increasing sense of obligation and mutual effort on behalf of the community. An online community offers the beginning learners a safe environment in which to ask expert learners questions about their areas of interest.

The Mentoring Component

Mentoring refers to a relationship in which a more experienced or knowledgeable person (the mentor) provides advice and help to a less experienced or knowledgeable person (the mentee). Mentoring is a strategy that can help young people of all circumstances realize their potential (NMP, 2005). Over the past few decades, mentoring has become popular in education (Penny & Bolton, 2010). There are several models for mentoring that can be used in educational settings, such as traditional one-to-one mentoring, group mentoring, team mentoring, peer mentoring, and online mentoring (NMP, 2005). Mentors may provide a significant contribution to a student's educational experience by providing a positive influence as they begin to seriously consider future career options (Long & Close, 2012).

The AAUW recommended introducing girls to successful female role models and mentors in STEM as a strategy to encourage girls in science and mathematics (Hill et al., 2010). Mentoring programs can help female students develop an interest in STEM and help them persist in their studies of STEM (Blake-Beard et al., 2011; Burgstahler, 2006; Farland-Smith, 2009; Halpern et al., 2007; Wasburn & Miller, 2004). Female STEM mentors can be paired or grouped with girls to offer advice, guidance, and answer questions about their careers. These mentors can teach girls that struggles and successes in STEM are normal and that becoming good in science and mathematics takes hard work (Halpern et al., 2007). Mentors can also convey to girls positive images of women and be role models in STEM (Farland-Smith, 2009). It has been shown that girls who work with mentors from within the scientific community are more likely to pursue their interests in science (Farland-Smith, 2009; NRC, 2006; Weber, 2011).

Online Mentoring

The design of the OMC used in this project connected adults with students through the Internet using the secure social network Edmodo. Harris (2011) described OMCs in K-12 settings as those which typically support the exploration of career interests and personal issues. She recommended that K-12 students be afforded the opportunities to communicate with content specialists who share similar interests, experiences, and expertise. The *2010 Horizon Report* (Johnson et al., 2010) discussed OMCs as self-contained online spaces for collaboration, exchange of ideas, and knowledge sharing. Such spaces allow students the opportunity to build knowledge in their own ways, work creatively, and learn from others who possess a wide range of expertise and experiences.

The Einstein Girls, when connected online with the female STEM mentors functioned as an OMC with the goals of interesting the girls in science and STEM, informing them about STEM careers, and encouraging their senses of science identity. The Einstein Girls OMC utilized the team mentoring model within the community, which involved “several adults working with small groups of young people, with an adult-to-youth ratio no greater than one to four” (NMP, 2005, p. 12). The team mentoring allowed students to interface with STEM professionals as well as one another through the Internet. Since we used the team mentoring model, there was no one-to-one matching of girls with specific mentors. Instead, the girls were able to ask questions of any one or more of the participating mentors. This contributed to the community nature of the Einstein Girls online mentoring program.

Edmodo as the Online Platform

Before I began this project I spent about a year researching several educational social networking platforms available to use as my online mentoring delivery system. I began the search by looking at the following platforms: Blogger, Edmodo, Edublogs, ePals, Mentornet, Moodle, Ning, and Wordpress. At the time of writing, these platforms were open-source community-based tools used for various purposes in education and for personal use. I narrowed the search down to Edmodo and Moodle, which were both used at my school. The sixth grade Einstein Girls had used Moodle in academic settings but none of the participants had used Edmodo prior to the project. I reached out to several technology experts at my school for advice and chose to use Edmodo for my OMC delivery platform. I opened a teacher account through my school and created a group within my Edmodo account called the Einstein Girls Group.

Context

The purpose of this project was to create an OMC that connected the Einstein Girls with female STEM mentors, allowing the girls to explore STEM careers, interest, and identity. The project was conducted during the spring 2013 semester of the Einstein Girls after-school academy at my school using Edmodo as the online mentoring delivery system. The Einstein Girls were the student participants and six female STEM mentors were the adult participants. The components of the OMC are described below.

Participants

There were 27 participants who were a part of this project. There were 20 Einstein Girls, six female STEM mentors, and me as the director of the program. In addition, the parents of the Einstein Girls were able to observe the OMC if desired. The following sections describe the participants and their roles in this project.

Einstein Girls

There were 20 Einstein Girls who were a part of this project. The program had an enrollment of 19 fifth and sixth grade female students and one eighth grade former Einstein Girl student assistant who were all members of the school population. The Wednesday group consisted of 14 girls (eight fifth grade girls and four sixth grade girls) and the Thursday group consisted of six girls (one fifth grade girl, four sixth grade girls, and the eighth grade student assistant). The information from all 20 students was considered together during the data collection phase and the data analysis phase of the OMC project.

The Einstein Girls members were defined as those students whose parent(s) or guardian(s) received the Parent Introduction Letter to Study (see Appendix E) and signed the Parental Consent Form (see Appendix F). The research protocol was approved through the University of Florida Institutional Review Board and all minor participants gave their assent to be included in this project (see Appendix G). All of the students chose to be a part of the Einstein Girls program and also volunteered to participate in this research study; therefore there was no selection process. To protect the anonymity of the girls, I created pseudonyms and used them throughout the project.

The 20 Einstein Girls participants were a racially and culturally diverse group of girls. The demographics of the group at the time of the study were: 10% African-American, 5% Asian, 40% Caucasian, 10% Hispanic, 25% Eastern Indian, and 10% Middle-Eastern. The girls shared a similar high socioeconomic background which is typical for a private school.

Einstein Girls parents

The parents of the Einstein Girls were invited to participate in the online mentoring community. Parents were emailed parent enrollment passwords to allow them access to the Edmodo site. Their access was limited, allowing them to read the posts and discussions between students and mentors. They were not active participants in the community and could not post any comments or delete any comments. The rationale for including parents was to allow them the ability to monitor the activities and discussions of the community if desired.

Female STEM mentors

A critical step in creating a successful OMC for the Einstein Girls was the selection of the female STEM mentors. Many women STEM professionals offered their services to the project and I spent several months contemplating which mentors to use, how many to use, and which STEM areas to include. My first decision was to choose women who were parents of students in the school community. I chose women that I knew to insure the safety of my Einstein Girls and the comfort for their parents. Two of the mentors (Dr. B and Dr. K) were parents of former Einstein Girls and one mentor (Dr. G) was the parent of a rising Einstein Girl. In addition, I taught science to all of their children. Another mentor (Dr. P) was involved with me on several science and school-related projects and I taught science to her two children. I also taught Dr. M's two daughters and Ms. N's two sons. I decided not to select parents who had daughters in the Einstein Girls program during the time of this study.

I asked the six women if they would consider being mentors for the Einstein Girls OMC in February or March 2013. I asked Dr. G and Dr. K at school functions and gave them a general idea of what to expect from the project. I then emailed Dr. P, Dr. B. and Ms. N in February with the same general information. The last mentor contacted was Dr. M; she was invited to join in March. All of the women graciously said yes and offered their services to the project and to the girls.

The female STEM mentors were defined as those participants who signed the Participant Consent Form (see Appendix H). The six mentors represented all areas of STEM. Representing areas of science were a clinical psychologist (Dr. K), a reproductive endocrinologist (Dr. P), and a veterinary surgeon (Dr. M). Representing the area of technology was a chemical engineer (Dr. G) who served as a research scientist in the electrical and computer engineering department at a nearby university. Representing areas of engineering were the chemical engineer as well as a geotechnical engineer (Ms. N). Representing the area of mathematics was a high school mathematics teacher (Dr. B). Dr. B did not teach mathematics at our school, she taught at another school in town.

The mentors were a racially and culturally diverse group of women. One of the mentors was African-American, one was Eastern Indian, one was Hispanic, and three were Caucasian. One of the Caucasian mentors was born and raised in Canada. Five of the six mentors held terminal degrees. Two of the mentors attained the degree of Doctor of Philosophy (Dr. G and Dr. K) and one of the mentors attained the degree of Doctor of Education (Dr. B). Dr. P attained the degree of Medical Doctor and along with being a practicing physician, was an Assistant Professor at [university] College of Medicine. Dr. M attained the degree of Doctor of Veterinary Medicine and was a board-certified animal surgeon. Ms. N received her undergraduate degree in geotechnical engineering and was a successful business owner. To protect the anonymity of the mentors, pseudonyms were assigned and used throughout the project. The mentor pseudonyms consisted of the mentor's title and the first letter of the last name.

Director

I served as the director and owner of the Einstein Girls Group contained within the Edmodo site. After setting up the teacher account through my school, I had the sole ownership of the group as well as the control of the group. I had to approve all comments submitted to the Edmodo site prior to posting and could lock, unlock, or shut down the site at any time.

Roles of the Participants

The following sections describe the roles of the participants of the OMC. First the role of the Einstein Girls is discussed followed by an explanation of the role of the female STEM mentors.

Role of Einstein Girls

The Einstein Girls were first introduced to the Edmodo social network site during program meetings in February of 2013. On February 8, 2013, I emailed all parents of the Einstein Girl participants and told them about my plans to form on online mentoring community through Edmodo; I received permission from every parent to enroll their daughter in the OMC. We began working with Edmodo during the second week of the Einstein Girls after-school academy in February 2013 with both the Wednesday group and the Thursday group. During our meetings I displayed the Welcome to Edmodo image on a large screen using my teacher computer and a projector. I demonstrated the procedure for enrolling a student in the Einstein Girls Group using a fictitious name. Each girl was then assigned to a computer in my science laboratory, given a teacher-created username and password, and created their own student account.

Once the 16 girls in the Wednesday academy were enrolled I took them on a virtual walk-through of the Edmodo site. I showed the girls how to type and send a note (which was the same procedure used to begin a discussion thread) with the fictitious name. I typed a note in the box, selected “Einstein Girls” from the drop-down menu on the “send to” box, and selected “send.”

The message did not display immediately on the Edmodo screen but instead, a message displayed that said “Post sent for moderation—Your teacher must approve this message before it displays” (see Figure 4-1). I explained to the girls that I set up the program in such a way that every post from every participant (whether Einstein Girl or STEM mentor) had to be moderated or approved by me as the teacher and owner of the group. Once I approved the note from my teacher computer, the message displayed on the Edmodo Einstein Girls Group site. After each note a box appeared that said “Type a reply….” I explained that this is where a student could answer a question or add a comment to another post. These replies and comments were also sent to me for approval before appearing on the Edmodo Einstein Girls Group site. I set up my account with the approval feature to ensure the appropriateness of the comments and preserve the integrity of the site. For the remainder of the class, the students practiced writing notes and replying to one another.

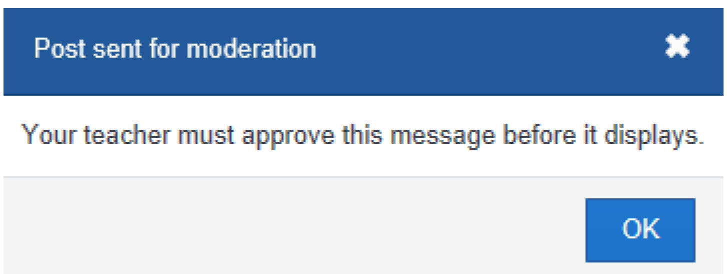

Figure 4-1. Post sent for moderation screenshot.

The enrollment process was repeated with the Thursday Einstein Girls group the following day. The six girls were enrolled in the same group as the Wednesday girls, and the initial group consisted of 23 members, including 20 Einstein Girls, 2 fictitious students (one from Wednesday and one from Thursday), and me. At this point I went to my Edmodo account and locked the group. The project was set aside for the girls until April 2013 and I turned to the mentors.

Role of mentors

The six mentors were chosen by the process described earlier in this chapter. Once the mentors were selected, all communications were accomplished by email. On April 3, 2013, the first email was sent to the six mentors with more details about the program. On April 11, 2013, a second email was sent explaining how the Edmodo site would work and more about their role in the OMC. A third email was sent on April 21, 2013 requesting permission for me to enroll each mentor in the Edmodo community. I unlocked the Einstein Girls group so I could add the mentors to the group as students. Each mentor responded favorably and was enrolled as a student in the community. I sent each mentor a username and password that allowed them private access to the Edmodo site from any computer or mobile device. The final group had 29 members, which included the 20 Einstein Girls, six female STEM mentors, two fictitious students, and the owner (see Figure 4-2). The group was locked again to keep it secure.

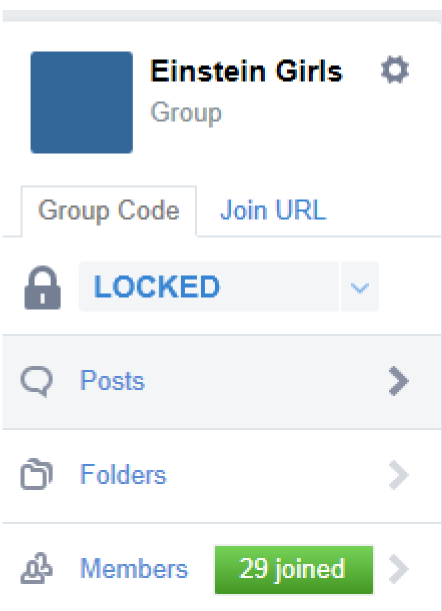

Figure 4-2. Einstein Girls group locked screenshot.

A training document was emailed to each of the mentors on April 23, 2013 (see Appendix I). The training document was created from the synthesis and adaptation of several mentor training documents encountered during my search for mentoring information (Cravens, 2000; MMP, 2013). In the training document I requested that the mentors serve as supportive and caring adult supervisors for fifth and sixth grade girls who had demonstrated an interest in science or STEM. Their role was to answer any of the girls' questions posted on the Edmodo site. The questions centered on the mentors' careers, their educational experiences, their STEM interests, and their science identities. I asked the mentors to visit the Edmodo site whenever their schedules permitted, but requested that they visited the site a minimum of three times a week over the course of the four week program and answer the girls' questions in a timely fashion. In addition to answering any questions posted by the girls, I suggested that they also ask the girls questions, ask each other questions, and ask me questions. I told the mentors they could e-mail or call me with questions at any time during the months of April and May.

The Project

The project began after I received approval from the University of Florida's Institutional Review Board and collected all of the approval documents described earlier in this chapter. Before officially beginning the OMC project, I went back to the Edmodo site and deleted all of the practice posts written by the girls. The project began on the evening of April 23, 2013 when I opened up the emptied Edmodo site and created an initial post for each of the six mentors. Each mentor received the same initial post from me, in which I welcomed the mentors to the Einstein Girls OMC and asked the question, "What is your career and what do you do in your career" (Mrs. Scott, Edmodo transcript, April 23, 2013)? I asked the mentors to try to answer the question before the Week 1 Einstein Girls after-school meetings set for April 24, 2013 and April 25, 2013. If they did not answer the question prior to the meetings, I requested they answered sometime during Week 1. Dr. K and Dr. M (see Figure 4-3) posted their responses before the Wednesday group meeting and Dr. G posted her response before the first Thursday group meeting.

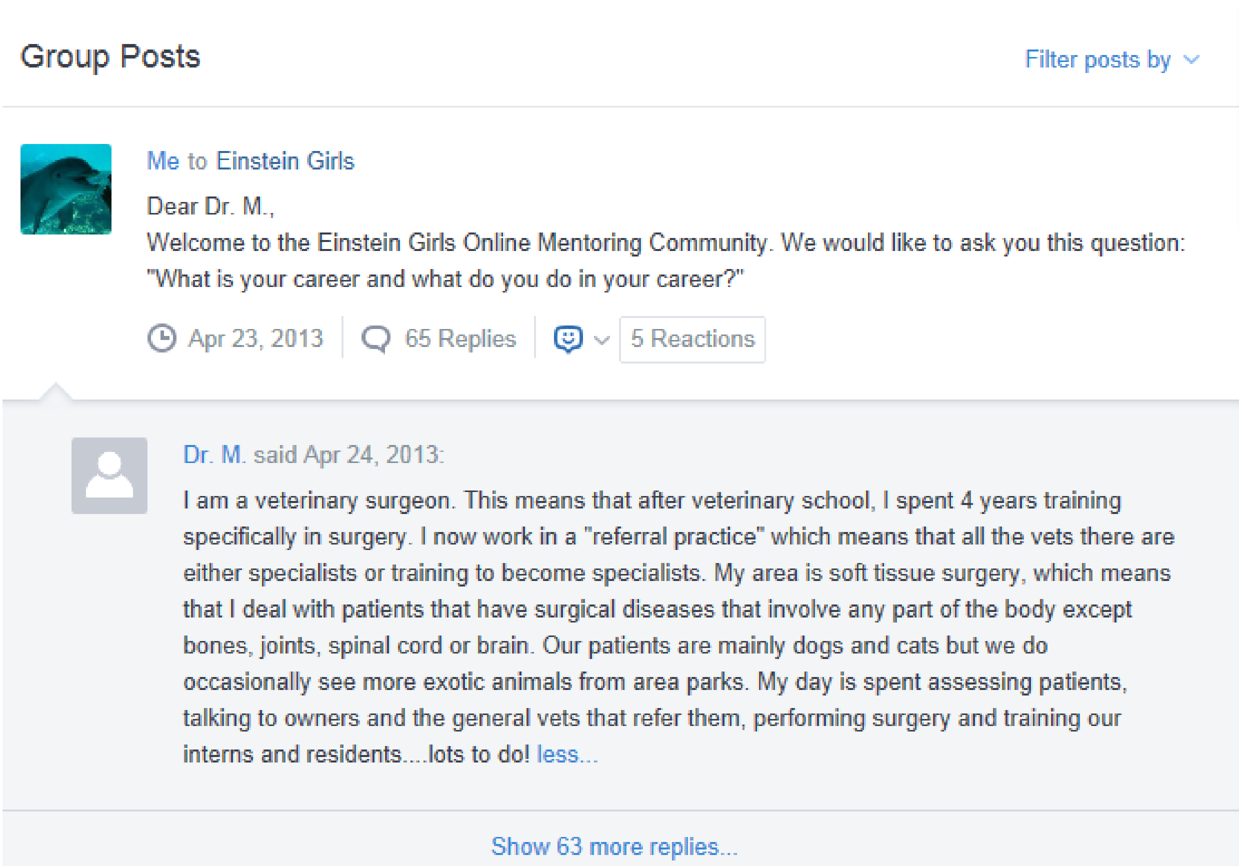

Figure 4-3. Dr. M initial post screenshot.

During the Week 1 meetings, the girls were reminded how to access the Edmodo site and logged into the group with their individual usernames and passwords. Each girl was given a list of suggested questions about career exploration designed to help them initiate discussion threads (see Appendix J). Research literature on mentoring and girls in science as well as the a priori codebook (see Appendix A) informed the design of the questions. The questions were divided into career, STEM interest, and science identity. The girls initially asked questions that related to mentors' careers and the girls were not restricted to the list of suggested questions but were free to ask their own questions as well. The mentors' initial job descriptions provided enough general information to prompt the girls to ask many questions about their STEM careers. Before the girls left the Week 1 meetings, they were told that they could access their Edmodo accounts from their homes with a computer or mobile device. I reminded them to obtain parental permission first and encouraged them to show the site their parents. After the class ended, I read the posts and approved all of them except for a few that were not relevant to the project. Then I sent a separate email to each Einstein Girl parent and assigned them a parent code. This code gave each parent private read-only access to the Edmodo site; parents were not active participants of the OMC.

By the end of the Week 1, all six mentors had answered the initial question and answered some of the questions posted by the girls during the Einstein Girls meetings. The theme for Weeks 1 and 2 of the OMC was career exploration. During those two weeks the mentors were asked to visit the site at least three times per week at their own convenience and to answer any questions posted by the girls. The theme for Week 3 was STEM interest, and the theme for Week 4 was science identity. The mentors answered the various questions posted at the Edmodo site in an asynchronous manner at their convenience.

During Weeks 2-4 the Einstein Girls had access to the Edmodo network during regular meeting times. In addition, I encouraged the girls to visit the site away from school. During the last week of the OMC I reviewed the Edmodo site and identified a few unanswered questions. I then emailed each mentor with remaining questions and asked them to answer them in a final post. Individual question and answer threads are discussed in greater detail in Chapter 5.

Research Design

Much of the literature on online mentoring is dominated by reports on programs and less focused on the possibilities that exist for the design and study of programs (O'Neill, 2011). The Einstein Girls OMC was created through the intentional design described earlier in this chapter. However, the goal for the project was to study the outcomes of the OMC. By examining the nature of the online mentoring process and discovering the participants' perceptions of the program, I was able to describe the online mentoring activities between the students and female STEM mentors. The results of this study were specific to the Einstein Girls program but generalizations may be made from this study to similar programs connecting students with adult mentors through OMCs. Information learned from this project may be cautiously generalized to inform future designs of comparable communities.

Research Question 1

> RQ 1: What is the nature of the online mentoring process--with special focus on mentees' career exploration, interest in STEM, and their science identities?

Data collection

The first research question was designed to explore the online mentoring process that took place between the Einstein Girls and the female STEM mentors. In particular, I was interested in examining the constructs of career exploration, STEM interest, and science identity for the girls. I examined the discussions threads that took place between the girls and the mentors on several levels and explored the themes that were present in those threads. A discussion thread consisted of a question posed by a student, an answer from the mentor, and any subsequent discussions related to the original question. The following paragraphs describe the ways in which data was collected.

Once the project was completed and the questions were answered, I went back to the Einstein Girls Group at the Edmodo site and read through the conversations that took place between the students and the six mentors. Each post contained in the Edmodo site represented a participant's thoughts and functioned as a unit of data analysis (Garrison et al., 2001). I created one transcript for each mentor that reflected all of the exact conversations in which the mentor was involved. These transcripts were organized chronologically by date, with the oldest post listed first and the newest post listed last. I labeled these transcripts as (mentor pseudonym) Protocol A. There were six Protocol A transcripts, one for each mentor. For a sample of a Protocol A transcript, please see Appendix K.

Since these transcripts were organized by date and the conversations were asynchronous, student question and mentor answer did not always correspond. In addition, because the girls asked most of the questions during Einstein Girls meetings and were not necessarily aware of the questions being asked by their peers, several questions were repetitious. Because of this, I created a second set of transcripts that were organized by question and not by date. I grouped similar questions together with the corresponding mentor answer(s) and assigned each question a number. These transcripts were labeled as (mentor pseudonym) Protocol B. There were six Protocol B transcripts, one for each mentor. For a sample of a Protocol B transcript, please see Appendix L.

Finally I formatted the Protocol B transcripts on documents with open margins to allow for coding of data. This was accomplished by assigning line numbers to identify each line within the data and was used later for cross-referencing the data. The pages were also numbered for identification purposes. These transcripts were labeled as (mentor pseudonym) Protocol C. There were six Protocol C transcripts, one for each mentor. For a sample of a Protocol C transcript, please see Appendix M.

In addition to the various protocols, I kept a researcher journal to record observations, thoughts, and wonderings. I used the Protocol A transcripts, the Protocol B transcripts, and the Protocol C transcripts as well as the researcher journal to complete the data analysis for RQ 1.

Data analysis

There were three areas of interest in evaluating the nature of the online mentoring process. First, I was interested in the various approaches to the community used by the members. I used the numerical information contained in the Edmodo site to analyze the frequencies of participation for each of the members of the OMC. I was interested in how many times each participant posted to the site. The Edmodo site allowed for any member of the group to access information on any other member. When a member’s name was selected, their profile appeared on the screen. The profile indicated the number of posts and replies attributed to that member during the project. For example, fifth grade student Jordan posted 29 times and mentor Dr. M posted 27 times. I was also able to determine which girls (if any) posted questions from outside of school by observing the Protocol A transcripts. I could see if the posting dates matched the dates of Einstein Girls meetings. In addition, there were times when I had the Edmodo site opened up in the evening and saw that some girls had posted questions. I kept notes of this in the researcher journal. I counted the number of mentors each girl questioned using the Protocol B transcripts. I viewed their questions and determined whether they used questions off the list of suggested questions (see Appendix J) or asked their own original questions. Finally I looked at each mentor and counted how many girls engaged them with questions.

The second area of interest in evaluating the nature of the online mentoring process was an in-depth analysis of the types of interactions that took place between the student and the mentors in the OMC. The interactions between the students and the mentors were represented by question and answer threads or longer discussion threads contained within the Edmodo site. According to Zhang, Chen, Xi, Zeng, and Ma (U.S. Patent No. 7,437,382 B2, 2008), a discussion thread allows participants to take part in a conversation about a specific topic through the Internet. A discussion thread usually begins when one participant creates an initial message or asks a question that relates to a topic. Other participants read the initial message or question and post responses or replies, thus beginning a discussion thread. Other participants may join in the discussion making the thread longer and more diverse. Their definition described the student and mentor interactions contained within the Einstein Girls OMC.

For me to better understand the nature of the online mentoring process, I decided it was important to look more closely at these interactions. Zhang et al. (2008) created a method or system for ranking the messages contained within discussion threads. Their system was designed for the business world and utilized a ranking system defining the attributes of a message and an author (Zhang et al., 2008). This system was unsuitable for describing and understanding the interactions that took place in our community. I then conducted searches of the mentoring and online community literature for discussion thread classification systems (Dorner, 2012; Harris, 2011; Hong & Davison, 2009; Lin, 2009; Nisbet, 2004; Pena-Shaff, 2004; Ravi & Kim, 2007; Schrire, 2006; Swan, 2002; Turvey, 2006). I was unable to find a classification system that could be used to organize and classify the interactions between the mentors and the girls, although some of the categories described by Harris (2011) were useful. I felt a classification system would allow me to identify what types of interactions took place and with whom they took place. This was a key component in understanding the nature of the online mentoring process being studied in this project. For this reason I devised my own classification system to identify, organize, and analyze the data.

I observed four general types of interactions between the students and the mentors contained in the OMC discussion threads. I labeled the four types of interactions terminal discussion threads, group terminal discussion threads, associated terminal discussion threads, and extended discussion threads. Descriptions of the four types of threads and an example of each are presented in Chapter 5. I went through the six Protocol B transcripts that were organized by question and labeled every question and answer thread by interaction type. I also totaled the numbers of each interaction type by mentor and counted the number of girls involved in the threads. Then I totaled the number of discussion threads for all mentors by type of interaction and determined which type of interaction was the most common and which type was the least common.

The third and final area of interest in evaluating the nature of the online mentoring process was an in-depth analysis of the discussions that occurred between the girls and the mentors. I analyzed the six Protocol C transcripts using the thematic analysis framework of qualitative data analysis. This framework was described by Braun and Clarke in 2006. More specifically, a 'theoretical' thematic analysis framework was utilized, which documented the mentoring process from both the mentors' and mentees' perspectives. This type of analysis was "driven by the researcher's theoretical or analytical interest in the area, and is thus more explicitly analyst-driven" (Braun & Clarke, 2006, p. 84). While this form of analysis provided a less thick description of the overall data, it did provide a more "detailed analysis of some aspect of the data" (Braun & Clarke, 2006, p. 84). Using the theoretical approach of thematic analysis, I was interested in the way the constructs of career exploration, STEM interest, and science identity appeared throughout the data. I focused on those particular features while analyzing, coding, and interpreting the data (Braun & Clarke, 2006).

I created an a priori codebook (see Appendix A) before I began the project that focused on career exploration, STEM interest, and science identity. The a priori codes were identified from a variety of sources, such as existing research and theories, or from hunches about the data or the setting (Gibbs & Taylor, 2010). To create such a codebook, it was imperative that I synthesized what was already known in the research literature about those constructs (see Chapter 2) as well as what was already known about learning communities, mentoring, and online mentoring (see Chapter 3). The codes were developed from the K-12 science education, mentoring, and educational media literature as well as from my own experiences and observations. According to

MacQueen, McLellan, Kay, & Milstein (1998), these codes formed the foundation on which the arguments rested and embodied the assumptions that framed the analysis.

The career exploration a priori codes related to themes such as, career definition, career specifics, educational pathways, career satisfaction, and career challenges. The STEM interest a priori codes related to the themes developed by Maltese and Tai (2010) of timing of interest, source of interest, and nature of interest. The science identity a priori codes related to the more personal issues of self, being a science person, being shaped by surroundings, and being attracted to science.

Some of the steps of thematic analysis are similar to those of other qualitative research (Braun & Clarke, 2006) and I utilized their phases of thematic analysis to inform the first research question. Data analysis began with a familiarization of the data. I read through the six Protocol C transcripts several times and made general observations about the nature of the discussion threads. Then I began the initial coding process of the transcripts of Dr. B and Dr. G using the a priori codebook as a guide. The process of coding was an essential part of the analysis process since coding organized the data into meaningful groups (Braun & Clarke, 2006; Miles & Huberman, 1994). I initially wrote the code names in pencil in the right-hand margins of the transcripts. Some discussion threads corresponded directly to a code and some corresponded to two or more codes. However, some discussion threads did not correspond to any of the codes. I made note of this and wondered if I found some emerging codes and needed to add to the a priori codebook.

By the time I finished the initial coding of the two transcripts I noted two unexpected codes. Several girls asked Dr. B for advice relating to their mathematics classes. There was no code for “mentor advice” so I placed that code in the a priori codebook under the emerging codes section. Dr. G talked about the importance of collaboration in her work as a chemical engineer. There was no code for “mentor collaboration” so was also added to the emerging codes section. Next I coded the four remaining transcripts and noted several more examples of mentor advice and mentor collaboration so I kept these new codes in the codebook.

The process of coding the discussion threads continued, using Corbin and Strauss’ (2008) constant comparison method (CCM). I kept notes of the evolving nature of the codes in my researcher journal and established an audit trail to allow for the examination of “the processes of data collection, analysis, and interpretation” (Gay et al., 2009, p. 377). The original a priori codebook contained eight codes that related to career exploration. Some of the original codes did not appear in any of the transcripts so those codes were removed from the codebook. For example, none of the girls asked about the middle school or high school experiences of the mentors, but asked several questions about college and graduate school. However, some of the mentors discussed their pre-college experiences in their answers. I decided to eliminate “middle school” and “high school” as original codes and changed the code to “educational pathways.” At this point, I did one more read-through of all the transcripts and checked the codes again and created a final a priori codebook. This codebook also contained eight codes relating to career exploration, but not all of the codes were the same as in the original book.

Six new versions of the Protocol C transcripts were created. Using the markup feature on my computer, I transferred the penciled-in codes to the computer documents and called these new versions Protocol D transcripts. There were six Protocol D coded transcripts, one for each mentor. For a sample of a Protocol D transcript, please see Appendix N. The final codes were collated from the Protocol D transcripts and transferred to documents which included all data relevant to a potential theme. For a sample of a theme sheet, please see Appendix O. The themes were broader units of analysis than the individual codes (Braun & Clarke, 2006). Themes were then reviewed, which meant they were checked to verify whether they related to the final a priori codes as well as the entire data set. The themes were refined, named, and defined, until they revealed the overall story told by the analysis of the data (Braun & Clarke, 2006). The themes were placed in a thematic map (see Appendix P) which informed the writing of Chapters 5 and 6.

Research Question 2

> RQ 2: What are the participants' perceptions of the opportunities and constraints surrounding online mentoring?

Data collection

To analyze the second research question, I also utilized a qualitative research methodology. I returned to the relevant posts of the online transcripts and purposefully selected individual girls to interview. I looked for two types of girls; those who seemed interested in the online mentoring process and those who did not seem interested in the online mentoring process. In this way I was able to determine their perceptions of both the opportunities and the constraints surrounding the process. The interviews took place at school and were video recorded and transcribed. The interviews followed a semi-structured format which allowed me to explore issues by asking probing questions and following hunches (Maltese & Tai, 2010). Questions were prepared in advance using an interview guide, which was a list of questions that were explored through the individual interviews (see Appendix C). The interview guide was prepared to verify that essentially the same material was covered with each participant. I transcribed the interviews from the video recordings and the texts were formatted on documents with open margins to allow for coding of data. This was accomplished by assigning line numbers to identify each line within the data and was used later for cross-referencing the data. Six out of seven of the girls completed a member check of the interview transcripts; the seventh girl moved out of the area after the study.

I conducted a focus group with the mentors to gain insight into their perceptions of the opportunities and constraints surrounding the OMC. Three of the mentors were physically present for the focus group. The other three mentors sent in their answers by email prior to the focus group. A colleague also attended the focus group meeting and kept notes. The interviews followed a semi-structured format (see Appendix D) and were conducted on the school campus during an early dismissal day. I recorded and transcribed the audio interview, then combined the transcript with the answers from the non-present members and the notes from the colleague. This became the final focus group transcript. All six of the mentors and the colleague completed a member check of the focus group transcript. I kept notes in the researcher journal for additional insights into the research questions.

Data analysis

The qualitative analysis of the eight interviews (seven student interviews and one focus group interview) was completed using Patton's (1987) rules for interviewing and the CCM (Corbin & Strauss, 2008). The interviews were read through using open coding on the transcripts. Inductive coding was used that was developed during the direct examination of the data collected from the interviews. Each incident in the data was “compared with other incident for similarities and differences” (Corbin & Strauss, 2008, p. 73). Similar incidents were grouped together and categorized as a specific concept or category. Codes were modified, added, merged, or deleted until the codes were saturated, revealing all of the concepts or categories surrounding the second question. In addition, an audit trail was established of the evolution of the coding system.

The inductive categories were refined and renamed when necessary, using ongoing CCM to perfect the specifics of each category as well as to look at the overall story that was being told by the analysis of the data. This step also generated the names for each category as well as a clear definition for each category. The categories were assembled into a concept map (see Appendix Q) which informed the writing of Chapters 5 and 6.

Summary

An online mentoring community was created connecting fifth and sixth grade girls who were interested in science with female STEM mentors. The data collection took place during the months of April and May, 2013 and sought to answer two research questions described in Chapter 4. Chapter 5 presents the results of the two research questions and is followed by a discussion of the results in Chapter 6 and a presentation of the implications of the research in Chapter 7.

CHAPTER 5
RESULTS

Introduction

The purpose of this project was to create an online mentoring community among fifth and sixth grade girls and female STEM mentors, to examine the mentoring process that took place within the community, and to determine the participants' perceptions of the opportunities and constraints of the community. This chapter presents the results of the project by research question, with the results of RQ 1 presented first, followed by the results of RQ 2.

Research Question 1

> RQ 1: What is the nature of the online mentoring process--with special focus on mentees' career exploration, interest in STEM, and their science identities?

To answer this first question I looked at two aspects of the online mentoring process: the participation in the OMC by the community members and a thematic analysis of the online discussions. The results of RQ 1 are presented in two parts, with the analysis of the participation by community members presented first followed by the thematic analysis of the online discussions.

Analysis of Participation by Community Members

To analyze the participation by community members, numerical data contained within the Edmodo site were examined to determine the frequencies of participation for community members. Then the transcripts of the student and mentor conversations were evaluated to determine the participation approaches by the various community members. Next the types of interactions that took place between the mentors and the students were analyzed and classified. In addition to identifying the interactions that took place in the Edmodo site, I also examined the participation approaches of the various community members. Each community member was free to approach the community in their own way; there were no requirements or expectations for either the students or the mentors. The following sections describe the mentors and the students, their frequencies of participation, and their approaches to the community.

The Students

The students who participated in this project were the nineteen fifth and sixth grade girls enrolled in the Einstein Girls after-school academy and one eighth grade former Einstein Girl student assistant. The demographics of the 20 participants were described in Chapter 4. To protect their identities, the girls who participated in the project were identified only by pseudonyms.

Student Frequencies of Participation

Each student was involved in the Einstein Girls OMC in her own unique way, as evidenced by the varying numbers of posts (see Table 5-1). The OMC project lasted for approximately four weeks. Over the course of the four weeks, all 20 of the girls visited the site on multiple occasions during Einstein Girls meetings held after school. One girl chose not to post any questions but still was observed during three Einstein Girls meetings reading the questions and answers contained in the Edmodo site. Five girls (Denise, Gail, Jordan, Kim, and Xitali) also chose to login from outside of school. As the Edmodo group administrator I was able to see how many times each student posted to the site. The students posted a varying number of questions with different combinations of mentor(s). Overall, the girls posted to the Edmodo site 141 times. Table 5-1 summarizes the student activity levels according to pseudonym, grade, number of posts, and an indication of activity outside of school.

Table 5-1. Einstein Girls participants by pseudonym, grade, number of posts, and login from home

Student	Student grade	Number of posts	Login from home?
Annie	Fifth	12	No
Beth	Fifth	1	No
Connie*	Eighth	1	No
Denise	Sixth	15	Yes
Emily	Sixth	5	No
Gail	Fifth	10	Yes
Georgia	Fifth	0	No
Greta	Sixth	6	No
Heather	Sixth	2	No
Jordan	Fifth	29	Yes
Kay	Sixth	6	No
Kim	Sixth	6	Yes
Mary	Fifth	8	No
Mary Ann	Fifth	2	No
Pam	Sixth	2	No
Reddie	Fifth	11	No
Rickie	Sixth	12	No
Shammie	Sixth	5	No
Tabbie	Fifth	2	No
Xitali	Sixth	6	Yes

* Eighth grade student assistant

Different girls posted different numbers of times on the site. Jordan posted 29 times which was the highest number of posts for any of the girls. She posted from school and out of school. Denise posted 15 times and also accessed Edmodo from school and out of school. Annie, Gail, Reddie, and Rickie each posted 10 or more times. Of these four girls, Gail was the only one who accessed Edmodo out of school. The remainder of the girls posted less than 10 times each, with Georgia electing not to post any questions at all.

Student Approach to the Community

The students asked a variety of questions relating to the STEM areas represented by the mentors. However, not all students approached the community in the same fashion. I reviewed the Edmodo site and found that three girls (Denise, Jordan, and Mary) posted one or more questions for all six mentors, three girls (Annie, Reddie, and Shammie) posted one or more questions for five of the mentors, and five girls (Emily, Gail, Greta, Kim, and Rickie) posted one or more questions for four of the mentors. Xitali posted one or more questions for three of the mentors, Heather and Mary Ann posted one or more questions for two of the mentors, and Beth, Connie, Kay, Pam, and Tabbie posted one or more questions for only one of the mentors. Georgia did not post any questions during the four week project.

Denise, Jordan, and Mary posted one or more questions for all six mentors. All of their questions were original and did not come off of the list of recommended questions I provided for the girls (see Appendix J). Conversely, even though Reddie and Shammie posted questions for five different mentors, when I reviewed the Edmodo transcripts I noticed that Reddie (Edmodo transcript, May 8, 2013) asked four of the five mentors the same question, "Do you see yourself as a science person?" The question came directly off of the list of questions supplied to the girls. Shammie (Edmodo transcript, May 15, 2013) also asked the five mentors the same question, which was, "Have all your life you wanted the job you have today?" The remaining girls posted varying amounts of questions to the mentors of their choices.

The Mentors

The mentors were six female STEM professionals described in Chapter 4 who represented various fields of science, technology, engineering, and mathematics. They were all parents from the school community and were known by me and purposefully selected by me. Two of the mentors were parents of former Einstein Girls and one was the parent of a rising Einstein Girl. None of the mentors were parents of current Einstein Girls. The mentors volunteered their time to participate in the project and expressed enthusiasm for the project. To protect their identities, the mentors who participated in the project were identified by pseudonyms of their titles and the first letter of their last names.

Mentor Frequencies of Participation

Each mentor was involved in the Einstein Girls OMC in her own unique way, as evidenced by the varying number of posts (see Table 5-2). Different mentors posted different numbers of times on the site. Two of the mentors were involved in multiple question and answer sessions and posted over 20 times each while another mentor posted only five times during the four-week project. In all, the six mentors posted to the Edmodo site 104 times. Table 5-2 lists the mentors by name, STEM career, number of posts, and number of girls who posted question for mentor.

Table 5-2. Female STEM mentors by name, career, number of posts, and number of girls who posted questions for mentor

Mentor name	STEM career	Number of posts by mentor	Number of girls who posted questions for mentor
Dr. B	High school mathematics teacher	17	12
Dr. G	Chemical engineer	15	10
Dr. K	Clinical psychologist	25	14
Dr. M	Veterinary surgeon	27	14
Ms. N	Geotechnical engineer	5	5
Dr. P	Reproductive endocrinologist	15	10

Mentor Approach to the Community

Every mentor was asked questions by different combinations of girls (please see Table 5-2). Dr. M and Dr. K were asked questions by the largest number of girls; they each had 14 different girls post questions. Dr. B had 12 different girls post questions, Dr. G and Dr. P had 10 different girls post questions and Ms. N had different 5 girls post questions. The number of answers varied by mentor and by question. Some mentors grouped several questions together and answered them all at once; some mentors answered each question individually. Most of the mentors (Dr. B, Dr. G, Dr. K, Dr. M., and Dr. P) replied to the girls(s) by name.

Student and Mentor Interactions

The interactions between the students and the mentors were represented by question and answer threads or longer discussion threads that appeared on the Edmodo site. Some of the discussion threads were short, and consisted of a question by a student followed by an answer from the mentor. Other threads were longer and in some cases involved multiple students. It became apparent that there were several types of interactions or exchanges between the students and the mentors in the OMC.

Identifying Types of Interactions

Over the course of the project, I observed four general types of interactions that took place between the girls and the mentors. These interactions were contained in the OMC discussion threads. I labeled the four types of interactions terminal discussion threads, group terminal discussion threads, associated terminal discussion threads, and extended discussion threads. The types of threads are described with an example from the OMC in the following sections.

Terminal discussion thread

The first and most common type of interaction observed was one in which a student asked a mentor one question and the mentor answered the question. No more exchanges of information about that question occurred between the participants and no one else joined in the discussion thread. I chose to label this type of interaction a terminal discussion thread (TDT). This type of interaction was demonstrated in the following example.

> What would you say were the people, things, or events that got you interested in Geoscience (Denise, Edmodo transcript, May 1, 2013)?
>
> My father! He was a geotechnical engineer and I used to spend Saturdays with him driving to job and construction sites to look at the soils and sometimes even a sinkhole and once he took me to the phosphate mines of [state] which is amazing (Ms. N, Edmodo transcript, May 3, 2013).

Group terminal discussion thread

A second and similar type of interaction observed was one in which two or more students asked one mentor the same or a similar question and the mentor answered their questions with one response. No more exchanges of information about that question occurred between the participants and no one else joined the discussion. I chose to label this type of interaction a group terminal discussion thread (GTDT). This type of interaction was demonstrated in the following example.

> What are the symptoms of a dog that has cancer (Xitali, Edmodo transcript, May 8, 2013)?
>
> What cancer is most prone to dogs (Jordan, Edmodo transcript, May 9, 2013)?
>
> Xitali and Jordan- dogs and cats get lots of different types of cancer. The most common are skin cancers...so a lump or bump that you can see. The also get many cancers that you cannot see until they make the animal sick.....so cancers of the lung, liver, kidneys, spleen, bladder...on and on. Usually you see general signs of illness....loss of appetite, vomiting, loss of energy, weakness etc. Some of these diseases can be very advanced before the pet shows signs, which makes them challenging to treat. Just as I am a specialist in surgery, there are specialists in cancer medicine - there are veterinary oncologists, radiation oncologists and surgical oncologists. I like oncology a great deal, especially when I have cases where the surgical aspect of the treatment goes far to help the patient (Dr. M, Edmodo transcript, May 11, 2013).

Associated terminal discussion thread

A third type of interaction observed was one in which a student asked a mentor a question and the mentor answered the question. Another student joined the discussion thread. The student asked an associated or related question which the mentor subsequently answered. No more exchanges of information about the questions took place again between the participants. I chose to label this type of interaction an associated terminal discussion thread (ATDT). This type of interaction was demonstrated in the following example.

> How do you react to people's problems (Mary, Edmodo transcript, April 24, 2013)?
>
> Hi Mary! I like your question. I react in many ways. I try to understand the origins and history of their problems and determine if these problems arise in a specific environment or at a particular time. I try to figure out the individual strengths of a person and incorporate them into a treatment plan. For example, if a person is insightful, they will likely deduce after therapy what types of environments are triggers for their disorders so they may employ adaptive coping strategies when confronted. Like anybody, I feel sad when I hear of loss. I feel anger when someone has been a victim, I feel frustration when individuals struggle with addiction etc. however, I mostly feel hopeful that with therapeutic intervention, they will make improvements and positive changes in their lives (Dr. K, Edmodo transcript, May 2, 2013)
>
> That is really interesting! It is an amazing thing to be able to cure people in any way! It is really sad to see someone hurt and you have the power to fix it! Is your job hard? What if you have no answer? Do you send them somewhere else? Have you ever not had an answer (Gail, Edmodo transcript, May 8, 2013)?
>
> Gail, thank you for your questions! Like any profession, it is has its challenging moments. I find that it challenging when patients are full of fear and anxiety which may prevent them from changing destructive behavioral courses. If I feel that if they need a very specific trained therapist to overcome their issues, I will refer them out. For example, some therapists are highly trained in the treatment of Obsessive Compulsive Disorder and design their practice around treating this one disorder. In the cases of severe OCD, I would refer them to this type of specialist (Dr. K, Edmodo transcript, May 9, 2013).

Extended discussion thread

The final type of interaction observed was one in which a student and a mentor engaged in an extended conversation about the same or similar topic. One student asked a mentor a question and the mentor answered the question. The student subsequently asked the mentor another related question. A lengthier discussion thread developed between the two participants until the original question and any subsequent questions were all satisfied. I chose to label this type of interaction an extended discussion thread (EDT). This type of interaction was demonstrated in the following example between Kim and Dr. G. In her initial post, Dr. G (Edmodo transcript, April 25, 2013) mentioned “my specialty is in Semiconductors”. Kim wanted to find out more about the topic.

> What exactly is a Semiconductor? I understand they are used to make computer chips, but what do the computer chips do in cell phones, cars, computers, etc. (Kim, Edmodo transcript, May 1, 2013)?
>
> Kim, Good question! It helps if you think of materials as being in one of three categories: a conductor (like metal), an insulator (like glass) or a semiconductor (like silicon). A conducting material allows free flow of electrons through it. An insulating material barely allows electrons to move through it. A semiconductor is somewhere in the middle of a conductor and an insulator. It lets some electrons flow through it. A semiconductor is perfect for computer chips because engineers can control how many electrons flow through it at a given time. By controlling whether the electrons flow or not, we can control when the computer chip is "on" and when it is "off." We can also use these electrons as little data packets. So, a computer processing chip uses electrons to represent data and do computations. There are other computer chips that are used for storing data. Your cell phone has some of both, too (Dr. G, Edmodo transcript, May 2, 2013).
>
> I understand now, also you said the engineer(s) can control how many electrons pass through at once. So if I saved two different pictures on a laptop, would different amounts of electrons pass through if the pictures had different quality, colors, etc. (Kim, Edmodo transcript, May 2, 2013)?

> Kim, Another excellent question. With the pictures on a computer, that is a completely different type of semiconductor than a processor chip. It is made of different semiconductor elements. Usually, a processor chip is made out of Silicon or Gallium & Arsenide. A computer monitor or television screen is made of a different type of material. Usually something like thin layers of Zinc Sulfide on glass. This Zinc Sulfide type of material emits light in packets. So, if you are seeing a certain picture on a computer screen, then yes, the processor inside the computer communicates with another chip that controls the display screen, which then controls what color and how much color to emit….(Dr. G, Edmodo transcript, May 6, 2013).

Frequencies of Interactions

There were 81 separate and distinct discussion threads contained in the Edmodo site. These discussion threads represented all of the interactions between the girls and the mentors over the four-week period. I went through the six mentor Protocol C transcripts and categorized each discussion thread by type of interaction (TDT, GTDT, ATDT, and EDT). The discussions between the mentors and the students represented the four types of interactions. For two of the mentors (Dr. M and Dr. P), all four types were represented; for four of the mentors (Dr. B, Dr. G, Dr. K, and Ms. N), less than four types were represented.

There were 21 discussion threads between Dr. K and the Einstein Girls. Of the 21 threads, 20 were TDTs and one was an ATDT. There were no GTDTs or EDTs. Fourteen different girls asked Dr. K one or more question. There were also 21 discussion threads between Dr. M and the Einstein Girls. Of the 21 threads, 13 were TDTs, five were GTDTs, one was an ATDT, and two were EDTs. Fourteen different girls asked Dr. M one or more question and ten girls posted questions for both of the mentors.

Dr. B was involved in the next highest number of discussion threads with the Einstein Girls; there were 13 threads. Of the 13 threads, nine were TDTs, one was a

GTDT, and three were EDTs. There were no ATDTs. Twelve different girls asked Dr. B one or more questions. Dr.G was involved in 12 discussion threads with the Einstein Girls. Of the 12 threads, eight were TDTs, two were GTDTs, and two were EDTs. There were no ATDTs. Ten different girls asked Dr. G one or more questions.

There were 10 discussion threads between Dr. P and the Einstein Girls. Of the 10 threads, three were TDTs, five were GTDTs, and one was an EDT. There were no ATDTs. Ten different girls asked Dr. B one or more questions. Ms. N was involved in the least number of discussion threads during the online mentoring program. There were four discussion threads between Ms. N and the Einstein Girls. Of the four threads, three were GTDs, and one was an EDT. There were no TDTs or ATDTs. Five different girls asked Ms. N one or more questions. Please see Table 5-3 for a summary of the types and number of threads associated with each mentor.

The discussion threads for all the mentors were also totaled by type represented (see Table 5-3). Of the 81 discussion threads, 53 were TDTs (65.4%), 16 were GTDTs (19.8%), 3 were ATDTs (3.7%), and 9 were EDTs (11.1%). Approximately 85 % of the conversations between the Einstein Girls and the female STEM mentors were either TDTs or GTDTs.

Table 5-3. Discussion threads by type, by mentor, total by type, and total by mentor

Mentor	TDT*	GTDT*	ATDT*	EDT*	Total
Dr. B	9	1	0	3	13
Dr. G	8	2	0	2	12
Dr. K	20	0	1	0	21
Dr. M	13	5	1	2	21
Ms. N	0	3	0	1	4
Dr. P	3	5	1	1	10
Total	53	16	3	9	81

* TDT stands for terminal discussion thread.
GTDT stands for group terminal discussion thread.
ATDT stands for associated terminal discussion thread.
EDT stands for extended discussion thread.

Thematic Analysis of Online Discussions

The online mentoring community was designed to give girls who were interested in STEM the chance to communicate online with women who were successful STEM professionals. The community provided them a venue to ask the women questions about their careers, their interests, and their science identities. The transcripts of the online conversations between the students and the mentors were thematically analyzed to better understand the nature of the online mentoring process. Results of the career exploration portion of the project are presented in the following section.

Career Exploration

The Edmodo site opened up for the first time during Week 1 of the project when the mentors were asked to answer the initial question about their careers. The mentors were listed on the site by their pseudonym which was their title and the first letter of their last name. The order in which the mentors were listed was randomly chosen: Dr. M, Veterinary Surgeon; Ms. N, Geotechnical Engineer; Dr. K, Clinical Psychologist; Dr. B, High School Mathematics Teacher; Dr. P, Reproductive Endocrinologist; and Dr. G, Chemical Engineer.

Introductory posts by mentors

The opening question was posted for each of the six mentors designed to initiate the conversations prior to Week 1 of the project. During Week 1 of the project each of the six mentors logged in and answered this question: “What is your career and what do you do in your career” (Mrs. Scott, Edmodo transcript, April 23, 2013)? Each mentor answered the question with a brief overview of their STEM career. The following paragraphs present excerpts from the mentors’ initial posts:

Dr. M (Edmodo transcript, April 24, 2013) told the girls, "I am a veterinary surgeon. This means that after veterinary school, I spent 4 years training specifically in surgery." She also added that "my area is soft tissue surgery, which means that I deal with patients that have surgical diseases that involve any part of the body except bones, joints, spinal cord or brain" (Dr. M, Edmodo transcript, April 24,2013). Ms. N (Edmodo transcript, April 29, 2013) shared that "my professional background and education is as a Geotechnical Engineer, BS in Engineering from [university]" and that in her job she helps "clients build on unsuitable or challenging sites that had high groundwater, soft organic soil, trash/landfills, and even contamination in the soil or water." Dr. K (Edmodo transcript, April 24, 2013) said that she was "a Clinical Psychologist" and that she conducted "psychotherapy with adult individuals suffering from depression, anxiety, post-traumatic stress disorder, grief, co-dependency, addiction, (etc)" as well as helping "individuals develop coping strategies to manage anxiety and depression associated with pain and lifestyle changes."

Dr. B (Edmodo transcript, April 26, 2013) told the girls that "I am a high school math teacher responsible for teaching freshman Algebra 1/Honors." Dr. P (Edmodo transcript, April 29, 2013) shared that she was "a reproductive endocrinologist" and that she "went to college at [university] which is also where I completed medical school. After medical school, I went to a residency in obstetrics and gynecology for four 4 years.". Finally Dr. G (Edmodo transcript, April 25, 2013) said that she was "a Research Scientist at [university] in the Electrical and Computer Engineering Department" and that her specialty was in semiconductors. She added "these materials are used to make computer chips and laser devices used in such products as computers (duh), cell phones, cars, Xbox, Playstations, DVD players and stuff for outer space." These statements were the first posts to appear in the Edmodo site and began the online mentoring community discussions.

Once the girls read the mentors' introductory posts, they began asking their questions according to the method described in Chapter 4. Table 5-4 presents an overview of the eight codes from the final a priori codebook that informed the career exploration portion of the project, including a definition for each code and the number of times each code appeared in the Edmodo transcripts. The results of the theoretical thematic analysis portion of this project are presented in the following sections of this report. To discuss each code, excerpts of representative discussion threads are presented and the type of interaction (TDT, GTDT, ATDT, or EDT) indicated.

Table 5-4. Career exploration codes, definition of code, and frequency of appearance of code

Career exploration code	Definition of code	Frequency of appearance of code
Specific questions for mentors	A specific detail or aspect of the mentor's job	52
Mentor daily routine	Relating to the mentor's day-to-day tasks in job	6
Mentor career choice	Reason(s) mentor chose her career	11
Mentor career satisfaction	Source(s) of satisfaction for mentor in her career	27
Mentor career challenges	Source(s) of challenge for mentor in her career	27
Mentor educational pathway	Course pathways in high school, college, and professional school	25
Collaboration with STEM peers	Ways in which mentor works with other STEM professionals in career	14
Advice from mentors	Girls sought advice from mentors	18
Total		262

Code 1: Specific questions for each mentor

During the Einstein Girls meetings in Week 1 the girls went to the Edmodo site and read the mentors' answers to the initial question, "What is your career and what do you do in your career" (Mrs. Scott, Edmodo transcript, April 23, 2013)? After reading the answers they began posting questions for the mentors. Many of the questions asked were directed towards individual mentors and were often specific in nature. The girls asked 53 questions during the first week as they accessed the Edmodo site during Einstein Girls meetings. Jordan, Denise, and Kim also posted questions from home. The mentors answered most of the questions posted at the site during the Weeks 1 and 2. Most of the questions were of the Terminal Discussion Thread (TDT) type but the other three discussion thread types were also observed.

Dr. K (clinical psychologist) and Dr. M (veterinary surgeon) were the first mentors to login to the Edmodo site and answered the initial question. Several of the girls were interested in a portion of Dr. M's (Edmodo transcript, April 24, 2013) initial post that said, "Our patients are mainly dogs and cats but we do occasionally see more exotic animals from area parks." This comment seemed to pique the interest of three of the girls who asked similar questions, such as "What type of exotic animals" (Mary Ann, Edmodo transcript, April 24, 2013)? Dr. M (Edmodo transcript, April 25, 2013) responded by saying, "I guess the strangest was a crocodile - she was egg-bound & needed a C-section! That was interesting! I've done procedures on a Florida panther & a mandrill from [animal park] & various other things." This discussion thread was an example of a GTDT since three students asked similar questions that were answered with one post by the mentor. There were no more exchanges of information about the question and no one else joined the discussion.

Similarly, Gail was interested in the segment of Dr. K's (Edmodo transcript, April 24, 2013) initial post about her career as a clinical psychologist, "A portion of my practice is also centered upon Clinical Health Psychology, in which I help individuals develop coping strategies to manage anxiety and depression associated with pain and lifestyle changes." Gail (Edmodo transcript, April 24, 2013) responded to the statement by asking, "Do you advise people as to how to fix their problem or just help them by yourself?" Dr. K (Edmodo transcript, May 8, 2013) responded in this way, "I do a little of both! In psychotherapy, I help people develop strategies to identify negative thoughts and behaviors that could be contributing to depression, anxiety, etc." She also told Gail that she helped people understand how past events created "certain fears that may be hindering their ability to function in a healthy manner. Once patients learn these strategies, they are asked to independently put them into action in their daily lives" (Dr. K, Edmodo transcript, May 8, 2013). This was an example of a TDT.

Kim (Edmodo transcript, April 30, 2013) asked Dr. B. a specific question about her upcoming Algebra Honors class in another example of a TDT, "Hi Dr. B.!! I love math and will be entering Algebra Honors next year…does Algebra use the same content and similar equations as I solve now?" Dr. B (Edmodo transcript, May 7, 2013) responded to Kim's question in this way, "@Kim-I am so super excited to hear that you love math! That positive attitude about the subject will definitely lead to continued success in math." She added that, "Pre-Algebra is a great prep course for Algebra 1. The concepts are the same, just a higher level of complexity" (Dr. B, Edmodo transcript, May 7, 2013).

Jordan and Rickie had GTDT questions for Dr. G about how she used mathematics in her job. She told them, "I use very difficult math in my job every day. In my field of science, we use math equations to describe how the atoms and electrons in a crystal move around" (Dr. G, Edmodo transcript, May 13, 2013). She continued, "I take these complex equations and put them into a computer program. Some of my computer programs have hundreds of math equations that have to be solved all at the same time" (Dr. G, Edmodo transcript, May 13, 2013).

The final example of a specific question was an example of an ATDT combined with an EDT which had an unusual outcome. Ms. N shared that her father was also a geotechnical engineer and used to take her out to job and construction sites on Saturdays to look at soils, phosphate mines, and sinkholes. This prompted Jordan to ask a question about sinkholes because they had been discussing them in her fifth grade science class. She asked, "How are sinkholes created" (Jordan, Edmodo transcript, May 3, 2013)? Part of Ms. N's (Edmodo transcript, May 8, 2013) answer was, "Sinkholes are possible because of caverns or solution openings that exist underground. They occur because the sand above these 'openings' can ravel and slowly move downward to fill these openings." This response caused Jordan and Mary to ask follow-up questions about sinkholes. Jordan (Edmodo transcript, May 8, 2013) asked, "I heard that Florida is prone to sinkholes…is that true?" Mary (Edmodo transcript, May 8, 2013) asked, "What are the chances of a sinkhole forming underneath your house?" Ms. N did not answer either question. Instead, for her last post in Edmodo, she wrote this response, "My life has never been scripted. I have always tried to do my best in everything I do and also challenge myself to learn and do more. Those qualities have allowed me to grow fully and quickly…" (Ms. N, Edmodo transcript, May 17, 2013).

The code career specifics appeared 52 times in the data, more times than any other code in the project. Many of the discussion threads were TDTs but there were also examples of GTDTs, ATDTs, and ETDs in the career specifics category. When the threads were EDTs the participants explored the topics in question at a greater depth. The next code examined was mentor daily routine.

Code 2: Mentor daily routine

Several girls asked questions about the daily routines of the six STEM professionals. Since the STEM areas represented were diverse, questions about their jobs were wide-ranging. The girls seemed interested in finding out about what the women did in their careers on a daily basis including working hours, working locations, and job responsibilities. For example, Kay wanted to know about Dr. P's daily schedule: She asked the question, "How long do you work each day" (Kay, Edmodo transcript, April 24, 2013)? Dr. P. (Edmodo transcript, April 29, 2013) responded by saying, "I start my day anywhere from 7 am to 8 am and finish by 4-5 pm. I see patients in clinic, I do procedures in the office and operate as well."

Rickie also wanted to know something about a mentor daily routine when she asked Dr. K how many patients she saw each day. Dr. K's (Edmodo transcript, May 8, 2013) response was, "Rickie, I usually see anywhere from 6-8 patients in one day of work. The therapy session lasts approximately one hour." Mary Ann also had a daily routine question for Dr. K. She asked, "Does your practice just do adults or does somebody else do children" (Mary Ann, Edmodo transcript, April 24, 2013)? Dr. K's response was, "Mary Ann, my practice is for patients ages 18-older aging population.

There are also therapists who primary focus on the needs of the child" (Dr. K, Edmodo transcript, May 8, 2013).

One last example of a mentor daily routine came from Annie and was directed towards Dr. G. Annie (Edmodo transcript, May 8, 2013) wanted to know, "How does your job work?" Her response was, "I do my job from a computer. Twice a year I have to drive to [city] to give an update on my work and have a conference with my boss and colleagues" (Dr. G, Edmodo transcript, May 13, 2013). She added that, "In between, I have phone calls with them to discuss our progress and exchange ideas" (Dr. G, Edmodo transcript, May 13, 2013).

The code mentor daily routine only appeared six times in the data. All of the discussion threads were TDTs. Each question asked about mentor daily routine was answered directly by the mentor and there were no were no other exchanges of information on that topic between the two participants. The next code examined was mentor career choice.

Code 3: Mentor career choice

The reasons why a mentor chose her career were as varied as the careers themselves. All six mentors were asked by the girls why they selected their particular career. For example, Jordan wanted to know why Dr. G decided on chemical engineering as a career. Her response was, "Like you, I loved math and science in school. When I was in high school I especially liked Chemistry" (Dr. G, Edmodo transcript, April 25, 2013). She went on to tell Jordan that she "took a class in the Materials Science department that was about Semiconductors and computer chips" (Dr. G, Edmodo transcript, April 25, 2013) She said she "loved it and realized that was what I wanted to study some more. So, I went to graduate school at [university] to study semiconductors and crystals and have been happy ever since" (Dr. G, Edmodo transcript, April 25, 2013)!

Dr. M. (Edmodo transcript, April 25, 2013) said that she "wanted to be a vet since I was your age" and that what initially got her interested in her job was the opportunity to work with animals. She said she "loved the James Herriot novel series when I was your age & thought his life was pretty cool" (Dr. M, Edmodo transcript, April 29, 2013). Dr. P. (Edmodo transcript, May 6, 2013) said she was first inspired to pursue medicine was after watching her aunt struggle with infertility and was inspired by Mother Theresa by "her compassion and her selfless devotion to those who desperately needed medicine and medical care." Ms. N probably had the most personal reason for wanting to become a geotechnical engineer. When asked by Greta if she always wanted to be a geotechnical engineer, Ms. N said, "My father was a VERY committed engineer. He would take me on weekends to job sites. I became fascinated looking at the big construction projects and wanted to be a part of it someway [*sic*]" (Ms. N, Edmodo transcript, May 9, 2013).

The code mentor career choice appeared 11 times in the data. All of the questions about mentor career choice were TDTs. Each question asked about mentor career choice was answered directly by the mentor and there were no were no other exchanges of information on that topic between the two participants. The next code examined was mentor career satisfaction.

Code 4: Mentor career satisfaction

Several girls asked the mentors if they were satisfied in their careers. Some girls also asked if they liked what they did or if they enjoyed their career. For example, Tabbie asked Dr. M what she liked most about her job as a veterinary surgeon. She answered, “Hi Tabbie. Wow, there is a lot I like. My love of medicine & animals is a given” (Dr. M, Edmodo transcript, May 3, 2013). She added, “After that, I think it is the opportunity to work with the other doctors, veterinary technicians, assistants & staff, all of whom are really smart & fun to work with” (Dr. M, Edmodo transcript, May 3, 2013). She also added, “I really enjoy educating my clients as well....I've become good at explaining complex medical issues in terms they can understand & I know that is appreciated.” She concluded with some personal insights into her job satisfaction by saying “I also know my girls & husband are proud of me for what I do & that makes me very happy & makes the late nights & weekends apart from them more tolerable” (Dr. M, Edmodo transcript, May 3, 2013).

Similarly, Dr. P (Edmodo transcript, April 29, 2013) shared with the girls what she enjoyed about her job when she said, “My favorite part is getting to know my patients and figuring out what is causing their infertility. An equally favorite part is when they are finally pregnant and we get to hear the fetal (future baby's) heart beat….” She told the girls that she loved being a doctor “because I have the privilege of helping others. I am grateful that every morning I love going to work” (Dr. P, Edmodo transcript, April 29, 2013).

Denise (Edmodo transcript, May 1, 2013) asked Dr. B. if she enjoyed being a teacher of mathematics “even though students may be hard to deal with.” She replied, “@Denise-Your first question made me smile:-) Each day brings a new set of challenges with the students and discipline issues, but it does not deter me from teaching them. I enjoy what I do” (Dr. B, Edmodo transcript, May 7, 2013).

The code mentor career satisfaction appeared 27 times in the data. Some of the mentors were asked directly about their satisfaction in their jobs and some shared information when asked other questions. The code appeared in a few TDTs but also appeared in other discussion threads. In a similar way, the mentors discussed with the girls some of the challenges they faced in their careers.

Code 5: Mentor career challenges

A few of the girls asked mentors about the challenges they faced in their careers, but most of the mentors shared about their career challenges while answering other questions. Jordan specifically asked Dr. G if she ever had a project fail. She responded by saying, "Engineering and science research is mostly about failure. Every researcher tries a bunch of things that fail before they ever think of the idea that succeeds. The failures lead to the success" (Dr. G, Edmodo transcript, April 25, 2013). Gail (Edmodo transcript, April 24, 2013) also asked a direct question about career challenges when she asked Dr. M if she "ever cried after having to see an animal let go." Dr. M (Edmodo transcript, April 25, 2013) shared this response, "I have put animals 'down' (euthanasia). It is always sad but usually the most compassionate choice for the animal. Surgeries do fail or involve complications from time to time." She also shared that she has "cried after a patient dies...but usually I am sad for the owners more than the animal" (Dr. M, Edmodo transcript, April 25, 2013).

In most of the discussion threads, mentor career challenges were shared when answering other questions. Dr. B (Edmodo transcript, May 7, 2013) told Denise that "each day brings a new set of challenges..." and Dr. P (Edmodo transcript, April 29, 2013) mentioned that at first "there were many concepts I didn't understand and overwhelming information about topics I considered to be personal." Both mentors concluded that through perseverance would not deter them from moving forward in their professions. Similarly, Dr. K (Edmodo transcript, May 8, 20130) said, “Like any profession, it is has its challenging moments. I find that it challenging when patients are full of fear and anxiety which may prevent them from changing destructive behavioral courses.”

The code mentor career challenges appeared 27 times in the data. The code appeared in a few TDTs but also appeared in other discussion threads. The next code examined was mentor educational pathways.

Code 6: Mentor educational pathways

Several questions were asked about the mentors’ college and professional school selections and their educational pathways. Five of the six mentors were asked by the girls something about their college experiences. The sixth mentor (Ms. N) mentioned her college experience during her opening remarks.

Kim wanted to know about Dr. K’s college experiences. She responded by saying, “I went to college for 4 years at [university] and I received my Ph.D. from [university]. It took a total of 6 years to obtain my Ph.D.” (Dr. K, Edmodo transcript, May 2, 2013). She added that “this included coursework, clinical experience, dissertation research, internship and post-doctoral clinical work” (Dr. K, Edmodo transcript, May 2, 2013). Dr. M. (Edmodo transcript, April 25, 2013) also discussed her path to becoming a veterinary surgeon when she said, “I graduated vet school in 1989 & finished my surgical residency in 1995.” She also shared that she was “boarded by the American College of Veterinary Surgeons” and that she was “Canadian & did all my training there” (Dr. M, Edmodo transcript, April 25, 2013). Dr. P (Edmodo transcript, April 29, 2013) shared that after she completed medical school she did her residency in “obstetrics and gynecology for four years" where she decided to "pursue infertility and so completed a fellowship at [university]. Once I completed my training I took an exam to become board certified in both OB/GYN and infertility." Annie asked a question about Dr. M's experiences during veterinary school. In reply, she said, "The first few years were probably the most tough...lots of study and memorization. Once we got into the later years and actually saw live animals, then it definitely was more rewarding" (Dr. M, Edmodo transcript, May 18, 2013).

The code mentor educational pathways appeared 25 times in the data. Most of the question and answer interactions were examples of TDTs where the question was answered directly by the mentor and there were no were no other exchanges of information on that topic between the two participants. The next code examined was collaboration with peers.

Code 7: Collaboration with peers

Several of the mentors talked about the importance of working with other STEM professionals in their own careers. For example, Dr. G mentioned collaboration or working with co-workers six times. Dr. G (Edmodo transcript, April 25, 2013) shared how she worked with colleagues when she said, "Working with other people is great because you can all collaborate to come up with ideas. Sometimes each teammate comes up with one piece of an overall solution." She also said in a different post that "the people I worked with [on a difficult project] were very smart and dedicated" (Dr. G, Edmodo transcript, April 27, 2013). Dr. K. mentioned that she works with other psychologists when dealing with some of her patients. She said, "If I feel that they [her patients] need a very specific trained therapist to overcome their issues, I will refer them out" (Dr. K, Edmodo transcript, May 9, 2013). Dr. M (Edmodo transcript, April 25, 2013) also mentioned that she communicated "regularly with other surgeons & specialists in other areas almost every day." Finally Ms. N (Edmodo transcript, May 17, 2013) shared that she has been "an employee, a founder of a firm that grew to 300 employees and 8 offices, then merged it with a 3000 person firm."

The code collaboration with peers appeared 14 times in the data. None of the students asked direct questions about the code of collaboration with peers, but the information was shared during their various answers. The final code examined was advice from mentors.

Code 8: Advice from mentors

Several of the girls took advantage of the opportunity to ask a particular mentor advice about a topic relevant to their interests. For example, fifth grader Jordan took the occasion to ask for advice from Dr. B. regarding her mathematics courses in school. She asked, "I am also in accelerated math. Next year I might have the option of Pre-Algebra and I do not know if I am ready" (Jordan, Edmodo transcript, May 10, 2013). Dr. B. (Edmodo transcript, May 17, 2013) gave her advice by saying, "@Jordan-If you are currently in Accelerated Math, then you are definitely ready for pre-algebra/honors next year. The accelerated course definitely provides you with good foundational knowledge for success."

Rickie, who was interested in veterinary medicine, asked Dr. M for advice on finding ways to work with animals. She asked, "I love animals, and I would like to work with them when I grow up. Do you have any advice you could give me" (Rickie, Edmodo transcript, April 24, 2013)? Dr. M (Edmodo transcript, May 18, 2013) responded by saying, "there are many careers that involve working with animals. These include dog/cat grooming/training, veterinary medicine where there are a huge variety of opportunities - horses, cows, small animals, exotics etc, to working with marine animals, fish, birds." She also advised her to "aim toward going to university to pursue a science degree" (Dr. M, Edmodo transcript, May 18, 2013). Dr. P (Edmodo transcript, April 29, 2013) shared advice to the girls when she said, "The best advice I have for you is to find something you love doing and will enjoy doing everyday [*sic*]." She also told the girls that if they are interested in pursuing a career in a medical field, then they should consider "being a medical doctor, a nurse practitioner, a PA, a health administrator, a counselor, a MA, a surgical tech, an embryologist" (Dr. P, Edmodo transcript, April 29, 2013).

An interesting discussion thread was an EDT occurred between Denise and Dr. M. This thread had seven entries and was the longest thread in the project. Denise (Edmodo transcript, April 25, 2013) began the thread wanting to know if Dr. M. "knew any local animal shelters that accept young girls. I love animals, and I wanted to volunteer!" Dr. M (Edmodo transcript, April 26, 2013) told her, "you must be a certain age to volunteer…I would call to check." Denise (Edmodo transcript, April 29, 2013) responded with some questions about "creating a non-profit program" for dog adoptions with her family and asked Dr. M for "any tips for me?". Dr. M. (Edmodo transcript, April 29, 2013) told Denise that her idea was "very interesting" and asked her to consider creating "a rescue group that catered to the older dog....8/9 & up." Denise (Edmodo transcript, April 30, 2013) wrote back that she "never thought about catering to older dogs" and she thanked Dr. M by saying, "you've given me a lot to think about and discuss with my family." One day later, Denise (Edmodo transcript, May 1, 2013) added more to the discussion by asking, "Hello again, Dr. M! I talked over the idea of aiming our program to older dogs with my parents and they love it." She also wanted to know if Dr. M got "a lot of older dogs to operate on, or are the ages mixed" (Denise, Edmodo transcript, May 1, 2013)? Dr. M's (Edmodo transcript, May 3, 2013) final response in the EDT was, "Hi Denise! Yes, many, many of the dogs I operate on are older…."

While this discussion thread was taking place, Jordan joined in with her own EDT which was an associated thread with the one initiated by Denise. She wanted to know more about pet shelters and she asked, "Have you ever volunteered at a shelter before? If so do you have any tips" (Jordan, Edmodo transcript, April 30, 2013)? Dr. M told Jordan that she did volunteer at many vet hospitals when she was a teenager. She said, "I would walk dogs, clean cages, feed etc & eventually the staff would know & trust me enough to let me 'hang out' & watch" (Dr. M, Edmodo transcript, April 30, 2013). This prompted Jordan (Edmodo transcript, May 2, 2013) to ask, "Is there a difference between 'pet hospitals' and vets?" Dr. M's (Edmodo transcript, May 3, 2013) response was, "Vet hospitals/clinics/pet clinics/pet hospitals are different…The bottom line is that not all of these establishments are the same in terms of the services they offer, quality of service, staffing & so on."

This set of 11 exchanges took place between two Einstein Girls and one mentor over an eight-day period. The conversations were associated with each other and both threads represented distinct conversations between two girls and one mentor. The threads were examples of two EDT's that were associated with each other. Most of the remaining discussion threads were TDTs. Overall, the code advice from mentors appeared 18 times in the data.

The construct of career exploration was one that the girls had great interest, as demonstrated by the number of their questions. Over half of the OMC discussions between the girls and mentors focused on career exploration. The remainder of the discussions focused on the constructs of STEM interest and science identity. The results of those constructs are presented in the next two sections.

STEM Interest

The topic of science interest has been well-documented in the science education literature and was discussed in Chapter 2. For the purposes of this project, science interest and STEM interest are used interchangeably. In addition to questions on career exploration, the girls also asked questions about the mentors' science interest. Table 5-5 presents an overview of the three codes from the final a priori codebook that informed the STEM interest portion of the project, including a definition for each code and the number of times each code appeared in the Edmodo transcripts. The results of the theoretical thematic analysis portion of this project are presented in the following sections of this report. To discuss each code, excerpts of representative discussion threads are presented and the type of interaction (TDT, GTDT, ATDT, or EDT) indicated. The criteria developed by Maltese and Tai (2010) were used as codes for this portion of the project.

Code 9: Timing of interest

The girls asked the mentors questions about their interests in STEM. Most of the STEM questions were TDT's. They wanted to know if the mentors could remember when they first became interested in STEM. The mentors' answers were coded using Maltese & Tai's (2010) timing criteria (see Table 5-5). The answers varied among the mentors, but all six were able to identify an approximate time at which they became interested in science or STEM and there was an example from each category.

Always. Dr. K and Ms. N indicated that they were always interested in STEM. Dr. K (Edmodo transcript, May 8, 2013) said, “I was always interested, from an early age, in trying to figure out why people had so many different kinds of reactions to the same event.” Ms. N indicated that she became interested in geotechnical engineering when going with her father “on weekends to job sites. I became fascinated looking at the big construction projects and wanted to be a part of it someway [*sic*]” (Ms. N, Edmodo transcript, May 9, 2013).

K-5. Dr. M and Dr. P indicated they became interested in their STEM fields by late elementary school. Dr. M (Edmodo transcript, April 29, 2013) said, “I had wanted to be a vet since I was your age…I loved the James Herriot novel series when I was your age & thought his life was pretty cool.” Dr. P (Edmodo transcript, May 6, 2013) indicated she knew she was “going to be a doctor by 11.”

6-8. Dr. B and Dr. G mentioned the middle school years as the defining time for their interests in STEM. It was interesting that Dr. B preferred science over mathematics during those years. She said, “I definitely consider myself more of a math person, however as a middle schooler [*sic*] I preferred science. Biology was my favorite because I loved dissections” (Dr. B, Edmodo transcript, May 14, 2013). Dr. G (Edmodo transcript, May 13, 2013) said, “I became interested in Science in 8th grade, when I started to learn physics with my excellent teacher….”

9-12. Both Dr. G and Dr. M said their interests in STEM increased during high school. Dr. G (Edmodo transcript, April 27, 2013) said she became more interested in "becoming a research scientist" in ninth grade. Dr. M. also mentioned that ninth grade was a defining year for her as well.

College. Even though the mentors were already interested in STEM by their college years, three of them mentioned their college years as influential times for their careers. Dr. K (Edmodo transcript, May 18, 2013) said, "…when I started to take Psychology classes in college, it became very obvious to me what my career choice should be." Dr. G. (Edmodo transcript, April 25, 2013) mentioned that taking "a class in the Materials Science department" during her last year in college caused her to want to attend graduate school to "study semiconductors and crystals." Dr. M. (Edmodo transcript, April 25, 2013) became interested in her specialization during "vet school", when she "became more interested in surgery."

Table 5-5. STEM interest codes, definition of code, and frequency of appearance of code

STEM interest code	Definition of code	Frequency of appearance of code
Timing of interest	Point in time when participant became interested in STEM: Always, K-5, 6-8, 9-12, or college	21
Source of interest	School, family, or self	16
Nature of interest	Intrinsic, education-based themes, or cannot identify	23
Total		60

Code 10: Sources of interest

The girls also asked questions about the sources of STEM interest for the mentors. A few of the questions were direct, such this question posed by Emily (Edmodo transcript, May 1, 2013) to Dr. G, "What made you interested in science and how old were you?" In other cases, the mentor shared about the sources of STEM interest while answering other questions. The answers varied from mentor to mentor but all six mentors were able to identify their sources of interest in STEM. Most of the discussion threads were TDTs. The responses were divided into Maltese & Tai's (2010) source of interest criteria of school, family, and self (see Table 5-5).

School. Dr. B. talked about school and a specific teacher being the source of her interest in mathematics. She said, "in high school I had a wonderful teacher who loved math and loved teaching and therefore made going to class fun. He took what seemed impossible and made it understandable" (Dr. B, Edmodo transcript, May 1, 2013). Dr. B (Edmodo transcript, May 14, 2013) also mentioned that "biology was my favorite because I loved dissections." Dr. G (Edmodo transcript, May 2, 2013) mentioned being inspired by an eighth grade teacher who "taught us physics and really let us do a lot of experiments." She said that teacher "made science very fun and she expected all of us to understand" (Dr. G, Edmodo transcript, May 2, 2013).

Family. Ms. N was inspired to become a geotechnical engineer by her father. "He was a geotechnical engineer and I used to spend Saturdays with him driving to job and construction sites to look at soils and sometimes even a sinkhole and once he took me to the phosphate mines…" (Ms. N, Edmodo transcript, May 3, 2013). Dr. B (Edmodo transcript, May 17, 2013) mentioned that her mother inspired her to work hard and instilled in her "the value of lifelong learning even though she did not attend college herself."

Self. The only mentor to mention self as the source of interest was Dr. K. She said that she was interested from an early age in "trying to figure out why people had so many different kinds of reactions to the same event" (Dr. K, Edmodo transcript, May 8, 2013). She went on to say that, since she came from a fairly large family, she "always wondered how we-my siblings and I came from the same environment yet were different people" (Dr. K, Edmodo transcript, May 8, 2013).

Code 11: Nature of interest

Maltese and Tai (2010) defined the nature of interest as "the subject matter or type of experience-that participants associated with their initial interest" (p. 679). In most of the cases, the mentor shared about the nature of their STEM interests while answering other questions. The answers varied from mentor to mentor but all six mentors were able to identify the nature of interest in STEM. The responses were divided into Maltese & Tai's (2010) nature of interest criteria of intrinsic, education-based themes, and cannot identify (see Table 5-5).

Intrinsic. Dr. K, Ms. N, and Dr. P mentioned that the source of their interest came from within. Dr. K (Edmodo transcript, May 18, 2013) told the girls that she was always interested in "why people 'do the things they do' even when I was a child. I often would think about things such as birth order, family dynamics, genetics to see if I could come up with any plausible explanations." Ms. N (Edmodo transcript, May 9, 2013) also shared her fascination with "big construction projects" as a child and knew that she "wanted to be a part of it." Dr. P also mentioned that she knew from an early age that she wanted to become a reproductive endocrinologist. She told the girls that her favorite aunt "had infertility and I used to travel with her to her doctors [*sic*] appointments. Experiencing her journey through treatments made me realize I loved being a woman's advocate" (Dr. P, Edmodo transcript, May 6, 2013). She recognized her intrinsic nature was that of being "compassionate and caring and this particular specialty requires alot [*sic*] of that" (Dr. P, Edmodo transcript, May 6, 2013).

Education-based themes. Dr. B and Dr. G both discussed the impact of teachers and school experiences on their interest in STEM. Dr. M also talked about the influence of college lectures on her STEM interest. She said, "I found myself going to lectures that just interested me (that I didn't have to go to) and they were often science related" (Dr. M, Edmodo transcript, May 11, 2013).

Cannot identify. This code did not appear in any of the discussions with the mentors.

Science Identity

The topic of science identity has been well-documented in the science education literature and was discussed in Chapter 2. In addition to questions on career exploration and STEM interest, the girls also asked questions about the mentors' science identities. Table 5-6 presents an overview of the three codes from the final a priori codebook that informed the science identity portion of the project, including a definition for each code and the number of times each code appeared in the Edmodo transcripts. The results of the theoretical thematic analysis portion of this project are presented in the following sections of this report. To discuss each code, excerpts of representative discussion threads are presented.

Table 5-6. Science identity codes, definition of code, and frequency of appearance of code

STEM identity code	Definition of code	Frequency of appearance of code
Science person	Person sees themselves as a science person	5
Attracted to science	Person is attracted to science, scientific concepts, and science activities	8
Shaped by surroundings	Person enjoys science due to something in her surroundings	9
Total		22

Code 12: Science person

All six mentors were asked some form of the question, “Do you see yourself as a science person” (Reddie, Edmodo transcript, May 8, 2013)? This question came from the list of suggested questions about science identity designed to help the girls get the conversations initiated (See Appendix J). The answers varied but each mentor answered the question with the exception of Ms. N.

For example, Dr. K (Edmodo transcript, May 9, 2013) answered Reddie by saying, “Reddie, Yes, I see myself as a science person. More specifically, I see myself as a behavioral and cognitive specialist who focuses on examining behavior and cognition.” Dr. M also said she saw herself as a science person. She said that she related to the sciences “much more readily than other subject areas. For me, becoming a ‘science person’ was an evolution....I didn't decide and therefore, I was...but I started to identify more with science in University” (Dr. M, Edmodo transcript, May 11, 2013). Dr. P said that she considered herself a science person. Dr. B (Edmodo transcript, May 14, 2013) told Reddie she considered herself “more of a math person” than a science person.

Dr. G (Edmodo transcript, May 13, 2013) also answered the question posted by Reddie by saying, “I definitely see myself as a Science person. I took all the hardest science classes through high school and had so many friends who were science people, too. We really loved the challenge of figuring out complicated problems.” She then asked Reddie the question, “Do you see yourself as a Science person, too” (Dr. G, Edmodo transcript, May 13, 2013)? Reddie never answered the question posted by Dr. G.

The code science person appeared 5 times throughout the data. All of the questions were TDTs. Each question asked about being a science person was answered directly by the mentor and there were no more exchanges on information on that topic between the two participants. The next code examined was attracted to science.

Code 13: Attracted to science

None of the girls asked the mentors if they were attracted to science but four of the six mentors shared examples in which they loved science or were drawn to science classes in school. For example, Dr. G (Edmodo transcript, April 25, 2013) said, "Like you, I loved math and science in school. When I was in high school I especially liked Chemistry." Dr. P (Edmodo transcript, April 29, 2013) said, "In school, I loved biology and the sciences" and Dr. M (Edmodo transcript, May 3, 2013) said, "My love for medicine & animals is a given" while answering a question from Tabbie about job satisfaction. Finally, Ms. N (Edmodo transcript, May 9, 2013) shared with the girls that she was fascinated with the big construction projects of her father and "wanted to be a part of it."

The code attracted to science appeared 8 times throughout the data and appeared when the mentors were answering other questions. The final code examined was attracted to science.

Code 14: Shaped by surroundings

None of the girls asked the mentors if their science identity was shaped by their surroundings but four of the mentors shared examples in which this was true. For example, Dr. G (Edmodo transcript, May 13, 2013) shared how she "took all the hardest science classes through high school" and had "many friends who were science people."

She also shared that of the “20 chemical engineering students in my class” six were women, and she indicated that it “was a small but very fun group” (Dr. G, Edmodo transcript, May 6, 2013). Dr. K (Edmodo transcript, May 8, 2013) was “greatly influenced” to “pursue my career” by “my Psychology professors” because they “were great scholars, orators” and also “conducted interesting research.” Dr. M (Edmodo transcript, May 3, 2013) relayed a story about the influence of those around her when she said, “A very good friend, who was actually in medical school at the time, helped me realize where my passions & skills lay & I was back on the vet school track.” Ms. N shared about the influence of her surroundings while visiting construction sites as a child with her father, and Dr. P (Edmodo transcript, May 9, 2013) said she enjoyed “learning about science through museums, classes or community activities.”

The code shaped by surroundings appeared 9 times throughout the data and appeared when the mentors were answering other questions.

Summary

I counted the frequency in which the mentors and girls were involved in discussion threads pertaining to the constructs of career exploration, STEM interest, and science identity. Of the 81 separate and distinct discussion threads contained in the Edmodo site, 59 related to career exploration, 17 related to STEM interest, and 5 related to science identity. There were 262 coded units located in the six Protocol C transcripts of the discussions between the mentors and girls. Of the 262 coded units, 180 coded units referred to career exploration, 60 coded units referred to STEM interest, and 22 coded units referred to science identity.

Research Question 2

RQ 2: What are the participants' perceptions of the opportunities and constraints surrounding online mentoring?

The next portion of this project focused on the perceptions of the online mentoring community from the perspectives of the Einstein Girls and the female STEM mentors. I was seeking information on both the opportunities and the constraints of the program. Seven girls spoke about the opportunities and constraints through their interviews. A focus group also was conducted with the six mentors to collect their data. The results are presented in the sections below and are presented by students and mentors.

Students' Perceptions of OMC Opportunities

During the interviews, the girls discussed six areas that they perceived as opportunities related to the OMC. These areas were: Edmodo site operation, impressions of mentors, exploring STEM careers, increase STEM interest, increase science identity, and personal satisfaction with program. The following sections present the six areas the girls identified as opportunities afforded by the OMC. Each area includes supporting quotations from the interview transcripts.

Edmodo site operation

Several girls mentioned that they felt the Edmodo program was easy for them to use. Denise (personal interview, May 23, 2013) said that the program had no "glitches" like previous online programs she had used and that "it ran better than I thought it would run." Tabbie (personal interview, May 28, 2013) said "I don't think it really had that many problems." Jordan (personal interview, May 20, 2013) concurred, saying "I thought it would be a little harder to ask a question but it really wasn't" and "I thought that they [the mentors] would take a lot longer to answer questions but they didn't." She also said she "liked it because if I had any questions I could just ask and I would get an immediate answer and good answer" (Jordan, personal interview, May 20, 2013). Some girls noted that when they went back to the site they discovered that answers had been posted to their questions. Kim (personal interview, May 21, 2013) mentioned this when she said, "I liked how you wouldn't have to wait very long to get an answer." Pam (personal interview, May 24, 2013) also said that the online mentors "would be able to go back and answer the questions later."

Two of the girls said they liked the online features of the site. Gail (personal interview, May 28, 2013) mentioned that for her it was "easier to talk with someone [the mentors] like that because you don't have to be there in person, and when you can always come back and keep asking them questions." Tabbie noted that since she was a little shy she liked the anonymity afforded by the online format. She said, "What I liked best about it was probably that it was online and you don't have to ask them the questions face-to-face because I'm sort of shy" (Tabbie, personal interview, May 28, 2013). Gail also noted that she may have felt intimidated by the mentors if she met with them face-to-face.

The girls were able to read the other questions and answers posted on the site. Pam (personal interview, May 24, 2013) said she could read other people's comments and "other people's responses" and that "everybody could read your question and answer." Jordan (personal interview, May 20, 2013) noted that when she read other answers "three more questions popped into my head." Tabbie also mentioned reading the answers by some of the mentors. She said, "Sometimes when I was reading the answers to other peoples' questions I figured out why they became a scientist and it really…inspired me" (Tabbie, Personal Interview, May 28, 2013).

Two girls mentioned they liked being able to go to the Edmodo site where they had a choice of mentors and careers to explore. Jordan (personal interview, May 20, 2013) said, "Whenever I had a question about anything I could just see which one covered that topic and ask that question and I always got a response." Kim mentioned a positive feature for her was being able to talk to a variety of professionals from diverse career areas. She said, "I also liked how you could really ask any question that you wanted to know because obviously they are very smart people" (Kim, personal interview, May 21, 2013).

Three girls mentioned that they visited the Edmodo site outside of school. Kim (personal interview, May 21, 2013) said, "I can just do this at home instead of having to wait for once a week when I can do it on this school computer." Denise also mentioned visiting the site from outside of school. She said, "I think what I liked best was that we could…do it in school and out of school…We could do it [visit the Edmodo site] in school and either download the app or go on our own computers and do it out of school" (Denise, personal interview, May 23, 2013). Finally, Jordan mentioned using a mobile device to use Edmodo out of school. She said, "I used my iPad because I found the Edmodo app which was really easy to log on and off" (Jordan, personal interview, May 20, 2013). Gail, Jordan, and Kim all reported that they had their parents' permission to access the Edmodo site from home.

Impressions of mentors

The girls also shared about the mentors that were a part of the OMC. When prompted, the girls interviewed made several specific comments about the mentors.

One positive feature of the OMC for the girls was the opportunity to talk online with real STEM professionals. Kim (personal interview, May 21, 2013) said, “I have always been pretty interested in science and math but have never had any good opportunities to actually learn more about what actual scientists do in their everyday lives.” Georgia (personal interview, May 29, 2013) said she liked it “because usually you don’t get to talk to…scientists.” Denise (personal interview, May 23, 2013) mentioned a similar perspective when she said, “I really enjoyed being a part of the online community because I thought it was really cool how we could talk to…actual women scientists outside working in their fields of medicine and science.”

Four girls also mentioned feeling comfortable talking online with the mentors. Pam (personal interview, May 24, 2013) said “they were really friendly,” and Kim (personal interview, May 21, 2013) said “they were very nice and helpful and informative.” Denise said she “felt really comfortable talking with all of them because they were so kind and they were so open with us on how they loved their fields in medicine.” She specifically mentioned Dr. P being open and “did not make us feel awkward. She led us in in-depth conversations as her friends… one-on-one, not as a teacher to student” (Denise, personal interview, May 23, 2013). Jordan commented that she felt one of the mentors put some thought into her answer. She said, “I had a lot of questions about that [geotechnical engineering] and, um, I got really good answers from her [Ms. N.]” (Jordan, personal interview, May 20, 2013). Pam (personal interview, May 24, 2013) also noted that the mentors gave lengthy answers “in their explanations and that was really nice of them.” She also commented that she liked that some of the mentors answered the questions by student name.

Exploring STEM careers

Another positive feature of the OMC mentioned by the girls was the opportunity to explore STEM careers with the mentors. Jordan, Kim, Denise, Gail, Tabbie, and Georgia all mentioned that they enjoyed learning about the various careers from the mentors. The girls interviewed were interested in exploring different careers. Denise (personal interview, May 23, 2013) said that she learned about "two interesting new jobs [clinical psychology and veterinary surgery] and researched them." Jordan (personal interview, May 20, 2013) also mentioned being interested in "veterinary one and the psychologist." Kim (personal interview, May 21, 2013) was interested in "the math teacher because "I am very interested in math and it's one of my favorite subjects." She was also interested in the chemical engineering career because "it was interesting to learn about the semiconductors and the computers" (Kim, personal interview, May 21, 2013). Pam was interested in learning about veterinary science as well as endocrinology, while Gail (personal interview, May 28, 2013) mentioned an interest in "the therapist one, because I think it was interesting how she's able to actually cure them of their problems." Finally, both Tabbie and Georgia mentioned an interest in the veterinary surgeon's career because they both said they loved animals.

A few girls mentioned learning more about other jobs relating to the careers of the mentors. Gail said that there were aspects of medicine that she had not considered. She said, "you just think that…they only see patients but there are so many more complicated branches of being a doctor" (Gail, Personal Interview, May 28, 2013). Pam (personal interview, May 28, 2013) found out that "there are different types of scientists, there's not just chemistry." Tabbie (personal interview, May 28, 2013) did not know that regular veterinarians did not do surgery on animals but that "they had a special surgeon for it." Dr. M. discussed some of the various areas associated with veterinary medicine and Dr. P. also discussed some of the various branches associated with medicine. Denise, Tabbie, and Gail said this made them interested in studying their fields and the areas of specialization.

When I asked the girls during their interviews if meeting with the mentors caused them to consider studying their fields in STEM, all seven girls responded affirmatively. Kim had an interesting perspective on the question. She said, "I think it would be…interesting to learn more about that [engineering and technology] and maybe try researching more about…what colleges are good for that" (Kim, personal interview, May 21, 2013). She found out that "it takes a lot of years in college" for the mentors to pursue their various careers (Kim, personal interview, May 21, 2013). She also said that, after talking with the veterinary surgeon, she "could probably see what…would help me to what I would like to do for my future" (Kim, personal interview, May 21, 2013).

Increase in STEM interest

All seven girls interviewed said that in some way their interest in STEM increased because of the OMC. Jordan, Kim, and Tabbie mentioned that, while they already had an interest in STEM prior to the program, their interest increased over the course of the project. Kim (personal interview, May 21, 2013) noted that she already was interested in science prior to the OMC program "because I did Einstein Girls last year" and that the program "helped my science interest." Tabbie (personal interview, May 28, 2013) had a similar response when she said "I've been interested in science for my entire life" but that her interest was "a little bit greater" after the program. She also mentioned that the mentors “inspired me to get interested in different types of science” (Tabbie, personal interview, May 28, 2013).

Gail, Georgia, and Pam reported that their STEM interest increased a little over the course of the program. Denise (personal interview, May 23, 2013) mentioned that talking with the STEM mentors “was a great way to get us a little bit more interested in science.” She also pointed out that “the math teacher helped me with my interest in science because I knew vaguely that science and math interlocked with each other” (Denise, personal interview, May 23, 2013). She felt Dr. B. “opened my eyes to how much math was…really important to science” (Denise, personal interview, May 23, 2013).

Increase in science identity

The girls also talked about their science identities and most said that participating in the program caused some sort of increase in their science identities. Denise and Kim said that they already saw themselves as science people before the program and Denise (personal interview, May 23, 2013) said “they [the mentors] helped a little bit.” Kim (personal interview, May 21, 2013) said she saw herself as both a science and math person and that she “couldn’t really choose between either one.” Jordan (personal interview, May 20, 2013) said that before the program she probably “had a small one [science identity] but I think it definitely increased because of this [the OMC].” Georgia, Pam, and Tabbie all said the program helped them with their science identities but Gail said she did not know.

Personal satisfaction with program

Several of the girls expressed personal satisfaction with the program during their interviews. Six of the girls either said they enjoyed the program or were interested in the program. Pam (personal interview, May 24, 2013) said the program was “really cool.” Gail (personal interview, May 28, 2013) also mentioned that it was “fun to be able to do that [access the site] even outside of class.” Tabbie (personal interview, May 28, 2013) said it was “fun to learn about what they [the mentors] do for a living” and that she “really enjoyed it [the program].” Jordan (personal interview, May 20, 2013) said “I was really really interested” and “I really…loved all of it.” Kim (personal interview, May 21, 2013) felt the program was interesting and “I felt like it was very informative.” Georgia did not answer the question.

Both Denise and Jordan mentioned that they benefitted from a piece of advice given to Gail by Dr. B. regarding taking mathematics tests. Jordan (personal interview, May 20, 2013) said the advice “helped me with math because I took a math test like Gail and her [Dr. B.’s] advice helped me a lot and saved me a lot of time on one of the questions.” Denise (personal interview, May 23, 2013) mentioned being helped by the same advice and discussed “really good test taking tips” that she picked up from Dr. B. Jordan and Kim also mentioned they appreciated receiving advice from Dr. B. regarding their Pre-Algebra and Algebra courses for the upcoming year. Finally, Denise expressed her personal satisfaction with the program. She said, “I loved them [the mentors], they were awesome” (Denise, Personal Interview, May 23, 2013).

Mentors’ Perceptions of OMC Opportunities

Following the conclusion of the program I conducted a focus group with the six mentors to determine their perceptions of the opportunities and constraints afforded by the online mentoring community. The mentors mentioned the following as positives: features of the Edmodo site, benefits to students, opportunity to motivate girls in STEM, and personal satisfaction with program. The following sections present the four areas accompanied by supporting quotations taken from the focus group transcript.

Features of Edmodo site

The first positive comments about the program related to the Edmodo site itself. Five of the six mentors (Dr. B, Dr. G, Dr. K, Dr. M, and Dr. P) mentioned the asynchronous nature of the OMC program as a positive feature. This feature allowed the mentors to access the Edmodo site when it was convenient for their personal schedules. Dr. B (focus group interview, May 30, 2013) pointed out that “the online format was conducive to possible schedule conflicts as a result of work schedules and other commitments that prevent face-to-face interactions.” Dr. K (focus group interview, May 30, 2013) added that the program offered “flexibility for working Moms.”

Four of the mentors noted that along with being asynchronous, the online format offered a level of anonymity for the students. During the focus group, Dr. G, Dr. M, and Dr. P. all concurred that they felt that since the girls could ask questions anonymously, they could do so without fear of intimidation or judgments by anyone. Dr. K (focus group interview, May 30, 2013) mentioned that she “loved the nature of the conversations: Non-threatening because it is online.” She added that “children often feel intimidated speaking to adults F2F” so this issue was alleviated with the online format (Dr. K, focus group interview, May 30, 2013).

Dr. G, Dr. M, and Dr., P thought the way the girls were guided through some of the questions was helpful. I gave the girls a list of suggested questions to get them started with the question and answer process (see Appendix G). The three mentors also mentioned that they thought it was a good idea that all messages had to be approved by the owner of the site before messages posted in the Edmodo site. This was a feature selected in the Edmodo program when the site was set up. Finally, they felt the program was just the right length of time to hold the interest of the girls and to accommodate the maximum number of questions; the program lasted approximately four weeks.

Benefits to students

The mentors also thought that the program was beneficial to the Einstein Girls. Three mentors (Dr. B, Dr. K, and Ms. N) made references to the students who participated in the program. Dr. B (focus group interview, May 30, 2013) felt the girls were "truly eager to seek information about their interests." Dr. K was encouraged that the girls did not appear to be afraid to talk with the mentors. She indicated that she enjoyed the nature of the conversations that took place. She also noted that several of the girls wanted to know about "the timing of when my interest peaked in my field" and that "many of the students were interested in the most difficult challenges that I have professionally encountered" (Dr. K, focus group interview, May 30, 2013).

Dr. B and Dr. K mentioned that they both felt comfortable talking with the students and Dr. B (focus group interview, May 30, 2013) added that "the students were asking heartfelt questions and deserved honest, candid responses." Ms. N (focus group interview, May 30, 2013) felt the "biggest stand out to me was how inquisitive the girls are" and "how wide ranging the ? [*sic*] were." Dr. B (focus group interview, May 30, 2013) was excited that "there is still a cadre of students who are so very interested in the sciences and pursuing STEM careers."

Opportunity to motivate girls in STEM

The mentors used the OMC as an opportunity to help encourage the Einstein Girls in STEM. Dr. K (focus group interview, May 30, 2013) mentioned that she was “excited to research in the area of investigating factors involved in motivating students” and felt “this research helps students view the practical application of their studies and interests to the real world professions.” Ms. N (focus group interview, May 30, 2013) thought that it was “important that they [the girls] have a venue in which to ask and receive answers.” She mentioned that she “often thought that a simple question that they might not know the answer to could BLOCK them from ever pursuing a STEM career” (Ms. N, focus group interview, May 30, 2013). Dr. K (focus group interview, May 30, 2013) felt that the Einstein Girls program and the online mentoring program helped the girls because “their science identity was fostered from a positive educational experience.” Ms. N (focus group interview, May 30, 2013) added that she was interested in seeking “opportunities to share as it relates to STEM because women need to be encouraged into these careers.”

Personal satisfaction with program

The mentors indicated that they enjoyed being included in the program and made several comments that indicated personal satisfaction with the program. Dr. G, Dr. M, and Dr. P said they had never been a part of such a program and were interested in seeing how it would work. Dr. K (focus group interview, May 30, 2013) said “it was a very pleasant experience” for her and Dr. M (focus group interview, May 30, 2013) said “I enjoyed it more than I anticipated.” Dr. B (focus group interview, May 30, 2013) added that she “truly enjoyed the experience.”

Students’ Perceptions of OMC Constraints

While the overwhelming majority of the responses were positive, the students interviewed did have several comments regarding what they perceived were limitations of the OMC program. The first limitation was mentioned by Kim. She noticed that over time, the size of the Edmodo site became increasingly unmanageable as more questions and answers were posted by the girls and the mentors. She said, “I didn’t know that there would be that many questions to look through and have to look at every single one to make sure that someone hasn’t already asked your question” (Kim, personal interview, May 21, 2013). Georgia had an interesting insight as well. She was the girl who did not post any questions to the site but was observed on three occasions reading the questions and answers from her computer. When I asked her why she did not ask the mentors any questions she had a candid answer. She said, “I wanted to ask what the psychologist did but Mary already asked that question” (Georgia, personal interview, May 29, 2013). Pam thought it became increasingly difficult to think of questions for the mentors as the project moved on. “It got harder to think of what to ask the different, like [*sic*], scientists” (Pam, personal interview, May 24, 2013). I mentioned to her that I thought the project had a life-span and that we probably reached the end by mid-May. She agreed and said, “the fun of it [the OMC] started to wear away a little” and it got “a little less interesting” (Pam, personal interview, May 24, 2013).

Two other interesting comments came from the girls regarding the choices of mentors. Kim and Gail thought there should have been more female STEM mentors included in the program. Kim (personal interview, May 21, 2013) said, “maybe more scientists” and Gail (personal interview, May 28, 2013) said “I think that you could have included more people.” Several of the girls mentioned that they were not interested in all of the STEM fields represented. Denise (personal interview, May 23, 2013) said that she “wasn’t really not interested in any of them” but that the one she paid the least attention to “was the geoscientist even though I still though it was really cool.” Gail (personal interview, May 28, 2013) stated she also was less interested in the geotechnical engineer than the other careers because “I’ve heard a lot of that stuff before and the other jobs I haven’t heard a lot about.” Georgia, Pam, and Tabbie all mentioned being the least interested in the career of the High School Mathematics Teacher. Pam (personal interview, May 24, 2013) said that she didn’t think being a “math professor” was “much of a career.” Georgia (personal interview, May 29, 2013) said, “I really don’t like math that much.” Tabbie (personal interview, May 28, 2013) added that “math isn’t exactly my favorite subject.”

Mentors’ Perceptions of OMC Constraints

The mentors’ comments about what they considered to be constraints of the OMC centered on the functionality of the site. Two of the mentors expressed uncertainty about the program prior to the start of the program. Dr. B (focus group interview, May 30, 2013) mentioned “although you provided several overviews, I really wasn’t sure what to expect.” Dr. K (focus group interview, May 30, 2013) made a similar comment, “I didn’t really know what to expect from the program.” Dr. B (focus group interview, May 30, 2013) added that since she had never “done anything like this in the past, did not have a benchmark whereby I could gauge how it was being run.”

Dr. G., Dr. M., and Dr. P. noted that there were several duplicate questions on the site. One girl did not login until the final week of the program and asked Dr. M several questions already asked by other girls. Dr. G felt that the order in which the mentors were presented may have influenced the number of questions posted for each mentor. Dr. M was presented first in the Edmodo site and had the most posts. Dr. G wondered if the engineers would have experienced more activity had they been presented first. Finally, several mentors also shared that they had to think about how to frame their answers with understandable language that was age-appropriate for the students. They had to rely on their written answers since their communication tools were limited within the Edmodo site.

Rating the OMC

The participants were asked if the program met their expectations and to rate the program. The girls interviewed felt the program either met their expectations or exceeded their expectations. Kim (personal interview, May 21, 2013) said she didn't think we "should change very much because…it's already running so smoothly." Denise (personal interview, May 23, 2013) "thought it ran a lot better than I thought it would run." Pam (personal interview, May 24, 2013) concurred saying "it was actually better that what I thought it was." Gail (personal interview, May 28, 2013) thought "it was better" and Georgia and Tabbie thought the program ran the way they expected. The mentors had similar comments. Dr. M (focus group interview, May 30, 2013) said she "enjoyed it more than I anticipated" and Dr. P agreed. Dr. G (focus group interview, May 30, 2013) said "I think it matched my expectations."

The participants were asked to rate the online mentoring program. The girls rated the program with high marks. Jordan (personal interview, May 20, 2013) said, "on a scale of 1-10 with 10 being the highest…10." When asked the same question, Kim (personal interview, May 21, 2013) said, "out of 10 or out of five stars? Maybe 9 out of ten stars." Denise (personal interview, May 23, 2013) agreed by saying, "One to a hundred…a hundred and five!" Pam (personal interview, May 24, 2013) said, "on a scale of 1-10…a 7 or an 8." Gail (personal interview, May 28, 2013) rated the program with "a ten." Tabbie (personal interview, May 28, 2013) gave the program an "8" and Georgia (personal interview, May 29, 2013) rated the program with a "9."

The mentors gave similar comments. Dr. K (focus group interview, May 30, 2013) said she would “rate the online mentoring program as superior.” Dr. B (focus group interview, May 30, 2013) said “on a scale of 1-10, an 8.5.” Dr. P (focus group interview, May 30, 2013) said “great” and Dr. G (focus group interview, May 30, 2013) agreed with “a 9.8.” Finally, Dr. M (focus group interview, May 30, 2013) said “for a first program, a 10.”

Summary

The seven student interviews and the focus group interview together were important data sets to understand the participants’ perceptions of the opportunities surrounding the OMC and the constraints afforded by the OMC. Chapter 6 presents a summary of the project and discussion of the results.

CHAPTER 6
DISCUSSION

Introduction

This project was designed to give girls who were interested in STEM the chance to communicate online with women who were successful STEM professionals. The community provided the girls a setting in which to ask the women questions about their careers, their interests, and their science identities. Through the venue the girls were able to explore various STEM careers, were exposed to positive role models, and potentially increase their interest in STEM for the future. To better understand the mentoring process, I examined the discussions that took place between the girls and the mentors on several levels and explored the themes that emerged from those discussions. To determine the participants' perceptions of the online mentoring process, I conducted interviews of seven selected Einstein Girls and conducted a focus group with the six mentors and analyzed their collective responses.

The project took place through the Internet using the secure educational social networking program Edmodo and spanned a four-week period between April and May 2013. All of the communications between the participants were asynchronous. The students used the Einstein Girls after-school academy meeting time to participate in the project and several of the students also accessed the site from their homes. The mentors accessed the site when convenient to their schedules from the locations of their choice. The girls posted questions for the mentors about their careers and their interests in STEM as well as the mentors' science identities. The mentors responded to the posts and in several cases engaged some of the girls in extended discussions.

Discussion of RQ 1

> RQ 1: What is the nature of the online mentoring process--with special focus on mentees' career exploration, interest in STEM, and their science identities?

The first research question was designed to determine the nature of the online mentoring process that took place between the Einstein Girls and six female STEM mentors. Special emphasis was placed on the constructs of career exploration, STEM interest, and science identity. To better understand the nature of the online mentoring process, I looked at specific aspects of the participation by the Einstein Girls in the OMC and specific aspects of the participation by the mentors in the OMC. Next I studied the types of discussion threads that took place between girls and mentors and determined the types and numbers of interactions that occurred between the members. Finally, I examined the overarching themes that were present in the community. As I made these investigations, several interesting discoveries were revealed. These discoveries related to the way community members participated in the OMC and the types of interactions that occurred between the members. In addition, there were several interesting findings that were generated by the thematic analysis of the online discussions. These findings are presented in the sections below.

Each Einstein Girl Participated in Her Own Way

The first set of findings related to the way in which the girls participated in the OMC project. Since the girls were members of the Einstein Girls after-school academy, their involvement in an ISL program was voluntary. Membership in the OMC was also voluntary and participation in the community was up to the discretion of the girls and their families. As such, each girl was free to participate in the community in her own unique way. Some girls immersed themselves in the program right away and posted many times while others waited two or three weeks to join in the discussions and posted only a few times or not at all. There were several girls whose participation efforts fell between the two extremes. Overall, the girls posted a varying number of questions as well as a variety of types of questions. They posted from school and in some cases posted from home. To determine the participation of the Einstein Girls, I looked at their numbers of questions posted, their types of questions posted, their numbers of mentors questioned, and their participation from inside and outside of the classroom. There were several findings from this portion of RQ 1 which are discussed in the following sections.

Numbers of questions posted

To better understand the nature of the online mentoring process for the girls, I began with an examination of the numbers of questions posted by the girls for the mentors. The girls posted a varying number of questions on the Edmodo site. Jordan posted more questions than anyone else in the Einstein Girls. She asked 29 questions which was almost twice as many as anyone else. Denise asked 15 questions, Rickie asked 12 questions, Reddie asked 11 questions, and Gail asked 10 questions. Seven girls posted five to nine questions, six posted one to four questions, and one girl did not post any questions. Five girls (Denise, Gail, Jordan, Kim, and Xitali) posted from outside of school in addition to posting during Einstein Girls meetings.

I wondered why the number of posts by the girls varied so much, so I asked that question of two of the girls interviewed for RQ 2. The question was first posed to Jordan, "You were the one who posted the most questions…what was your reason for that" (Mrs. Scott, personal interview, May 20, 2013)? Her response told the reason. She said, "I was really, really interested. And whenever they [the mentors] had an answer I, just like [*sic*], three more questions popped into my head reading my answer" (Jordan, personal interview, May 20, 2013). It seemed apparent that she was the girl most interested in the project. She asked the greatest number of questions during the project. In addition, I observed and noted that Jordan was engaged in the other science-related activities that took place during the semester that were not directly a part of the OMC. Finally, she was the first girl to post from out of school and the girl who posted the most times from out of school. Jordan posted six questions during Einstein Girls meetings and 23 questions from out of school.

I wondered how she was able to post so many times, especially from out of school. In her interview I asked her, "What device did you use to post your questions" (Mrs. Scott, personal interview, May 20, 2013)? Jordan (personal interview, May 20, 2013) told me she "used my iPad because I found the Edmodo app which was really easy to log on and off." I asked her if her parents "were okay with you doing that from home" (Mrs. Scott, personal interview, May 20, 2013), to which she responded affirmatively.

Some girls seemed content to ask a minimum number of questions or no questions at all. I considered the case of Georgia who did not post any questions to the Edmodo site. I know she was logged into the site because she altered her online profile. In addition, I observed her viewing the site during Einstein Girls meetings on three separate occasions, which was noted in the researcher journal. Because of her apparent lack of involvement, she was another one of the girls I selected to interview for RQ 2. During the interview I asked her, "You did not actually ask any questions…did you not want to" (Mrs. Scott, personal interview, May 29, 2013)? She responded by saying, “I wanted to ask what the psychologist did, but Mary already asked that question” (Georgia, personal interview, May 29, 2013). This was her explanation for not posting questions for the mentors. I had assumed that she was not interested in asking questions but found out through her interview that she was not interested in asking questions that had been already asked by another girl.

Two girls (Beth and Connie) posted only one time. Beth joined the group late and only participated in one Einstein Girls meeting. During that meeting she wrote Dr. M a series of questions about her career as a veterinary surgeon, most of which had already been asked. Connie (the eighth grade former Einstein Girl student assistant) asked a very specific question for Dr. K. She was working on a project for school and took the opportunity to reach out to the clinical psychologist and obtain help on her project. Four girls (Heather, Mary Ann, Pam, and Tabbie) only posted two questions during the entire project. I wondered why they asked so few questions despite having four weeks to work on the project. Pam gave some insight into the question when she said, “it was pretty fun at first, but then afterwards it started to…it got harder to think of what to ask the different like [*sic*] scientists” (Pam, personal interview, May 24, 2013). The four girls only asked TDTs and received their responses from the mentors. They did not ask any follow up questions.

Types of questions posted

To better understand the nature of the online mentoring process for the girls, I also examined of the types of questions posted by the girls. The girls posted a variety of types of questions at the Edmodo site. It appeared that several of the girls put a great deal of thought into their questions and that they took advantage of the opportunity to have an online forum with actual STEM professionals. I observed that Denise, Gail, Jordan, and Kim asked the greatest variety of questions of the mentors. Based on their numbers of questions and types of questions, it seemed they were interested in the mentoring process, or in the very least were interested in being a part of the Edmodo social network. They were eager to ask their questions as well as to receive their answers and were all involved in EDTs.

Denise, Gail, Jordan, and Kim asked questions about the constructs of career exploration, STEM interest, and science identity. Not surprisingly, these same four girls accessed the Edmodo site from outside of school. I selected these girls as interview candidates for RQ 2 based on their high level of involvement in the project. Conversely, some girls did not appear to put a lot of thought into their questions. Shammie (Edmodo transcript, May 15, 2013) asked five of the mentors the same TDT question which was, “Have all your life you wanted the job you have today?” She asked this question during Week 4 of the project and asked the mentors no other questions. I wondered if she was interested in having discussions with the mentors or simply interested in the social experience with friends during Einstein Girls meetings. Similarly, Reddie (Edmodo transcript, May 8, 2013) asked four of the mentors the TDT question, “Do you see yourself as a science person?” This question came off the list of suggested questions. In a response to this question by Dr. G, Reddie was asked, “Do you see yourself as a Science person, too” (Dr. G, Edmodo transcript, May 13, 2013)? It appeared that Dr. G was attempting to initiate a discussion thread with Reddie. However Reddie never answered the question on the Edmodo site. This made me wonder if she went back to the Edmodo site to read the discussion threads, if she saw the answer to her question, or even noticed that Dr. G had asked her a question.

There were a number of interesting questions posted by other girls. Rickie, Tabbie, and Xitali have all mentioned they were interested in becoming veterinarians. They asked Dr. M the veterinary surgeon several specific questions about her career and asked her for advice. Several girls asked Dr. B for advice on mathematics courses. Dr. G also received a wide variety of questions regarding her career as a chemical engineer; questions about her favorite project, her longest project, and her most difficult project. These were all examples of TDTs. Dr. K also received an interesting array of TDT questions regarding her practice as a clinical psychologist, such as questions about her daily routine, her patients, and dealing with difficult issues. Several questions were also asked about STEM interest and science identity.

Numbers of mentors questioned

To better understand the nature of the online mentoring process for the girls, I then examined of the numbers of mentors questioned by the girls. Denise, Jordan, and Mary posted questions for all six of the mentors. I was not surprised to see Denise and Jordan engaged with all of the mentors because they were the two girls who seemed to be the most involved in the OMC. They took the opportunity to post original questions for all the mentors. They also were two of the five girls who went to the Edmodo site from home. Mary also posted questions for all six of the mentors but several of her questions came off of the list provided for her during meetings. She posted all of her questions during Einstein Girls meetings.

Annie, Reddie, and Shammie posted questions for five of the six mentors. As discussed earlier, Shammie and Reddie posted similar questions for all five mentors. However, Reddie asked a few other questions as well. Annie addressed five of the mentors but in most cases did not ask any questions but made general comments to the mentors thanking them for participating in the project. An example of this was when Annie made this comment to Dr. B, “I am in accelerated math, which means I do the grade above my grade’s math! I love math, and I really admire what you do” (Annie, Edmodo transcript, May 8, 2013). She also said to Dr. P, “i [*sic*] really admire what you do for ladies. thank [*sic*] you for doing what others can’t” (Annie, Edmodo transcript, May 8, 2013)! While these posts were complimentary to the mentors, neither contained a question or generated a significant discussion thread.

The other girls posted questions for three or four of the mentors. This did not necessarily indicate that these girls were not interested in the online mentoring process. For example, Kim was interested in careers that involved technology and mathematics; this was confirmed in her interview. Rather than asking questions of all six mentors, she focused most of her attention on Dr. B the mathematics teacher and Dr. G the chemical engineer. Her questions were direct and thorough, as demonstrated in the EDT showcased in Chapter 5. Her direct line of questioning with Dr. G demonstrated her desire to understand more about semiconductors and how they were used in her technology devices. Similarly, her questioning of Dr. B regarding her upcoming Honors Algebra I course demonstrated that she seized the opportunity to get advice from a high school mathematics teacher who could help direct her mathematics trajectory through middle school and high school.

Several girls only posted questions for one or two of the mentors. In most cases, it appeared that the girls were marginally engaged in the program. They participated in the mentoring process but did not take full advantage of the opportunity to communicate with STEM professionals. However, it appeared that two girls purposefully chose to talk with only one mentor. It appeared they did this because they were specifically interested in that one career. Tabbie was so focused on veterinary medicine that she only posted questions for Dr. M. Similarly, Kay expressed an interest in becoming a physician, so she involved herself in an EDT as well as a TDT with Dr. P, the reproductive endocrinologist.

Posted from school and home

To better understand the nature of the online mentoring process for the girls, I finished by looking at which girls posted only at school and which girls posted from both school and home. The girls were given four weeks of Einstein Girls meetings to ask questions of the mentors and read the responses by the mentors. All of the girls except Georgia posted at least one question during the meetings. Since each girl had their own username and password, they could visit the Edmodo site outside of the classroom. They were reminded of this every week. Only five girls visited the site from off-campus; they were Denise, Gail, Jordan, Kim, and Xitali. It was confirmed through interviews with Denise, Gail, Jordan, and Kim that these four girls were given permission from their parents to visit the Einstein Girls Edmodo site from off-campus. I was not able to obtain that information from Xitali. I also wondered whether the other girls were permitted by their parents to login from home.

I concluded that these five girls appeared to have put the most effort into the OMC. I based my conclusion on the findings regarding the participation of the various Einstein Girls. It was apparent that some of the girls were interested in participating in the OMC and others were not. The girls who seemed the most interested in the program and put the most effort into the program appeared to be the ones who received the most benefits from the program. Conversely, the girls who seemed the least interested in the program and put the least amount of effort appeared to be the ones who received the least benefits from the program.

Each Mentor Participated in Her Own Way

Other findings related to the way in which the mentors participated in the OMC project. Each mentor volunteered her time and energy to the project and as such, was free to participate in the community in her own way. In the mentoring training document (see Appendix I) I asked that the mentors login a minimum of three times per week over the course of the four week project and answer questions addressed to them. They were free to decide when to login, how many times to login, and choose the manner in which they answered questions. In the same document it was suggested that the mentors ask the girls questions as well. Some mentors immersed themselves in the program right and answered many questions while others waited until the end of the first week or beginning of the second week to join in the discussion threads. To determine the participation of the mentors, I looked at their numbers of answers posted, the timing of their posts, and made other observations about their participation in the OMC. The findings from this portion of the research question are discussed in the following sections.

Number of answers posted

To better understand the nature of the online mentoring process for the mentors, I began with an examination of the numbers of posts made by the mentors. Each mentor posted a varying number of times on the Edmodo site. Dr. M, the veterinary surgeon, posted the most number of times at 27, followed closely by Dr. K, the clinical psychologist, who posted 25 times. Not surprisingly, these were the first two mentors to answer the initial question about their careers. Their posts appeared on the Edmodo site before the first Einstein Girl Wednesday Week 1 session, giving the girls initial posts to read and questions to ask. Dr. K and Dr. M received more questions than the other mentors the first week. In fact, Dr. M received ten questions on the very first day of the project. Both of these mentors had 14 different girls ask them questions.

Several of the girls were interested in the career of the veterinary surgeon. During the first week of the project, the girls posted 20 questions for her. Many of the questions were specifics about her job. Dr. M answered each and every question with a direct answer that was scientifically challenging and utilized terminology that was appropriate for the age group represented (10-12 year olds). It was apparent from the dates recorded in the Edmodo site that Dr. M visited the site and answered questions more frequently than any of the other mentors. The mentors were asked to visit the site three times per week and answer any of their questions. Dr. M’s posts often appeared around noon. During the focus group interview she told me that she used some of her lunch hours to answer questions. This likely accounted for the timing and high number of posts.

Dr. B, the high school mathematics teacher, had the third most posts at 17. Twelve different girls asked her questions. Gail, Jordan, and Kim, took the opportunity to ask her questions about their mathematics courses. Gail even asked for advice on an upcoming test which she said helped her. During their interviews, Denise and Jordan said they read the advice given to Gail and that they used the advice on their mathematics tests; both reported the advice helped them on their tests. Dr. G, the chemical engineer and Dr. P, the reproductive endocrinologist, both posted 15 times to the Edmodo site and they both had ten different girls post questions for them.

The mentor with the least number of posts was Ms. N, the geotechnical engineer. She only posted to the site five times. During a review of her Protocol B transcript (for an example, see Appendix L), I noticed several interesting findings about her participation in the OMC. She was the last mentor to answer the initial question and did not answer six of the questions posted by the girls. Her answers were thorough and to the point for the questions she did address. Rather than answering the last round of questions, she chose to address the girls addressed the girls with a final summary post.

Timing of posts

To further assess the nature of the online mentoring process, I looked at the timing of the posts by the mentors. This information was obtained from the Protocol A transcripts (for an example, see Appendix K). These transcripts were obtained directly from the Edmodo site and were arranged by date of post. The project lasted approximately four weeks and the weeks of the project ran from Wednesdays to Tuesdays. Dr. K and Dr. M were the first mentors to answer the initial question about their careers, which were posted during the day on Wednesday (April 24, 2013) prior to the first Einstein Girls meeting. Dr. G posted her response the next morning (April 25, 2013), which made her initial post available for the Thursday group. Since Dr. K and Dr. M posted prior to the first Einstein Girls meeting, there were many questions posted by the girls on the first two days of the project. Dr. M answered 11 questions addressed to her by that afternoon (Thursday, April 25, 2013) and answered three more questions by the next day (Friday, April 26, 2013). Conversely, even though Dr. K posted her initial question regarding her career on Wednesday (April 24, 2013) and received 12 follow-up questions, she did not answer any of the questions until Thursday, May 2, 2013. Similarly, Dr. B did not answer the first five questions posted for her until Wednesday, May 1, 2013. Since May 1, 2013 marked the beginning of Week 2 and I noted that Dr. B and Dr. K had a combined 17 unanswered questions, I made the decision to email all of the mentors with a gentle reminder to visit the Edmodo site and answer their questions.

Dr. G posted her initial response on the morning of Thursday, April 25, 2013, in time for the Thursday Einstein Girls meeting and for any girl who chose to access the Edmodo site from outside of school. Greta asked Dr. G a question during the meeting and Jordan had logged in from home after school and asked three more questions. Dr. G answered one of Jordan's questions that evening and answered the other three questions two days later.

For Dr. P's first post, she did not answer the initial question about her career but said, "Hello future scientists! Ask me any questions you may have about science and careers" (Dr. P, Edmodo transcript, April 24, 2013). She posted this question on Wednesday evening, in time for the Thursday Einstein Girls group but too late for the Wednesday group. This posting confused several of the girls since Dr. P did not give any specifics about her job so they did not know what types of follow-up questions to ask. Their response was to ask questions about medical school, her sources of inspiration, and her daily routine. They asked her 12 questions the first two days of the project. She responded by writing a lengthy answer that addressed their questions in one large post on April 29, 2013. She did this after I emailed her earlier that day reminding her to check the Edmodo site. Because of her busy schedule, she asked me to email her three times a week to remind her to visit the Edmodo site and answer questions.

Dr. B and Ms. N were the last mentors to answer the initial question, with Dr. B posting her answer on Friday, April 26, 2013, and Ms. N posting her answer on Monday, April 29, 2013. Both of these posts were available on the Edmodo site prior to Week 2 of the project. Jordan and Kim posted follow-up for Dr. B from outside of school asking her questions about her career as a mathematics teacher which she answered on Wednesday, May 1, 2013. Denise, Greta, Jordan, and Mary responded to Ms. N's response with follow-up questions which she answered on Friday, May 3, 2013. She visited the site again on Wednesday, May 8, 2013 and answered a question and on Thursday, May 9, 2013 and answered another question. I emailed her one last time on Friday, May 17, 2013 asking her to respond to any unanswered questions. She did so with the final post that summarized her career pathway in a few sentences.

The timing of the posts was interesting to me since each mentor participated in the OMC in her own way. Two of the mentors were able to post their initial responses prior to the Einstein Girls Wednesday meeting; two posted prior to the Thursday meeting, and the other two posted prior to the beginning of Week 2. For the girls who visited the Edmodo site from outside of school (Denise, Gail, Jordan, Kim, and Xitali), they were at an advantage since they were able to read the posts near to the time the posts went live on the site. The other girls had to wait for Einstein Girls meetings to read the posts.

Another interesting finding related to the number of days each mentor visited the site. I went back to the Protocol A transcripts and made a fascinating discovery. I had asked the mentors to visit the site three times a week over the course of four weeks to answer questions posted by the girls. This would mean that each mentor would have visited the site on approximately 12 different days. What actually happened was very different. Four of the mentors (Dr. B, Dr. G, Ms. N, and Dr. P) visited the site on five different days, and Dr. K visited on six different days. The only mentor who came close to the goal of 12 visits was Dr. M, who visited the site on 11 different days. As mentioned earlier, Dr. M said she often visited the site during her lunch breaks and was able to answer most of her questions in a timely fashion.

This was significant for the EDTs with both Denise and Jordan who wanted to know more about pet shelters, pet hospitals, non-profits, and volunteer work. Because Dr. M, Denise, and Jordan visited the site more frequently than the others, they were able to carry on significant discussion threads among themselves. The conversations, though asynchronous, moved quickly between participants. The rapid pace of the discussions appeared to hold the interest of the girls for a longer period of time, which led to longer and more significant two-way discussions.

Other comments

The mentors answered most of the posted questions. In general, they provided the girls with age-appropriate answers. Some of the answers were short and concise while other answers were long and detailed. Some questions were grouped together and answered with one post (GTDTs) while other questions were answered individually (TDTs). During the final week of the project, I noticed that there were several unanswered questions. Dr. B, Dr. K, Ms. N, and Dr. P had not answered one or more questions addressed to them. I emailed them and asked them to go back to the site one last time and address any unanswered questions, which they did.

Only two of the mentors posted questions back for the girls. In the training document it was suggested that they reach out to the girls with questions of their own.

However, Dr. B and Dr. G were the only mentors to do so. Dr. B asked Greta a question which she read and subsequently answered. Dr. G asked Reddie a question, but Reddie never responded with an answer. This finding was helpful to inform future projects of a similar nature. Recommendations for future projects are discussed later in this chapter.

Variety of Discussion Threads

Harris (2011) described 12 types of learning activities that focused on the primary communicative functions of mentors in K-12 online settings. The 12 activities were: advise/coach, assist, chat, co-create, discuss/debate, impersonate, problem-solve, provide feedback, question-and-answer, share information, supervise, and tutor (Harris, 2011). Her research related to the design of online mentoring opportunities for the K-12 classroom in a curriculum-based setting, but the learning activities are applicable for an informal, out-of-school setting such as the one used for this project. Of the 12 activities listed, four were present in the discussion threads contained in the Edmodo site. They were: question-and-answer, advise/coach, chat, and discuss/debate. Harris (2011) described question-and-answer learning activities as, “mentors respond to a variety of questions posed by students…” (p. 7). She described advise/coach learning activities as, “mentors provide suggestions and formative feedback…” (Harris, 2011, p. 7). Question-and-answer and advise/coach learning activities generally corresponded with the various types of terminal discussion threads that took place during the project (TDTs, GTDTs, and ATDTs). There were 81 separate and distinct discussion threads contained in the Edmodo site. These represented all of the interactions that took place between the Einstein Girls and the mentors. Of the 81 discussion threads, 72 (88.9 %) were terminal in nature (TDTs, GTDTs, or ATDTs). These types of threads tended to be one-way in nature, or what Dorner (2012) described as vertical questions seeking information. The girls asked questions and the mentors answered the questions. These questions usually related to the various codes presented in Chapter 5. In addition, some of the questions related to advice-seeking by the girls. Advice from mentor was a code that emerged during the thematic analysis of the online transcripts and is also discussed later in this chapter. In most cases, no follow-up questions were asked by the girls or the mentors and no extended discussions were formed.

This finding was important for several reasons. First, the finding indicated that the most of the girls used the OMC primarily to ask one-directional questions of the various mentors. The question-and-answer threads were considered one-directional because the questions appeared to be a one-way mentor to student process, and occurred as TDTs. Almost 70 percent of the discussion threads were classified as TDTs. In these discussions a girl asked a question and the mentor answered the question; the girl did not ask any more questions about the topic. This was true for all of the questions regarding the codes mentor daily routine, mentor career selection, timing of STEM interest, source of STEM interest, and science person. It was also true for most of the questions regarding the code mentor educational pathways and for some of the questions regarding the code specific questions for each mentor. These results indicated that while most of the girls took advantage of the opportunity to talk to real scientists, they did not use the opportunity to deepen the discussions by asking follow-up questions, or in other words to pursue two-directional questions.

There were 16 GTDs in the Edmodo site, which represented nearly 20 percent of the discussion threads. I believe that there were two underlying reasons for the large number of GTDs. Most of the questions were asked during Einstein Girls meetings and needed to be approved by me before posting to the site. Since some of the girls used the questions from the suggested list and since the approval process sometimes took several minutes, they may have been unaware that other girls were asking similar questions. In addition, each girl would have to scroll through most of the Edmodo site to see if anyone else had asked their question. Some of the girls spent time reading others' posts but some girls posted questions without carefully reading through the site. This was best evidenced in the string of questions posted late in the project by Beth. On May 17, 2013, Beth asked Dr. M several questions that had already been asked earlier in the project. Dr. M (Edmodo transcript, May 17, 2013) responded by saying, "Some of your questions I've answered in earlier posts." She then answered the questions again for Beth.

Harris (2011) described chat learning activities as, "mentors share personal stories, information about themselves and their families, 'behind the scenes' views of their professional work, etc." (p. 7). These types of discussions took place between the mentors and the girls during several of the discussion threads. The girls asked the kinds of questions that elicited personal stories from the mentors, such as the story shared by Dr. P (regarding her aunt who struggled with infertility) or the story shared by Ms. N (her father took her to his construction sites), or the personal story shared by Dr. K (regarding birth order and sibling differences). Most of these discussion threads were terminal in nature and inherently one-way in direction. However, chat-type learning activities moved closer to being two-way in direction, because of the personal nature of the comments. There were three ATDTs present in the Edmodo site. One was described in Chapter 5 and took place between Mary, Dr. K, and Gail. Mary asked the initial question about how Dr. K reacted to the problems of her patients. Dr. K discussed the ways in which she tried to help her patients, and how her job was to “figure out the individual strengths of a person and incorporate them into a treatment plan” (Dr. K, Edmodo transcript, May 2, 2013). Gail (Edmodo transcript, May 8, 2013) found her answer “really interesting” and thought it was an “amazing thing to be able to cure people in any way!” This exchange between the three participants had the feel of being two-way in direction since Gail took Dr. K’s answer and extended it into a deeper and more comprehensive discussion. Dr. K (Edmodo transcript, May 9, 2013) replied to Gail’s discussion comments that she felt that her profession “has its challenging moments.”

Harris (2011) described discuss/debate learning activities as, “mentors dialogue with students and/or teachers, constructively challenging their assertions and views” (p. 7). Discussion threads that included dialogue between girl and mentor participants tended to be more two-way in nature, or what Dorner (2012) described as horizontal questions which started a discussion. Of the 81 discussion threads, nine of the discussion threads (11.1 %) were extended in nature (EDTs). These represented significant and longer discussions between girls and mentors. Gail, Greta, and Kim were involved in EDTs with Dr. B, Denise and Kim were involved in EDTs with Dr. G, Denise and Jordan were involved in EDTs with Dr. M, Jordan was involved in an EDT with Ms. N, and Kay was involved in an EDT with Dr. P. Denise, Jordan, and Kim were involved in ETDs with two separate mentors; the other three girls were involved with one mentor. In the discussion mentioned earlier in this chapter between Kim and Dr. G (the chemical engineer), Kim wanted to know more about semiconductors. Dr. G answered with a detailed and age-appropriate answer which prompted Kim to seek more clarity in her understanding. Dr. G responded with a lengthy answer that addressed all the parts of her questions. Denise, Jordan, and Dr. M were involved in an ATDT and two EDTs that occurred in two lengthy discussion threads. These discussions were presented in Chapter 5 under the section Code 8 advice from mentors.

I wondered why there were so few EDTs contained in the Edmodo site. First, I considered the ages of the girls; they ranged in ages from ten to 12. Perhaps it was somewhat unreasonable on my part to expect young girls of these ages to have the maturity to carry on lengthy discussions with women they did not know. The girls who did participate in the EDTs were in the fifth grade (Gail and Jordan) and the sixth grade (Denise, Greta, Kay, and Kim). Four of these girls (Denise, Gail, Jordan, and Kim) were the girls who seemed most involved in the OMC, as previously discussed, so it was reasonable that these girls were the ones who participated in ETDs.

I also considered the training received by the mentors. I looked back over their training document (see Appendix I) in which I recommended that the mentors asked the girls questions in addition to answering their questions. Only two mentors asked one question each during the entire project. I wondered if more ETDs would have taken place if the mentors had been given more guidance on ways to develop two-way discussion threads. I could have encouraged the mentors to ask the girls questions and encouraged the girls to involve themselves in longer discussion threads as well. A discussion whether the mentoring process was one-way or two-way in direction appears later in Chapter 6.

Thematic Analysis

The thematic analysis of the codes derived from transcriptions of the Edmodo site yielded several interesting findings. The discussions of the findings are presented in the following sections: the a priori codebook, career exploration, STEM interest, science identity, and other comments.

The a priori codebook

The original a priori codebook contained 14 codes, including eight codes relating to career exploration, three codes relating to STEM interest, and three codes relating to science identity. After reading through the transcripts and coding them in the manner described in Chapter 4, there were several changes made to the codebook. Since I was documenting the mentoring process from both the mentors' and mentees' perspectives, I noted the emergence of unexpected codes as well as the absence of several anticipated codes. It was imperative to have the codebook accurately represent the mentoring process since the codes formed the assumptions that framed my analysis (MacQueen et al., 1998). Using the CCM (Corbin & Strauss, 2008), I noted that two significant codes emerged from the data, the codes of collaboration with peers and advice from mentors.

Collaboration with peers. The code of collaboration with peers was significant in that it reflected the mentors' perspectives regarding their careers. It was interesting to note that several of the mentors talked about the importance of working with fellow STEM professionals in their careers. For example, Dr. G the chemical engineer spoke on six different occasions about how important it was in her career to collaborate with co-workers. She said, “every time I think about the problem [in her research] over a few days or weeks, and WORK WITH MY CO-WORKERS to find a solution, then I usually come up with a new idea to try” (Dr. G., Edmodo transcript, April 25, 2013). She said in another post, “I also really like to collaborate with my fellow scientists. We all contribute ideas that make our project better than if we had worked alone. And these scientists are from around the world” (Dr. G, Edmodo transcript, May 13, 2013). The girls found out through these and other direct examples ways in which the mentors worked with others in their jobs. I felt it was important for the girls to understand the concept of collaboration even at their young ages. Through the mentors they saw that scientists rarely work alone and gained insights into the importance of teamwork and collaboration in real-world STEM environments.

Advice from mentors. Another code that emerged from the data was advice from mentors. I expected that the mentoring site would contain many question-and-answer threads regarding the constructs of career exploration, STEM interest, and science identity. This did take place, and the questions were thoughtfully answered by the mentors. However, several girls took the opportunity to ask the mentors advice about their careers or topics relating to their careers. Advise/coach (from the mentor perspective) and advice-seeking (from the mentee perspective) are learning activities that relate to what participants do when engaged in online mentoring (Harris, 2011). Some of the advice-seeking discussion threads were highlighted in Chapter 5. I thought it significant that Gail asked Dr. B for advice on test-taking strategies. Gail (Edmodo transcript, May 8, 2013) said, “I love math, and understand it well, but my teacher says when it comes to math and science, I don’t trust myself and cause myself to set it wrong." She went on to say, "I hate doing this because I actually know the right answer. Do you have any advice" (Gail, Edmodo transcript, May 8, 2013)? Dr. B (Edmodo transcript, May 14, 2013) responded by telling her, "Before submitting your work for grading, leave it for a while then come back to it…Re-check your work, but do not second guess yourself or over think the problems" (Dr. B, Edmodo transcript, May 14, 2013). Gail (Edmodo transcript, May 15, 2013) was grateful for the advice and told Dr. B, "I had a math test today and I used your advice and it helped lots." Denise and Jordan mentioned in their interviews that they had used Dr. G's advice on tests and found it helpful as well. Jordan (personal interview, May 20. 2013) said the advice "helped me a lot and saved me a lot of time on one of the questions."

It was also noteworthy that Jordan and Kim sought advice from Dr. B about their upcoming mathematics courses. In addition, Mary (Edmodo transcript, May 8, 2013) admitted that "I truly don't like math, but when I get the hang of something like dividing fractions, I enjoy math." Dr. B (Edmodo transcript, May 14, 2013) wrote her back and told her not to get discouraged, and said that "as your subject knowledge increases, so will your interest in the topic. Math can be fun! The best way to get better is to practice, practice, practice…just like an athlete or a musician." This piece of advice was important for Mary who was an aspiring soccer player.

Dr. M shared specific ways in which girls could meet their goals in becoming veterinarians. Dr. M's advice was solicited by both Rickie and Xitali; Rickie's question was featured in Chapter 5. Xitali (Edmodo transcript, May 8, 2013) said, "I would also like to know how you get a job as a vet…do you start your own company or do you go to another company?" She also asked Dr. M if she "could come and shadow you [Dr. M]"

(Xitali, Edmodo transcript, May 8, 2013). Xitali not only was seeking advice on getting a job as a veterinarian, but demonstrated an understanding of veterinary medicine as a business as well as a job in which one works with animals. She was also direct in asking permission to visit Dr. M's place of professional practice. These examples indicated that Xitali felt a level of comfort with the mentors and was not afraid to ask questions that were important to her.

Educational pathways. Just as some codes emerged, other codes became obsolete. Some of the anticipated codes did not appear in the Edmodo transcripts and were either deleted or merged with existing codes. Prior to beginning the project, I anticipated that the girls would be interested in learning of the mentors' middle school and high school STEM-related experiences. The literature reviewed in Chapter 2 pointed to late elementary, middle school, and high school as the times to inspire an early interest for girls in STEM. As I continued to use the CCM (Corbin & Strauss, 2008) to analyze the data, I noted that no questions were asked of the mentors about pre-college STEM experiences, with the exception of girls asking Dr. B for advice on what mathematics courses to pursue. However, a few mentors mentioned their pre-college experiences in their answers. Dr. G (Edmodo transcript, May 13, 2013) said, "I took all the hardest science classes through high school." Dr. B (Edmodo transcript, May 1, 2013) said, "in middle school math was not my favorite subject, but I always enjoyed numbers. Then in high school I had a wonderful teacher who loved math…he took what seemed impossible and made it understandable." Even though the girls were not focused on the pre-college experiences of the mentors, they were interested in the mentors' college experiences. For the final a priori codebook, I deleted the codes middle school coursework, high school coursework, and college coursework, and combined all three codes into a new merged code known as educational pathways.

Final a priori codebook. The final a priori codebook also contained 14 codes. The final eight career exploration codes included mentor collaboration and mentor advice, and replaced the codes middle school coursework, high school coursework, and college coursework with educational pathways. The three STEM interest codes and the three science identity codes remained the same. The final codebook is listed in Appendix A.

Career exploration

The thematic analysis of the codes that pertained to career exploration revealed several interesting findings. The first finding was that the girls posted more questions about career exploration than on STEM interest and science identity combined. The girls were interested in the STEM careers represented and took advantage of the opportunity to talk with real STEM professionals about what they did in their careers. Not surprisingly, the largest number of questions related to the code of specific questions for mentors. This code was defined as a specific detail or aspect of the mentor's job and appeared 52 times in the data. The girls posted a wide array of questions that were based off of the mentors' initial introductory posts. Once they found out what the mentors did in their jobs they possessed the initial information that prompted them to ask the various specific questions about their jobs. Many of the specific question-and-answer threads were discussed in Chapter 5, and in most cases were terminal or one-way in nature.

The girls were also interested in the reasons behind the mentors' career choices. All six mentors were asked by the girls why they chose their particular careers. Several of the answers were highlighted in Chapter 5. I felt these were significant question and answer threads for the girls. The girls were able to learn from the mentors the stories behind their career choices. For example, Ms. N talked about visiting construction sites with her father as a child. Ms. N recognized that those visits helped encourage her to become a geotechnical engineer. Dr. P was motivated to become a reproductive endocrinologist because of the story of Mother Theresa and her aunt's struggles with infertility. Dr. M said she was inspired by the James Herriot novel series during her childhood. I wondered if these stories had the potential to inspire any of the girls. Halpern et al. (2007) noted that woman role models may serve as inspirations for girls to persist in their STEM interest. Tabbie (personal interview, May 28, 2013) said she was able to figure out why each woman became a scientist and that it "kind of inspired me." Denise (personal interview, May 23, 2013) said, "I loved them, they were awesome."

The girls were also interested in the mentors' educational pathways. The girls wanted to know where the mentors went to college, how long the mentors were in college, and what the mentors liked about college. I wondered why the girls asked questions about college and not about high school or middle school. I looked at our school community to find some possible explanations. Our school is a tight-knit, college-preparatory, PK-12 independent school. There are many opportunities for the students in each division to interact with students in other divisions. Students in fifth and sixth grade often networked with high school students in academic, athletic, and artistic settings and several of the girls had older siblings. The girls were aware of the college selection processes and pressures facing the older students, and were also aware that many of our students pursue STEM professions in college. In addition, a significant number of parents in the school community are STEM professionals. Ten of the 20 Einstein Girls participants have one or two parents who are STEM professionals. These girls were likely aware of the educational pathways of their mothers and fathers and were possibly more able to articulate questions for the mentors regarding their own educational pathways. Perhaps these factors influenced the girls to only ask questions about the mentors' college experiences.

It was interesting that several girls wanted to know about the opportunities as well as the challenges associated with the various careers of the mentors. The code mentor career satisfaction appeared 27 times in the data and the code mentor career challenges also appeared 27 times in the data. The girls wanted to know if the mentors were happy in their careers, and asked specific questions about their career satisfaction. The mentors talked with the girls about their sources of satisfaction and shared many examples. Several of these discussion threads were presented in Chapter 5, but there were some other interesting comments shared by the mentors. Dr. G (Edmodo transcript, April 25, 2013) told the story about her project that "went up in the Space Shuttle Endeavor in 1994." She said they were "studying the effect of space conditions on computer chips. That was FUN, too" (Dr. G, Edmodo transcript, April 25, 2013)! She also mentioned her love for working with microscopes. She shared an amusing story about working with the transmission electron microscope (TEM). She said the microscope was very sensitive and was stored in a building next to the [university] football stadium. She told the girls, "When there was a football game, we couldn't use it [the TEM] because the crowd noise would shake the ground and then the microscope would move a little bit and ruin our pictures" (Dr. G, Edmodo transcript, May 6, 2013)! Ms. N shared a source of satisfaction in her career. She told the girls that she started her own business and was CEO of her company which "focused on developing leaders and engineers and cultivating clients" (Ms. N, Edmodo transcript, April 29, 2013). She also encouraged the girls to learn about the way businesses work because that could potentially help them in their own STEM endeavors.

I imagine that these and similar comments about the mentors' satisfaction were significant for the Einstein Girls. The stories were fun and exciting, and provided the girls with examples of STEM women who were successful and satisfied in their careers. Halpern et al. (2007) recommended presenting girls with "female role models who are experts in math and science fields" (p. 21). They also mentioned that women who have succeeded in STEM fields may serve as role models that inspire girls to persist in their studies in STEM. When girls hear about the positive aspects of STEM careers, they may be encouraged to work hard and pursue a STEM career.

The mentors shared many examples of challenges they faced in their careers as well. Several of these were highlighted in Chapter 5. One of the more interesting comments came from Dr. G. Jordan asked her if any of her projects failed. Dr. G (Edmodo transcript, April 25, 2013) responded by saying, "Engineering and science research is mostly about failure. Every researcher tries a bunch of things that fail before they ever think of the idea that succeeds. The failures lead to the successes." This was a very important lesson that needed to be conveyed to the girls. Halpern et al. (2007) recommended female role models who have achieved in STEM can teach girls about the challenges they may face as they aspire to become STEM professionals. They suggested that these role models can teach students that “struggle and eventual success are normal” (Halpern et al., p. 21) and that “becoming good at math or science takes hard work and that self-doubts are a normal part of the process of becoming expert at anything worthwhile” (Halpern et al., p. 21).

STEM interest.

The thematic analysis of the three codes that pertained to STEM interest revealed several interesting findings. First, all of the mentors were able to identify the timing of their initial interest in STEM. Two of the mentors (Dr. K and Ms. N) said they were always interested in some aspect of STEM. Many of the Einstein Girls indicated that they too were always interested in science. For example, Tabbie (personal interview, May 28, 2013) told me, “I’ve been interested in science for my entire life!” Tabbie was able to read the responses by Dr. K and Ms. N and realize that she had something in common with two professional scientists. Dr. M and Dr. P indicated that they became interested in STEM at approximately the same age as the Einstein Girls. Dr. B and Dr. G both mentioned the middle school years as the defining time for their initial interest in STEM. All of the Einstein Girls were able to read the responses by these four mentors and realize that they had early interest in STEM in common with STEM professionals.

The mentors articulated who they attributed with initiating their interest in STEM. Using the Maltese and Tai (2010) coding categories of self, family, or school-based, the sources of interest were identified for the mentors. Two mentors (Dr. B and Dr. G) mentioned school activities or a teacher who helped them make the connection with science. As discussed in Chapter 2, schooling experiences for girls can have both positive and negative influences on their interest in STEM. Ms. N talked about the great influence of her father on her decision to become a geotechnical engineer, and Dr. P mentioned the struggles of her aunt as the decisive factor for her career choice. Maltese and Tai (2010) discussed sources of intrinsic science self-interest in terms of activities (such as playing with toys or blocks and taking things apart) and curiosity about the world and how things worked. Dr. K mentioned that she knew from an early age that she was interested in the types of factors (i.e. behaviors, birth order, and differences between siblings) that led her to become a clinical psychologist. Dr. M talked about books and volunteering at vet hospitals as a girl.

Finally, the mentors were able to articulate the nature of their interest in STEM. Using the Maltese and Tai (2010) coding categories of intrinsic interest, education-based themes, or cannot identify, the nature of science interest was identified for the mentors. The mentors mentioned many subjects or experiences that promoted their interest in science or STEM. For some of the mentors, it was difficult to identify a single experience. Several mentioned being involved in activities that encouraged their interest in science, such as a book, a science museum, a construction site, or volunteering. Others mentioned a teacher, a dissection, an experiment, a lecture, a family member, or a friend as the catalyst for interest in STEM. Many of these activities were outlined by the NRC (2009) as activities that occur outside of the classroom in non-school settings. Dr. G talked about how the challenge of figuring out complex problems contributed to her interest in STEM. She said she loved science “because it is like solving a mystery” (Dr. G, Edmodo transcript, May 13, 2013). She recognized that “every person can add at least one thing to the knowledge of the world, and then other people can take what you've learned and add to that" (Dr. G, Edmodo transcript, May 13, 2013).

Science identity

The thematic analysis of the three codes that pertained to science identity also revealed several interesting findings. Science identity was discussed in Chapter 2, and according to Farland-Smith (2009) means that someone recognizes themselves as a science person and is seen that way by others as well. Five of the six mentors mentioned that they saw themselves as a science person. All seven girls interviewed mentioned that they saw themselves as a science person as well. Tan and Calabrese Barton (2007) said that identity construction requires the participation with others of similar background since identity is socially constructed. By participating together in the OMC, the Einstein Girls were able to learn about science identities from the mentors and receive help and encouragement regarding their own science identities. The mentors also discussed ways in which they were attracted to science, or were shaped by their surroundings. These examples were shared in Chapter 5.

Other comments

The conversations between the various girls and mentors were impressive. The quality of the questions written by the girls surprised me. The questions were thoughtful, probing, and genuine. In retrospect, it seemed reasonable that their questions were high-quality in nature since these girls voluntarily chose to be a part of the Einstein Girls program as well as the OMC. Equally impressive was the quality of the answers provided by the mentors. In most cases, the mentors addressed the girls' questions with straight-forward answers and age-appropriate vocabulary. They usually addressed the girls by name which made it easier for the girls to find their answers in the Edmodo site.

Mentoring has been shown to have a positive impact on female students and help improve their attitudes towards science (Weber, 2011). Others (Blake-Beard et al., 2011; Burgstahler, 2006; Farland-Smith, 2009; Hill et al., 2010; and Wasburn & Miller, 2004) concurred, suggesting that mentoring programs can help girls develop an interest in STEM and help them persist in their studies of STEM. Mentoring programs, such as the one created for this project, may be designed for girls in "an attempt to provide them with role models and foster their interest in mathematics and science" (Halpern et al., 2007, p. 21). The girls were able to read about the six mentors' STEM careers, their sources of STEM interest, and science identities through the OMC. By reading their posts and considering their responses, the girls found role models and sources of inspiration for their own STEM pathways.

Discussion of RQ 2

> RQ 2: What are the participants' perceptions of the opportunities and constraints surrounding online mentoring?

This research question was designed to determine the perceptions of the Einstein Girls and female STEM mentors of the opportunities afforded by the OMC as well as the constraints posed by the community. To answer the question, seven Einstein Girls were purposefully selected and interviewed after the project was completed. A focus group interview was also conducted with the six mentors after the project was completed. The data was collected from the girls' interview transcripts and the focus group interview transcript. An analysis of the transcripts revealed their perceptions of the opportunities and the constraints surrounding online mentoring.

Perceived Opportunities

The following discussions relate to the perceived opportunities surround the online mentoring community from the perspectives of the Einstein Girls and the female STEM mentors. The opportunities of both groups are presented in the sections below.

The Einstein girls

Seven of the 20 Einstein Girls were selected and interviewed to determine their perceptions of the opportunities afforded by the OMC. While their answers varied, there were several common themes among their answers. All seven of the girls said they enjoyed the online format of the community and that it was easy for them to use. They also said they were happy that the site was safe and secure. Kim said it appealed to her since it looked and appeared similar to Facebook. These results mirrored Harris' (2011) comments about social networking in educational settings. She said that educational technologists are experimenting with "educational networking" (p. 1), which seeks to capitalize on students' interest and attraction to social networking. It appeared that the girls enjoyed the opportunity to navigate in an online social networking site separate from a traditional school setting; they enjoyed the social side of the communication process.

The girls also enjoyed the asynchronous nature of the OMC. During traditional mentoring, girls and mentors would have to schedule a time to meet together as well as a place in which to meet; these logistics may be challenging and costly. Using an online mentoring format alleviated these challenges. Penny and Bolton (2010) said that online mentoring was "both cost- and time-efficient, allowing for maximum exchange of information in a minimal amount of time" (Penny & Bolton, 2010, p. 19). The girls mentioned that they appreciated finding quick answers for their questions. This encouraged them to ask more questions or in some cases seek clarification of answers. Five of the girls visited the Edmodo site from off-campus. They were able to access the information more quickly than the girls who waited for after-school meetings to read their answers.

The online format also facilitated discussions between girls and mentors who did not know each other. F2F mentoring may involve some barriers of age, gender, race, or status, which might negatively affect the relationships between the participants (Penny & Bolton, 2010). Gail, Georgia, and Tabbie mentioned that they felt a little shy or intimidated to speak with adults who were STEM professionals. They were grateful for the anonymity afforded by the online nature of the community, which allowed them to overcome these barriers. Several girls even mentioned that the mentors made them feel comfortable and at ease. Denise discussed that Dr. P led the girls in conversations "as her friends…not as a teacher to student" (Denise, personal interview, May 23, 2013). This comment reminded me of two of the learning activities associated with online mentoring discussed by Harris (2011). In a chat learning activity, mentors often share personal stories and information about themselves. Denise felt that Dr. P was talking with her as a friend rather than as a stranger and was willing to share personal stories from her own life. In a discuss/debate learning activity, a dialog takes place between mentor and student (Harris, 2011). When Denise said "not as a teacher to student" (Denise, personal interview, May 23, 2013), she felt that she could carry on a discussion with Dr. P that was two-way in nature rather than one-way in nature.

The group dynamics of a community also came into play, where the girls could navigate throughout the site and read the discussion threads posted by all of the participants. Since there were 20 girls asking questions and six mentors answering questions, there were always topics and themes to explore. Some of the girls mentioned that they enjoyed reading the discussions between other girls and the mentors. They felt they learned a great deal from the discussions and were inspired to ask more questions themselves.

The girls enjoyed the opportunities to speak with real STEM professionals. They enjoyed hearing about how the careers of the various women and were interested in finding out how and why they chose their professions. They valued the opportunity to ask specific questions about the mentors' careers and enjoyed hearing the stories told by the mentors. They appreciated the fact that they could choose which mentors to question and which careers to explore. They could talk with all of the mentors or none of the mentors; there was no pressure from me as the Einstein Girls director, from the mentors, or from their peers. Several girls mentioned that they were inspired by the STEM women and all seven of them said that their senses of STEM interest and science identity increased to some extent. Almost all of the girls interviewed mentioned that they enjoyed the program and found it to be interesting to them. Several of the girls asked me to continue the OMC program during the next school year. The girls all rated the program highly, with ratings of 10 out of 10, nine out of 10, and 105 out of 100.

The mentors

The six mentors participated in a focus group designed to determine their perceptions of the opportunities afforded by the OMC. Three of the mentors participated in person. The other three mentors sent in their answers prior to the focus group and their answers were included in the transcript. While their answers varied, there were several common themes among their answers. In addition, they pointed out some of the same positive features cited by the girls.

Five of the mentors mentioned the ease and the convenience of the Edmodo site as a positive feature. The asynchronous nature of the program worked well for their busy schedules as mothers and as professionals. Penny and Bolton (2010) said that online mentoring "lowers the barriers to participation by providing easy access through the Internet and requiring a minimal investment of time on the part of the mentor" (p. 19). The mentors were willing to help but were careful not to overextend their schedules. They also indicated that the program and their commitment to the program was the right length of time.

The mentors also appreciated the anonymous nature of the OMC for the girls as well as for themselves. Dr. P wondered if the girls felt more comfortable asking questions via an online mentoring format than they would have in a traditional mentoring setting. Dr. K, as a clinical psychologist, was keenly aware of the benefits of using an online format. She felt the discussions were less threatening online and that the girls were more comfortable and not afraid of speaking with the mentors through the Internet. The barriers that Penny and Bolton (2010) discussed were eliminated by using the online format.

The mentors felt the program was beneficial to the Einstein Girls and were grateful for the opportunity to encourage girls in STEM. Dr. B was happy to be able to work with girls who were interested in pursuing STEM careers. Ms. N thought it was important for the girls to have a place in which they could ask questions about the various fields in STEM and mentioned that she often sought out opportunities to work with and mentor girls. Halpern et al. (2007) formulated specific recommendations that may be used to encourage girls in the STEM fields. One of their recommendations was to expose girls to female role models who are successful STEM professionals. The mentors recognized the importance of their participation in the project since they knew they were serving as role models for the Einstein Girls.

Finally, two mentors spoke about their personal satisfaction with the program. Ms. N (focus group interview, May 30, 2013) said she appreciated the opportunity to be a part of the program because “the industry needs them” and “they do well and succeed in the STEM industry.” Dr. K (focus group Interview, May 30, 2013) said, “I enjoyed being a part of the online mentoring program” because it allowed her to be a part of “research in the area of investigating factors involved in motivating students.” The mentors rated the OMC as superior, an 8.5 out of 10, a 9.8 out of 10, and a 10.

Perceived Constraints

The following discussions relate to the perceived constraints posed by the online mentoring community from the perspectives of the Einstein Girls and the female STEM mentors. The opportunities of both groups are presented in the sections below.

The Einstein Girls

The Einstein Girls had definite opinions about the constraints posed by the OMC. Pam felt that the project had a life cycle and that it had been reached by the end of the four weeks. I agreed with her and noted that the mentors said that four weeks was the perfect length of time for the program to last. At the beginning of the program, it was not too difficult to navigate through the Edmodo site. However, as the project moved into Week 2, Week 3, and Week 4, the site became increasingly large and more difficult to manage. By the time the program was over, there were 245 posts contained in the

Edmodo site. It became difficult for individual girls to locate the answers to their questions unless the mentor included a girl's name in the answer. The girls had scroll through many pages of text. For some girls, that became too difficult and they simply quit trying. That was one of the problems I noted with the site. Another problem related to the way the questions and answers were ordered. Every post was listed by date, so in many cases the questions and answers did not match up on the site. The participants had to read through many posts to find the ones meant for them.

Some of the girls mentioned wanting more time to navigate the site. Denise recommended more Einstein Girls meeting times devoted to the OMC. However, she was one of the girls who posted from outside of school. If she felt she needed more time, I wondered about the other girls who did not access the site from off-campus. The girls had different opinions about the numbers and types of mentors included in the OMC. Some girls wished for more mentors while others thought the number of mentors was correct. Some girls were interested in all of the careers represented by the mentors while others only gravitated towards mentors that represented their perceived interests. This may have affected their engagement with the program. Jordan (personal interview, May 20, 2013) mentioned that she was the least interested in "the person who makes the computer chips." In spite of her lack of interest, she still asked Dr. G five questions. It was important that the community included several mentors representing a variety of STEM careers. What was interesting to one girl was not necessarily interesting to another girl, so the key was to give the girls a choice.

The mentors

The mentors also talked about what they saw as constraints posed by the community. An area of concern for the mentors was in the presentation of their careers.

Dr. G felt the site limited her ability to adequately explain what she did as a chemical engineer. She would have preferred creating a video presentation for her postings in which she showed the girls a periodic table of the elements to facilitate her discussion about semiconductors.

Dr. G, Dr. M, and Dr. P mentioned that there were several duplicate questions on the site. They suggested that the girls divide the questions among themselves to alleviate that problem. Dr. B (focus group interview, May 30, 2013) suggested that the "mentees should get together during a session and collaborate on the types of questions to which they want responses, then divide those questions up amongst themselves." Dr. B (focus group interview, May 30, 2013) suggested that a "meet and greet" session be scheduled between the mentors and students either "before the start of the program or at the conclusion." Ms. N (focus group interview, May 30, 2013) recommended that the program "start with a session where the mentors could share their story" for the girls to initiate the program and possibly "encourage even more questions and dialog." Dr. G and Dr. P suggested that each mentor record a one-minute video to introduce themselves to the mentees and provide a brief overview of their career. They wondered if these videos could be embedded in the Edmodo site.

Dr. G made an interesting comment during the focus group interview. She felt that the girls may have been more interested in careers in which they had more familiarity. For example, she believed the girls knew what a veterinarian did for a job and noted that they asked her many questions. She wondered if the girls found it easier to ask the veterinary surgeon questions than some of the other mentors. In addition, she noted that the veterinary surgeon was listed first on the Edmodo site and wondered if an engineers would have received more questions if she were listed first. In retrospect, it might have been a worthy idea to present the mentors in a different order.

Emerging Questions

Two questions emerged as a result of this study. The first question related to the actual mentoring process: Was the process one-way or two-way in nature? The second question related to the presence of a sense of community: Was a sense of community developed among the participants? The following sections explore the two emerging questions in more detail. The section is followed by discussions of the implications of the study and recommendations for future research.

Was Mentoring a One-Way or Two-Way Process?

O'Neill et al. (1996) defined mentoring as a relationship characterized by "a rich interdependence between two people" (p. 42). The use of mentoring in an ISL incorporates social constructivist methods as students construct their knowledge and scaffold personal meanings through social interactions with their mentors (Penny & Bolton, 2010). The relationships between the mentors and the Einstein Girls provided the social interactions and the scaffolding of the learning environment.

A study of the discussion threads contained in the Edmodo site shed light on the mentoring process. Most of the discussions were question-and-answer discussions which were vertical in nature (Dorner, 2012; Harris, 2011), and included the TDTs, GTDTs, and ATDTs. These types of discussions were inherently one-way in direction, a mentor to student process. The girls chose to use the OMC in these examples as a venue to seek information from the mentors about their careers, STEM interest, and science identity. However, several of the discussion threads were more personal in nature or were extended in length. These discussions were inherently two-way in direction, where students constructed their knowledge by scaffolding personal meanings through social interactions with the mentors.

My conclusion is that the mentoring process was both a one-way and a two-way process; with aspects of both processes contained in the Edmodo site transcripts. I asked several of the participants their thoughts regarding the mentoring process to test my conclusion. Jordan said she felt the mentoring process was two-way since the mentors got involved in answering the girls' questions and in some cases asked follow-up questions. Gail also felt the process was two-way but was not able to articulate the reasons for her answer. Kim had an interesting insight into the mentoring process; she said it depended on the discussion. She said the mentoring process was one-way when the thread consisted of a question and answer. Kim was involved in several of these threads, the ones labeled TDTs, GTDTs, or ATDTs. However, she felt the mentoring process was two-way when she had an actual discussion with a mentor. Kim's response was consistent with my conclusion that the mentoring process was one-way and two-way.

I also asked four of the mentors for their thoughts on the mentoring process. Dr. M said the process was two-way. She felt since she was able to learn from the girls' questions and comments, she gained insight into what interested them about her career and what was important to them. She was able to tailor her answers to focus on the girls' needs and what they needed to take away from their conversations. Dr. M said a one-way process would be more like a lecture and said for her, this was not the case. She concluded by saying the two-way process was important to both the student and the mentor since the student got her questions answered and the mentor was able to speak to the issues that mattered to the student.

Dr. P said the process way two-way since she was able to learn about the interests of the girls and how they approached a topic. Dr. B also felt the process was two-way since it allowed for open dialogue between the girls and the mentors via the Edmodo site. Not only were the girls able to ask questions, but the mentors were able to ask questions of the girls to seek further clarification on their STEM aspirations and fears about subject matter. I went back to Dr. B's transcripts and reflected on her comments. While she only asked one distinct question, she did probe more deeply into some of the girls' comments, especially regarding their future mathematics courses and their fears about subject matter. However, this only happened when she and the student were involved in an EDT.

The only mentor with an opposing point of view was Dr. K. She said the mentoring process appeared to be a one-way mentor to student process. This was no surprise since she was involved in 20 TDTs, one ATDT, and no ETDs. She did not participate in any extended discussions with the girls and she did not ask any follow-up questions in her responses. However, she did offer a suggestion for a more interactive paradigm. She suggested the girls schedule a time with a mentor for an online chat. During this time the girl and the mentor could carry on significant discussions about STEM careers or other areas of interest.   She said this design would better represent a two-way mentoring process as opposed to a one-way process. She also felt the girls would enjoy the design and leave the community with a stronger attachment and sense of identity with the mentor.

Was a Sense of Community Formed?

A learning community is comprised of a group of learners who work together, build relationships, and construct knowledge (Gunawardena et al., 2009; Land et al., 2012). The focus for the OMC was to support the participants in the active construction of meaning by connecting students online with mentors. Palloff and Pratt (1999) said that in an online community "attention needs to be paid to the developing sense of community within the group of participants in order for the learning process to be successful" (p. 29). The girls and the mentors were able to share interests they had in common. The girls were able to learn from the mentors and in many cases be inspired by their stories. The mentors were able to share their stories with the girls and influenced them in positive ways.

The Einstein Girls was a learning community before beginning the project and an online learning community during the project. However, I wondered if the mentors felt that they were a part of the community as well. The concept of community was discussed during the focus group. Dr. K felt that a sense of community was formed during the project. Dr. M felt a sense of community was formed between the girls and the mentors but not among the mentors. Most of the mentors did not know one another and met for the first time during the focus group. The mentors made several suggestions designed to develop a greater sense of community. Dr. P suggested the group meet F2F near the end of the project so the participants would have known each other. Some of the other suggestions were discussed earlier in this chapter. During the project, Dr. P took seven of the Einstein Girls and me to [university] College of Medicine for a field trip. Dr. G and Dr. M offered to take the girls on field trips to their places of professional practice as well. They felt trips with the mentors to real-world scientific laboratories would help build a sense of community among the participants.

Finally, I wondered if a community of practice formed among the participants. Most attribute the term “community of practice” to Lave and Wenger (1991) but the term was used simultaneously by Brown and Duguid (1991) and traced back to work by others (Constant, 1987; Orr, 1990). A community of practice is defined as a community whose members share their practice with one another and is situated in authentic contexts that is located between individuals and their cultures (Barab & Duffy, 2012; Hoadley, 2012). Lave and Wenger (1991) defined a community of practice as the description of the process of knowledge creation, application, and duplication. They noted that the central and defining phenomenon of the community was the act of joining and identifying with the community (Hoadley, 2012). The OMC as it existed virtually between the Einstein Girls and female STEM mentors may have taken on some of the features of a community of practice, based on the notion that learning is a cooperative process between the members, their actions, and the world (Luppicini, 2003). Further research would be required to explore this notion in more depth.

Summary

Through the course of this project I was able to determine the nature of the online mentoring process by studying various aspects of the online mentoring community. I was also able to determine the participants’ perceptions of the community after interviewing key students and mentors that participated in the program. Chapter 6 presented a discussion of the results of the project. Chapter 7 will present the implications of this project and suggestions for future research.

CHAPTER 7
IMPLICATIONS AND CONCLUSIONS

Implications for Action

Online mentoring communities are important in a variety of settings, since the programs open up "the possibility for relationships that cross boundaries of time, geography, and culture" (Bierema & Merriam, 2002, p. 220). These programs introduce new possibilities for professional practice (Harris, 2011) and offer the potential for connecting groups of individuals across many settings. While the online community described in this study matched pre-adolescent girls with female STEM mentors, students from other demographic groups could potentially be matched with mentors who are experts in different disciplines. Examples of successful ISL-based mentoring groups for girls are listed in Appendix B.

Online mentoring programs have a "tremendous potential for impact on the lives of a broad spectrum of school children" (O'Neill, 2011, p. 15). As mentioned in Chapter 3, The Electronic Emissary Project is the longest-running curriculum-based online mentoring program for K-12 students and their teachers (Harris, 2011). The EEP has sponsored and facilitated approximately 800 online mentoring programs over the past 20 years and has connected students, teachers, and experts in the areas of science, literature, writing, history, sociology, computer science, politics, and the arts (Harris, et al., 1996; Harris, 2011). In addition to these projects, online mentoring communities have also been set up to help minority, disabled, urban, and rural disadvantaged students in K-12 settings (Penny & Bolton, 2010). Similar initiatives could connect low socioeconomic status (SES) and middle-SES students with STEM mentors in online communities similar to the one described in this project.

Online mentoring communities could be formed connecting many types of participants. For example, at-risk youths could be connected with mentors who will serve as role models for them. Students who are home-schooled or home-bound could be matched with subject-area experts to supplement their academic experiences. Students interested in business could be matched with mentors from the business world and students with political ambitions could be matched with mentors from the public service sector. Students interested in the arts could be matched with professional artists, musicians, or actors and aspiring athletes could be matched with professionals from their sport. Any combination of participants is possible.

Transferability of Research

The findings from this study have direct implications in the design and operation of future online mentoring programs. Lincoln and Guba (1985) proposed the four criteria of credibility, transferability, dependability, and confirmability to insure the rigor and trustworthiness of research. Transferability refers to the application of the findings of one study to other contexts outside of the study. This project was designed to determine the nature of the online mentoring process with special focus on career exploration, STEM interest, and science identity. The project also identified the participants' perceptions of the opportunities afforded by the community as well as the constraints posed by the community. The research represented by this study was practitioner research with my work connecting theory with practice. The knowledge gained through the intentional reflection on and study of the Einstein Girls OMC was useful in the production of knowledge that is transformative for my own professional practice and transferable to other similar settings. The results of this study are most applicable to online mentoring programs with similar contexts and demographics, but are also applicable to other online mentoring settings such as the ones proposed at the beginning of Chapter 7. The lessons learned from this study will guide the design and implementation of future online mentoring communities.

Components of an OMC

In Chapter 7, I will provide designers and directors of online mentoring communities my perspective on how to successfully build and operate a community to support STEM or other initiative. I served as designer and implementer for this project. My perspective is based on reflections about my work throughout the project and design-based research principles (O'Neill, 2011). During my reflections, I considered why I built the online mentoring community the way I did, and whether there might have been more effective design or implementation options. The following sections describe necessary components for the design and operation of an OMC and present my recommendations for the components based on what I learned from this research study. The components relate best to an OMC situated in either a K-12 curriculum setting or an informal extracurricular setting. The components include, but are not limited to, the design of the community, goals and time frame for the community, the online delivery system for the community, the choice of the participants, the preparation of the participants, the role of the facilitator, and methods for assessment of the community.

Design of the community

Several factors need to be considered when attempting to create an online mentoring community. Harris (2011) described the design process for K-12 curriculum-based online mentoring as a series of steps. First, she recommended that the designer carefully choose their learning goals. The goals for the community should be clearly articulated before designing and implementing an OMC project. Next, the designer should make “practical pedagogical decisions about the nature of the learning experience” (Harris, 2011, p. 4). Answers to specific questions will guide the design and sequence of learning activities that form the OMC. Who will be the student participants? Will there be training for the student participants? If so, how will the student participants be trained? Will the community be a part of a classroom curriculum or will the community be a part of an extracurricular activity? Will the student participants be given time during class to participate in the OMC or are the students be expected to participate on their own time? What will be the online delivery system? Who will be the mentors and how many mentors should be selected? What mentoring model will be used: one-to-one, group, team, or peer (NMP, 2005)? What are the expectations for the mentors? Will there be training for the mentors? If so, how will the mentors be trained? Do all the participants have reliable and secure Internet access? How long will the community operate?

The designer should select the tools and resources that help students “benefit from the learning experience being planned” (Harris, 2011, p. 4). Finally, if online mentoring is to be used in a K-12 classroom setting, assessments would be chosen that “reveal what and how well students are learning” (Harris, 2011, p. 4) and determine whether or not the OMC is attaining the learning goals set forth by the designer. Evidence-based reflections on what was learned from each OMC trial would be useful for revision of future works (O’Neill, 2011).

Selecting the online delivery system

The designer of an OMC needs to carefully consider which online delivery system would best facilitate the project. A platform should be selected that enables the community to utilize communication tools allowing for participation of all members.

Communication through an online mentoring community is generally asynchronous and text-based, with participants spread out geographically (Harris et al., 1996). Therefore, the OMC relies on interaction strategies among members to create the maximum benefit. The selection of the best online delivery system is critical, ensuring the community builds itself up through interactions and communications among members (Frady, 2012).

Several programs are well-suited to host an online mentoring community. There are dozens of open-source community-based online social networks available free-of-charge for educators interested in setting up an OMC. For this project, Edmodo was chosen as the online mentoring delivery system. Edmodo is a free social networking program created for educational purposes. The program provides a safe and secure online platform that can be used in school and other settings to connect communities of individuals for sharing ideas and collaboration (Anderson, 2010). In addition, Edmodo has a simple and intuitive interface that offers the participants an easily managed environment. As owner of the Einstein Girls group, I had complete control of the site and could enroll participants, assign usernames and passwords, moderate all posts, and shut down the site if necessary. Whatever online delivery is chosen, the designer should spend time learning the features of the program prior to the launch of a mentoring project.

Selecting the student participants

The community designer needs to consider the recruitment of student participants. The students may be part of a K-12 classroom, a virtual learning program, an after-school academy, a summer camp, or other similar group. The student participants may be teacher-selected, school-selected, parent-selected, or self-selected.

The students should be willing to participate in an online mentoring program. They will also require reliable and secure access to the Internet, whether at school, at home, or at a meeting place. The student participants for my project were part of the Einstein Girls after-school academy. All girls expressed a desire to be a part of the online mentoring program.

Preparing the student participants

Prior to beginning an online mentoring program, some form of student participant training needs to take place. Spend time teaching the students how to use the online delivery system that is chosen to host the program. For my project, I spent Einstein Girls academy time demonstrating the proper use of the Edmodo site and allowed time for the girls to practice creating posts and responding to other members' posts. This enabled the girls to become familiar with the features of the online program and become comfortable with the workings of the site. These practice session posts were deleted from Edmodo prior to the official launch of the mentoring project.

Another part of preparing the students involves teaching them how to become active participants in the community. Student-to-mentor and student-to-student interactions are important for the success of an online community (Swan, 2002). Lead a discussion with the student participants on the community nature of an online mentoring program. Encourage the students to make a plan for their communications with the mentors, including suggesting topics and potential questions for the mentors. For my project, I gave the student participants some suggested questions designed to initiate conversations (see Appendix J). These suggestions were designed to begin discussions and to help keep conversations flowing; the girls were free to ask their own questions as well.

Talk with student participants about types of questions they can ask and present them with the online mentoring learning activities discussed by Harris (2011). Learning activities include: question-and-answer, advice/coach, chat, and discuss/debate (Harris, 2011). The first three types of activities tend to be one-way in nature, with the student asking a question and the mentor answering a question. Students wanting to receive specific information from mentors could follow the question-and-answer format, where "mentors respond to a variety of questions posed by students" (Harris, 2011, p. 7). Students seeking advice from mentors could utilize the advise/coach format, where "mentors provide suggestions and formative feedback as students progress with their project-related work" (Harris, 2011, p. 7). Students who want to pursue more personal interests with the mentors could utilize the chat format, where "mentors share personal stories, information about themselves and their families, 'behind the scenes' views of their professional work, etc." (Harris, 2011, p. 7). Encourage student participants to consider pursuing two-way relationships with the mentors where "mentors dialog with students" (Harris, 2011, p. 7), developing deeper, more meaningful discussions. Students will benefit from two-way online mentoring relationships (Penny & Bolton, 2010). Encourage students to become involved in other student/mentor discussions and carry on discussions with each other.

Selecting the mentors

The designer/implementer of the OMC will need to decide on which mentors to include in the program. This is one of the most critical steps for the success of project. I selected mentors that I knew and trusted who were members of the school community. These women were asked to lead the Einstein Girls in meaningful discussions regarding STEM and to serve as supportive, caring role models. Careful decisions need to be made regarding which mentors to select. Mentors should be chosen who are experts or have careers in areas that relate to the focus of the OMC. In addition, personal qualities or features may make certain mentors well-suited for a project, such as gender, ethnicity, SES, career area, job experience, level of education, or geographical location. Mentors must be willing to commit the time and effort to make the project a success for the sake of the student participants. Above all, the mentors must be willing to take on the responsibility of being quality role models and examples for the students.

Preparing the mentors

The mentors should receive some sort of training information prior to beginning an online mentoring program. Don’t assume mentors automatically know how to mentor students; “challenges of time, medium, and differing expectations” (Harris et al., 1996, p. 7) may arise unexpectedly. Mentors who do not have teaching experience should receive training and suggestions for working with student participants (Harris et al., 1996). The training includes “information about and suggestions for working with students with whom they are communicating online” (Harris et al., 1996, p. 7). Encourage mentors to be involved in “active, inquiry-based and student-centered communications” (Harris et al., 1996, p. 6). Mentors should listen to the questions and respond with answers that are thoughtful and meaningful to the girls. Responses may initiate additional questions from students, leading to longer and meaningful two-way discussions between participants.

It is optimal to have the mentors first meet F2F for a training session. During this time, show the mentors how to use the online delivery system and lead a discussion on how to effectively serve as a mentor. If a F2F meeting is not an option, consider a virtual meeting or series of telephone calls. Training may also be accomplished through written documents and email communications. The mentors for my project were trained in this way. I sent out several email communications prior to beginning the program. I also emailed a mentor training document (see Appendix I) created from the synthesis and adaptation of several mentor training documents (Cravens, 2000; MMP, 2013).

The training document described the role and commitment of the mentor. The mentors served as supportive and caring adult supervisors for girls who demonstrated an interest in STEM. I requested they visit the online site at least three times a week during the four week project. They were asked to answer questions posted by the girls about their STEM careers, interest, and identity. I also encouraged them to ask the girls and each other questions as well, with the goal of creating a community among the participants.

The mentors accomplished several of the goals for the community but also fell short in a few areas. The mentors were supportive and caring adults for the girls and answered most of the questions posted by the girls. However, they did not visit the site as frequently as requested and were not involved in many longer, more meaningful discussions. In retrospect, if I were to repeat this project I would change the mentor training component. A F2F training session would take place before beginning the project. The mentors would be encouraged to ask more questions, creating significant two-way conversations with the girls and each other. Swan's (2002) research showed that students who reported high levels of interaction with their instructors reported higher levels of satisfaction in their courses. Similarly, the girls who demonstrated the highest levels of interaction with the mentors (Denise, Gail, Jordan, and Kim) expressed the highest levels of satisfaction with the OMC.

The role of the facilitator

A crucial component of the online mentoring program is that of the facilitator. In most cases the designer of the community will function as its facilitator, since the designer/facilitator has a deep understanding of and connection to the community. The facilitator's role is critical for ensuring the goals of the community are met (Frady, 2012). It is the job of the facilitator to organize the community and to promote interactions among the members (Frady, 2012). He or she may also be viewed as a manager of the community, using management techniques to engage the members, reach out to new members, and encourage members to become more involved (Frady, 2012). The facilitator pays attention to what is taking place in the group and works to move the group in the desired direction.

Harris (2011) described some of the more specific functions of a facilitator who works in a curriculum-based online mentoring project. Several of the functions are applicable for this discussion. The facilitator sets up the online platform, tests, and resolves any technical or security issues (Harris, 2011). The facilitator teaches the members how to use the online platform. The facilitator ensures the community is operating according to the articulated goals for the community. The facilitator communicates off-site with mentors to offer assistance and guidance if needed regarding their mentoring. Finally the facilitator works to keep the communication moving throughout the project, starting discussions, guiding discussions, and encouraging participation (Harris, 2011).

I designed, implemented, and directed the Einstein Girls OMC, acting as the principal investigator for the project. To ensure transferability of research, I chose the role of participant observer of the community rather than embedding myself in the community as the facilitator. In this way I was able to observe the community and determine the nature of the online mentoring process without inserting myself directly into the workings of the community.

The Einstein Girls after-school academy will continue as a part of my professional practice and new online mentoring programs are being planned. Along with designing and implementing the program I will take the role of facilitator for the next project. I have several recommendations for anyone planning on facilitating their own online mentoring community. First, help the student participants plan their communications before they compose messages for the mentors. Create a list of questions for the students that relate to the focus of the group; this will help them begin conversations with the mentors. Next, encourage a “regular ‘rhythm’ of message traffic; short enough turnaround time to maintain a bilateral flow of electronic conversation” (Harris et al., 1996, p. 5). This could be accomplished via email for the mentors and during F2F time with students. If a question went unanswered or if a discussion thread had the potential to evolve into a meaningful two-way conversation, reach out to the participants and encourage them to expand the discussion.

Harris et al. (1996) found that exchanges perceived to be most successful by community members are those in which “participants know each other as multidimensional people, as well as intellectual compadres” (p. 6). They encouraged communication “utilizing intellect and emotion, balancing scholastic and personal information shared in the exchange” (Harris et al., 1996, p. 6). The facilitator can encourage such personal connections between participants by modeling self-disclosure in his or her own posts as well as through encouragement of individual participants.

Again, this may be accomplished by via email, the online site, or personal F2F encouragement. In the Einstein Girls community, discussions regarding STEM interest and science identity have the potential to become personal for those involved in the interactions. The facilitator should share comments about these topics, encouraging mentors to discuss their own thoughts and stories as well. Encourage the mentors to talk with each other about their STEM interests and science identities. By doing so, they may create more personal connections with the girls and further the development of community.

Evaluating the community

An evaluation should take place to assess the effectiveness of the OMC after the program ends. An evaluation will help stakeholders determine whether the program has met its goals, whether to continue the program, modify the program, extend the program, or terminate the program. Plan the assessment activities prior to the launch of the project. On a micro-level, consider observing the frequencies of participation, individual approaches to the community, and types of interactions that occur in the OMC. These were some of the factors I studied during this project. On a macro-level, consider studying the topics discussed by the participants to determine if the discussions met of the goals of the community. Conduct interviews and/or focus groups with the participants to determine the strengths and weaknesses of the program. I conducted a focus group with the mentors and interviewed selected Einstein Girls for this project (see Appendix C and Appendix D). An overarching view of the community at all levels from the perspective of all participants will help stakeholders make an accurate evaluation of the initiative.

For a longer-term evaluation of the community, follow-up with the student participants who were mentored to determine how participation in the project affected them over time. This may be difficult to accomplish if stakeholders are not able to remain in contact with the participants. A longitudinal study of the student participants and their career choices would be important; this data would provide significant information on the long-term success of the program.

Suggestions for New Research

During the time I was involved in this study, several questions came to mind. I wondered if the outcomes would have changed had I used a different number of mentors, or used mentors from different fields. What if I presented the mentors in a different order? What if I had used a combination of male and female mentors instead of using only female mentors? What if I had used mentors that I didn't know? Then I expanded my thinking and asked what if I had matched high school girls or college-aged women with female STEM mentors? Would they ask different types of questions? Would they be interested in other topics, such as balancing family and career?

Future studies involving online mentoring should be designed for different settings. A review of existing literature should be completed to find and examine the research that has been collected regarding online mentoring. Instructional design of communities should be considered, making recommendations for design of future projects. Case study research should be conducted focusing on a unit of study, such as existing community. The conversations contained in an OMC could be studied through a content analysis or the stories contained in the conversations could be studied through qualitative narrative research. Different groups of mentors and protégés could be matched and studied through a variety of methods. Program evaluation research should also be used to assess the effectiveness of an existing OMC and help stakeholders determine whether to continue, modify, extend, or terminate a program. Finally, a longitudinal study that observed developmental trends over time could follow participants of OMCs and study the long-term effects of membership in the program.

Concluding Thoughts

Online mentoring has the potential to support the growth of individual students. There are options and iterations available for online mentoring communities that were not explored in this study. Some of these were mentioned earlier in Chapter 7. The purpose of this project was to design, implement, and study an online mentoring community that connected fifth and sixth grade girls interested in science with six female STEM mentors. The project was designed to give girls the opportunity to communicate in a safe and secure online platform with women who were successful STEM professionals. The community provided the girls a venue to ask the women questions about their careers, their interests, and their science identities. Through this venue the girls were able to explore the careers of a chemical engineer, a clinical psychologist, a geotechnical engineer, a high school mathematics teacher, a reproductive endocrinologist, and a veterinary surgeon. Findings revealed that the participants approached the community uniquely and explored many aspects of the themes of the project. The participants also identified what they perceived as the opportunities afforded by the community as well as the constraints posed by the community. Several girls said their STEM interest and science identity increased because of the program. Several also said they were inspired by the mentors, and indicated plans on pursuing related careers in the future. This initiative is significant in that it identifies a concrete and research-based strategy designed to encourage girls in STEM.

I am a practitioner-scholar, and the practitioner research represented by this project will be used to transform my own professional practice and perhaps the lives of many girls. A structure is now set in place to facilitate a new Einstein Girls online mentoring community. This community will link Einstein Girls and female STEM mentors with several girls from a local, low SES charter school located less than two miles from my place of practice. By connecting theory with practice, knowledge was generated from this project that is valid and useful. The findings from this study are transferable and have direct implications in the design and operation of future online mentoring programs.

APPENDIX A
A PRIORI CODEBOOK FOR RQ 1

CAREER EXPLORATION		
Code	**Description**	**Citations**
Specific questions for mentors	A specific detail or aspect of the mentor's job	Burghstahler, 2006; O'Neill, 1998; Penny & Bolton, 2010
Mentor daily routine	Relating to the mentor's day-to-day tasks in job	Burghstahler, 2006; O'Neill, 1998; Penny & Bolton, 2010
Mentor career choice	Reason(s) mentor chose her particular career	AAUW, 2004; Koenig & Hanson, 2008; NRC, 2009
Mentor career satisfaction	Source(s) of satisfaction for the mentor in her career	Sohn, 2011
Mentor career challenges	Source(s) of challenge for the mentor in her career	Farland-Smith, 2009; Halpern et al., 2007
Mentor educational pathway	What courses mentor took in high school, college, and professional school	Halpern et al., 2007; Hill et al., 2010; NRC, 2011b; Sjaastad, 2012
Collaboration with STEM peers	Ways in which the mentor works with other STEM professionals in her career	AAUW, 2004; Halpern et al., 2007
Advice from mentors	Girls ask for advice or mentors give unsolicited advice	Blake-Beard et al., 2011; Halpern et al., 2007, NSF, 2010; Weber, 2011
STEM INTEREST		
Code	**Description**	**Citations**
Timing	When were you first interested in science?	Halpern et al., 2007; Hill et al., 2010; Lindahl, 2007; Maltese & Tai, 2010; NAS, 2012
Source	What was the initial source of your interest in science?	Jones et al., 2000; Maltese & Tai, 2010
Nature	What was the nature of your initial interest in science?	Jones et al., 2000; Maltese & Tai, 2010
SCIENCE IDENTITY		
Code	**Description**	**Citations**
"Science person"	Does the person see themselves as a "science person"?	Archer et al., 2010a; Brickhouse et al., 2000; Brotman & Moore, 2008; Farland-Smith, 2009; Tan & Barton, 2007
Attracted to science	Is the person attracted to science?	Kahle, 1990
Shaped by surroundings	Has the person been shaped by their surroundings to have a science identity?	Brickhouse et al, 2000; Carlone, 2004; Jones et al., 2000; Kahle & Lakes, 1983; Tan & Barton, 2007

APPENDIX B
LIST OF SUCCESSFUL ISL's

Program Name and Website	Scope	Format	Inquiry Based	Explore Careers	Long-Term Interest
aspire2inspire www.women.nasa.gov/a2i	National	Online		X	X
Engineer Girl www.engineergirl.org	National	Online		X	X
The GEMS Club http://www.gemsclub.org/index.html	National	F2F	X		X
Girlstart www.girlstart.org	National	Online	X		X
Girls at the Center www.fi.edu/tfi/programs/gac.html	Local	F2F, Online	X		X
Great Science for Girls www.greatscienceforgirls.org/	National	Online	X	X	X
National Girls Collaborative Project www.ngcproject.org	National	Online	X	X	X
Sally Ride Science www.sallyridescience.com	National	Online	X	X	X
SciGirls http://pbskids.org/scigirls/	National	Online	X	X	X
Techbridge www.techbridgegirls.org	Local, National	F2F Online	X	X	X
Women's Adventures in Science www.iwaswondering.org	National	Online		X	X

APPENDIX C
INTERVIEW QUESTIONS FOR GIRLS

Semi-Structured Interview Questions for the Girls

1. Did you enjoy being a part of the online mentoring program? Why or why not?
2. What careers were you the most interested in? Why?
3. What careers did you learn about from the mentors?
4. Tell me something you learned from one of those mentors.
5. What careers were you the least interested in? Why?
6. Did meeting with the mentor cause you to consider studying their field in STEM?
7. Did you learn anything new from the mentors? If so, what did you learn?
8. Did the mentors share anything that helped you with your science interest? If so, what?
9. Did the mentors share anything that helped you with your science identity? If so, what?
10. Did you feel comfortable talking with the mentors? Why or why not?
11. What did you like best about the online mentoring program?
12. What did you not like about the online mentoring program?
13. What do you think we should change or do differently next year?
14. Did the online mentoring program run as you thought it would? Why or why not?
15. How would you rate the online mentoring program?

APPENDIX D
FOCUS GROUP QUESTIONS FOR MENTORS

Focus Group Questions for the Adult Mentors

1. Did you enjoy being a part of the online mentoring program? Why or why not?
2. Did you learn anything new about STEM careers from one or more of the other mentors? If so, what?
3. Did you learn anything new about science or STEM interest from one or more of the other mentors? If so, what?
4. Did you learn anything new about science or STEM interest from one or more of the other students? If so, what?
5. Did you learn anything new about science identity from one or more of the other mentors? If so, what?
6. Did you learn anything new about science identity from one or more of the other students? If so, what?
7. Did you feel comfortable talking with the students? Why or why not?
8. Did the online mentoring program run as you thought it would? Why or why not?
9. What do you think were the strengths of the online mentoring program?
10. What do you think could be improved in the online mentoring program?
11. Can you think of anything we should change or do differently next year?
12. How would you rate the online mentoring program?

APPENDIX E
PARENT INTRODUCTION LETTER TO STUDY

University of Florida
College of Education
School of Teaching and Learning
2403 Norman Hall
P.O. Box 117048
Gainesville, FL 32611-7058

March 2013

Dear Parent of Einstein Girl,

I am a doctoral candidate in the School of Teaching and Learning at the University of Florida and am working under the supervision of Dr. Kara Dawson. As a part of my graduate work, I am creating an online mentoring community that connects the Einstein Girls with female science, technology, engineering, and mathematics (STEM) mentors. This will be accomplished using the secure educational online social networking site Edmodo. Lake Highland uses Edmodo at the Middle School in English and social studies classes. The purpose of the research project is to study the nature of the online mentoring process between the Einstein Girls and the female STEM mentors, with special focus on the constructs of career exploration, interest, and identity. I am also interested in the girls' and the mentors' perceptions of the opportunities and constraints surrounding e-mentoring. All of the mentors were purposefully selected by me and are Lake Highland parents. The results of my study will be specific to the Einstein Girls program, but generalizations can be made from this study to similar programs connecting students with adult mentors through online mentoring communities.

With your permission, I would like to ask your daughter to be a part of this research project. According to the University of Florida's Institutional Review Board, I need to seek your consent to collect data regarding your daughter, both from the Edmodo site and through student interviews. After receiving your consent, I also need to receive your daughter's assent to participate in my study. Please read the attached "minor assent script" for information on how I will obtain assent from your daughter. The research is not a part of her schooling and will not affect her school grades or her interaction with me.

The research project will be conducted during April and May of 2013. The interviews will be recorded after school on campus and I will transcribe the interviews. The recordings will be destroyed and the interviews archived. You have the right to read the transcription of the interview. The identity of all students will be kept confidential to the extent provided by law. when reporting results. Pseudonyms will be used to identify individual participants. Participation in the research study is voluntary. Any non-participating student will still have the opportunity to be a part of the Einstein Girls academy without penalty.

If you do chose to participate, you and your daughter have the right to withdraw consent and/or assent for your daughter's participation at any time without penalty. There are no direct benefits, risks, or compensation to you or your daughter for participating in the study. Group results of this study will be available in the fall of 2013 upon request. If you have any questions about this research protocol, please contact me at 407-206-1900, extension 1174, or my faculty supervisor Dr. Dawson at (352) 273-4177. Questions or concern about your daughter's rights as a research participant may be directed to the IRB02 Office, University of Florida, Box 11250, Gainesville, FL 32611, (352) 392-0433.

Please sign and return the attached consent form to me.

Sincerely,
Jill Scott, Ed.S., M.Ed.
Coordinator of Science Education, PK-6
Einstein Girls Director

Approved by
University of Florida
Institutional Review Board 02
Protocol # 2013-U-0411
For Use Through 04/23/2014

APPENDIX F
PARENTAL CONSENT FORM

University of Florida
College of Education
School of Teaching and Learning
2403 Norman Hall
P.O. Box 117048
Gainesville, FL 32611-7058

Parental Consent Form

Protocol Title:
Einstein Girls: Exploring STEM Careers, Interest, and Identity in an Online Mentoring Community

Purpose of the Project:
The purpose of the research project is to study the nature of the online mentoring process that will take place between the Einstein Girls and the female science, technology, engineering, and mathematics (STEM) mentors, with special focus on the constructs of career exploration, interest, and identity. I am also studying the girls' and the mentors' perceptions of the opportunities and constraints surrounding e-mentoring.

Description of the Project:
I am conducting a qualitative research project connecting the Einstein Girls with female STEM mentors. This will be accomplished using the secure educational online social networking program Edmodo. The girls will use Edmodo in Einstein Girls meetings during the months of April and May 2013. In addition, I am encouraging the girls to access the Edmodo site during out-of-school hours. The girls will ask the mentors questions about their STEM careers as well as questions about interest and identity in STEM. I will give them a list of the questions, but am encouraging them to ask their own questions as well. The questions are listed on the back of this page. I will also interview several of the girls to find out their perceptions of the opportunities and constraints surrounding e-mentoring. These interviews will take place after the Einstein Girls semester has ended. The interviews will take place in my classroom after school and will be recorded and transcribed. The recordings will be destroyed and the transcriptions archived. You have the right to read the transcription of the interview.

I am asking for your consent to allow your daughter to participate in my research study. After receiving your consent, I also need to receive your daughter's assent to participate in my study. There are no direct benefits or risks to your daughter and your daughter will receive no compensation for participating in the study. Participation is completely voluntary and you can withdraw your daughter's consent and your daughter can withdraw her assent at any time without penalty.

Confidentiality:
The identity of all students will be kept confidential to the extent provided by law when reporting results. Pseudonyms will be used to identify individual participants. Any non-participating student will still have the opportunity to be a part of the Einstein Girls academy without penalty.

I have read the procedure described above. I voluntarily give consent for my child,

____, to participate in Jill Scott's qualitative research project "Einstein Girls: Exploring STEM Careers, Interest, and Identity in an Online Mentoring Community". I have received a copy of the study purpose and description. I understand that I may withdraw my child from the study at any time without consequence.

____ ____________________
Parent/Guardian Date

____ ____________________
2nd Parent/Guardian/Witness Date

Approved by
University of Florida
Institutional Review Board 02
Protocol # 2013-U-0411
For Use Through 04/23/2014

APPENDIX G
MINOR ASSENT SCRIPT

University of Florida
College of Education
School of Teaching and Learning
2403 Norman Hall
P.O. Box 117048
Gainesville, FL 32611-7058

Minor Assent Script

"Hi, (participant name).

"I am studying the Einstein Girls online mentoring community and writing a paper for a project I am completing at the University of Florida. Your parents have given me their permission to talk with you about your experiences in the online mentoring community and also to look at what you have written in the Edmodo online mentoring community site. I also would like to get your permission to talk with you about your experiences in the online mentoring community and look at what you have written in the Edmodo online mentoring community site.

"Even though your parents have given me their permission to talk with you about your experiences in the online mentoring community and look at what you have written in the Edmodo online mentoring community site, you do not have to participate if you don't want to. Your participation is completely voluntary and you can withdraw your assent at any time without penalty. My study is not a part of your Lake Highland schooling and will not affect any of your Lake Highland grades or your relationship with me. If you do not want to participate, it will not affect your relationship with me or your ability to be in Einstein Girls.

"If you agree to participate, I would like to read and study your conversations with the female STEM mentors in our Edmodo online mentoring community site. I would also like to interview you about what you liked and did not like about the Edmodo online mentoring community site. I will record your interview and write down what you say. The recordings will be destroyed and I will save the transcription of your recording. This will happen sometime after the Einstein Girls semester is over before the end of the school year. The interview will take place in my classroom after school. You will not have to answer any question you do not wish to answer.

"Even if you agree to participate, you can choose to stop participating at any time. All of your answers will be confidential. That means no one will know who you are and your name will not be used in my written paper.

"Thank you (participant name) for your time and I hope that you will give me your assent to talk with me and allow me to read what you wrote about in our Edmodo online mentoring community site."

Mrs. Scott
Einstein Girls Director

Approved by
University of Florida
Institutional Review Board 02
Protocol # 2013-U-0411
For Use Through 04/23/2014

APPENDIX H
PARTICIPANT CONSENT FORM

University of Florida
College of Education
School of Teaching and Learning
2403 Norman Hall
P.O. Box 117048
Gainesville, FL 32611-7058

Participant Consent Form

Dear Female STEM Mentor,

I am a doctoral candidate in the School of Teaching and Learning at the University of Florida and am working under the supervision of Dr. Kara Dawson. As a part of my graduate work, I am creating an online mentoring community that connects the girls from my Einstein Girls after-school program with female science, technology, engineering, and mathematics (STEM) mentors. This will be accomplished using the secure educational online social networking site Edmodo. The purpose of the qualitative research project is to study the nature of the online mentoring process between the Einstein Girls and the female STEM mentors, with special focus on the constructs of career exploration, interest, and identity. I am also interested in the girls' and the mentors' perceptions of the opportunities and constraints surrounding e-mentoring. The results of my study will be specific to the Einstein Girls program, but generalizations can be made from this study to similar programs connecting students with adult mentors through online mentoring communities.

I would like to ask you to be a part of this research project. As a female STEM mentor, I am asking that you answer the questions the Einstein Girls post on the Edmodo site regarding your career and your interest and identity in STEM. The girls have been given a list of questions to ask, but they may ask their own questions as well. My request is that you visit the Edmodo site at least three times per week during the month of April 2013 and answer any questions directed to you. I would estimate that this would take you no longer than 30 minutes per visit. You may visit the site more than three times per week if you wish, and you may also ask questions of the girls, the other mentors, or of me, the teacher/facilitator of the Edmodo site. The site is secure and you will be given directions on how to access the site. You will not have to answer any question you do not wish to answer. I will analyze the transcripts of the online communications between the Einstein Girls and the female STEM mentors in my project to determine the nature of the nature of the online mentoring process. Only I will have access to the transcripts of the online communications, but you have the right to read the transcripts at any time. You may be identified in the final manuscript by a pseudonym, but your real identity will be kept confidential to the extent provided by law and will not be revealed in the final manuscript.

I would also like to conduct a focus group with all of the mentors after the data collection period ends to find out your perceptions of the opportunities and constraints surrounding e-mentoring. The focus group will meet in my classroom and will be recorded and summarized. The recording will be destroyed and the summary archived. You have the right to read the summary. You also have the right to choose not to participate in the focus group.

There are no direct benefits, risks, or compensation to you for participating in the study. Participation is completely voluntary and you may withdraw your consent at any time without penalty.

If you have any questions about this research protocol, please contact me at 407-206-1900, extension 1174, or my faculty supervisor Dr. Dawson at (352) 273-4177. Questions or concern about your rights as a research participant may be directed to the IRB02 Office, University of Florida, Box 11250, Gainesville, FL 32611, (352) 392-0433.

Sincerely,
Jill Scott, Ed.S., M.Ed.

I have read the procedure described above. I voluntarily give my consent to participate in Jill Scott's qualitative research project "Einstein Girls: Exploring STEM Careers, Interest, and Identity in an Online Mentoring Community". I understand that I may withdraw from the study at any time without consequence.

______________________________ _______________
Signature Date

Approved by
University of Florida
Institutional Review Board 02
Protocol # 2013-U-0411
For Use Through 04/23/2014

APPENDIX I
MENTOR TRAINING DOCUMENT

Dear Female STEM Mentor,
As a mentor online you will work to be a supportive and caring adult advisor to fifth and sixth grade girls who have demonstrated an interest in science or STEM.
The Einstein Girls Online Mentoring Community has been set up to help support the goals of the Einstein Girls program. The goals include:

- Providing an opportunity for girls to explore STEM careers
- Providing STEM role models for girls
- Giving the girls opportunities to “talk” with women who are successful STEM professionals and ask questions about their interest in science and science identity
- To form an online mentoring community between the girls and the female STEM mentors

Other outcomes I hope to achieve are increasing interest in STEM, increasing science identity, and learning about STEM careers from you.
The girls will go to the Edmodo site each Wednesday (14 girl group) and Thursday (6 girl group) during four weeks in April and May. I have encouraged them to go to the Edmodo site frequently from home as well. They will start new conversations with you from school and hopefully at home. I have given them the starting questions but anticipate they will come up with more questions on their own. Conversations will center on learning more about your career, your college schooling, and your pre-college courses. In addition, I am encouraging that they ask questions about your own interest in STEM, your “science identity”, and any struggles you may have experienced in elementary, middle, high school, in college, graduate school, and in your career.
For the first week, I will post the initial question to you about your career-what is your career and what do you do in that career. Please try to answer this question prior to the Wednesday meeting. Here is a table that describes what will happen the first week:

Week 1	Mentors	Einstein Girls
Monday	Answer initial questions about careers	
Wednesday after school		Read answers and ask additional questions about careers
Wednesday evening	Answer additional questions about careers	
Thursday after school		Read answers and ask any additional questions about careers
Friday evening	Answer any additional questions about careers	

After Week 1, you can visit the Edmodo site whenever your schedule permits and answer any questions that are sent to you. You can also ask questions of the girls, of each other, or of me. I am hoping to make this a “community affair”. I hope that each of you can visit the site at least three times a week to communicate with the girls over the course of the four week period. These exchanges are the core of the mentoring community and are the priority of the program. Please contact me if you have any questions.

Thank you! *Jill*

APPENDIX J
LIST OF SUGGESTED QUESTIONS

Questions for Einstein Girls to ask Female STEM Mentors

Career Exploration

1. What is your career and what do you do in your career?
2. Where did you go to college and how many years did you go to college?
3. What was your field of study in college? What was it like to study your field in college?
4. What kinds of courses did you take in middle school and high school to prepare you for your career?
5. Do you like your career? Why or why not?
6. What were some of the reasons you decided to pursue your career?
7. When did you first decide to pursue your career?
8. What are some ways I can prepare myself for a career like yours?

Interest in STEM

1. When did you first become interested in science?
2. What was the source of your interest in science?
3. What is the nature of your experience in science?
4. What kinds of science activities did you do outside of school?
5. How did you stay interested in science during the middle school and high school years?

Identity in Science

1. Do you see yourself as a “science person”? Why or why not?
2. What are some of the reasons you were attracted to science?
3. How did your surroundings shape you as a “science person”?
4. What can I do to become a “science person”?
5. What should I do to remain as a “science person”

APPENDIX K
PROTOCOL A TRANSCRIPT SAMPLE

Dr. M, Protocol A

Dear Dr. M,
Welcome to the Einstein Girls Online Mentoring Community. We would like to ask you this question: "What is your career and what do you do in your career?" *April 23, 2013*

Dr. M. - I am a veterinary surgeon. This means that after veterinary school, I spent 4 years training specifically in surgery. I now work in a "referral practice" which means that all the vets there are either specialists or training to become specialists. My area is soft tissue surgery, which means that I deal with patients that have surgical diseases that involve any part of the body except bones, joints, spinal cord or brain. Our patients are mainly dogs and cats but we do occasionally see more exotic animals from area parks. My day is spent assessing patients, talking to owners and the general vets that refer them, performing surgery and training our interns and residents....lots to do! *Apr 24, 2013*

Mary - Does it make you sad to perform surgery on animals? *Apr 24, 2013*

Rickie - What was the most unusual animal that you have done surgery on? *Apr 24, 2013*

Jordan - What is your favorite animal? *Apr 24, 2013*

Mary Ann - What type of exotic animals. *Apr 24, 2013*

Rickie - Has an animal that you have done surgery on ever bitten you? *Apr 24, 2013*

Gail - Dr. M, Wow! I love animals. Why did you decide to do this job? You mentioned both exotic patients and house pets. Which do you work with more? –Abigail *Apr 24, 2013*

Rickie - I love animals, and I would like to work with them when I grow up. Do you have any advice you could give me? *Apr 24, 2013*

Rickie - How long have you been a veterinary surgeon? *Apr 24, 2013*

Reddie - Where did you go to college and veterinary school? *Apr 24, 2013*

Dr. M. - I sometimes feel sad when a cherished pet is very ill and there is little I can do for them, but I do not feel sad in the operating room...there is a job to do and one cannot be overly emotional about it. *Apr 24, 2013*

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APPENDIX L
PROTOCOL B TRANSCRIPT SAMPLE

Dr. M, Protocol B

(1) Dear Dr. M,
Welcome to the Einstein Girls Online Mentoring Community. We would like to ask you this question: "What is your career and what do you do in your career?" *April 23, 2013*

Dr. M. - I am a veterinary surgeon. This means that after veterinary school, I spent 4 years training specifically in surgery. I now work in a "referral practice" which means that all the vets there are either specialists or training to become specialists. My area is soft tissue surgery, which means that I deal with patients that have surgical diseases that involve any part of the body except bones, joints, spinal cord or brain. Our patients are mainly dogs and cats but we do occasionally see more exotic animals from area parks. My day is spent assessing patients, talking to owners and the general vets that refer them, performing surgery and training our interns and residents....lots to do! *Apr 24, 2013*

(2) Mary. - Does it make you sad to perform surgery on animals? *Apr 24, 2013*

Dr. M. - I sometimes feel sad when a cherished pet is very ill and there is little I can do for them, but I do not feel sad in the operating room...there is a job to do and one cannot be overly emotional about it. *Apr 24, 2013*

(3) Rickie - What was the most unusual animal that you have done surgery on? *Apr 24, 2013*

Jordan - What is your favorite animal? *Apr 24, 2013*

Jordan - What was your favorite animal to work with. What was the strangest? *Apr 25, 2013*

Mary Ann - What type of exotic animals. *Apr 24, 2013*

Gail - What is your favorite type of animal, land, sky, or water, in the whole world? *May 15, 2013*

Dr. M. - My favorite animals to work with are sweet dogs & cats. I guess the strangest was a crocodile - she was egg-bound & needed a C-section! That was interesting! I've done procedures on a Florida panther & a mandrill from [animal park] & various other things. *Apr 25, 2013*

APPENDIX M
PROTOCOL C TRANSCRIPT SAMPLE

Researcher: Jill Scott · Topic: Nature of Online Mentoring Process
Protocol C Transcript
Mentor Name: Dr. M, #4 Dates: 4/23/13 to 5/18/13

STEM Area: Science STEM Career: Veterinary Surgeon

(1) Dear Dr. Madden,
Welcome to the Einstein Girls Online Mentoring Community. We would like to ask you this question: "What is your career and what do you do in your career?" *April 23, 2013*

Dr. M. - I am a veterinary surgeon. This means that after veterinary school, I spent 4 years training specifically in surgery. I now work in a "referral practice" which means that all the vets there are either specialists or training to become specialists. My area is soft tissue surgery, which means that I deal with patients that have surgical diseases that involve any part of the body except bones, joints, spinal cord or brain. Our patients are mainly dogs and cats but we do occasionally see more exotic animals from area parks. My day is spent assessing patients, talking to owners and the general vets that refer them, performing surgery and training our interns and residents....lots to do! *Apr 24, 2013*

(2) Mary - Does it make you sad to perform surgery on animals? *Apr 24, 2013*

Dr. M. - I sometimes feel sad when a cherished pet is very ill and there is little I can do for them, but I do not feel sad in the operating room...there is a job to do and one cannot be overly emotional about it. *Apr 24, 2013*

(3) Rickie - What was the most unusual animal that you have done surgery on? *Apr 24, 2013*

Jordan - What is your favorite animal? *Apr 24, 2013*

Jordan - What was your favorite animal to work with. What was the strangest? *Apr 25, 2013*

Mary Ann - What type of exotic animals. *Apr 24, 2013*

Gail - What is your favorite type of animal, land, sky, or water, in the whole world? *May 15, 2013*

Dr. M. - My favorite animals to work with are sweet dogs & cats. I guess the strangest was a crocodile - she was egg-bound & needed a C-section! That was interesting! I've done procedures on a Florida panther & a mandrill from animal kingdom & various other things. *Apr 25, 2013*

APPENDIX N
PROTOCOL D TRANSCRIPT SAMPLE

Researcher: Jill Scott | Topic: Nature of Online Mentoring Process
Protocol Draft D
Mentor Name: 4-Dr. M. | Dates: 4/23/13 to 5/18/13
STEM Area: Science | STEM Career: Veterinary Surgeon

Focus Statement: The purpose of this qualitative project is to determine the nature of the online mentoring process within an online mentoring community between 20 fifth and sixth grade girls (known as Einstein Girls) and six STEM mentors. Special focus is placed on the mentees' STEM career exploration, interest in STEM, and their science identities.

This protocol is a transcript of the postings of the members of the Einstein Girls participants and the individual mentor listed above. The postings are organized by discussion thread and question. The postings were taken directly off of the Einstein Girls Online Mentoring Community secure educational site Edmodo. The names of the girls have been changed to pseudonyms; the name of the mentor is listed by title and the first letter of their last name.

(1) Dear Dr. M.,
Welcome to the Einstein Girls Online Mentoring Community. We would like to ask you this question: "What is your career and what do you do in your career?"

Dr. M. - I am a veterinary surgeon. This means that after veterinary school, I spent 4 years training specifically in surgery. I now work in a "referral practice" which means that all the vets there are either specialists or training to become specialists. My area is soft tissue surgery, which means that I deal with patients that have surgical diseases that involve any part of the body except bones, joints, spinal cord or brain. Our patients are mainly dogs and cats but we do occasionally see more exotic animals from area parks. My day is spent assessing patients, talking to owners and the general vets that refer them, performing surgery and training our interns and residents....lots to do!

Comment [JRS1]: C-Defined

(2) Mary - Does it make you sad to perform surgery on animals?

Dr. M. - I sometimes feel sad when a cherished pet is very ill and there is little I can do for them, but I do not feel sad in the operating room...there is a job to do and one cannot be overly emotional about it.

Comment [JRS2]: C-Challenges

(3) Rickie - What was the most unusual animal that you have done surgery on?

Jordan - What is your favorite animal?

Jordan - What was your favorite animal to work with. What was the strangest?

Mary Ann - What type of exotic animals.

APPENDIX O
CODED THEME SAMPLE

Researcher Name: Jill Scott

Topic: Nature of Online Mentoring Process

Einstein Girls Online Mentoring Community
Data Collection Dates: 4/23/13 to 5/22/13

Data collected online from *Edmodo*
Coding Completion Date: 6/25/13

	Protocol Code	**A Priori Code Recorded in Protocol "Career-Specifics"**
	P/PG/LN	**P=Protocol Number; PG=Page; LN=Line**
1	1/2/26-30	Pre-Algebra is a great prep course for Algebra 1. The concepts are the same, just a higher level of complexity. Because of the multiple levels of students I teach in one class, my teaching methods are quite differentiated. I use a lot of technology to deliver instruction to ensure that I keep the kids engaged.
2	1/3/41-45	Teaching Algebra I have not experienced not knowing the topic, however I have learned through the yrs multiple ways to present problem solving on the same topic. If my students do not understand one method, I try to show them multiple options and give them the choice of which method they prefer to use to answer questions.
3	1/4/43-44	Instructional placement is based on the needs of the school as well as the teachers qualified to teach that subject.
4	2/1/21-31	My specialty is in Semiconductors. These materials are used to make computer chips and laser devices used in such products as computers (duh), cell phones, cars, Xbox, Playstations, DVD players and stuff for outer space. Right now I use computer simulations to try out new ways to make these chips and also figure out why they sometimes fail when they are used. I used to work at a manufacturing plant here in [city] that made all these chips. That was really fun. The plant was open every day of the year except Christmas, 24 hours a day. On Christmas Day, the employees still worked, but they used the day to shut down the equipment and clean it.
5	2/2/38-46, 3/1	What was your most favorite project you've ever worked on? Jordan, my favorite project was my job as a product engineer at Agere Systems. I loved that job because I ended up learning everything about making computer chips from start to finish. I worked with the customer in the beginning to find out what kind of chip they needed. Once we had an order for a company that was $25 million dollars! I was involved with ordering the initial materials, then I was responsible for tracking the chips as they went through the 200 steps or more to completion. I even was responsible for figuring out what went wrong with a chip if the customer sent it back because it didn't work!

APPENDIX P
RQ 1 THEMATIC MAP

Researcher: Jill Scott

RQ 1: What is the Nature of the Online Mentoring Process with Special Focus on STEM Career, Interest, and Identity?

Career Exploration	Career Details	Career Defined	
		Mentor Daily Routine	
		Specific Questions for Each Mentor	Veterinary Surgeon
			Clinical Psychologist
			Chemical Engineer
			High School Mathematics Teacher
			Reproductive Endocrinologist
			Geotechnical Engineer
	Other Information Regarding Career	Mentor Career	Choice
			Satisfaction
			Challenges
		Collaboration with STEM Peers	
		Mentor Educational Pathway	High School
			College
			Graduate School
		Advice from Mentors	
STEM Interest	Timing of Interest	Always	
		K-5	
		6-8	
		9-12	
		College	
	Source of Interest	School	
		Family	
		Self	
	Nature of Interest	Intrinsic	
		Education-Based Themes	
		Cannot Define	
Sci. ID	Science Person	See Self as a Science Person?	
	Attracted to Science	When?	
		Why	
	Shaped by Surroundings	When?	
		Why	

APPENDIX Q
RQ 2 CONCEPT MAP

Researcher: Jill Scott

RQ 2: What are the participants' perceptions of the opportunities and constraints surrounding online mentoring?

Perceived Opportunities	Einstein Girls	Edmodo site operation
		Impressions of mentors
		Exploring STEM careers
		Increase in STEM interest
		Increase in science identity
		Personal satisfaction with program
	Mentors	Features of the Edmodo site
		Benefits to students
		Opportunity to motivate girls in STEM
		Personal satisfaction with program
Perceived Constraints	Einstein Girls	Increasing size of Edmodo site
		Life span of project
		Change number of mentors?
		Change types of mentors?
	Mentors	Uncertain of role prior to program
		Order of presentation of mentors
		Uncertain of how to talk with girls
		Limited tools for communication
Rating of OMC	Einstein Girls	Various number ratings
	Mentors	Various number ratings

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BIOGRAPHICAL SKETCH

Jill Rice Scott has been a science teacher for 30 years. She has taught elementary, middle, and high school students in public and private schools in the United States. For the past 22 years she has directed a science laboratory for students in grades Pre-Kindergarten through Six at Lake Highland Preparatory School. She is also the Coordinator of Science Education, the Science Subject Coordinator, and a Faculty Leader at the school. She is the creative force behind the Einstein Girls program and continues to inspire fifth and sixth grade girls in STEM. Jill received her Ed.D. from the University of Florida in Curriculum and Instruction in 2013 and her Ed.S. from the University of Florida in 2008. She also holds degrees in Zoology and Science Education from the University of Florida. In 1999, Jill received the Presidential Award for Excellence in Mathematics and Science Teaching from the President of the United States.