Summer 8-1-2019

STEM Heroes: A Narrative-based Intervention to Increase Self-Efficacy and Interest in Science, Technology, Engineering, and Mathematics in Elementary School-aged Children

Lauren M. Carino
lauren.petrillo@student.shu.edu

STEM Heroes:

A Narrative-based Intervention to Increase Self-Efficacy and Interest in Science, Technology, Engineering, and Mathematics in Elementary School-aged Children

by

Lauren M. Carino

Submitted in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

Department of Professional Psychology and Family Therapy

Seton Hall University

2019

SETON HALL UNIVERSITY
COLLEGE OF EDUCATION AND HUMAN SERVICES
OFFICE OF GRADUATE STUDIES

APPROVAL FOR SUCCESSFUL DEFENSE

Lauren M. Carino has successfully defended and made the required modifications to the text of the doctoral dissertation for the **Ph.D.** during this **Spring Semester 2019**.

DISSERTATION COMMITTEE
(please sign and date beside your name)

Mentor:
Dr. Pamela Foley ______ Pamela Foley, PhD ______ 6/1/2019

Committee Member:
Dr. Mary Mueller ______ 5/2/2019

Committee Member:
Dr. Minsun Lee ______ 5/2/2019

Committee Member:
Dr. Thomas Massarelli ______ 5/2/2019

The mentor and any other committee members who wish to review revisions will sign and date this document only when revisions have been completed. Please return this form to the Office of Graduate Studies, where it will be placed in the candidate's file and submit a copy with your final dissertation to be bound as page number two.

TABLE OF CONTENTS

Acknowledgements

First, I would like to thank my family for all their love and support as they saw me through my doctoral journey. To my parents, Gail and Larry “Mocha Joe” Petrillo, I am incredibly grateful for all that you have done to support me in life and through this process. To my brother, “Ham”, thank you for your well-timed puns and for always believing in me.

To my friends and family both near and far, thank you for all your words of encouragement and warm wishes. Thank you for being there for me when I needed you most. Finally, thank you to my grandparents, who are all dearly missed.

To my cohort, I would not have made it through this process without you. I truly believe that we became a family on this journey, and your encouragement, support, and love is what got me through this experience. I would especially like to thank Jeffrey Goulding for connecting me with this study’s incredible illustrator, and Kristen Wesbecher for your statistical brilliance.

To my mentor, Dr. Pamela Foley, thank you for always believing in me and this project. I never once doubted your enthusiasm in me or in the “Heroes of STEM”. Thank you to the other wonderful members of my committee, Dr. Mary Mueller, Dr. Minsun Lee, and Dr. Thomas Massarelli for your thoughtful feedback and guidance. Finally, to Dr. Brian Cole, this study would not have been possible without your encouragement back in my second year.

To Mark Harmon, thank you for your beautiful illustrations. You truly were able to bring my characters and stories to life, and I am so, so grateful that I was able to connect with you.

To my clinical supervisors, especially Dr. Lisa Weinberg, Dr. Stephanie Lyon, Dr. Eileen Kurowski, Dr. Daniel Chung, Dr. W. Reese Mayer, and Dr. Tricia Woodin-Weaver, I cannot express how much I have learned from you. I have grown as a clinician and as a person from your guidance, and it was truly my pleasure to work with you all as a part of my doctoral experience. Thank you also to Pamela Lubbers, Kim Spinelli, and the rest of the CSP team for your support in the final months of this process.

To the kitties, Elsa & GLaDOS, thank you for being adorable. Thank you also for (generally) not stepping on my keyboard while I was working.

Finally, thank you to my best friend, my husband Matthew. I consider myself so lucky to be on this adventure in life with you. Thank you for your unconditional support. Thank you for your unconditional belief in me. Thank you for your unconditional love. I can think of no better person to be the "companion" to my "doctor". I like you and I love you, forever.

Abstract

Over time, researchers have struggled to identify effective interventions to support girls' self-efficacy and interest in science, technology, engineering, and mathematics (STEM). The primary purpose of this study was to examine whether a theoretically-grounded narrative-based intervention would be able to increase elementary school-aged girls' self-efficacy in respect to future careers and interest in STEM subjects in school. The study sought to do this by using the stories of the "Heroes of STEM", a series of four graphic novels developed by the principal researcher, as an intervention tool linking girls' typically preferred subject (i.e., reading, language arts) to math and science. A quasi-experimental pretest-posttest design was used for the current study. The participants included 4th and 5th grade girls who attended after-care programs in Central New Jersey. The results of the study indicated: (a) that the narrative-based intervention (i.e., the graphic novels) did not affect self-efficacy in STEM careers in the present sample of elementary school-aged girls, (b) that the narrative-based intervention did not affect interest in STEM subjects in school in elementary school-aged girls, and (c) there was not a significant change in girls' perceptions of who can and cannot be considered members of the scientific community as explored through a pre- and post-intervention drawing task. The non-significant findings of this study impress upon the need to continue to explore effective intervention tools for young girls. They also anecdotally suggest a need for materials similar to the graphic novels that were used in the study as that several of the participants indicated a desire to personally own the stories they were presented with.

Keywords: STEM, girls, children, intervention, SCCT, careers

Chapter I

INTRODUCTION

Background of the Problem

Significant disparity exists between the representation of women and men in the science, technology, engineering, and mathematics (STEM) fields. Though more women than ever before are studying in STEM as undergraduate and graduate students, the retention rate for these women after they graduate is dismal. For example, according to the National Center for Education Statistics (NCES, 2015) in the fields of biology and premedicine, women earned 60% and 57% of undergraduate degrees respectively in the 2013-2014 academic year; at the graduate level, 54% of doctoral degrees in biology and 57% of master's degrees in premedicine were awarded to women in the same academic year. However as of 2013, women made up 47% of the overall workforce, but they only made up 27% of science and engineering fields, which illustrates a sharp drop between education and occupational establishment for these highly qualified women (U.S. Bureau of Labor Statistics, 2014). The relatively abundant degrees awarded to women in biological sciences additionally signifies an issue inherent in the *types* of fields that women study and eventually enter. In a study by Su, Rounds, and Armstrong (2009), findings suggested that women were more likely to gravitate towards occupations that are "people" oriented, whereas men gravitated towards occupations that are "thing" oriented. For example, women continue to be outnumbered in areas such as computer science, engineering, and all other physical sciences (i.e., chemistry, physics, etc.) where they earned only 18%, 21%, and 33% of all doctoral degrees in the 2013-14 academic year respectively (Heilbronner, 2013; NCES, 2015). Translating those numbers into the workforce, in the year 2009, 2,534 in of workers in computer science and math were male, whereas only 929 workers were female (e.g., 27% of the workforce in computer science and math were female). This representation between men and women STEM fields such as computer science, math, and engineering have been remarkably consistent, as that research conducted by governmental agencies have found marginal increases in the presence of women over the past decade (U.S. Department of Commerce, 2011). Thus, as these statistics suggest, gender disparities exist between the types of STEM fields that men and women prefer.

Obviously, a significant disparity between men and women exists at the career level, but educational statistics suggest that the barriers that prevent women from entering into STEM extend beyond the professional domain. Gender stereotypes, such as the commonly-held belief that "girls are bad at math," have pervaded American society and been shown to negatively influence even the youngest students. The way in which these stereotypes manifest, however, is complex, as past research has indicated through a process of stereotype stratification. Stereotype stratification explains how individuals can maintain stereotypic beliefs when confronted with individuals that defy the stereotype. Girls have been shown to distinguish themselves from women (a group that they do not yet belong to) as being different in terms of math ability. Essentially, through the process of stereotype stratification, girls are able to maintain the stereotypic belief that women are less skilled in tasks such as mathematics, while not applying the stereotypic belief to themselves. For example, children have been found to be affected by gender stereotyping as early as the 1st grade. When tasked with drawing a picture of an "adult mathematician" or a "child mathematician," girls were more likely to depict the "adult mathematician" as male, and the "child mathematician" as female (Steele, 2003). This study indicated that from an early age, girls implicitly adhere to stereotypic beliefs that assert that differences exist between the abilities of men and women in the domain of math, and therefore expect less of women participating in these activities. More importantly, the study suggests that negative schemas in regard to self-efficacy in STEM domains are formed and internalized at a critical developmental period in young girls' lives. Despite the fact that these stereotypes have little supporting evidence, and in fact, have been disputed when assessments of girls' and boys' achievement have been conducted, they have the potential to profoundly impact young girls and cause them to prematurely foreclose on entering into a STEM field later on in life (Bages, Verniers, & Martinot, 2016; Boaler & Irving, 2007; Else-Quest, Hyde, & Linn, 2010; Riegle-Crumb & King, 2010; Shapiro & Williams, 2012).

Finally, the lack of female mentors represents another major issue for girls and women in STEM. The underrepresentation of women in STEM has been noticeable for some time in the scientific community, and instances of unfair hiring practices, bias, and double standards in work qualifications between men and women has been pervasive (Ceci & Williams, 2011). Many women, up to a third of those in SET (science, engineering, and technology) fields have indicated the culture of their workplace environment as the catalyst for their decision to leave the lab. Feelings of bias, exclusion, and unfair hiring or evaluation practices have been specifically noted as reasons why those women elect to leave their positions (Sherbin, 2015). Workplace culture represents a significant factor in keeping women engaged in their work, as that research has indicated that women become less engaged or motivated when talking with male peers about their work (Vedantam, 2012). Additionally, the career atmosphere, particularly in academia, in STEM appears highly skewed in favor of men, as seen through little to no available childcare provided by employers, insufficient maternity leave, and poor family health benefits, which subsequently presents as unfriendly and unwelcoming to women (Cadwalader & Bandows

Koster, 2013). As that many women who have pursued advanced degrees or training in STEM enter the workforce during their peak childbearing years, they are often faced with several difficult choices that evade their male peers: continue to pursue their career path and either delay family formation or balance family-work responsibilities in a hostile environment, or abandon extensive investments of time and money pursing this path in favor of family (Cadwalader & Bandows Koster, 2013). More often than not, one-third of all women in science, engineering, and technology specifically in the United States opt to leave their careers before the end of their first year due to toxic laboratory working environments (Franke Kleist, 2015). Further, the retention rate for all STEM careers (including mathematics) is only 25%, which suggests that many women decide to leave the field, leaving up-and-coming professionals with limited resources and less positive representations of themselves as active members of the field. This point is especially significant, as that research indicates that girls perform better when they have visible female role models excelling in their field (Else-Quest et al., 2010).

Statement of the Problem

As the research suggests, girls and women occupy a disadvantaged place when attempting to break into STEM fields. They often face stereotyping, sexism, and adversity at various points in their vocational development that their male peers do not encounter. Recent high-profile incidents clearly illustrate that this is a systemic issue, from the sexist shirt worn on international television by a member of the European Space Agency to the disparaging comments that women are "distractingly sexy" in research laboratories by Nobel Prize winner Dr. Tim Hunt (Chappell, 2015; Respers France, 2014). Though the experiences of women in STEM at the professional level represents a cause for concern, the loss of girls' interest in STEM fields before they even enter college suggests that experiences of girls earlier in their vocational development need to be better understood and addressed. While past research interventions have greatly contributed to understanding the complex experiences of girls and STEM, they have failed to engage girls in way that supports the development of their interests or models resiliency in the face of adversity. Thus, the current study represents an intervention designed to engage young girls by tapping into their interests to build their curiosity and self-efficacy in STEM.

Theoretical Conceptualization: Social Cognitive Career Theory

Social cognitive career theory (SCCT) is a vocational theory that is grounded in the social cognitive theory of Albert Bandura. The theory acknowledges the reciprocal role that plays out between the individual and his or her environment, and it explains how these factors can ultimately shape how individuals interact with the world around them. Subsequently, SCCT assumes that individuals can exert some degree of agency over their environments and situations, while recognizing the ways in which external sources (e.g., barriers such as institutional racism or sexism) can impede the agency of an individual (Lent, Brown, & Hackett, 1994).

Foundational to SCCT is understanding the ways in which self-efficacy beliefs, outcome expectations, and personal goals shape an individual's movement towards or away from specific tasks or occupations. According to Lent, Brown, & Hackett (1994), self-efficacy beliefs represent the domain-specific determinations that individuals make in regard to how competent they are at completing a task. Again, it is important to emphasize that self-efficacy beliefs are *domain-specific* and do not refer to an individual's global sense of self-assessment. For example, an individual may have a high degree of self-efficacy beliefs in her writing ability, but low self-efficacy beliefs in her math ability. Self-efficacy beliefs are dynamic, in that they can be changed due to experience or due to environmental factors (e.g., support). Past experiences tend to be the strongest factors in the development of self-efficacy beliefs, as "success experiences with a given task or performance domain tend to strengthen self-efficacy beliefs in relation to that task or domain; convincing or repeated failures tend to weaken these beliefs" (Lent, 2013, p. 118).

Outcome expectations in SCCT refer to the expected consequences (or outcomes) of engaging in particular behaviors. They can be developed through a process of both direct and vicarious learning experiences. Outcome expectations thus represent an extension of self-efficacy beliefs, since prior self-efficacy beliefs can inform whether the outcomes of engaging in specific tasks are expected to be positive or negative. Thus, outcome expectations can serve as predictors of the behaviors or activities that individuals will approach or avoid (Lent, 2013). Returning to the previous example, if an individual has low self-efficacy belief in her math ability, then she may hold more negative outcome expectations as related to engaging in math-related tasks, such as taking a math exam.

Finally, personal goals influence the amount of energy an individual will put into certain behaviors or tasks to ultimately reach their objective. Personal goals are thought to motivate and sustain behaviors, especially when there is no immediate reward (i.e., pursuing advanced education or training). Within the construct of personal goals, SCCT denotes two additional forms of goals that individuals may work toward: (1) choice-content goals and (2) performance goals. Choice-content goals simply refer to the types of activities or occupations that one desires to pursue. Performance goals represent effort that one wishes to exert when engaging in an activity or task. SCCT insists that personal goals are also directly related to the individual's self-efficacy beliefs and outcome expectations, and that their attainment, or lack thereof, can also reciprocally affect self-efficacy beliefs and outcome expectations. Higher self-efficacy beliefs and positive outcome expectations are thought to lead to stronger personal goals, or the pursuit of goals relevant to the activity or task at hand (Lent, 2013).

The literature on SCCT and STEM careers has indicated several factors that explain why many women decide to leave their careers in STEM fields. SCCT asserts that contextual variables, such as the vocational environment, supports, barriers, and experiences can have a direct influence on whether an individual will decide to stay within her given career (Lent, Brown, Brenner, Batra Chopra, Davis, Talleyrand, & Suthakaran, 2001). Additionally, lower self-efficacy beliefs, outcome expectations, and support, in conjunction with higher amounts of perceived barriers predict lower interest and persistence in STEM (Hardin & Longhurst, 2016).

SCCT also contains four distinct but interrelated models: the interest model, the choice model, the performance model, and the satisfaction model. The interest model illustrates how self-efficacy and outcome expectations can influence career interests. More specially, the model theorizes that interest is more likely to develop when an individual hold high self-efficacy beliefs in an activity or task, and expects favorable consequences as a result of their participation in that activity or task (Lent, 2013).

Finally, research has also been conducted to illustrate the application of SSCT within various populations, including children. SCCT has shown that parental support has a direct relationship between the development of children's career self-efficacy and interests (Kenny & Medvide, 2013). For example, in a study by Navarro, Flores, and Worthington (2007), perceived parental support predicted adolescent Mexican American girls' self-efficacy in science. Additionally, the role of support has been found to be a complex contextual factor within SCCT. Research has indicated a positive relationship between parents' levels of perceived support given and children's' levels of perceived support received, which indirectly has an influence on the child’s career self-efficacy and interest (Ginevra, Nota, & Ferrari, 2015). Thus, parental support represents an integral factor in the developing child’s perception of success in a given career.

Limitations of Existing Studies

A review of the literature has identified consistent limitations of past research, specifically in the domains of the ages of previous participants and the modality of STEM intervention. Past studies have focused on populations of girls and women educationally ranging from middle school to undergraduates (Betz & Sekaquaptewa, 2012; Cheryan, Siy, Vichayapai, Drury, & Kim, 2011; Gibson & Chase, 2002; Tyler-Wood, Ellison, Lim, & Periathiruvadi, 2012). The major conclusions from these studies have been that intervention at the point of middle school may be too late in terms of increasing self-efficacy or interest in girls in STEM subjects; thus, interest may be more crystallized by early adolescence and unchangeable by the time the individual reaches college. Past research has indicated that a gender gap in regards to boys’ and girls’ attitudes towards STEM subjects increases as they continue in their education, thus indicating that early intervention may serve as more of a protective factor (Subrahmanyan & Bozonie, 1996). Diminished self-efficacy as a whole has also been implicated in the flight of women from STEM careers. Lower self-efficacy in the face of higher cases of perceived barriers have been related to lower levels of interest and persistence (Hardin & Longhurst, 2016).

Additionally, the modality of the intervention has also been identified in the literature as a potential limitation. Several studies have attempted to engage girls with STEM through the presentation of female role models. These past studies sought to create conditions in which young girls could identify with these role models passively by having the children interact with or read about them and their accomplishments (Betz & Sekaquaptewa, 2012; Cheryan et al., 2011). Thus, a gap exists within the research in which girls are able to engage in a process of vicarious learning by following a female role model through her own process of discovery. Past studies have implemented a variety of interactive science programs, and have yielded positive results (Tyler-Wood et al., 2012). However, the literature has also noted that girls consistently tend rate other subjects, such as language arts, as being more preferable than science or math (Freeman, 2004; Stoking, 1993). The research has indicated that this preference may be maintained by several factors, such as motivation (i.e., girls value English and language arts over math and science and therefore apply themselves more in those subjects) and through gender differences (i.e., girls preferring cooperative interaction in English subjects vs. boys preferring competition through math and science subjects) (Li & Adamson, 1995). Though past research has indicated that girls tend to connect more with science and math activities through interactive methods due to increased opportunities to utilize verbal and language skills, there is little research indicating how girls would connect with these subjects through a solely narrative format (Subrahmanyan & Bozonie, 1996; Tyler-Wood et al., 2012). One study by Ford, Brickhouse, Lottero-Perdue, and Kittleson (2006) highlighted the utility of science-related books to engage elementary school-aged girls. The researchers found that though access to and directives made by parents and teachers to read science-related books did increase the girls' eagerness to engage in the subject, the girls tended to revert out of their "good student" identity when given the choice to read something intrinsically motivating. The authors ultimately called for content that would make science reading pleasurable. Additionally, the literature suggests that students employ different strategies in their learning. Students tend to prioritize learning modalities that allow them to best represent their mental abilities (Rizza, 1999). Thus, engaging girls in a learning modality that they consistently tend to prefer (i.e., the narrative), may represent an opportunity for them showcase their potential in a format that is congruent with their learned preferences.

Another important consideration examined in past studies is the level of parental education. Past research has indicated that parental education can be a predictor of children's educational achievements. More highly educated parents, particularly mothers, were shown to have more congruent educational expectations towards their children's actual abilities than their less educated peers, regardless of income status (Halle, Kurtz-Costes, & Mahoney, 1997). The literature also suggest that more educated parents may provide more effective and nurturing home learning environments for children, factors that may be linked to higher achievement in school (Smith, Brooks-Gunn, & Klebanov, 1997). Hence, because parental education appears to play a role in children's school achievement and may also subsequently structure the development of children's interests, it represents a variable of interest in assessing the effectiveness of interest and self-efficacy intervention programs.

Finally, limitations exist within past research conducted using SCCT as the theoretical model. Prior research using SCCT have found significant results regarding the development of self-efficacy and interest as factors of parental support (Ginevra et al., 2015; Kenny & Medvide, 2013; Navarro et al., 2007). However, not much is known as to how other forms of support (i.e., the narrative) may grow children's self-efficacy and interest in fields such as STEM. The current study sought to address this gap by using the narrative intervention as an alternate means of self-efficacy and interest support.

Research Questions

The primary purpose of this study was to examine whether a theoretically-grounded narrative-based intervention would have an affect on the reported interest and self-efficacy in elementary school-aged girls. Four research questions were addressed through the present study:

1. After controlling for parental/caregiver educational levels, will a narrative-based intervention affect self-efficacy in STEM careers in elementary school-aged girls?
2. After controlling for parental/caregiver educational levels, will a narrative-based intervention affect interest in STEM subjects in school in elementary school-aged girls?
3. Will children be more likely to draw a male scientist in a drawing task prior to STEM intervention?
4. Will children be more likely to draw a female scientist in a drawing task after STEM intervention?

Statement of Hypotheses

The hypotheses are as follows:

1. After controlling for parental/caregiver educational levels, a narrative-based intervention will increase self-efficacy in STEM careers in elementary school-aged girls.
2. After controlling for parental/caregiver educational levels, a narrative-based intervention will increase interest in STEM subjects in school in elementary school-aged girls.
3. Children will be more likely to draw a male scientist in a drawing task prior to STEM intervention.

4. Children will be more likely to draw a female scientist in a drawing task after STEM intervention.

Operational Definitions

The following terms have been defined for the purposes of this study. These terms will be referred to throughout the dissertation.

STEM

For this study, *STEM* will refer to the acronym for science, technology, engineering, and mathematics. The acronym came into the popular vernacular after it was used in an address by the 11^{th} director of the National Science Foundation (NSF), Dr. Rita Colwell. Dr. Colwell's tenure of the NSF saw the advancement of multidisciplinary work and a shift in the paradigm from compartmentalization to integration in the teaching of science and mathematics (A Timeline of NSF History).

Self-Efficacy

In this study, *self-efficacy* refers to the term defined by social cognitive career theory (SCCT). According to SCCT, self-efficacy refers to the "dynamic set of self-beliefs that are linked to particular performance domains and activities" (Lent, 2013, p. 118). Additionally, self-efficacy in regards to task performance may be acquired or modified through the process of vicarious learning; thus, self-efficacy in this study will be viewed as a reflection of vicarious learning principles. This construct was measured using the Elementary School Self-Efficacy Scale (ESS-ES), an adapted version of the Middle School Self-Efficacy Scale (MSS-ES; Fouad, Smith, & Enochs, 1997). Lower scores on this measure reflect stronger self-efficacy beliefs in math and science subjects in school. The reliability and validity of this measure is discussed further in Chapter III.

Interest

For the purposes of this study, *interest* was also defined by the interest model of SCCT. According to the model, interest is developed as individuals view themselves as competent at a task or activity, and as they come to anticipate positive outcomes as a result of their participation in the task/activity (Lent, 2013). This construct was measured by using one of the subscales on the adapted ESMS-ES.

Parental/Caregiver Educational Level

For the purposes of this study, *parental/caregiver educational level* referred to the highest amount of education in years attained by the parents of the participants in the study. Parental/caregiver education level was determined by collecting demographic information from the parents.

Limitations of this Study

There are several limitations to the current study. Participant recruitment specifically excludes young males. Thus, although the focus of the study is intentionally on girls because of the gender gap in STEM fields, comparisons of the effectiveness of the intervention across genders was not able to be determined. Sampling also represents a limitation to the current study. Participants were sampled specifically from one affluent county in central New Jersey, thus, data collected from this study may not be generalizable to children of all SES background or those living in differing communities. The nature of the study's timeline should also be considered a limitation; long terms gains will not be able to be determined. Finally, the limitation inherent in self-report measures, such as participant distortions, will also be present in this study.

Chapter II

REVIEW OF THE LITERATURE

The Future of Children in STEM

This study will examine the variables of STEM interest and self-efficacy in fourth- and fifth-grade children in STEM through the use of a graphic novel intervention, with special interest on the female students. Provided below is a review of the current literature addressing the vocational development of boys and girls in this age group, as well as a review of the differences in STEM experiences between boys and girls.

Elementary School Interest and Learning in STEM

By virtue of nature, children are inquisitive beings. Through experience, they develop and alter their intrinsic interests, with some experiences opening up new worlds of discovery while others closing the door on these developing interests. Though children are exposed to a multitude of topics and subjects throughout their formative years, girls and boys quickly diverge along gender lines in their academic preferences and interests.

Interests, according to motivational theory (Ryan & Deci, 2000), can develop through intrinsic and extrinsic motivational forces. Intrinsic motivation may be considered engagement in an activity purely for the internal pleasure that is gained from the activity itself. Extrinsic motivation, on the other hand, may be thought as engagement in an activity for external rewards contingent on actually performing the activity (Ryan & Deci, 2000). Not surprisingly, children are also subject to intrinsic and extrinsic motivational forces, which can subsequently influence their interest in different subjects in school. A study by Guay and colleagues (2010) found that elementary school-aged children show clear discriminatory patterns in their motivation towards subjects such as reading, writing, and math. 425 Canadian elementary school children spanning grades 1, 2, and 3 participated in a study that sought to determine differentiated motivation within and, but more importantly, across school subjects. The results suggested the girls were more intrinsically motivated towards reading and writing than boys (Guay et al., 2010). Thus, the study proposed that children are able differentiate their enjoyment of different school subjects, and that girls in particular actively discriminate in favor of language-based subjects.

Though many prior studies have indicated a rationale for connecting language arts, or narrative, based learning with girls and STEM, few studies have actually examined the effectiveness of the narrative modality in fostering better learning. Aside from noting girls' general preference for reading and language arts in school, little research to date has shown that engaging girls in a verbal or narrative-based medium would be an effective way to instruct them in STEM. A notable exception may be seen in the work of Bigozzi, Biggeri, Boschi, Conti, and Fiorentini (2002), in which the researchers were able to show that in a year-long study of 118 Italian 3rd and 4th grade students, the use of narratives in science instruction led to a deeper understanding of science concepts. The experimental group of 79 children experienced multi-modal instruction during science lessons including the observation of experiments led by the teacher, classroom discussions, and justification of the observed phenomena through writing assignments; the 39 children in the control group, however, were only exposed to concepts through lecture by the teacher, and did not participate in discussions or writing assignments. When the students of both groups were instructed to write science reports regarding the experiments they were exposed to, the children in the experimental group were found to use more scientific language and to connect the scientific concepts at a higher rate than those in the control group (Bigozzi et al., 2002). The results suggested that because the students in the experimental group routinely were required to justify their scientific thinking through language (oral and written), they were better able to understand and internalize the scientific concepts.

Finally, school interests, which may eventually grow into career interests, develop along several different models as according to SCCT, which are the interest, choice, and performance models (Lent, 2013; Lent et al., 1994). According to the interest model, a feedback loop of self-efficacy and outcome expectations forms interest in various subjects or activities over time. The SCCT interest model proposes that interest is more likely to develop when an individual feels competent, or self-efficacious, in performing a task, and when she anticipates that her participation in the task will produce positive outcomes. As these positive outcomes are achieved, the individual may desire to continue to develop competency in the task, subsequently increasing her engagement in it and thus practicing and honing her skills (Lent, 2013). The interest model in SCCT also acknowledges the role that socialization plays in directing children in particular towards what may be considered "gender appropriate" interests. For example, girls' access to "male-typed" activities, such as robotics or coding, may be limited due to a possible gender-norm violation, which may prompt negative feedback from her environment. As interests are artificially blocked due to socialization, children may prematurely foreclose on them as potential career options.

The choice model of SCCT builds upon the interest model while also considering how one's career environment plays a dynamic role in the sustaining or discouraging career decisions (Lent et al., 1994). Choice making within the model is divided into three parts: (a) expressing a choice to enter into a field, (b) acting upon that choice (such as taking classes, undergoing specific training, etc.), and (c) one's performance experiences that ultimately shape future choice options. The choice model keeps in mind the role that environment plays in the kinds of experiences the individual has along the way—if the career environment does not allow for career successes, the individual may reevaluate her career options. Again, SCCT acknowledges that in some cases, choices may be circumscribed due to gender, race, ethnicity, or other socio-cultural influences, thus limiting some individuals to more presently available careers rather than those that may be more personally desirable (Lent, 2013).

The quality of achievement and the level of persistence in a task represents the focus of the performance model of SCCT. Past performance on a task in particular is thought to affect current and future performance in a given domain, as that past experiences can indirectly affect self-efficacy and outcome expectations (Lent et al., 1994). Thus, successes and failures may serve as schemas in an individual's learning history, subsequently causing her to reevaluate her self-efficacy and outcome expectations given what she has learned about herself in the past (Lent, 2013). It can be further argued that performance can be directly influenced by the quality of one's environment, as that an impoverished environment lacking in quality education, access to extracurricular activities, or even appropriate role models may disadvantage otherwise capable individuals. For example, an extensive study by Davis-Kean (2005), which included 868 White and African American 8-12-year-olds and their families, examined the impact of parental educational level on the home environment in regard to children's educational attainment. The results suggested that parent's education impacted the quality and provision of a stimulating home environment, which both directly and indirectly affected the children's academic achievement. More highly educated parents appeared to interact more effectively with their children, (i.e., displaying more warmth, willingness to provide stimulating educational and play materials), which in turn promoted better educational achievement (Davis-Kean, 2005). Thus, evidence exists to suggest that more environmentally privileged children may perform better in a variety of domains than their less environmentally advantaged peers, which may set them on a path towards lower performance, self-efficacy, and outcome expectations.

Career Socialization Differences between Boys and Girls

Research has shown that the paths that girls and boys take to STEM participation varies greatly as a result of the child's socialization experiences. Parental beliefs often represent a child's first experience in gender socialization, which can have a significant impact on their current and future interests and levels of self-efficacy in a variety of domains. As past work has shown, parents' own beliefs in regards to gender norms and gender role expectations can guide their child rearing practices. Those parents who adhere more rigidly to traditional gender norms may adopt different strategies of interacting with their children and providing opportunities for their children to learn based on what they consider to be "appropriate" behaviors or interests for each gender respectively (Gunderson, Ramirez, Levine, & Beilock, 2012; Simpkins, Davis-Kean, & Eccles, 2005; Tenenbaum & Leaper, 2003).

For example, Tenenbaum and Leaper (2003) found that parents differ in the intensity and frequency of their conversations about science with their sons and daughters. The researchers surveyed 52 6th and 8th grade girls and boys and their parents from the San Francisco and coastal areas of California, examining factors related to parents' socialization of gender differences in science participation. They found that fathers, and in some cases, mothers have more detailed and challenging conversations about science with their sons than they do with their daughters. Additionally, in regard to detail, Tenenbaum and Leaper also noted that fathers in particular tended to use more cognitively demanding language with their sons than with their daughters. The authors noted that language usage may have long lasting sociocultural implications, as that children exposed to more demanding language may appropriate similar language for themselves, allowing them to further develop their scientific mindset. Thus, early interactions in the home have the potential to inadvertently steer children towards or away STEM participation.

Additionally, past research has shown that stereotypic beliefs can influence girls' perceptions as to who can be considered a competent member of the mathematic and scientific communities. In a study by Steele (2003), 58 predominantly White children (n = 26 males; n = 32 females) attending after-care were tasked with drawing a picture of a character in a story. The children were randomly assigned to story conditions of either a child or an adult, and listened to two stories of a character who was competent in math or spelling. Both boys and girls displayed a bias in depicting male characters at 68% versus the 32% of female characters drawn. However, in a Chi Square analysis of age and math competency, girls were more likely to depict the child mathematician as being female (i.e., 69% child mathematician vs. 36% adult mathematician). The author suggested that this imbalance may reflect an inherent stereotype in girls that only adult men, and not adult women, can be considered competent in math, thereby potentially perpetuating a sense of inappropriateness of women as members of the mathematic and scientific communities (Steele, 2003).

However, issues of socialization extend beyond language usage. Parents who hold math-gender stereotypes and gender-biased math expectancies can greatly impact the self-efficacy of their children in this domain. In a review of the literature, Gunderson and colleagues (2012) found that by sixth grade, many parents hold beliefs that boys have greater natural talent in math, and generally feel that math aptitude is a more important skill for their sons rather than their daughters. The concept of "natural" ability is worthy of further discussion. As parents believe that their sons' success in math is a reflection of natural talent, conversely, they tend to attribute their daughters' math success to effort. This reflects an important point when considering how parents subsequently interpret their children's failures—when sons, who "naturally" excel at math fail, it must be a reflection of lack of effort, however, when daughters fail at math, it must be a reflect of the lack of natural ability. This stereotypic mindset promotes the unfounded belief that girls are at an inherent disadvantage in math domains (Gunderson et al., 2012; Yee & Eccles, 1988). Additionally, these parents often indicate stereotypic beliefs about their own children's ability to perform on math- or science-related tasks, despite having evidence (i.e., homework, test grades) reflecting their child's true ability.

Girls' and Boys' Self-Efficacy in STEM

Stereotypic gendered beliefs of parents are not only harmful to their perception of their own children, but they have the potential to negatively impact the beliefs and attitudes of the children as well. Review of the literature suggests that parents who hold stereotypic gendered beliefs in regard to aptitude, ability, and future success/failure tend to transmit these beliefs to their children. Subsequently, these children may adopt their parents' gendered beliefs which, for girls, can be especially harmful due to the increased risk of damage to their sense of interest, self-efficacy, and anticipation for future success in math- or science-related domains (Gunderson et al., 2012). Thus, negative and gendered beliefs are perpetuated in a system that unfairly favors boys to the detriment of girls.

Teachers too can have a profound impact on their students' beliefs and self-efficacy in math and science. For example, "math anxiety" represents another barrier with the potential to negatively impact girls', but not boys', math self-efficacy. The phenomenon is described as a "negative emotional reaction to the prospect of doing math" (Gunderson et al., 2012, p. 157; Ashcraft, 2002). Those who experience math anxiety may perform worse on math-related tasks even when they possess the same degree of math knowledge. Math anxiety has been found to be particularly pervasive in female elementary school teachers, who make up 76% of the elementary school teaching population, with its effects negatively impacting female students (NCES, 2015). The effects of were directly observed in a study by Beilock, Gunderson, Ramirez, & Levine (2010) that assessed the math anxiety of 17 female first- and second-grade elementary school teachers from a large Midwestern urban school district. The study included 117 students (65 girls and 52 boys), whose math achievement was assessed during the first three months and the last two months of the school year. The researchers found that by observing math-anxious female teachers, girls included in the study showed less math achievement by the end of the school year; the boys, on the other hand, did not appear to be affected (Beilock et al., 2010). In a subsequent study of math anxiety, girls reported endorsing the presence of math anxiety in themselves as early as 1st and 2nd grades, while also indicating a preference for reading and language arts, subjects that are typically associated with female gender norms (Cvencek, Maltzoff, & Greenwald, 2011). In a child-modified implicit Association Test (IAT), Cvencek and colleagues examined the implicit math-gender attitudes of 247 predominantly White 1st through 5th grade girls and boys from the greater Seattle area. The participants were instructed that they would be playing a computer game in which they were required to sort male and female names (e.g., David, Andrew, Jessica, Emily) and math or reading words (e.g., numbers, addition, books, letters). The children participated in single sorting tasks (i.e., sorting names into categories of boy or girl) before moving on to the combined tasks. The first combined task included categories of “boy and math” and “girl and reading,” while the second task flipped the conditions by pairing “boy and reading” and “girl and math.” Additionally, the children participated in an IAT that measured their implicit self-concepts regarding math ability, which included categories such as *me*, *not-me*, *boy*, *girl*, and math-related words in a format similar to the IAT which assessed math gender stereotypes. Implicit attitudes are inferred by the speed in which the participant sorts the target word—a more rapid sorting thus reflects a more closely held association. The results of this study suggested that the children held implicit beliefs that girls and math are incompatible, and that the girls endorsed weaker self-concepts of their math ability which suggests math anxiety (Cvencek et al., 2011). Indeed, math anxiety represents another factor implicated in perpetuating negative gender stereotypes that have a direct result on children's self-efficacy.

Effectiveness of Programs Designed to Generate Interest and Self-Efficacy in STEM for Girls

Programs aimed at generating STEM interest in girls have often failed to achieve the results they sought. A significant amount of research has been conducted to better understand how to engage young girls in these fields so that a STEM field may one day be a career option. As has been observed, parental engagement alone is not a strong enough motivator. Though girls may observe that their parents "do" math or science at home, such as using the family computer or making a budget, girls require more active engagement than observational learning in order to develop their own independent interests and math and science skill sets (Simpkins et al., 2005). In a longitudinal study including 448 predominantly White families from three school districts in the Midwest area of the United States, Simpkins et al. found that girls and boys required more direct instruction and structure rather than pure observation to understand complex mathematical and scientific tasks and then subsequently develop them as independent interests. Simpkins et al. suggested instead that parental encouragement, coactivity, and the provision of activity-related materials in the home may be superior modalities, as compared to the children's passive observation, for parents to engage their children in out-of-school math, science, and computer activities. Subsequently, the researchers observed an increase in the children's voluntary participation in these activities after parents had provided the opportune environment for their interests to develop.

STEM-focused academic programs have been one answer to addressing the gender disparity that is present in STEM careers. A consistent finding throughout the literature has indicated that the later the intervention, the less effective the intervention is in having long term effects. By seventh grade, the gender gap between boys and girls is quite apparent, as girls become less likely to rate subjects other than language arts as their favorite subject (Freeman, 2004; Stoking, 1993; Tyler-Wood et al., 2012). For example, Stoking (1993) surveyed 1,272 7^{th} grade students identified through the Talent Search conducted by the Talent Duke University Identification Program, who ranked as being in the top three percent of their elementary school's achievement tests. The students were asked to identify their favorite school subjects, with the girls consistently rating language arts as their most preferred subject, while boys rated math and science higher.

One notable success in engaging and, more importantly, retaining girls and women in science later on in their lives was the Bringing Up Girls in Science (B.U.G.S.) program. The B.U.G.S. program represented an intensive, hands-on afterschool and summer experience aimed at engaging elementary school-aged girls in different modules of scientific exploration (e.g., animals, the environment, micro-organisms) using a specific science-based curriculum. The program included an afterschool science lab activity held at a local elementary school, and a once a month activity held at a university in Texas. Finally, the program included a mentoring component, and BUGS participants were matched with female high school students who were pre-identified as being high achievers in the subject of science and an adult mentor from the university who oversaw all of the interactions.

The initial cohort for the program consisted of 32 4th and 5th grade girls in the B.U.G.S. group and 32 4th and 5th grade girls in the matched comparison group. The participants were selected from a large school district in north Texas, and they were a part of the program for one academic year. The results suggested short-term gains, such that the B.U.G.S. participants showed higher science achievement on a test of science skills than the contrast group. Eight years following the conclusion of the initial B.U.G.S. cohort's year of participation in the program, Tyler-Wood and colleagues (2012) conduced a follow-up with 14 of the initial B.U.G.S. participants, who were then college freshmen. The former B.U.G.S. participants were compared with four other all-female contrast groups: 12 original B.U.G.S. contrast students, 10 science majors and 10 elementary education majors from a large Texas university in their senior and freshmen years of study respectively, and 9 STEM professionals (i.e., women currently working in a STEM career). In addition to the short-term gains, the researchers also found that the B.U.G.S. program produced long-term gains in science achievement and interest. The B.U.G.S. participants showed higher levels of interest in science and awareness of science-related careers than the non-B.U.G.S. contrast group and the education majors, possibly reflecting the long-term gains of the program. Though the career decisions of the student participants of the follow-up study were unknown at the time, the higher levels of STEM interest and career-awareness of the B.U.G.S. participants may represent a hopeful outcome of similar intervention programs. The results of the B.U.G.S. study suggest that the program was promising in generating, and subsequently sustaining, interest and achievement in science (Tyler-Wood et al., 2012); however, the intensive nature of the program (i.e., a year-long commitment, access to willing peer and professional mentors, access to the specialized curriculum) may not make this kind of program possible in disadvantaged or impoverished communities or school districts.

Thus, a more cost-effective, low-stakes in regard to commitment, and easily accessible intervention may represent a more generalizable option for students and educators.

Another significant barrier to the success of programs designed to increase girls' interest and self-efficacy in STEM fields is the traditional view of gender in mainstream U.S. culture, in which STEM-identification is generally considered incongruous with the female gender role. In popular media, characters who are meant to represent STEM individuals are often depicted by men, and portrayed as cold, socially awkward, and obsessive in their interests (e.g., the male scientists from the popular television show *The Big Bang Theory*). The slings of "geek" and "nerd" are not uncommon in these portrayals, and often lead to the ostracization of these characters. Not surprisingly, research suggests that girls socialized to adhere to traditional female gender roles focused on attractiveness and friendliness may attempt to distance themselves from this kind of association by devaluing anything that they consider incongruous with female gender role norms, such as STEM interest. The stereotype is so pervasive that even cultural symbols of STEM appear to be strong enough to cause girls and women to distance themselves from such environments out of fear of appearing unfeminine (Cheryan, Plaut, Davies, & Steele, 2009). In a series of studies Cheryan and colleagues (2009) were able to demonstrate how simply altering the environment can have a positive effect on women's interest in stereotypically male fields. In a study of 22 female and 17 male university students, participants were instructed to "ignore their surroundings" in a room that contained either stereotypical (e.g., a science-fiction poster, electronics, and technical books and magazines) or non-stereotypical (e.g., a nature poster, healthy snacks, and general interest books and magazines) items. The women in the non-stereotypical condition overwhelmingly rated higher interest in computer science than did both men of the same condition and women in the stereotypical condition; in fact, the women in the stereotypical condition rated their interest in computer science as the lowest across all groups. The results provide evidence that environmental cues of stereotypicality can remind women that they are in an unfeminine environment and that they subsequently do not belong there.

Cheryan and colleagues (2009) reported similar findings in a group of 62 female and 23 male undergraduates, asked to assess two post-graduation jobs. The jobs were identical in salary, duties, and work hours, and the participants were told that women made up half of the employees at both companies. The participants were then given descriptions of what they would find in the offices, which reflected either the stereotypical or non-stereotypical technical environments. The women again indicated a stronger desire to work in the non-stereotypical office environment and a stronger sense of belonging in that environment. They also distanced themselves from the stereotypical environment to a greater degree than the male participants, suggesting that the stereotypicality of the office did not affect the men's decision to associate themselves with the stereotypical image of computer science. These studies shed further light on the idea that stereotypes greatly affect the professional decisions that women make, and that they may be discounting their interests and career possibilities out of fear of not feeling like themselves or fitting in.

The possibility of appearing unfeminine represents a highly salient threat for many girls, as being identified by others as unfeminine can bring with it many negative consequences, such as being less liked and being considered less competent (Betz & Sekaquaptewa, 2012; Etcoff, Stock, Haley, Vickery, & House, 2011; Rudman & Glick, 2001). For example, a study by Rudman and Glick (2001) illustrated the discrimination women face when violating communal norms (i.e. behaving in a nurturing manner or being socially attuned to others) by acting agentically (i.e., behaving competitively and goal directed) in the workplace. The researchers recruited 109 female and 70 male undergraduates from large East Coast university to participate in a study examining discrimination in job hiring practices. Rudman and Glick found that the agentic female applicant was found to be less competent, socially skilled, and hirable than her identical male counterpart. On the other hand, a study by Heilman and Okimoto (2007) sought to subvert the negative responses that agentic women often receive in male-dominated work spaces. In a series of three studies conducted by Heilman and Okimoto, the researchers were able to demonstrate that agentic women actually receive *less* backlash or discrimination when also displaying communal qualities. These studies suggest that women tread an incredibly thin line of agency without betraying their femininity, lest they suffer occupational and professional hardship, an experience that appears to be theirs and not one of male colleagues.

Ameliorating this effect has thus been an uphill challenge for those attempting to bridge the gap between girls and STEM participation. A study conducted by Cheryan et al. (2011) illustrated how powerful traditional portrayals of STEM culture can be as a deterrent to women. The researchers randomly assigned 85 female non-computer science undergraduate students to a situation in which they interacted with one of two female or two male confederate stereotypical or non-stereotpyical computer science majors. The models were made stereotypical or non-stereotypical through their dress (i.e., generally unfashionable clothes vs. generic clothes), hobbies (i.e., playing video games, watching foreign-language television, working with computers vs. engaging in social activities, listening to music), favorite movies (science-fiction vs. drama), television shows (cult vs. mainstream-television), and magazine (subject-focused vs. generic-tabloid). After interacting with the confederates, the participants were given a questionnaire in which they were asked to recall their partner’s responses from a getting-to-know-you-exercise, and how successful they felt that they would be in their partner’s major (i.e., computer science). Cheryan and colleagues (2011) found that the women who interacted with the stereotypical computer science major rated their own perceived ability for success within that major as significantly lower than those who interacted with the non-stereotypical computer science major. Additionally, when asked about their perceived similarity to the confederates, the women significantly indicated feeling dissimilar to the stereotypical computer science major.

Thus, researchers have been aware of how stereotyping can apply in regards to STEM, but additional research has also shown that stereotypiciality of the opposite variety (i.e., ultra-femininity) does not appear to be an alternate route to STEM interest or self-efficacy. A study by Betz and Sekaquaptewa (2012) attempted to see whether feminine STEM role models would be able to bridge that gap. The study included 144 middle school-aged girls (67 White, 19 Black, 11 Asian, 3 Latina, and 29 who reported multiple ethnicities or who provided another response; 15 did not respond), who were classified as either STEM-identified or STEM-disidentified based on what the students listed as their favorite school subjects. The girls interacted with female university student role models who displayed ultra-feminine (i.e., traditionally feminine clothes and hobbies) and neutral (i.e., generic clothes and hobbies) characteristics. The role models also included information about themselves that indicated either STEM or general academic success. Across both the STEM-identified and STEM-disidentified students, the girls rated themselves as less similar to the ultra-feminine STEM role model than the neutral college role model. Additionally, when asked to compare the likelihood of their own future success as compared to the role models, the STEM-disidentified girls rated themselves as less likely to achieve the same level of success as the ultra-feminine role model. This study suggested that role models at the opposite extremes of stereotypicality may actually demotivate girls who are the most vulnerable to gender threats. Thus, it appears that just increasing the model's feminine characteristics is not the easy solution to realistically engaging girls in STEM.

Summary and Conclusions

Indeed, significant time and energy has been spent in attempts to better understand the experience of girls and women in STEM, and subsequently, the ways in which to retain interested individuals. Past research has identified the obstacles that girls and women face when displaying interest in or as members of the STEM community, such as socially-constructed gender bias and fears of not conforming to prescribed gender roles, that have the potential to demotivate these individuals. Additionally, the literature has also identified methods of intervention appear to be more effective in developing interest and self-efficacy in girls and women, such as hands-on activities and relatable same-sex role models. The past research has thus served as a starting point for the current study, and this study attempted to contribute to this growing body of information in a unique manner. Specifically, the current study sought to examine how engaging girls through a modality that they have previously endorsed to prefer (i.e., reading and language arts) will affect their interest and self-efficacy in STEM subjects. Additionally, the current study sought to sample a younger demographic of girls, specifically elementary school-aged girls, as the literature has suggested that early intervention may be more effective in creating interest and supporting self-efficacy. The current study sought to accomplish this task through the use of original graphic novels depicting four positive, female role-models in STEM and the ways in which they overcome obstacles to achieve their goals. A thorough discussion and description of the graphic novels, and characters is included in the next chapter.

Chapter III

METHODOLOGY

This chapter will provide an overview of the current study. The study design, participants, and procedure are described. Additionally, a review of the instruments used and the reliability and validity of each instrument is also provided. Finally, the hypotheses and statistical analysis for each hypothesis are also discussed.

Study Design

A quasi-experimental pretest-posttest design was implemented to answer the research questions and study hypotheses. The dependent variables of this study are as follows (a) self-efficacy in STEM as measured by the ESS-ES and (b) interest in STEM, measured by the M-SIS. Participants completed a questionnaire to assess the variables listed above. Questionnaires were distributed individually to all study participants. Finally, a drawing task was administered to the participants in the first and fourth months only of the study as an additional test of the effectiveness of the graphic novels.

Hypotheses and Variables

The following are the hypotheses that were tested, (a) after controlling for parental/caregiver educational levels, a narrative-based intervention will increase self-efficacy in STEM careers in elementary school-aged girls, (b) after controlling for parental/caregiver educational levels, a narrative-based intervention will increase interest in STEM subjects for elementary school-aged girls, (c) children will be more likely to draw a male scientist in a drawing task prior to STEM intervention, and (d) children will be more likely to draw a female scientist in a drawing task at after STEM intervention. The variable of interest for the first hypothesis was self-efficacy, the variable of interest for the second hypothesis was interest, and the variables of interest for the third & fourth hypotheses was the gender of the scientist in the drawings.

Instruments

Participants completed a brief demographic questionnaire at the onset of the current study and one self-report measure at the beginning and end of the study. The self-report measure included is the Middle School Self-Efficacy Scale (MSS-ES; Fouad, Smith, & Enochs, 1997). The measurement material was adapted from its original form, with the permission of the author and henceforth will be referred to as the Elementary School Self-Efficacy Scale (ESMS-ES), to accommodate the younger children that were sampled in this study.

Demographic Questionnaire

A demographic questionnaire was used to obtain background information for the participants in this study. The following information was requested of the parents/caregivers: participant’s age, gender, race/ethnicity, elementary school grade, favorite school subject, and parent’s/caregiver’s educational level in years. This information was used to gather descriptive information about the participants sampled.

Middle School Self-Efficacy Scale

The Middle School Self-Efficacy Scale (MSS-ES; Fouad et al., 1997) is a measure of self-efficacy, outcome expectancy, and intentions in the subjects of math and science. The MSS-ES was divided into two distinct parts; for the purposes of the current study, only Part II of the

MSS-ES was administered to study participants, and thus represents the focus of this review. Part II included three subscales related to Math and Science Self-Efficacy (MSSE), and the combined Math and Science Outcome Expectancies and Intentions and Goals (MSOE/IG). Items on Part II of the measure were further identified as being content-specific for math or science, denoted by a (M) or (S) following each question respectively.

The MSSE is a 12-question subscale with a 5-point Likert-type response format that measures self-efficacy in math and science. Respondents are asked to rate their level of confidence in their ability in a variety of math and science-related activities. The internal consistency reliability for this subscale is .84 (Fouad & Smith, 1996; Fouad et al., 1997). Individually, the internal consistency alphas of math and science items are .70 and .79 respectively. The discriminant validity coefficient associated with the MSSE is .54, which was corrected for attenuation. The MSOE/IG is a 13-question subscale with a 5-point Likert-type response format that measures outcome expectancies in math and science. It should be noted that due to poor psychometric characteristics, one item was dropped from the final subscale and thus not included in the formal analysis. Respondents are asked to rate how much they agree or disagree with a variety of math and science-related statements. The internal consistency reliability for the MSOE/IG are .80 and .81 respectively (Fouad et al., 1997). The internal consistency coefficient alphas for math and science-specific items on the MSOE are .76 and .62 respectively; for the MSIG the reported alphas are .56 and .77. The discriminant validity coefficients for the MSOE/IG are .71 and .66, also corrected for attenuation. Finally, the authors addressed the lower alphas that were obtained for several scales. They noted that the obtained scores dropped due to the psychometric analysis treating items related to math and science as distinct categories (i.e., math categories and science categories), rather than as combined items (i.e., math and science together). The scores were lowered because of unequal numbers of questions pertaining to math and science; they furthermore asserted that equal numbers of math and science questions would need to be developed for the items to be considered totally independent (Fouad et al., 1997).

The MSS-ES can also include an additional subscale pertaining to math and science. The Math-Science Interest Scale (M-SIS) is a 20-question subscale with a 3-point Likert-type response format that measures interest in math and science-related activities. Respondents are asked to rate how much they like or dislike an activity. The reliability of the M-SIS is .90 (Fouad & Smith, 1996).

Elementary School Self-Efficacy Scale

The Elementary School Self-Efficacy Scale (ESS-ES) was adapted from the MSS-ES (Fouad et al., 1997) with permission from the first author of the MSS-ES. The principal researcher consulted with an expert in elementary school math on the language and content abilities of a typical fourth- to fifth-grade student, and subsequently scaled-down the scale items from their original format. The ESS-ES only included items from Part II of the MSS-ES, which focuses on math and science self-efficacy (E-MSSE), outcome expectations, and intentions and goals (E-MSOE/IG). Because the ESS-ES had been originally adapted for the purposes of the current study, no psychometric information currently exists on this measure, and the data collected from this study provided the initial psychometric data of the ESS-ES. Specifically, the current study determined internal consistency reliabilities, internal consistency alphas for math and science items, and correlations for the E-MSSE and E-MSOE/IG.

Similarly to the MSSE on the original measure, the E-MSSE is a 12 question subscale with a 5-point Likert-type response format that measures self-efficacy in math and science.

Respondents were asked to rate whether they feel they "can or cannot" perform in a variety of math and science-related activities. The response choices are the following: I can totally do this (1), I think I can do this (2), I'm not sure I can do this (3), I don't think I can do this (4), and I totally can't do this (5), with high scores reflecting weaker endorsement of math and science self-efficacy. To additionally facilitate the ease in which the children access the scale, depictions of "smiley faces," ranging from very happy to very sad, also accompanied the text in which the children based their rating decisions. For example, a math-related item reads: "Get an A on my report card in math." The E-MSOE/IG is a 12-question subscale with a 5-point Likert-type response format that measures outcome expectancies in math and science. Respondents were asked to rate how much they agree or disagree with a variety of math and science-related statements. The response choices are the following: I Totally Agree (1), I Agree (2), I'm Not Sure (3), I Disagree (4), and I Totally Do Not Agree (5), with high scores reflecting weaker outcome expectancies. A science-related item on the MSOE/IG reads: "If I do well in science classes now, I will do well in middle school too." Finally, the ESS-ES also included an adapted version of the M-SIS, which is a 20-question subscale with a 3-point Likert-type format that measures interest in math and science-related activities. Respondents were asked to rate their level of interest in a variety of activities. The response choices range from Like (1), Not Sure (2), to Dislike (3), with high scores reflecting lower interest. The ESS-ES can be found in its entirety in the Appendix C.

Procedure

All participants were recruited through solicitation of local after-care programs. The current study took place during after-care sessions in the affiliated schools. Prior to the first intervention session, the principal researcher sent an informed consent and assent forms (Appendices A and B), and a prepaid self-addressed envelope home to the parents/caregivers of the students. The consent and assent forms contained a brief explanation of the study, the requirements of participants, when and how the study was to be conducted, and the contact information of the principal researcher. Participants and their parents/caregivers were also informed of the voluntary nature of the study and that they may withdraw from the study at any time with no penalty to themselves in the consent and assent forms. Included in the study material that was sent home with the children were directions for interested families to return the completed consent and assent forms using the prepaid self-addressed envelopes. Participants were identified as those who returned signed consent and assent forms to the principal researcher using the prepaid self-addressed envelopes provided by the principal researcher prior to the first scheduled intervention session. Prior to the first intervention session, the principal researcher contacted the identified participant families via email and instructed them to follow two links embedded in the email to the Qualtrics website to complete the survey materials. The parents/caregivers were asked to complete the demographic questionnaire, and the participants were instructed to complete the pretest copy of the ESS-ES. The principal researcher scheduled one-hour long group sessions during after-care, in which the participants were presented with all the study materials. The study lasted for four months in total, including the presentation of one graphic novel intervention per month and a drawing task in the first and fourth months of the study. To provide additional evidence as to the effectiveness of the graphic novel interventions, study participants also participated in pretest-posttest drawing tasks. During the first intervention session and prior to the presentation of the first graphic novel, participants were asked to “draw a picture of what a scientist looks like to you.” The principal researcher did not explain or elaborate on the directions of the drawing prompt so as not to bias the children in their drawings. Participants were asked to participate in the drawing task again at the conclusion of the study and after the presentation of the final graphic novel. The principal researcher provided the tools necessary for the activity (i.e., crayons/markers, paper) excluding the gendered colors of pink and blue as to have no effect on the children's gendered decision in their drawings (Steele, 2003). At the conclusion of the study (i.e., after the presentation of the fourth graphic novel), the principal researcher again contacted the participant families via email and instructed them to allow their children to follow the embedded link to the Qualtrics website to complete the posttest copy of the ESS-ES. Finally, to preserve confidentiality of the research participants, all children in attendance at after care were welcomed to participate in reading the graphic novels and drawing activities.

The graphic novel intervention was the main focus of the study sessions. The principal researcher read the graphic novel out loud and progressed through the narrative with the participants.

Graphic Novels

The graphic novels that comprise the intervention of the current study are an original creation, developed and written by the principal researcher, and illustrated by Mark Harmon, a professional illustrator and graphic designer. The graphic novels provided the stories of four women who embody each area within the acronym of "STEM." "Nova," the embodiment of science, focuses on Earth science and biology; "Plex," the embodiment of technology, focuses on technology and innovation; "Torque," the embodiment of engineering, focuses on engineering and physics; and "Radia," the embodiment of mathematics, focuses on the applied use of mathematics. The main characters were designed to be approximately twenty years-old, appropriately proportioned, and racially and ethnically ambiguous, subsequently having skin tones not otherwise found in nature (e.g., magenta, cyan, lilac). The characters were also assisted in their stories by a younger female companion. The companions were designed to be appear approximately nine to eleven years-old, consistent with the ages of the target demographic. Additionally, the companion characters were deliberately designed to be racially and ethnically diverse, reflecting Middle Eastern, Hispanic, African American, and White racial backgrounds.

Flesch-Kincaid readability tests, originally developed as measures of reading ability for the United States military, were conducted to determine the appropriateness of the language used in the graphic novels for use with the research participants for this study (Kincaid, Fishburne Jr., Rogers, & Chissom, 1975). A Flesch-Kincaid Grade Level score was calculated for all four of the graphic novels. Scores are derived by use of the Grade Level formula: (0.39 * ASL) + (11.8 * ASW) – 15.19, where ASL refers to the average sentence length and ASW refers to the average number of syllables per word, and the value being equivalent to the level of education needed by an individual to comprehend the text (Microsoft Test Your Document's Readability). The attained scores of the graphic novels were as follows: 4.4 (Nova), 3.5 (Plex), 3.5 (Torque), and 5.0 (Radia), which indicates that an average of a 4^{th} grade reading level was necessary to comprehend the graphic novels used in the current study.

Protection of Human Subjects

The current study sought the approval from the Institutional Review Board (IRB) of Seton Hall University following the successful defense of the proposal. Additionally, the current study sought approval for solicitation from local after-care programs in central New Jersey. Prior to their participation in the study, assent and consent were obtained from the participants and from their parents/caregivers. An assent form was provided to the participants in a manner that describes the study and the requirements in language that they were able to understand. A consent form was provided to parents/caregivers also explaining the study details and provided contact information of the principal research, her mentor, and the chair of the Institutional Review Board (IRB) of Seton Hall University. Deception was not used in this study; thus no debriefing was necessary. The current study did not have any negative consequences on study participants. Information collected from the questionnaires were de-identified and coded in Qualtrics, stored on a password-protected USB memory device, and stored in a secure location in the principal researcher's office.

Participants

The participants for this study were 21 elementary school girls between the ages of 9 to 11 years-old. The age range of 9 to 11 years-old was selected due to recommendations from the literature, which suggested that interventions with younger participants (i.e., elementary school-aged children) may more strongly influence STEM self-efficacy and interest (Freeman, 2004; Stoking, 1993; Tyler-Wood et al., 2012). Participants were recruited through elementary schools that offer after-care program services in central New Jersey. Consent was obtained from the parents/caregivers of all participants, and assent was obtained directly from study participants. The participants were free to withdraw from the study at any time and incurred no negative effects.

Data Preparation

Participant data was collected via Qualtrics and manually input into Statistical Program for the Social Sciences (SPSS) version 25.0. Data was de-identified, and all participants were assigned a participant number. Data was stored on a password-encrypted USB flash-drive and stored in a safe location in the principal researcher's office.

Descriptive Statistics

Descriptive statistics were used to describe the demographic characteristics of the participants and their parent's/caregiver's educational level. These statistics are presented through the use of frequencies and means.

Power Analysis

To reduce the chance of Type II error and to best analyze any data collected by the current study, an *a priori* statistical power analysis was conducted to determine the number of participants necessary for the study. G*Power, a free-to-download power analysis program, was used for this purpose (Erdfelder, Faul, Lang, & Buchner, 1996).

Because the participants were assessed at the onset and upon completion of the study, a repeated measures ANCOVA was determined to be the most appropriate statistical analysis of the hypotheses. To satisfy a medium effect size (d = 50) and 80% power to detect significance at the p = .05 level for both hypotheses, 48 participants were determined to be required for the current study.

Statistical Analysis

The following are the statistical analyses corresponding to the research hypotheses of the current study:

1. After controlling for parental educational levels, a narrative-based intervention will increase self-efficacy in STEM careers in elementary school-aged girls.
2. After controlling for parental educational levels, a narrative-based intervention will increase interest in STEM subjects in elementary school-aged girls.
3. Children will be more likely to draw a male scientist in a drawing task prior to STEM intervention.

4. Children will be more likely to draw a female scientist in a drawing task after STEM intervention.

The first and second hypotheses were analyzed using repeated measures ANCOVAs, in which the independent variable was the graphic novel intervention, the covariate was the parent's/caregiver's educational level in years, and the dependent variables was the level of self-efficacy and interest as reported by the participants. A power analysis using G*Power with assumed values of $\alpha = 0.05$, power = 0.80, a large effect size of .50, and 4 groups was used to calculate sample size. The results of the analysis indicated that a sample size of 48 participants was required.

The third and fourth hypotheses were analyzed using Chi Square goodness of fit tests, in which the independent variable was the drawing tasks and the dependent variable was the gender of the scientist in the drawing. A power analysis using G*Power with the assumed values of $\alpha = 0.05$, power = 0.80, a large effect size of .50 was used to calculate sample size. The results of the analysis indicated that a sample size of 32 participants was required.

Summary

The chapter provided the methodological information for the current study. The study design, independent, and dependent variables were outlined and further defined. Additionally, the intended participants, i.e., elementary school-aged girls, for the study were also presented. Psychometric data of the parent instrument of which this study used the adapted version were provided in detail. Finally, the hypotheses and corresponding statistical analyses of this study were fully discussed.

Chapter IV

RESULTS

The primary purpose of the study was to determine the utility of a narrative-based intervention on elementary school-aged girls' self-efficacy and interest in STEM. The theoretical foundation of the current study was Social Cognitive Career Theory (SCCT). The variables of self-efficacy and interest were measured at two intervals during the study. The intent of this study was to measure whether the narrative-based intervention would significantly impact the variables of interest prior to and post intervention. Findings of this study may assist other researchers in identifying effective interventions that may protect girls against premature foreclosure in respect to their attitudes towards STEM subjects and future career fields.

Statement of Design

A quasi-experimental pretest-posttest design was used for the current study. The dependent variables of this study were (a) self-efficacy in STEM as measured by the ESS-ES, (b) interest in STEM as measured by the M-SIS, and (c) the gender of the scientist in the drawing task. Questionnaires were distributed electronically (i.e., via secure link to the survey platform) to all study participants. The independent variables of the study were (a) the graphic novel intervention administered over a period of four consecutive months, and (b) the drawing task administered in the first and last month of the study intervention.

Descriptive Statistics

Twenty-one participants from central New Jersey elementary schools were recruited for the current study. Participants were female 4th and 5th grade elementary school students enrolled in two after-care programs.

Table 1 presents the demographic data for the overall sample. Demographic information was provided by the parents/caregivers of the participants prior to the first study intervention. Twenty parents/caregivers completed the demographic questionnaire and 1 parent/caregiver did not complete the demographic questionnaire. As indicated in the table, the sample for the current study consisted of 20 (95.2%) females. The mean age of the participants was 9.65 years. In respect to racial/ethnic identity, 17 (81.0%) of the participants were identified as White, 1 (4.8%) participant was identified as Black or African American, 1 (4.8%) participant was identified as Biracial, 1 (4.8%) participant was identified as Multi Ethnic, and 1 (4.8%) parent/caregiver did not complete the demographic questionnaire. The participants level of education ranged from 4th to 5th grade; 10 (47.6%) of participants were identified as being in the 4th grade and 10 (47.6%) were identified as being in the 5th grade; 1 (4.8%) parent/caregiver did not complete the questionnaire. The mean grade-level of the participants was 4.5. In terms of favorite school subject, as identified by parents/caregivers, 6 (28.6%) identified a STEM-related subject as their daughter's favorite subject and 14 (66.7%) identified a Non-STEM-related subject as their daughter's favorite subject (e.g., language arts, drama, art); 1 (4.8%) parent/caregiver did not complete the demographic questionnaire.

Table 1
Demographic Characteristics of the Sample (N=20)

	M	*n*	*%*
Gender			
Female	-	20	95.2
Participant Age	9.65	-	-
Race/Ethnicity			
White	-	17	81.0

Black or African American	-	1	4.8
Biracial	-	1	4.8
Multi Ethnic	-	1	4.8
Grade-Level	4.5	-	-
4th	-	10	47.6
5th	-	10	47.6
Favorite School Subject			
STEM	-	6	28.6
Non-STEM	-	14	66.7

Finally, 39 parents/caregivers were represented as a part of the demographic data. This variable was computed by averaging the variables of the years of education for parent/caregiver one and the years of education for parent/caregiver two. The mean parental/caregiver educational level was 26.10 years (*SD* = 3.29).

Preliminary Analysis

Preliminary analyses were conducted to determine statistical bias, such as skew and the presence of outliers, in the main study variables. The pre-E-MSSE, post- E-MSSE, and post-M-SIS subscales indicated a slight positive skew. Non-normality was defined as a skewness value greater than 3.0 and kurtosis value greater than 2.0 (Kline, 2004). Despite these samples indicating a slight positive skew (pre-E-MSSE skewness = 1.22 kurtosis = 1.27, post-E-MSSE skewness = 1.38 kurtosis = 1.27, post-M-SIS skewness = 1.48, kurtosis = 2.41), analyses suggested that the sample did not violate conditions of normality. Additionally, scores in the data set were transformed into standardized scores (e.g., Z-score) to determine if any outliers were present within the data sample (z-scores $\geq$ 3.0). No univariate outliers were found in the sample reflecting the pre-assessments. Regarding the post-assessments, none of the data points exceeded a value of 3.0.

Hypothesis Testing

Hypothesis 1

This hypothesis predicted that, after controlling for parental/caregiver educational levels, a narrative-based intervention will increase self-efficacy in STEM careers in elementary school-aged girls. A repeated measures ANCOVA was used to examine hypothesis one. A linear regression analysis was conducted to determine if a linear relationship was present between the variables. The analysis indicated that there is a linear relationship between the variables of self-efficacy and parental/caregiver educational levels for post-subscales E-MSSE (subscale 1) and E-MSOE/IG (subscale 2), however no significant relationships were found (significance level = .445 and .483, respectively). These results indicate that parental/caregiver educational level may not be predictive of the variable of self-efficacy. Preliminary analyses tested for the homogeneity of the regression slopes for the E-MSSE and the E-MSOE/IG; the variables did not violate this assumption. However, Levene's Test of Homogeneity Variances was violated by the E-MSSE and E-MSOE/IG (p = .001 and .017, respectively). Attempts to correct this assumption (e.g., logarithmic, absolute, and square root transformations) additionally yielded significant results that violated Levene's Test.

An analysis of the E-MSSE using a logarithmic transformation indicated that there was not a significant difference in self-efficacy from pre- to post-intervention, $F(8,6) = 3.333$, $p = .080$, partial $\eta^2 = .816$, while statistically controlling for parental/caregiver educational level. Additionally, an analysis of the E-MSOE/IG using logarithmic transformations indicated that there was not a significant difference in self-efficacy from pre- to post-intervention, $F(12,2) = 2.685$, $p = .303$, partial $\eta^2 = .942$, while controlling for parental/caregiver educational level.

Hypothesis 2

This hypothesis predicated that, after controlling for parental/caregiver educational levels, a narrative-based intervention will increase interest in STEM subjects in elementary school-aged girls. A repeated measures ANCOVA was used to examine hypothesis two. A linear regression analysis was conducted to determine if a linear relationship was present between the variables. The analysis indicated that there is a linear relationship between the variables of interest and parental/caregiver educational levels for post-M-SIS (subscale 3), however no significant relationship was found (significance level = .770). These results suggest that parental/caregiver educational level did not affect the results. Preliminary analysis tested for the homogeneity of the regression slope for the M-SIS, and the variables did not violate this assumption. Additionally, Levene's Test of Homogeneity of Variances was not violated by the M-SIS ($p = .258$).

An analysis of the M-SIS indicated that there was not a significant difference in interest from pre- to post-intervention, $F(9,5) = 1.837$, $p = .261$, partial $\eta^2 = .768$, while controlling for parental/caregiver educational level.

Hypothesis 3

This hypothesis predicted that children will be more likely to draw a male scientist in a drawing task prior to STEM intervention. A Chi Square goodness of fit test was used to examine hypothesis three. The analysis indicated that of the 20 participants who produced a drawing prior to STEM intervention, 15.0% drew a picture with a male figure, as opposed to 85.0% who drew a picture with a female figure.

Hypothesis 4

This hypothesis predicted that children will be more likely to draw a female scientist in a drawing task after STEM intervention. A Chi Square goodness of fit test was used to examine hypothesis four. The analysis indicated that of the 18 participants who produced a drawing after STEM intervention, 61.1% drew a picture with a female figure, as opposed to 27.8% who drew a picture with a male figure and 11.1% who drew a picture in which the gender of the figure could not be determined.

Paired Samples T-Tests

Finally, paired samples t-tests were conducted to supplement the non-significant findings of the repeated measures ANCOVAs that were used to test hypotheses one and two. Ultimately, paired samples t-tests did not indicate a significant change in self-efficacy (i.e., hypothesis one) or interest (i.e., hypothesis two) pre- to post-intervention (Table 2).

Table 2
Paired Samples T-Tests (n=16)

Subscale	Pre-Intervention		Post-Intervention					
	M	*SD*	*M*	*SD*	*t*	*df*	Sig (2-tailed)	*d*
E-MSSE	1.598	.408	1.609	.447	-.112	15	.904	-.029
E-MSOE/IG	1.923	.514	1.807	.399	.800	15	.436	.199
M-SIS	1.340	.209	1.425	.407	-.886	15	.390	-.220

Note: E-MSSE (Elementary-Math and Science Self-Efficacy), E-MSOE/IG (Elementary-Math and Science Outcome Expectations/Intentions and Goals), M-SIS (Math-Science Interest Scale)

Psychometrics of the ESS-ES

The current study also sought to determine preliminary psychometric data for the ESS-ES, specifically the internal consistency reliabilities, internal consistency alphas for math and science items in a younger population than the original developmental sample, and correlations between the E-MSSE and E-MSOE/IG. Analysis indicated that the internal consistency reliability for the pre- and post-E-MSSE were .77 and .88 respectively. Analysis indicated that the internal consistency reliability for the pre- and post-E-MSOE/IG were .75 and .88

respectively. The internal consistency coefficient alphas for math and science-specific items on the pre-E-MSSE was .74 and .61 respectively. The internal consistency coefficient alphas for math and science-specific items on the post-E-MSSE was .85 and .81 respectively. The internal consistency coefficient alphas for math and science-specific items on the pre-E-MSOE/IG was .78 and .70 respectively. The internal consistency coefficient alphas for math and science-specific items on the post-E-MSOE/IG was .79 and .87 respectively. Finally, analyses of suggested that the pre-E-MSSE and E-MSOE/IG were highly correlated, with correlation variables of .571. A factor analysis suggested that the items on the E-MSSE and E-MSOE/IG loaded on eight components, however, most of the items loaded onto component one. This analysis suggests that the E-MSSE and E-MSOE/IG may not in fact measure different constructs, and that they may be more closely related than they are dissimilar.

Summary

The results of the statistical analyses did not provide adequate support for the hypotheses of the current study. It was first hypothesized that, after controlling for parental/caregiver educational levels, a narrative-based intervention will increase self-efficacy in STEM careers in elementary school-aged girls. The results of repeated measures ANCOVAs did not indicate a significant change in self-efficacy pre- to post-intervention. Additionally, a paired samples t-test was conducted to determine if any kind of significant change was present in the study, however this analysis also did not yield significant results.

Second, it was hypothesized that, after controlling for parental/caregiver educational levels, a narrative-based intervention will increase interest in STEM subjects in elementary school-aged girls. Similar to the first hypothesis, the results of a repeated measures ANCOVA did not indicate a significant change in interest pre- to post-intervention. A paired samples t-test was also conducted to determine if any kind of significant change was present in the study, however this analysis did not yield significant results.

Third, it was hypothesized that children will be more likely to draw a male scientist in a drawing task prior to STEM intervention. The results of a Chi Square goodness of fit test did not indicate a significant likelihood of the participants to draw a male figure pre-intervention. Finally, it was hypothesized that children will be more likely to draw a female scientist in a drawing task after STEM intervention. The results of a Chi Square goodness of fit test did not indicate a significant likelihood of the participants to draw a female figure post-intervention.

Chapter V

DISCUSSION

The current study investigated whether a narrative-based intervention could increase self-efficacy and interest in STEM careers and subjects in elementary school-aged girls. The intent of this study was to show that a narrative medium could be an effective tool to engage girls and support novel interest in STEM. This chapter will provide an interpretation of the findings of the present study. The limitations of the current study, clinical implications, and recommendations for future research will also be discussed.

Interpretation of Findings

The first question of the current study asked after controlling for parental/caregiver educational levels, will a narrative-based intervention affect self-efficacy in STEM careers in elementary school-aged girls. Previous research suggested that parental/caregiver educational levels can be predictive of their children's educational achievement (and play a role in shaping future career interests), that more highly educated parents/caregivers have more congruent educational expectations towards their children's abilities, and may provide more effective and nurturing home learning environments (Davis-Kean, 2005; Halle et al., 1997; Smith et al., 1997). Previous research has also indicated that socialization experiences and experiences navigating gender norms or role expectations can also shape girls' self-efficacy when considering future career options for themselves (Gunderson et al., 2012; Simpkins et al., 2005; Tenenbaum & Leaper, 2003). Given the findings of previous research, it was hypothesized that a narrative-based intervention (i.e., graphic novels featuring positive female characters) would be an effective intervention in increasing girls' self-efficacy in STEM careers.

The results of a repeated measures ANCOVA did not indicate a significant change in self-efficacy pre-STEM intervention to post-STEM intervention. A paired samples t-test which was conducted to supplement the non-significant findings of the repeated measures ANCOVA also did not yield significant results. These results indicated that the narrative-based intervention (i.e., the graphic novels) did not affect self-efficacy in STEM careers in the present sample of elementary school-aged girls. Several factors may be considered as to why these results were found. First, at the onset of the study, participants indicated higher than expected self-efficacy in STEM careers. Further, it is important to note the lack of variance in parental/caregiver educational levels, and that most parents/caregivers indicated having achieved a high amount of education. Thus, because most of the participants came from households of high-achieving parents/caregivers, they may have had more affirming and nurturing experiences, and may not have been limited as to what kinds of careers they could be allowed to pursue. Third, the participants' unique educational experiences, such as curriculums that emphasized STEM education, may have also led to their higher than expected self-efficacy and predictions of success in STEM-related future careers. The SCCT model accounts for the relationship between self-efficacy and outcome expectations, thus more frequent and positive experiences in a particular task (e.g., exposure to a STEM curriculum) can lead to higher outcome expectations for engaging in a similar task (e.g., STEM career) in the future (Lent, 2013). Finally, the lack of adequate power may also have contributed to the non-significant results that were derived from the repeated measures ANCOVA.

The second question of the current study asked whether after controlling for parental/caregiver educational levels, would a narrative-based intervention affect interest in STEM subjects in school in elementary school-aged girls. Again, parental/caregiver educational levels have been known to impact their children's educational outcomes. Additionally, previous research has consistently indicated that girls tend to prefer reading and language-based subjects to math and science (Freeman, 2004; Guay et al., 2010; Stoking, 1993). The results of a repeated measures ANCOVA did not indicate a significant change in interest pre-STEM intervention to post-STEM intervention. A paired samples t test, conducted to supplement the non-significant findings of the repeated measures ANCOVA, also did not yield significant results. These results thus indicate that the narrative-based intervention did not affect interest in STEM subjects in school in elementary school-aged girls. Prior to the intervention, the participants indicated higher than expected interest in math and science. Because the participants expressed pre-inclined interest in math and science subjects, the graphic novel intervention may not have been powerful enough to cause significant changes in interest in a sample that began the study with a high baseline of interest. It is possible that a narrative-based intervention may have a more significant effect on girls who have lower initial interest in math and science subjects. Finally, similar to the first question of the current study, the lack of adequate sample size may have contributed to the non-significant findings.

The third and fourth questions of the current study asked whether children will be more likely to draw a male scientist prior to STEM intervention, and a female scientist after STEM intervention. Past research has suggested that stereotypic beliefs can impact girls' perceptions as to who can be considered members within STEM communities (Steele, 2003). The results of Chi Square goodness of fit tests did not indicate a significant change in girls' perceptions of who can and cannot be considered members of the scientific community. In fact, the results of these analyses were counter to what was predicted, given that the frequency of female figures in the drawing decreased after STEM intervention, and the frequency of male figures increased after STEM intervention. Though unexpected, these results may be accounted for by the opportunities that the participants were exposed to through their educational experiences. Again, the after-care programs represented in the study were affiliated with schools that had an emphasis in STEM education as a part of their curriculums. One affiliated school employed a female "STEM Coordinator" who met with the students regularly for specialized STEM lessons. Because the participants had exposure to more STEM-related activities and opportunities, and more frequently saw women in positions related to STEM, they may have been predisposed to view girls/women as members of the STEM community. Finally, it may be possible that the participants' perceptions of the STEM community may have been influenced by popular culture. Currently, there is slightly more representation of female STEM role models (e.g.,. "Shuri" from *Black Panther*, "Doc McStuffins" from *Doc McStuffins*) in popular media than there has been in the past, and this exposure may have also impacted girls' perceptions of members of the STEM community.

Limitations

There are several limitations to the current study. First, due to difficultly in participant recruitment, the number of participants in the study did not meet the minimum requirement as determined by the a-prior power analysis. An a-priori power analysis indicated that 48 participants were needed to adequately power hypotheses one and two, and that 32 participants were needed to adequately power hypotheses three and four. Thus, the insignificant results of this study may be related to the insufficient number of participants. Participant recruitment may have been hindered due to the methodology of the current study, specifically in seeking to present the study to students during after-care. The study may have limited itself to only those students who participate in after-care services, and unintentionally excluded interested participants who were not enrolled in after-care.

A second limitation was also seen participant representation. As stated previously, the current study excluded male and gender fluid participants, and exclusively examined cisgender female perspectives. Thus, the results of this study may not be generalizable to males or gender fluid individuals, and comparisons of the effectiveness of the intervention across the gender spectrum was not determined. In addition to excluding males, the current study also may not generalize across racial and ethnic backgrounds. The study included an over-representation of White participants (81.0%), with little representation of other racial or ethnic backgrounds. Thus, the results of the current may not be generalizable across larger and more diverse populations of students.

A third limitation may also be seen in the parent/caregiver representation. The demographic data of the study did not indicate significant variance in respect to parental/caregiver educational levels (M = 26.10 years). Almost all parents/caregivers indicated that they have earned at least a college degree, and many indicated that they have earned some kind of graduate degree. The results of the current study subsequently suggest that parental/caregiver educational level may not be predictive of the variable of self-efficacy.

A fourth limitation was reflected in the sample site populations themselves. The participating after-care programs were affiliated with elementary schools that included an emphasis in STEM education as a part of their curriculums. Thus, the participants had higher than average self-efficacy and interest in STEM at the on-set of the study due to the opportunities available to them through their elementary schools (see results section above). For instance, one participating after-care program's affiliated elementary school employed a "STEM Coordinator" who regularly met with and engaged their students in critical thinking activities and experiments in STEM. The participants in this study may have been unintentionally biased in favor of STEM due to their unique educational experiences. Thus, the results of the current study may not be generalizable to all students, especially to those students in more disadvantaged school districts.

Fifth, the current study was conducted using after-care programs in central New Jersey. The mean household income for residents in the areas represented in the study is $113,609 (Data USA). The participants may have access to more STEM-related opportunities outside of the classroom due to living in high SES communities. Subsequently, the results may not generalize to individuals in lower SES communities who do not have access to equitable resources.

Sixth, a limitation may be seen in the art design used in the graphic novels. Media such as graphic novels and comic books have been known to depict their characters in gender-fluid ways. Though the main characters in this study were specifically designed to appear female, to a younger audience with more exposure and comfort identifying in gender-fluid terms, the "femaleness" of the characters may not have been salient enough for them to recognize as an important aspect of the stories. Current research suggests that young people today have a more expansive and accepting view of gender, including more terms describing gender and openness to the expression of gender-fluidity (Bragg, Renold, Ringrose, & Jackson, 2018). Because younger people are so accepting of gender-fluidity, the gender of the characters in the stories may not have appeared noteworthy; the participants may have thus benefitted from further discussion or prompting to the "femaleness" of the characters.

Finally, the psychometric analyses for the current study should only be considered preliminary data, as that more investigation will be necessary to determine the appropriateness and utility of the ESS-ES. An analysis of the E-MSSE and E-MSOE/IG indicated that the subscales were highly correlated with each other. Additionally, factor analysis of the E-MSSE and E-MSOE/IG also suggested that the subscales may be measuring the same constructs. This finding can be considered consistent with SCCT, as that the theory acknowledges the reciprocal relationship between self-efficacy and outcome expectations. Finally, the internal consistency coefficient alphas for the science-specific items on the pre-E-MSSE were low. This may reflect the psychometric weaknesses of the original MSS-E, as that psychometric analysis concluded that the unequal number of questions of math- and science-related items may negatively impact coefficient alphas.

Clinical Implications

Although the current study did not yield any significant findings, there are still some clinical implications that can be derived from this research. Anecdotally, the study suggests a need for materials similar to the graphic novels that were used in the study. Several children throughout the intervention process expressed enjoyment and excitement in listening to the stories. They appeared eager to listen to the new stories that the principal researcher presented over the four-month intervention period and indicated that they connected to stories through informal conversation (i.e., discussing their favorite characters, favorite stories). They additionally expressed a desire to own the stories that were presented to them in the study, which suggests a need for these kinds of materials to be available to children on the public market.

Although numerous amounts of educational literature are already available to children, materials such as graphic novels may be a new way to connect children to STEM topics.

Finally, the current study may call to attention the need for a myriad of learning opportunities for girls in STEM. Though previous research has indicated girls' preference for reading and language-arts, stories alone may not be powerful enough to cause significant changes in their levels of self-efficacy and interest. Other researchers have suggested that one positive way to engage girls in STEM is by engaging them in multiple formats (i.e., traditional instruction in conjunction with Out-of-School Time (OST) programs and extended learning; Koch, Polnick, & Irby, 2014). OST programs, for instance, can provide hands-on learning experiences that girls may not receive in the classroom or just from reading stories. When facilitated by female mentors, they can also provide an experience that allows the mentees to see themselves in similar leadership and expert roles in the future. Vicarious learning can be a powerful contributor to self-efficacy and outcome expectations, and the ability to identify with expert role-models can help to support one's own view of themselves as a future expert in a similar field (Tan & Calabrese Barton, 2007). Consideration should thus be given to the marriage of multiple supports for girls in STEM and less of a reliance on a sole solution that will carry them from early elementary school interest to future career.

Recommendations for Future Research

The goal of the current study was to determine whether a theoretically-grounded narrative-based intervention could increase self-efficacy and interest in STEM subjects in elementary school-aged girls. Although this study provided some understanding into this issue, future researchers may benefit from integrating the following considerations in their investigations.

Several recommendations for future research may be taken from the present study. First, as indicated in the limitations, the current study suffered in participant recruitment. Thus, future studies may benefit from having a more robust number of participants. Future researchers may consider alternative methods of recruiting participants, such as working with students during library time during the school day, to prevent interested participants from being excluded due to their enrollment status as related to after-care.

A second recommendation that may be considered in future research is to sample from a more diverse population. The participants in the current study were predominantly White, from mid-to-high SES communities in central New Jersey. Thus, future researchers may consider sampling participants from a variety of communities so that results could be more generalizable to a larger and more representative population of students.

Third, future researchers may consider making certain aspects of the stories more prominent to study participants. For example, future researchers could consider making the gender of the characters more salient to the study participants. The principal researcher of the current study did not emphasize the “femaleness” of the characters. Thus, the characters’ gender may not have been a prominent feature that the study participants were aware of. Additionally, the principal researcher did not include “backstories” (i.e., information as to how the main characters became heroes) or provide an introduction/follow-up after the stories to process how the main characters were able to achieve what they did. Future researchers may consider including these elements to foster discussion as to how the characters developed their particular interests and what career paths would have allowed them to pursue their interests.

Finally, future researchers may consider changing the ages of the characters in the stories. Though the main characters were intentionally designed to be older than the study participants, future studies may consider making the heroes of the story the approximate age of the study participants. Future participants may better identify with the heroes if their ages are more similar, and subsequently may be better able to imagine themselves as being able to do the various activities that were depicted in the stories.

References

A Timeline of NSF History. (n.d.). Retrieved March 09, 2016 from http://www.nsf.gov/news/special_reports/history-nsf/timeline/index.jsp

Ashcraft, M. H. (2002). Math anxiety: Personal, educational, and cognitive consequences. *Current Directions in Psychological Science, 11,* 181-185. doi: 10.1111/1467-8721.00196

Bages, C., Verniers, C., & Martinot, D. (2016). Virtues of a hardworking role model to improve girls' mathematics performance. *Psychology of Women Quarterly, 40,* 55-64. doi: 10.1177/0361684315608842

Beilock, S. L., Gunderson, E. A., Ramirez, G., & Levine, S. C. (2010). Female teachers' math anxiety affects girls' math achievement. *Proceedings of the National Academy of Sciences of the United States of America, 107,* 1860-1863. doi: 10.1073/pnas.0910967107

Betz, D. E. & Sekaquaptewa, D. (2012). My fair physicist? Feminine math and science role models demotivate young girls. *Social Psychological and Personality Science, 00,* 1-9. doi: 10.1177/1948550612440735

Bigozzi, L., Biggeri, A., Boschi, F., Conti, P., & Fiorentini, C. (2002). Children "scientists" know the reasons why and they are "poets" too. Non-randomized controlled trial to evaluate the effectiveness of a strategy aimed at improving learning of scientific concepts. *European Journal of Psychology Education, 17,* 343-362.

Boaler, J. & Irving, T. S. (2007). Mathematics. In B. Banks (Ed.), *Gender and education: An encyclopedia* (pp. 287-293). Westport, CT: Praeger.

Bragg, S., Renold, E., Ringrose, J., & Jackson, C. (2018). 'More than boy, girl, male, female': Exploring young people's views on gender diversity within and beyond school contexts.

Sex Education, 18, 420-434. doi: 10.1080/14681811.2018.1439373

Cadwalader, E. & Bandows Koster, J. (2013, April 9). Investing in women in STEM: Because girls grow up [Web log post]. Retrieved from http://www.huffingtonpost.com /association-for-women-in-science/investing-in-women- in-stem_b_3037934.html.

Ceci, S. J. & Williams, W. M. (2011). Understanding current causes of women's underrepresentation in science. *PNAS Proceedings of the National Academy of Sciences of the United States of America, 108,* 3157-3162. doi: 10.1073/pnas.1014871108

Chappell, B. (2015, June 12). #Distractingly sexy tweets are female scientists' retort to 'disappointing' comments. Retrieved from http://www.npr.org/sections/thetwo-way/2015/06/12/413986529/-distractinglysexy-tweets-are-female-scientists-retort-to-disappointing-comments.

Cheryan, S., Plaut, V. C., Davies, P., & Steele, C. M. (2009). Ambient belonging: How stereotypical environments impact gender participation in computer science. *Journal of Personality and Social Psychology, 97,* 1045-1060. doi: 10.1037/a0016239

Cheryan, S., Siy, J. O., Vichayapai, M., Drury, B. J., & Kim, S. (2011). Do female and male role models who embody STEM stereotypes hinder women's anticipated success in STEM? *Social Psychological and Personality Science, 2,* 656-664. doi: 10.1177/1948550611405218

Cvencek, D., Meltzoff, A. N., & Greenwald, A. G. (2011). Math-gender stereotypes in elementary school children. *Child Development, 82*, 766-779. doi: 10.1111/j.1467-8624.2010.01529.x

Data USA. (n.d.) Retrieved November 20, 2018 from https://datausa.io/profile/geo/hopewell-nj/

Data USA. (n.d.) Retrieved November 20, 2018 from https://datausa.io/profile/geo/princeton-nj/

Davis-Kean, P. E. (2005). The influence of parent education and family income of child achievement: The indirect role of parental expectations and the home environment. *Journal of Family Psychology, 19,* 294-304. doi: 10.1037/0893-3200.19.2.294

Else-Quest, N. M., Hyde, J. S., & Linn, M. C. (2010). Cross-national patterns of gender differences in mathematics: A meta-analysis. *Psychological Bulletin, 136*, 103-127. doi: 10.1037/a0018053

Erdfelder, E., Faul, F., & Buchner, A. (1996). GPOWER: A general power analysis program. Behavior Research Methods, Instruments, & Computers, 28, 1-11.

Etcoff, N. L., Stock, S., Haley, L. E., Vickery, S. A., & House, D. M. (2011). Cosmetics as a feature of the extended human phenotype: Modulation of the perception of biologically important facial signals. *PLoS ONE, 6,* e25656.

Ford, D. J., Brickhouse, N. W., Lottero-Perdue, P., & Kittleson, J. (2006). Elementary girls' science reading at home and school. *Science Education, 90,* 270-288. doi: http://dx.doi.org/10.1002/sce.20139

Fouad, N. & Smith, P. L. (1996). A test of a social cognitive model for middle school students: Math and Science. *Journal of Counseling Psychology, 43,* 338-346.

Fouad, N., Smith, P. L., & Enochs, L. G. (1997). Reliability and validity evidence for the middle school self-efficacy scale. *Measurement and Evaluation in Counseling and Development, 30,* 17-31.

Franke Kleist, V. (2015). Women in STEM careers: What is working well. *Sex Roles, 73,* 276-278. doi: 10.1007/s11199-015-0522-9

Freeman, C.E. (2004). Trends in Educational Equity of Girls & Women: 2004 (NCES 2005–016). U.S. Department of Education, National Center for Education Statistics.

Washington, DC: U.S. Government Printing Office.

Gibson, H. L. & Chase, C. (2002). Longitudinal impact of an inquiry-based science program on middle school students' attitudes toward science. *Science Education, 86,* 693-705. doi: 10.1002/sce.10039

Ginevra, M. C., Nota, L., & Ferrari, L. (2015). Parental support in adolescents' career development: Parents' and children's perceptions. *The Career Development Quarterly, 63,* 2-15. doi: 10.1002/j.2161-0045.2015.00091.x

Guay, F., Chanal, J., Ratelle, C. F., Marsh, H. W., Larose, S., & Boivin, M. (2010). Intrinsic, identified, and controlled types of motivation for school subjects in young elementary school children. *British Journal of Educational Psychology, 80,* 711-735. doi: 10.1348/000709910X499084

Gunderson, E. A., Ramirez, G. Levine, S. C., & Beilock, S. L. (2012). The role of parents and teachers in the development of gender-related math attitudes. *Sex Roles, 66,* 153-166. doi: 10.1007/s11199-011-9996-2

Halle, T., Kurtz-Costes, B., & Mahoney, J. (1997). Family influences on school achievement in low-income African American children. *Journal of Educational Psychology, 89*, 527-537.

Hardin, E. E. & Longhurst, M. O. (2016). Understanding the gender gap: Social cognitive changes during an introductory STEM course. *Journal of Counseling Psychology, 63,* 233-239. doi: 10.1037/cou0000119.

Heilbronner, N. N. (2013). The STEM pathway for women: What has changed? *Gifted Child Quarterly, 57,* 39-55. doi: 10.1177/0016986212460085

Heilman, M. E. & Okimoto, T. G. (2007). Why are women penalized for success at male tasks?

The implied communality deficit. *Journal of Applied Psychology, 92,* 81-92. doi: 10.1037/0021-9010.92.1.81

Kenny, M., & Medvide, M. B. (2013). Relational influences on career development. In S. D. Brown & R. W. Lent (Eds.), *Career development and counseling: Putting theory and research to work* (pp. 329–356). New York, NY: Wiley.

Kincaid, J. P., Fishburne Jr., R. P., Rogers, R. L., & Chissom, B. S. (1975). Derivation of new readability formulas (Automated Readability Index, Fog Count, and Flesch Reading Ease Formula) for navy enlisted personnel. Research Branch Report 8-75. Millington, TN: Naval Technical Training, U.S. Naval Air Station; Memphis, TN; 1975.

Kline, R.B. (2004). Beyond significance testing: Reforming data analysis methods in behavioral Research. Washington, DC: American Psychological Association.

Koch, J., Polnick, B., & Irby, B. (2014). *Girls and women in STEM: A never ending story.* (pp. 139-152). Charlotte, NC: Information Age Publishing, Inc.

Lent, R. W. (2013). Social cognitive career theory. In S. D. Brown & R. W. Lent (Eds.), *Career development and counseling: Putting theory and research to work* (pp. 147-183). New York, NY: Wiley.

Lent, R. W., Brown, S. D., Brenner, B., Chopra, S. B., Davis, T., Talleyrand, R., & Suthakaran, V. (2001). The role of contextual supports and barriers in the choice of math/science educational options: A test of social cognitive hypotheses. *Journal of Counseling Psychology, 48,* 474-483. doi: 10.1037//0022-0167.48.4.474

Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of Vocational Behavior, 45,* 79-122. doi: http://dx.doi.org/10.1006/jvbe.1994.1027

Li, A. K. F. & Adamson, G. (1995). Motivational patterns related to gifted students' learning of mathematics, science, and English: An examination of gender differences. *Journal for the Education of the Gifted, 18*, 284-297.

Microsoft Test Your Document's Readability (n.d.) Retrieved June 05, 2017 from https://support.office.com/en-us/article/Test-your-document-s-readability-85b4969e-e80a-4777-8dd3-f7fc3c8b3fd2#__toc342546558.

National Center for Education Statistics (2015). *Digest of education statistics.* Retrieved from http://nces.ed.gov/programs/digest/d15/tables/dt15_318.30.asp.

Navarro, R. L., Flores, L. Y., & Worthington, R. L. (2007). Mexican American middle school student's goal intentions in mathematics and science: A test of social cognitive career theory. *Journal of Counseling Psychology, 54,* 320-335. doi: 10.1037/0022-0167.54.3.320

Respers France, L. (2014, November 14). Philae researcher criticized for shirt covered in scantily clad women. Retrieved from http://www.cnn.com/2014/11/13/living/matt-taylor-shirt-philae-rosetta-project/.

Riegle-Crumb, C. & King, B. (2010). Questioning a white male advantage in STEM: Examining disparities in college major by gender and race/ethnicity. *Educational Researcher, 39*, 656-664.

Rizza, M. G. (1999). Learning to play the game: Female students discuss their success in high school. *Journal for the Education of the Gifted, 22*, 243-265.

Rudman, L. A. & Glick, P. (2001). Prescriptive gender stereotypes and backlash toward agentic women. *Journal of Social Issues, 57,* 743-762. doi: http://dx.doi.org/10.1111/0022-4537.00239

Ryan, R. M. & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*, 68-78. doi: 10.1037//0003-066X.55.1.68

Shapiro, J. R. & Williams, A. M. (2012). The role of stereotype threats in undermining girls' and women's performance and interest in STEM fields. *Sex Roles, 66,* 175-183.

Sherbin, L. (2015, June 11). Female scientists feel the bias in their labs. Retrieved from http://www.nytimes.com/roomfordebate/2015/06/11/nobel-winning-sexism-in-the-lab/female-scientists-feel-the-bias-in-their-labs.

Simpkins, S. D., Davis-Kean, P. E., & Eccles, J. S. (2005). Parents' socializing behavior and children's participation in math, science, and computer out-of-school activities. Applied *Developmental Science, 9,* 14-30. doi: 10.1207/s1532480xads0901_3

Smith, J. R., Brooks-Gunn, J., & Klebanov, P. K. (1997). The consequences of living in poverty for young children's cognitive and verbal ability and early school achievement. In G. J. Duncan & J. Brooks-Gunn (Eds.), *Consequences of growing up poor* (pp. 132-189). New York: Russell Sage.

Steele, J. (2003). Children's gender stereotypes about math: The role of stereotype stratification. *Journal of Applied Social Psychology*, *33,* 2587-2606.

Stoking, V. (1993). Attitudes about school of academically talented seventh graders. In: Paper presented at the annual meeting of the American educational research association (ED 374034).

Su, R., Rounds, J., & Armstrong, P. I. (2009). Men and things, women and people: A meta-analysis of sex differences in interests. *Psychological Bulletin, 135,* 859-884. doi: 10.137/a0017364

Subrahmanyan, L. & Bozonie, H. (1996). Gender equity in middle school science teaching: Being "equitable" should be the goal. *Middle School Journal, 27,* 3-10, doi: 10.1080/00940771.1996.11496168

Tan, E. & Calabrese Barton, A. (2007). From peripheral to central: The story of Melanie's metamorphosis in an urban middle school science class. *Science Education, 92*, 567-590, doi: 10.1002/sce.20253

Tenenbaum, H. R. & Leaper, C. (2003). Parent-child conversations about science: The socialization of gender inequalities? *Developmental Psychology, 39,* 34-47. doi: 10.1037/0012-1649.39.1.34

Tyler-Wood, T., Ellison, A., Lim, O., & Periathiruvadi, S. (2012). Bringing up girls in science (BUGS): The effectiveness of an afterschool environmental science program for increasing female student' interest in science careers. *Journal of Science Education and Technology, 21*, 46-55. doi: 10.1007/s10956-011-9279-2

U.S. Department of Commerce. (2011). *Women in STEM: A gender gap to innovation.* Retrieved from http://www.esa.doc.gov/sites/default/files/womeninstemagaptoinnovation8311.pdf

Vedantam, S. (2012). How stereotypes can drive women to quit science [Radio series episode]. In A. Silverman & G. Smith (Senior producers), All things considered. Washington, DC: National Public Radio.

Yee, D. K. & Eccles, J. S. (1988). Parent perceptions and attributions for children's math achievement. *Sex Roles, 19,* 317-333. doi: 10.1007/BF00289840

Appendix A: Informed Consent

Dear Parents/Guardians,

Researcher Affiliation

Lauren M. Carino, M.A. is a doctoral student in Seton Hall University's Counseling Psychology program in the Department of Professional Psychology and Family Therapy in the College of Education and Human Services.

Purpose & Duration

Ms. Carino is running a study that will look to see if the use of stories will increase confidence in science, technology, engineering, and mathematics (STEM). She also wants to see if stories will increase interest in STEM. The study consists of the reading of four stories to you children. The stories are written by Ms. Carino. They were drawn by a professional artist. The stories follow the "Heroes of STEM". The main characters are friendly female role-models. Children in this study will be read one story per month. The study will last four months.

Procedure

The stories will be read in a group during after-care. Your child will also complete the Elementary School Self-Efficacy Scale. Your child will complete the surveys at home. They will use their personal computers by clicking on a link to the survey website. Ms. Carino will email you the link to the website. Your child will also complete two drawing activities in the study. They will draw a picture about math and science. Ms. Carino asks you to complete a short questionnaire. The questionnaire is to collect background information.

Instruments

The study will use the Elementary School Self-Efficacy Scale. The scale looks as confidence in math and science. It also looks at interest in math and science. It was adapted by Ms. Carino with permission from the authors of the Middle School Self-Efficacy Scale. Your child will rate their confidence level on different questions. They will also rate if they agree with different questions. They will rate how much they like different activities. Sample questions include: do I think I can do well in math? Can I get an A on my report card in math or science? Do I think I can do well in math? How much do I enjoy activities related to math or science?

Voluntary Participation

This study is voluntary. Your child is free to leave the study at any time.

Anonymity

Members of this study will also be anonymous. Personal information will be coded and de-identified. Your child's information will not be identifiable. The findings from the study will be written about as a group. No one person's identifying information will be presented.

Data Storage

All data will be collected via Qualtrics, an online survey software program.

Record Storage

Records will be transferred to a password-encrypted USB memory stick. The USB stick will be kept in a locked desk in my home. Only I will have access to the records.

Risks

There are no risks to your child in this study. Your child should not feel any distress from this study.

Benefits

A possible benefit to being in this study is adding to the understanding of better programs for girls in STEM.

Contact Information

If you have any questions or concerns about the study, please feel free to contact the principal researcher Lauren Carino (lauren.petrillo@student.shu.edu) , her adviser, Dr. Pamela Foley (pamela.foley@shu.edu), or Seton Hall University's Director of Institutional Review Board, Dr. Mary F. Ruzicka (irb@shu.edu). All participants will be provided with a copy of their signed consent form.

Please sign and return this form to Ms. Carino using the pre-paid self-addressed envelope provided with your study materials indicating your consent to allow Ms. Carino to approach your daughter between the ages of 9-11 years-old to be a part of this study. Please also provide your email contact information so that Ms. Carino may send you a secure link to the survey material once the study begins.

Consent to participate is indicated by returning this form to the researcher.

_______________________________ _______________________________

Parent/Caregiver Signed Name *Parent/Caregiver Email*

_______________________________ _______________________________

Parent/Caregiver Signed Name *Date*

Appendix B: Assent Form

Dear Participants,

Who I Am

My name is Lauren, and I am a college student at Seton Hall University. I am studying Counseling Psychology in the Department of Professional Psychology and Family Therapy in the College of Education and Human Services.

What I'm Doing

I am doing a study to see if comic books will increase girls' interest in science, technology, engineering, and mathematics (STEM). I also would like to see if comic books increase the "I can do it" feeling in STEM. The study will be made of four comic books about the "Heroes of STEM".

What You'll Do

You will get to hear these stories when we meet during after-care. The study will take place over the next 4 months. If you are a part of the study you will also fill out the Elementary School Self-Efficacy Scale. You will get to complete the survey on your computer at home. You will only take the survey two times during the study. Lastly, you will get to do two drawing activities. You will draw a picture of something about math or science.

Survey

The Elementary School Self-Efficacy Scale is a survey. The survey looks at interest in math and science. It also looks at the "I can do it" feeling in math and science. You will be asked to answer different questions about math and science. Here are some examples: Do I think I can get an A on my report card in math or science? Do I agree or disagree that I can do well in math? Do I enjoy math or science activities? The survey is not a test. There are no right or wrong answers. You will not get a grade on the survey.

Volunteering

You can volunteer to be a part of this study. You do not have to be a part of this study if you do not want to. You may stop at any time and no one will be upset.

Secret

You name and answers on the surveys will also be kept secret. No one will know your answers in the study.

Data Storage

I will gather your survey information on Qualtrics, a survey website.

Record Storage

I will keep your information on a password-protected USB stick. The USB stick will be kept in a locked desk at my house. Only I will see the information.

Risks

There are no risks to being a part of this study. You should not feel any discomfort in this study.

Benefits

A good thing about being in this study is learning about better activities for girls in STEM.

Questions

You can ask Laure if you have any questions about the study. Her email address is lauren.petrillo@student.shu.edu. You can also ask her teacher questions about the study. Her teacher's name is Doctor Pamela Foley. Doctor Foley's email address is pamela.foley@shu.edu.

You must be a 9, 10, or 11 year-old girl to be a part of this study. Please sign the bottom of this form to Lauren if you would like to be a part of this study. Signing the form shows that you agree to be in my study.

Assent to participate is indicated by returning this form to Lauren. You will get a copy of this signed form.

____

Student Signed Name

______________________________ ______________________________

Parent/Caregiver Signed Name *Date*

Appendix C: Elementary School Self-Efficacy Scale (ESS-ES)

Directions: Below are 12 statements that you might or might not be able to do. Decide if you think that you can or can't do them by checking in the box next to each sentence.

	I can totally do this 	I think I can do this 	I'm not sure I can do this 	I don't think I can do this 	I totally can't do this 
Get an A on my report card in math					
Get an A on my report card in science					
Get an A in math in middle school					
Get an A in science in middle school					
Figure out how many toys I can buy if I have $20.00 to spend					
Figure out how much change I should get back if I buy a book					
By looking at a clock figure out how many minutes are left before the school day ends					
Invent and talk about a					

science experiment at a science fair					
Sort animals into groups of mammals and reptiles					
Understand the weather by looking at weather pictures					
Collect and measure rainfall amounts					
Come up with ideas about why kids watch a TV show					

Directions: Below are 13 statements that you might agree or disagree with. Decide if you agree or not by checking a box next to each sentence.

	I totally agree	Agree	I'm not sure	Disagree	I totally do not agree
If I study math a lot, then I will be able to reach my future goals					
If I learn math, then I will be able to do lots of different jobs					
I can do well in math class					
If I do well in science classes now, I will do well in middle school too					
If I get good grades in math my parents will be happy					
If I get good grades in math and science my friends will be happy for me					
If I do well in science now, I will be ready for science in high school					
I want to take math classes					

in middle school					
I want to take science classes in middle school					
I study hard for science					
I want to have a job that uses math					
I want to use my science knowledge in my future job					
I want to have a job that uses science					

Directions: Below are 20 statements that describe different activities. Choose how much you like or dislike each of the following activities below by checking a box next to each sentence.

	Like	Not Sure	Dislike
Going to a science museum			
Listening to a famous scientist			
Solving computer problems			
Solving math puzzles			
Visiting a science lab			
Joining a science club			
Reading about science and discoveries			
Going to a science fair			
Doing activities in a science lab			
Learning about how energy and electricity work			
Inventing new technology			
Using a calculator			
Doing activities with plants and animals			
Doing astronomy activities			
Having science class in school			
Having math class in school			
Doing activities in a doctor's lab			
Doing activities with a chemistry set			
Inventing			
Watching a TV show about science			

Appendix D: IRB Approval Form

REQUEST FOR APPROVAL OF RESEARCH, DEMONSTRATION OR RELATED ACTIVITIES INVOLVING HUMAN SUBJECTS

All material must be typed.

PROJECT TITLE: STEM Heroes: A Narrative-based Intervention to Increase Self-efficacy and Interest in Science, Technology, Engineering, and Mathematics in Elementary School-Aged Children

CERTIFICATION STATEMENT:

In making **this application,** I(we) certify that I(we) have read and understand the University's policies and procedures governing research, development, and related activities involving human subjects. I (we) shall comply with the letter and spirit of those policies. I(we) further acknowledge my(our) obligation to (1) obtain written approval of significant deviations from the originally-approved protocol BEFORE making those deviations, and (2) report immediately all adverse effects of the study on the subjects to the Director of the Institutional Review Board, Seton Hall University, South Orange, NJ 07079.

Lauren M. Carino — 01/29/18
RESEARCHER(S) — DATE

Please print or type out names of **all researchers below signature. Use separate sheet of paper, if necessary.**

My signature indicates that I have reviewed the attached materials of my student advisee and consider them to meet IRB standards.

Dr. Pamela Foley — Pamela Foley, PhD, ABPP — 1/30/18
RESEARCHER'S FACULTY ADVISOR [for student researchers only] — DATE

Please print or type out name below signature

The request for approval submitted by the above researcher(s) was considered by the IRB for Research Involving Human Subjects Research at the 1st Feb 2018 meeting.

The application was approved ✓ not approved ___ by the Committee. Special conditions were _____ were not ✓ set by the IRB. (Any special conditions are described on the reverse side.)

Mary F. Ruzicka Ph.D — 4/9/18
DIRECTOR, SETON HALL UNIVERSITY INSTITUTIONAL REVIEW BOARD FOR HUMAN SUBJECTS RESEARCH — DATE

Gmail

Lauren Carino < >

Fwd: RE: Following Up from APA

1 message

Lauren M Carino < > Mon, Mar 12, 2018 at 3:07 PM
To: " " < >

Get Outlook for Android

From: Nadya A Fouad < >
Sent: Wednesday, March 7, 2018 2:28:47 PM
To: Lauren M Carino
Subject: RE: Following Up from APA

Yes, you have my permission. Good luck with your study!

Nadya A. Fouad, Ph.D., ABPP

University Distinguished Professor

University of Wisconsin-Milwaukee

Mary and Ted Kellner Endowed Chair of Educational Psychology

Editor, Journal of Vocational Behavior

Special Assistant to the Provost for Conflict Resolution