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Publication Date
2018

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UNIVERSITY OF CALIFORNIA

Los Angeles

Combating Math-Gender Stereotype Threat with Parent Education in Jewish Day Schools

A dissertation submitted in partial satisfaction of the requirements for the degree Doctor of Education

by

Michelle Erin Barton

2018
ABSTRACT OF THE DISSERTATION

Combating Math-Gender Stereotype Threat with Parent Education in Jewish Day Schools

by

Michelle Erin Barton
Doctor of Education
University of California, Los Angeles, 2018
Professor Rashmita S. Mistry, Chair

There is a significant gender gap in the STEM fields—a gap that is attributable to factors that occur much earlier than previously believed and that can be linked to early interactions with prominent role models such as parents. Given the crucial role that mothers play in a child’s development, it was important to understand how they affect math anxiety and math-gender stereotype, with the long-term goal of reducing both. This design-based research study, which took place on four separate occasions at three different Jewish day school sites, engaged mothers of middle school-aged students (male and female) in a parent education workshop. The workshop was designed to teach mothers about the impact of math-gender stereotype threat and math anxiety on students’ math performance and provide them with strategies for assisting their children with math. In keeping with the design-based research model, the workshop was modified following each iteration
based on participant feedback and retrospective analysis. Results indicate that participants learned about the negative implications of math-gender stereotype threat on their children’s future math performance. Posttest survey results further indicate that mothers learned strategies to help their children with math such as how to use open-ended questions, how to put the onus on the child to answer a math problem, and how to be aware of the language they use when assisting a child with math homework. The parent education workshop developed for this study can be utilized in the future by school leaders and researchers as a first step toward combating the pervasive stereotype that “women can’t do math.” Findings from this study contribute to the field on a larger scale by potentially uncovering a small step toward greater long-term gender equity in STEM fields.
The dissertation of Michelle Erin Barton is approved.

Mark Hansen

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University of California, Los Angeles  
2018
DEDICATION

This dissertation is dedicated to my first teachers—my grandma, Sally Giel (z”l), and my uncle Bob, Robert S. Giel (z”l).

I am forever grateful to them for their unconditional love and support, and for the ways in which they helped get me to this point. I only wish they could be here to share in this milestone.

“Whoever teaches a child, teaches not only that child, but also that child’s child—and so on to the end of generations.”

—Talmud, Kiddushin, 30a
TABLE OF CONTENTS

ABSTRACT OF THE DISSERTATION .................................................................................. ii
DEDICATION ...................................................................................................................... v
LIST OF FIGURES ........................................................................................................... viii
LIST OF TABLES ............................................................................................................... ix
ACKNOWLEDGEMENTS ................................................................................................... x
VITA ..................................................................................................................................... xi

CHAPTER 1: PROBLEM STATEMENT ........................................................................... 1
  Background of the Problem .......................................................................................... 1
  Math Anxiety and Math-Gender Stereotype ................................................................. 3
  Mitigating the Effects of Math Anxiety ......................................................................... 4
  Research Aim and Overview of the Study ..................................................................... 5
  Site and Population ....................................................................................................... 5
  Research Design ........................................................................................................... 6
  Significance of the Research ........................................................................................ 7

CHAPTER 2: LITERATURE REVIEW .............................................................................. 9
  Causes of the Gender Gap in STEM Fields ................................................................... 9
  Math Anxiety ................................................................................................................ 9
  Stereotype Threat .......................................................................................................... 12
  Effects on Math-Gender Stereotype Threat .................................................................. 14
  The Role of Teachers .................................................................................................... 14
  The Role of Parents ....................................................................................................... 15
  The Particular Role of Mothers .................................................................................... 18
  Female Role Models in STEM Fields ........................................................................... 19
  Mitigating the Effects of Math Anxiety ......................................................................... 21
  Need for Parent Education and the Importance of the Home Math Environment .......... 24
  Implications for the Future ............................................................................................ 27

CHAPTER 3: RESEARCH METHODS ............................................................................ 29
  Purpose of the Study and Research Aim ....................................................................... 29
  Research Design ........................................................................................................... 30
  Research Site and Population ....................................................................................... 31
  Demographic Data ........................................................................................................ 34
  Parent Education Workshops ....................................................................................... 37
  Data Collection .............................................................................................................. 38
  Pretest Survey .............................................................................................................. 39
  Posttest Survey ............................................................................................................. 43
  Data Analysis ................................................................................................................ 44
  Vignettes ....................................................................................................................... 44
  Perceptions of Math ...................................................................................................... 45
  Involvement in Child’s Math Education ......................................................................... 45
  Participant’s Math Beliefs ............................................................................................... 45
  Aspirations for Child ...................................................................................................... 46
  Main Strategies Learned from the Parent Education Workshop ...................................... 46
LIST OF FIGURES

Figure 1: The Design-Based Research Process ................................................................. 31

Figure 2: Math Activity—How Do You See the Shapes Growing? ............................... 51
LIST OF TABLES

Table 1: Participants’ Ethnicity ................................................................. 35
Table 2: Participants’ Household Income.................................................... 35
Table 3: Highest Level of Education Completed by Participants
and Their Spouses .................................................................................. 36
Table 4: Highest Level of Math Education Completed by Participants
and Their Spouses .................................................................................. 36
Table 5: Participants’ Occupations and Their Full-Time or Part-Time Status .... 37
Table 6: Parent Education Workshop Outline—Iteration 1 (Shalom School) .... 52
Table 7: Parent Education Workshop Outline—Iteration 2 (Kavod Academy) .... 58
Table 8: Parent Education Workshop Outline—Iteration 3 (Ahava Day School) .. 63
Table 9: Parent Education Workshop Outline—Iteration 4 (Kavod Academy) .... 68
Table 10: Participants’ Perceptions of Math (Pretest) ........................................ 71
Table 11: Participants’ Perceptions of Math (Posttest) ...................................... 71
Table 12: Participants’ Involvement in Child’s Math Education (Pretest) ............ 73
Table 13: Participants’ Involvement in Child’s Math Education (Posttest) ............ 73
Table 14: Participants’ Aspirations for Child’s Math Education (Pretest) .......... 74
Table 15: Participants’ Aspirations for Child’s Overall Education (Pretest) ........ 75
Table 16: Participants’ Aspirations for Child’s Math Education (Posttest) .......... 75
Table 17: Participants’ Aspirations for Child’s Overall Education (Posttest) ........ 76
ACKNOWLEDGEMENTS

I would first like to thank my incredible committee chair, Rashmita Mistry. Your guidance, support, and calming presence was a constant source of inspiration throughout this process. I am grateful for the ways you encouraged me, challenged me, and found just the right balance between the two. Thank you also to my committee members, Mark Hansen, Gerardo Ramirez, and Linda Sax. Your feedback was invaluable, and I am grateful to have benefited from your expertise.

Thank you to the Jewish day schools, educational leaders, and mothers who graciously agreed to help me with this study. Thank you to my phenomenal colleagues and students. It is my great pleasure to learn from you each day.

To my parents, Helene and Robert Rapport: Thank you for always believing that I can do anything I put my mind to, and for helping me believe it too. Thank you for your love and patience over these past three years and the many years before that. To my in-laws, Eileen and Sal, thank you for loving me like your own daughter. Garrett and Nicole, thank you for always being there for me and for infusing joy and laughter into my life.

Leigh, Mary Ann, and Emily, thank you for the weekend writing sessions and also for the much-needed breaks from writing. I simply would not have finished this without you, and I am blessed to have you as friends.

To the love of my life, my husband, Brandon, thank you for loving me unconditionally, supporting me, and being “my person.” You have been with me through it all. I can’t find sufficient words to express my love and gratitude, but I’ll spend the rest of my life trying. Here’s to the next chapter.
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CHAPTER 1: PROBLEM STATEMENT

Background of the Problem

According to the U.S. Census Bureau’s 2009 American Community Survey, women make up 48% of the United States workforce; however, only 24% of women work in science, technology, engineering, and mathematics (STEM) fields (Beede et al., 2011). The disproportionately low number of women in STEM fields has significant implications for women as individuals and for society as a whole. As Milgram (2011) indicated, the low number of women in STEM education and STEM careers affects more than the women; it is a missed opportunity for those fields as well. Although several factors may contribute to the disparity, some researchers have posited that the lack of women in STEM fields may be attributable to the impact of math-gender stereotypes and math anxiety in girls as early as elementary and middle school (Ashcraft, 2002; Beilock, Gunderson, Ramirez, & Levine, 2010; Maloney, Schaeffer, & Beilock, 2013).

Parents have great influence over the development of young children’s academic attitudes (Gunderson, Ramirez, Levine, & Beilock, 2012). The way parents think about their children’s math ability inevitably impacts the way their children develop perceptions of themselves as math students (Gunderson et al., 2012; Jacobs, Davis-Kean, Bleeker, Eccles, & Malanchuk, 2005). Additionally, the messages that parents provide about the value they attach to mathematics can influence their children’s motivation to pursue mathematics or related fields later in life (Jacobs et al., 2005). Frequently, a parent’s perception of a child’s competence
in mathematics is influenced by the child’s gender, independent of the child’s actual performance in mathematics (Eccles, Jacobs, & Harold, 1990).

Because elementary school and middle school students are not yet fully adept at assessing their own ability, they rely on their parents for interpretation of academic performance in terms of areas of strength and need (Jacobs et al., 2005; Gunderson et al., 2012; Maloney, Ramirez, Gunderson, Levine, & Beilock, 2015). Additionally, Frome and Eccles (1998) found that parents’ perceptions have a stronger influence on children’s perceptions than children’s own grades. As a result, parents’ expectations, beliefs, and gender stereotypes regarding math aptitude can have lasting effects on children’s attitudes toward math and their subsequent achievement (Jacobs et al., 2005; Gunderson et al., 2012). The pervasiveness of parental influence was also suggested by Bleeker and Jacobs (2004), who found that, in particular, mothers’ beliefs about children’s future success in math-oriented fields was a precursor to children’s career choices 12 years later, with this effect being only partially mediated by children’s initial perceptions of their own math competence. Tomasetto, Alparone, and Cadinu (2011) found that girls whose mothers endorsed gender stereotypes related to math were especially vulnerable to the negative effects of stereotype threat.

Because many basic and fundamental ideas that children have about mathematics are constructed through their interactions with important adult figures in their environment, an analysis of mothers’ perceptions of their math ability, their attitudes toward math, as well as their perceptions of their children’s math ability and attitudes is a crucial first step in understanding children’s foundational beliefs about mathematics and their own perceived mathematical ability.
Math Anxiety and Math-Gender Stereotype

Several factors, including math anxiety and math-gender stereotypes, can play a role in the development of children’s perceived mathematical ability and their attitudes toward math. Math anxiety refers to tension, apprehension, and fear of situations involving math in both academic and non-academic settings (Ashcraft, 2002; Beilock & Willingham, 2014; Richardson & Suinn, 1972). “Math anxiety” is not synonymous with poor math ability; rather, it describes a phenomenon where a student’s math performance is impeded by feelings of anxiety (Maloney et al., 2013; Ramirez, Gunderson, Levine, & Beilock, 2013). It includes negative reactions associated with problem solving, standardized testing, or even the fear of being called on to answer a question in a math class (Maloney et al., 2013). Feelings of anxiety negatively impact math performance, and students with math anxiety may question the usefulness of math, score poorly on assessments, and fail to demonstrate basic computational and problem-solving skills (Maloney et al., 2013).

Math anxiety impedes performance by exhausting a person’s valuable working (or short-term) memory—a person’s ability to store and recall information over a short period of time (Beilock & Willingham, 2014). This type of memory is directly tied to problem-solving skills and reasoning ability. Without a strong working memory, it can be difficult to reason, comprehend, or process new information. Math anxiety taxes working memory by forcing students to manage thoughts of worry and stress while simultaneously trying to problem solve (Maloney et al., 2013; Ramirez et al., 2013). Because of its impact on working memory, math anxiety therefore compromises math performance and limits student achievement (Ramirez et al., 2013).
Early identification of math anxiety in girls is particularly critical because research has shown that such anxiety may lead students with the highest potential—students with high working memories—to avoid math and pursue non-math-related coursework and careers (Ramirez et al., 2013). Math anxiety follows young women into adulthood and grows as they are exposed to math-gender stereotypes. For example, studies show that women are susceptible to experiencing “stereotype threat” in situations where they are asked to perform mathematical tasks (Maloney et al., 2013; O’Brien & Crandall, 2003). As I discuss in more detail in the next chapter, stereotype threat refers to the phenomenon whereby an individual’s performance is inversely correlated with exposure to negative stereotypes (Cvencek et al., 2011; Maloney et al., 2013; O’Brien & Crandall, 2003). The stereotype that “girls can’t do math” becomes ingrained in young women and further exacerbates their math anxiety (Beilock & Willingham, 2014; Cvencek et al., 2011; Nosek & Smyth, 2011).

**Mitigating the Effects of Math Anxiety**

Goetz, Bieg, Lüdtke, Pekrun, and Hall (2013) posited that the gender gap in mathematics can be substantially reduced by explicitly encouraging girls (and women) not to shortchange their potential for success in math-related fields. Specifically, Goetz et al. discussed the importance of educating women about the gender gap in perceptions of math anxiety as well as the detrimental effects of girls’ and women’s beliefs that they experience more anxiety than they actually do. Providing mothers with explicit parent education regarding this phenomenon may contribute to reducing math anxiety and math-gender stereotypes in female middle school students in the long-term.
Research Aim and Overview of the Study

This study was guided by the following research aim:

**Research Aim:** The aim of this study was to design a parent education workshop to better educate mothers about the impact of math anxiety and math-gender stereotype threat on their middle school-aged children and provide them with explicit strategies to better assist their child with mathematics.

Site and Population

To address the research aim, a total of 22 mothers took part in four iterations of a parent education workshop. An individual was eligible to participate in the study if she was the mother of a middle school-aged (sixth- to eighth-grade) male or female student who attended one of the three selected Jewish day schools in the Los Angeles and Northern California areas.

The Jewish day school site selection was crucial to the study for three reasons. First, some argue that the Jewish religion and culture is centered on the mother with respect to religious roots and cultural identity as well as to educational and religious upbringing. Some men and women within Jewish communities have even adopted the “middle-class view that women are responsible for inculcating moral and religious consciousness in their children and within the home more generally” (Hyman, 1995, p. 27). This includes a child’s educational upbringing, which is intertwined with religious studies and moral development. In many homes, Jewish mothers are the primary caregivers tasked with helping to educate the children, and the weight of such a task can cause anxiety and pressure. Second, while there is limited empirical evidence to suggest that Jews—or Jewish mothers, more specifically—are somehow more anxious than any other population,
the idea certainly has cultural momentum, making this population a compelling demographic group to study (Rosmarin, Pargament, & Mahoney, 2009). Third, there is a dearth of literature about Jewish day schools, and so the focus of this study is a way to further contribute to the field of Jewish education, specifically.

Within Jewish day schools, as is the case nationwide, there is a disparity between the number of girls and boys in advanced math courses. Given that a great deal of research already exists around high school and college-aged female students’ math anxiety and attitudes about math-gender stereotype threat, it was important to collect data regarding experiences and beliefs that impact middle school-aged students. As will be clear from the literature review presented in Chapter 2, a gap in the research points to the need for mothers to receive explicit education about the impact of math anxiety and math-gender stereotypes on their middle school-aged students as well as explicit strategies to use when assisting their middle school-aged children with math.

**Research Design**

The study consisted of a design-based research approach involving four iterations of a parent education workshop. The goal of such an approach is to solve current real-world problems by designing and enacting interventions as well as extending theories and refining design principles (Design-Based Research Collective, 2003; Van den akker, Gravemeijer, McKenney, & Nieveen, 2006). This study is process oriented as opposed to outcomes oriented. Each participant took part in an approximately 60-minute workshop that addressed (a) societal beliefs about math-gender stereotype threat and (b) the ways in which mothers can have
an impact on their children’s math anxiety and endorsement of stereotype threat through explicit strategies to help their children with math.

Following each workshop delivery—and before delivering the workshop to a different group of participants—I revised the content and structure based on participants’ feedback and retrospective analysis. Pre- and posttest surveys were also administered to participants. Study participants completed the pretest survey immediately upon arrival at the parent education workshop, and were emailed a link to a posttest survey one week after the workshop. The surveys asked about the mothers’ involvement in their middle school-aged child’s math education, their perceptions of their own and their child’s math ability and attitudes, societal beliefs about gender and math, and demographic data. The surveys also contained open-ended questions in the form of vignettes, which asked mothers how they would respond to a hypothetical situation in which they were asked to help their child with math.

**Significance of the Research**

The gender gap in STEM fields is attributable to factors that occur much earlier than previously believed and can be linked to early interactions with prominent role models such as parents. Parents often transfer their own math anxiety to young children, and female students are particularly susceptible to this transference (Cvencek et al., 2011). Given the crucial role that parents play in their children’s development, it is important to understand how mothers, as prominent role models, can affect math anxiety and math-gender stereotype, with the long-term goal of reducing math anxiety and math-gender stereotyping. This
research is especially important in the pre-secondary years, where only limited research has been done so far.

This study contributes to the field by creating an empirically informed parent education workshop educating mothers about the impact of math anxiety and math-gender stereotype threat and providing mothers of middle school-aged children with strategies for assisting their children with math. The findings contribute to the field on a larger scale by uncovering one small step toward achieving greater long-term gender equity in STEM fields.
CHAPTER 2:
LITERATURE REVIEW

This literature review investigates the causes of the gender gap in STEM fields (Beede et al., 2011). Because this gender gap has been linked to math anxiety in female students as early as elementary school and middle school, this chapter also explores pervasive stereotype threat theory and math-gender stereotypes in young students. It addresses the role of teachers and parents in perpetuating math anxiety and explores the transference of math anxiety from female role models to children. Given the crucial role that parents play in developing young students’ academic identity, the chapter concludes with an investigation of the home math environment, the need for explicit parent education, and implications for the future.

Causes of the Gender Gap in STEM Fields

Math Anxiety

In 1954, Mary Fides Gough, writing in an educational journal, noted that many of her female students showed signs of emotional difficulty as they completed math assignments and that they were failing to learn the material (Gough, 1954). Gough diagnosed this problem as “mathemaphobia” and, in so doing, was one of the earliest scholars to recognize what is now termed “math anxiety.” As noted in the previous chapter, math anxiety is not the same thing as poor math ability, but it can have the same results (Maloney et al., 2013; Ramirez et al., 2013). Students may feel math-related tension, apprehension, and fear in both academic and non-academic settings (Ashcraft, 2002; Beilock & Willingham, 2014; Richardson & Suinn, 1972). These feelings can negatively impact math performance, as students
may question the usefulness of math, score poorly on assessments, and fail to demonstrate basic computational and problem-solving skills (Maloney et al., 2013).

Math anxiety impedes performance by exhausting a person’s valuable working (or short-term) memory (Beilock & Willingham, 2014). Working memory is the ability to store and recall transient information over a short period of time, and it is directly tied to problem-solving skills and reasoning ability. As students manage thoughts of worry or stress while also trying to problem solve, their working memory is taxed. The result is difficulty reasoning, comprehending, or processing new information (Maloney et al., 2013; Ramirez et al., 2013). Therefore, math anxiety can compromise math performance and limit student achievement (Ramirez et al., 2013).

The majority of studies addressing math anxiety show that it is more prevalent in female students than in male students, and it has significant implications for their achievement in particular (Beilock et al., 2010; Ramirez et al., 2013). However, a study by Hembree (1990) exposed a significant limitation in this literature. Hembree showed that female students reported higher levels of math anxiety than their male counterparts, but this did not translate into lower math performance or greater mathematics avoidance. According to Hembree, this discrepancy can be explained by the fact that females may be more willing than males to admit their anxiety.

A more recent German study supported Hembree’s findings (Goetz et al., 2013). Goetz and colleagues noted that existing research on mathematics anxiety is almost exclusively based on self-reports of trait-like habitual anxiety as opposed to state (or momentary) anxiety assessed during real-life experiences. Because
trait anxiety reporting is significantly impacted by subjective beliefs, Goetz et al. (2013) proposed that the gender gap in trait mathematics anxiety was due to the use of trait self-report methods that allow personal competence beliefs to bias reports of anxiety. The researchers hypothesized that measures of anxiety completed by students while they were actually learning about math or being tested on math content would be less impacted by students’ personal beliefs and show weaker gender differences than trait measures.

To test their hypothesis, Goetz et al. (2013) studied 584 students from 24 classes at six different schools throughout Germany. The researchers asked participants to rate how they typically felt when taking mathematics tests and courses. In order to assess trait anxiety, students were asked questions like, “How much anxiety do you generally experience during mathematics classes?” In order to assess state anxiety, students were asked, “How much anxiety are you experiencing during this class?” Responses were given on a 5-point Likert scale from 1 (not at all) to 5 (very strongly). Students were also asked about their perceived competence by responding to statements such as, “I am confident that I can understand even the most difficult content in mathematics” and “Mathematics is one of my best subjects.”

Goetz et al. (2013) found that girls did not experience more anxiety than boys during mathematics instruction and testing situations, despite reporting higher levels of math anxiety. They also found that girls’ competence beliefs were lower than those of boys despite similar achievement levels, and this may have been partly responsible for girls’ higher levels of reported mathematics anxiety. This
study suggests that girls may opt out of mathematics occupations as a result of unjustified biases and perceived anxiety levels.

**Stereotype Threat**

According to Steele and Aronson’s (1995) seminal work on stereotype threat, the existence of a stereotype means that anything one does or any of one’s features that conform to that stereotype make it that much more plausible as a self-characterization in the eyes of others, and perhaps even in one’s own eyes. Stereotype threat refers to the phenomenon whereby an individual’s performance is inversely correlated with exposure to negative stereotypes (Cvencek et al., 2011; Maloney et al., 2013; O’Brien & Crandall, 2003). Therefore, Steele and Aronson (1995) discussed that a women’s math performance is inhibited under threat not because of insufficient talent or ability, but rather because women feel threatened at the possibility that their negative performance will confirm a negative stereotype associated with their social group.

Math-gender stereotypes are a primary cause of the math anxiety and apprehension experienced by female students. As early as elementary school and middle school, girls are highly susceptible to these stereotypes; by first or second grade, students have already developed conceptions of their math ability and overall academic sense of self (Cvencek et al., 2011). Cvencek et al. (2011) studied 247 male and female American elementary school students from public and private schools throughout Seattle. Students were asked a series of questions to identify the presence of math-gender stereotypes and to evaluate the students’ math self-concept (Cvencek et al., 2011).
Cvencek et al. (2011) showed study participants two pictures of children and asked them to identify which child (boy or girl) they believed possessed a particular attribute. Students were asked questions such as, "Which child likes to do math more?" and "Which child likes to read more?" Both male and female participants strongly associated math with boys rather than with girls. To evaluate the students’ math self-concept, the researchers asked them to classify words such as “me,” “not-me,” “math,” and “reading.” Cvencek et al. found that boys associated the word “me” with “math” more often than girls did. This study demonstrates that students learn math-gender stereotypes and develop gender-distinctive math self-concepts at an early age. This is particularly significant because young children will likely have lower interest in future coursework and career paths that conflict with their notion of themselves as learners and their assessments of their academic strengths (Cvencek et al., 2011).

Math anxiety follows young women into adulthood and grows as they are exposed to math-gender stereotypes. For example, studies show that women are susceptible to experiencing stereotype threat in situations where they are asked to perform mathematical tasks (Maloney et al., 2013; O’Brien & Crandall, 2003). In one study investigating the impact of negative stereotypes on math performance, women were tasked with completing multi-step math problems (Maloney et al., 2013). The study tested two groups, a stereotyped group and a control group. Both groups performed a set of mathematical problems that served as a baseline for mathematical ability. The groups were then given another set of problems. The stereotyped group was told that the test was being used to investigate why women do worse than men in mathematics, while the control group was told that
researchers were studying problem solving. The stereotyped group’s accuracy dropped 10% from the baseline to the posttest, whereas the control group saw an increase in accuracy, likely due to practice (Maloney et al., 2013). This study suggests that the stereotype that “girls don’t do math” becomes ingrained in women and further exacerbates their math anxiety (Beilock & Willingham, 2014; Cvencek et al., 2011; Nosek & Smyth, 2011).

**Effects on Math-Gender Stereotype Threat**

**The Role of Teachers**

Math-gender stereotypes and increased math anxiety are associated with lower enrollment in math-intensive college courses, and studies show that math anxiety is particularly prominent among elementary school education majors and elementary school teachers (Beilock et al., 2010; Gunderson et al., 2012; Hembree, 1990; Ramirez et al., 2013). Over 90% of elementary school teachers are female and many of them avoid taking math courses in college as a result of their own math anxiety (Beilock et al., 2009). The National Council of Teachers of Mathematics has recommended that teachers take college coursework in areas such as numbers and operations, algebra, geometry, probability, and statistics; however, only 10% of elementary mathematics teachers have taken courses in all of these five areas (Malzahn, 2013). Moreover, the 2012 National Survey of Science and Mathematics Education identified that fewer than half of kindergarten through fifth-grade teachers had completed any coursework in statistics, probability, college geometry, or calculus (Malzahn, 2013). These elementary school teachers, having had little experience with math content post-high school graduation, are then charged with teaching math to the next generation of math students.
Female elementary school teachers’ math anxiety has particular consequences for female students (Beilock et al., 2010). Beilock et al. (2010) assessed the math anxiety of 17 first- and second-grade teachers from a Midwestern urban school district as well as the math achievement of the students in these teachers’ classrooms. They looked at students’ math achievement in the first three months of the school year and again in the last two months of school and found that highly anxious math teachers influenced girls’ math achievement. Specifically, the researchers discovered that at the beginning of the school year there was no significant relationship between teachers’ math anxiety and students’ math achievement; however, by the end of the school year, the higher a teacher’s math anxiety, the lower the girls’, but not the boys’, math achievement.

Beilock et al. (2010) concluded that female teachers model gender stereotypes about math to their students. Elementary school girls see their female teachers as role models for gender-appropriate behaviors, and when teachers dislike, fear, or demonstrate anxiety about math, whether implicitly or explicitly, girls interpret that behavior as appropriate for all girls and women. This may cause girls to adopt certain math-gender stereotypes and perpetuate math anxiety and disengagement (Beilock et al., 2010).

The Role of Parents

In addition to teachers, parents also influence the development of young children’s academic attitudes (Gunderson et al., 2012). The way a parent thinks about a child’s math ability inevitably impacts the way that child develops her perception of herself as a math student (Gunderson et al., 2012; Jacobs et al., 2005). Additionally, the messages that parents provide about the value they attach
to mathematics can influence a child’s motivation to pursue that field later in life (Jacobs et al., 2005).

Elementary and middle school students rely on their parents for interpretation of academic performance in terms of areas of strength and need (Jacobs et al., 2005; Gunderson et al., 2012; Maloney et al., 2015). In fact, Frome and Eccles (1998) found that parents’ perceptions have a stronger influence than children’s own grades. Frequently, a parent’s perception of a child’s competence in mathematics is influenced by the child’s gender, independent of the child’s actual performance in mathematics (Eccles, Jacobs, & Harold, 1990). As such, parents’ expectations, beliefs, and gender stereotypes regarding children’s math aptitude can have lasting effects on students’ attitudes toward math and their subsequent achievement (Jacobs et al., 2005; Gunderson et al., 2012).

Studies show that parents foster math ability and interest in boys without facilitating the same level of interest in girls (Jacobs et al., 2005). In one longitudinal study, researchers followed 864 children and 550 parents from 10 Michigan elementary schools over the course of their elementary, middle school, and high school years. The researchers interviewed participants on a yearly basis in order to study the development of children’s self-perceptions and activity choices (Jacobs et al., 2005). Based on these interviews, the researchers concluded that girls’ interest in math decreased as fathers’ gender stereotypes increased, whereas boys’ math interest increased as fathers’ gender stereotypes increased. The study also showed that parents purchased more math and science games and toys for sons than for daughters and held higher perceptions of sons’ math ability than daughters’ math ability (Jacobs et al., 2005). Similarly, in a cross-cultural study of
parents and children in Japan, Taiwan, and the United States, researchers found that mothers of kindergarten students in all three countries believed that boys were better at math and girls were better at reading (Lummis & Stevenson, 1990). These studies suggest that girls whose parents undervalue their math competency may be less likely to pursue math-intensive careers (Gunderson et al., 2012; Jacobs et al., 2005).

Female students are not just affected by their parents’ perceptions of their math ability. Research indicates that parents with math anxiety who help their children with math homework on a consistent basis have a negative impact on student achievement (Gunderson et al., 2012; Maloney et al., 2015). In one study, Maloney et al. (2015) examined the relationship between parents’ math anxiety and children’s mathematical attitudes and achievement. They collected data pertaining to 438 first- and second-grade students from 90 separate classrooms in 29 public, charter, and private schools in three states in the Midwest. Maloney et al. found that parents with high math anxiety who frequently helped their children with math homework negatively impacted their children’s end-of-year math achievement. Notably, even parents comfortable with basic math concepts can still suffer from math anxiety when helping their children with first- or second-grade math homework: In another study, researchers determined that even reading aloud simple math problems can induce anxiety for highly math-anxious adults (Ashcraft & Ridley, 2005). Moreover, students are more likely to emulate the behavior of same-gender adults, making girls more susceptible to mothers’ and female caregivers’ commonly held beliefs, gender stereotypes, and attitudes about math (Beilock et al., 2010).
The Particular Role of Mothers

As the previous section made clear, parents impact their children’s math attitudes and perceptions of ability. Some studies have shown that mothers, in particular, play a key role. For example, Bleeker and Jacobs (2004) found that mothers’ beliefs about children’s future success in math-oriented fields was a precursor to children’s career choices 12 years later, and this effect was only partially mediated by children’s initial perceptions of their own math competence. Likewise, Tomasetto et al. (2011) explored the moderating role of mothers’ gender stereotypes on girls’ math performance. They hypothesized that girls whose mothers endorsed gender stereotypes of math would be especially vulnerable to the negative effects of stereotype threat and would therefore show a drop in performance when gender identity was made explicit in a testing situation. They further predicted that girls whose mothers rejected gender stereotypes regarding girls’ math ability would be protected against stereotype threat and demonstrate a comparably strong performance, even when gender identity was made salient (Tomasetto et al., 2011).

Their predictions were confirmed, and the findings of this study were the first to demonstrate the moderating role of mothers’ gender stereotypes on girls’ vulnerability to stereotype threat. As predicted, decreases in performance under stereotype threat were found only for girls whose mothers did not reject the stereotypical view of math as a male-typed domain. In contrast, when mothers strongly rejected the gender stereotype, the girls performed equally well in the stereotype threat and control conditions (Tomasetto et al., 2011). Also significant is the finding that fathers’ endorsement of gender stereotypes did not moderate
girls’ susceptibility to stereotype threat. The finding that only the mothers’ beliefs were influential is consistent with some of the previous studies on the influence of parental beliefs on children’s achievement-related attitudes and behaviors (Frome & Eccles, 1998).

**Female Role Models in STEM Fields**

A large body of research shows that math-gender stereotype significantly impacts women’s math performance; however, it is not clear what impact female role models in STEM fields have on mitigating the effects of math-gender stereotype threat. Some studies show that female STEM role models have a positive impact on students, whereas other studies show that female role models in STEM fields can have a negative impact on the very students they seek to motivate.

For example, Marx and Roman (2002) sought to determine whether female role models could protect the math test performance of women who were highly skilled in math from the adverse effects of math-gender stereotype. In their study, 22 female and 21 male undergraduate participants were selected based on criteria relating to their motivation and identification with math as an academic domain. In order to determine their “identification with math,” participants were asked a series of questions in an email screening such as “How important is it for you to do well on math exams?” and “How good are you at math?” The students responded by indicating a number of 1 (not at all/very bad) or 5 (very important/excellent), and only participants who scored 3 or higher on each question were eligible to participate. Additionally, participants were required to have scored a minimum of 650 on the mathematics section of the SAT and were required to have taken at
least one math course in college to ensure that they had the skills to succeed on the math test (Marx & Roman, 2002).

The participants were greeted by either female or male experimenters who explained that they were investigating the math performance of undergraduate students. In order to create an “impression of expertise and competence,” the experimenters explained to the students that they would be taking a challenging diagnostic math test created by the experimenters, and that they would provide participants with feedback about their mathematical strengths and weaknesses following the exam (Marx & Roman, 2002). Students then had 25 minutes to complete an exam similar to the mathematics section of the GRE test.

Findings of the study revealed that highly motivated and math-identified women performed better on the math test, even in a situation that has traditionally undermined women’s test performance—when a female experimenter or role model as opposed to a male experimenter gave the test (Marx & Roman, 2002). Thus, Marx and Roman found that female role models in math-related fields could have a positive impact on “math-talented” women because they represented “stereotype-disconfirming evidence about women’s inferior math ability” (2002, p. 1183).

Although it may be difficult to extrapolate findings from this rather small sample size, researchers posited that increasing the number of female role models in math and engineering classes may allow female students to view negative gender stereotypes that confront them as surmountable rather than insurmountable barriers (Marx & Roman, 2002).

A later study by Betz and Sekaquaptewa (2012) contradicted Marx and Roman’s (2002) findings. These researchers determined that feminine STEM role
models actually reduced middle school girls’ math interest, self-rated ability, and success expectations, and demotivated rather than inspired them. Although the researchers agreed that female students can benefit from “feminine general role models,” they found that, in the specific case of female STEM role models, they had an adverse effect (Betz & Sekaquaptewa, 2012). The study suggested that although counter-stereotypic role models can inspire students, people who do not conform to stereotypes do not necessarily weaken broadly held stereotypes.

Betz and Sekaquaptewa (2012) argued that “subtyping lets people maintain stereotypes in the face of seeming disconfirmation” (p. 738). They concluded that, in order to maintain the stereotype that women are bad at math, individuals stereotype women who succeed in STEM as unfeminine. The researchers further discussed that although the feminine STEM role model is a well-intentioned attempt to counter negative stereotypes, an explicitly feminine STEM role model is more contradictory or unexpected, so it may seem unmatchable to students who are struggling the most with math. Their study suggests that these female role models cause students to feel threatened, leading to negative self-evaluations and distancing from the role model’s field of success. Additionally, the middle school girls reported that female adult scientists were “too good” or “too smart” to be feasible role models. Betz and Sekaquaptewa concluded that “STEM-disidentified” girls feel less motivated by female STEM role models than STEM-identified girls because the career path seems even less likely or attainable.

**Mitigating the Effects of Math Anxiety**

Identifying early math anxiety in elementary and middle school students is an important first step toward increasing math achievement. Research indicates
that girls with poor number processing skills are more likely to develop math anxiety (Maloney & Beilock, 2012). Maloney and Beilock suggested that early focus should therefore be placed on increasing numerical and spatial processing skills. Additionally, they recommended targeted exercises designed to boost basic mathematical competencies and regulate potential math anxiety.

In addition, math anxiety can potentially be mitigated by using expressive writing assignments prior to math assessments. Ramirez and Beilock (2011) hypothesized that an expressive writing assignment would free up working memory and alleviate math anxiety, which would in turn lead to greater academic mathematic achievement. In their study, they asked high school students to write about their feelings about an upcoming exam 10 minutes prior to the exam. As a baseline, Ramirez and Beilock tested the students’ math anxiety six weeks prior to their final exam. On the day of the final, they separated the students into two groups. The control group was asked to write for 10 minutes about a topic that would not be on their exam and the expressive writing group was asked to write about their feelings regarding the upcoming exam. The results indicated that the expressive writing group had higher overall scores on their final exam than the control group. The researchers determined that students with the highest levels of math anxiety were also those who benefited most from the writing exercises, resulting in higher overall scores (Ramirez & Beilock, 2011).

Another potential means of mitigating the effects of math anxiety is to decrease teachers’ math anxiety. Beilock and Willingham (2014) posited that decreasing a teacher’s math anxiety may decrease or even eliminate the math anxiety in the students the teacher encounters throughout her teaching career.
They suggested that teacher education programs can help mitigate the effects of teacher anxiety on students by focusing coursework on *how* to teach math concepts as opposed to simply teaching teachers about math content. Additionally, while teachers with high math anxiety often perpetuate math-gender stereotypes among their students, teachers with low math anxiety and high self-efficacy can counteract those stereotypes and encourage female students to challenge preconceptions (Gunderson et al., 2012). Finally, increasing the math requirements for elementary school teachers may mitigate the long-term effects of math anxiety on student achievement (Beilock et al., 2010).

Likewise, parents can also counteract the effects of math anxiety by understanding that their daily behaviors and attitudes toward math influence their children’s views about the importance of math. Because parents with math anxiety who help their children with math homework have a negative impact on student achievement, schools can help by providing parents with tips and guidelines for how to help students with math homework (Maloney et al., 2015). This might include providing parents with positive ways to interact with their children about math, including math board games, computer games, math apps, or other math books. Maloney et al. also suggested that schools could provide parents with instructional videos or parent education opportunities that model effective ways to assist students with math homework. With proper support, parents with math anxiety can be better equipped to positively impact their children’s math achievement and attitudes about math (Maloney et al., 2015).

Finally, addressing math-gender stereotypes can combat math anxiety. One study has shown that simply telling female students about stereotype threat prior
to an exam reduces math anxiety, protects them from stereotype threat, and improves performance. Johns, Schmader, and Martens (2005) divided 144 male and female undergraduate participants into three groups. In the first group, a male researcher told participants that they would be completing a problem-solving exercise for a study of general aspects of cognitive processes. In the second group, participants were told that they would be completing a standardized test for a study of gender differences in mathematics performance. In the third group, participants were given the same instructions as the participants in the second group, but the researcher also described stereotype threat. They also suggested to women that if they began to experience anxiety during the test, it could be the result of stereotype threat and have nothing to do with their ability to perform well on the test. The participants were then given 20 minutes to complete 30 multiple-choice word problems taken from the GRE. The study indicated that women performed worse than men when they thought they were taking a diagnostic math test, but women who learned about stereotype threat and the anxiety it could potentially cause did not show this impairment. Teaching about stereotype threat actually improved female students’ academic performance (Johns et al., 2005).

Need for Parent Education and the Importance of the Home Math Environment

International studies show that by middle school, U.S. students understand fewer mathematical concepts than their peers in many European and Asian countries (Mitchell, Hawkins, Jackwerth, Stancavage, & Dossey, 1999). Studies have also shown that in the United States, female students have lower achievement in mathematics and take fewer mathematics courses than their male counterparts,
and this gender gap is not narrowing (Hall, Davis, Bolen, & Chia, 1999; Mitchell et al., 1999). Efforts to bolster students’ mathematics learning have mainly focused on improved teacher education, modified curricula, and school-wide and district-wide programs (Sheldon & Epstein, 2005). As Sheldon and Epstein (2005) noted, researchers and practitioners have given relatively little attention to developing connections between schools, families, and communities or to the need for explicit parent education as essential components of mathematics reform. In fact, efforts to change mathematics education have positioned parents on the sidelines and, in some cases, have characterized parents more as enemies than allies to the reform effort (Peressini, 1998). This is problematic because of research indicating that positive relationships exist between parental involvement and students’ mathematical outcomes (Cai, Moyer, & Wang 1997).

Several studies have indicated that providing families with support about ways to help their children succeed in mathematics can affect students’ performance (Sheldon & Epstein, 2005). In one study, Starkey and Klein (2000) found that students whose parents attended training and information workshops and obtained materials to help their children at home made greater gains in mathematics achievement than those students whose parents did not attend the workshops, even when controlling for other factors. Additionally, a study conducted by Shaver and Walls (1998) suggested that parental involvement, regardless of the child's gender or socioeconomic status, had an influence on elementary school students' academic success, and the effect held for total reading achievement, total mathematics achievement, and application of mathematics concepts.
Parents can support children’s learning and development through the environment created in the home (Hart, Ganley, & Purpura, 2016). Although ample research exists on the benefits of the “home literacy environment” and the role it plays in strengthening children’s literacy skills, far less research exists on the impact of the “home math environment” (HME) on student achievement. HME refers to “activities that parents and their children engage in which are intended to support mathematical development, either through direct (e.g., counting or number naming) or indirect (e.g., cooking or playing store) activities” (Hart et al., 2016, p. 2). Hart et al. (2016) determined that a child’s gender played a role in the general HME, in that parents with boys reported doing more home math activities than parents with girls did. Additionally, they determined that parent gender played a role in HME, as fathers reported doing more direct HME activities, and mothers reported doing more indirect HME activities.

Given deeply rooted gender biases and perpetuations of the math-gender stereotype, home–school partnerships in mathematics may be more difficult to organize and implement than partnerships in other academic content areas. Gal and Stoudt (1995) posited three reasons why parents might not be involved in their children’s mathematics education. First, parents may not have the content knowledge to sufficiently help their children, particularly as concepts become more complex throughout the grades. Second, parents may feel confusion or resistance to some of the new ways that math is taught in their children’s schoolwork. Third, teachers are not trained in how to teach adults to work on mathematics with their children, so parents may not have the necessary training to effectively work with their children. As Sheldon and Epstein (2005) explained, these factors may serve
as significant obstacles in mathematics reform and may impact whether most or all parents are able to help their children learn mathematics at home. Although additional research is needed, educators and policymakers may see results in mathematical reform by effectively implementing activities and parent education workshops that facilitate parent–child interactions involving mathematics (Sheldon & Epstein, 2005). Additionally, policymakers should work toward helping parents increase their comfort with mathematical skills and their comfort level with implementing direct and indirect HME activities (Sheldon & Epstein, 2005).

**Implications for the Future**

In a 2003 study, researchers surveyed boys and girls in the fourth, sixth, and eighth grades who were participating in a regional mathematics contest (Leedy, LaLonde, & Runk, 2003). The participants were selected by their schools based on their interest in the mathematics competition as well as their mathematical ability. Public and private schools representing urban and rural areas of northeastern Kansas were represented in the sample. The researchers also surveyed the students’ parents (mothers and fathers) as well the students’ math coaches and teachers. Questions addressed mathematics as a male domain, perceptions of support for mathematics by the father, perceptions of support for mathematics by the mother, confidence in learning mathematics, usefulness of mathematics, and effective motivation.

Leedy et al.’s (2003) findings suggest that traditional gender-based differences in beliefs regarding mathematics persist even among mathematically talented students. Boys, fathers, and certain mathematics teachers admitted to a low level of gender stereotyping, as evidenced by their scores on the mathematics
as a male domain subscale; however, the girls, mothers, and mathematics coaches did not endorse this stereotyping. Notably, although the questions were closed-ended, several girls, female teachers, and mothers wrote in unsolicited responses on the survey. For example, one mother wrote, “I do not approve of the questions in this survey. They are very gender biased, something I thought this country was trying to discourage.” Another mother wrote, “I thought we had progressed beyond these kinds of questions 20 years ago. I found them offensive and so did my daughter” (Leedy et al., 2003, p. 288). As the authors indicated, these comments suggest that mothers perceived the survey as biased, insulting to women, and “not reflective of current times”; however, no such comments were written by boys, fathers, or male teachers.

Leedy et al. (2003) pointed to an important discrepancy that highlights the need for additional parent education, and particularly education for mothers, on the topic of math-gender stereotypes. They discussed the “unrealistic relationship” set up when mathematics is viewed as a male domain by men, yet women and girls fail to acknowledge the existence of this bias. The researchers suggested that the findings point to the essence of the conflict: “We have been schooled to discount the presence of real gender differences in mathematics. To discuss these differences, we seem to believe, is to perpetuate a gender bias” (Leedy et al., 2003, p. 290). The researchers argued that the task is not to ignore or deny differences in learning styles, but to acknowledge such differences as an essential first step in education reform.
CHAPTER 3:
RESEARCH METHODS

Although extensive research exists on math-gender stereotype threat and math anxiety in high school and college-aged students, the early emergence of math anxiety in elementary and middle school-aged students has not received as much attention. Therefore, in this study, I surveyed a group of mothers whose middle school-aged children were attending one of three private Jewish day schools. The mothers participated in a parent education workshop that addressed societal beliefs about math-gender stereotype threat and the ways in which mothers can have an impact on their children’s math anxiety and endorsement of stereotype threat through the use of explicit strategies to help their children with math. The workshop was delivered four times, with changes to each iteration based on the previous workshops. The mothers were surveyed before and after the workshop to determine their math attitudes and perceptions, as well as the strategies they gained from participation.

Purpose of the Study and Research Aim

As a Jewish day school principal, I have often observed parents, specifically mothers, expressing math anxiety and negative perceptions of their own math ability. One aim of this study was to develop a parent education workshop that would help mothers alleviate their own anxieties about math so that they would not negatively impact their children’s math performance in the future. I utilized a design-based research method to develop the workshop. Mothers learned about math anxiety and math-gender stereotype threat, as well as how their beliefs about their own math ability and their attitudes toward math might influence their
children. The ultimate aim of the research was to create a parent education workshop that would provide mothers with concrete strategies for assisting their children with math. As noted in Chapter 1, the following research aim guided this study:

**Research Aim:** The aim of this study was to design a parent education workshop to better educate mothers about the impact of math anxiety and math-gender stereotype threat on their middle school-aged children and provide them with explicit strategies to better assist their child with mathematics.

**Research Design**

This study consisted of a design-based research approach involving a parent education workshop. Educational research has often received criticism for its weak link with practice, and design-based research can contribute to more practical relevance (Van den akker et al., 2006). A design-based approach was appropriate for this study because it allowed me to take a pragmatic approach to solving a real-world problem. In particular, this approach allowed me to make substantive changes before each iteration of the workshop and to provide participants with more effective strategies to use with their children. The study was process oriented as opposed to outcomes oriented.

Wang and Hannafin (2005) identified the primary characteristics of a design-based research approach including “pragmatic, grounded, interactive, iterative and flexible, integrative, and contextual” (p. 7). These characteristics are essential in designing and enacting an intervention that will improve practice in the field of education. As shown in Figure 1, in a design-based research approach, the researcher is involved in the design processes and works together with participants, allowing for a process that has an iterative cycle of analysis, design,
implementation, and redesign (Van den akker et al., 2006). It was imperative that the research process, research findings, and changes from the initial plan be detailed and well documented in order to increase the adaptability of the findings in new settings in the future.

Figure 1. The design-based research process.

Research Site and Population

I conducted this study at three Jewish day schools in the Los Angeles and Northern California areas. As the 2013–2014 Avi Chai Foundation Jewish day school census revealed, “smallness is embedded in the Jewish day school world, as the inevitable consequence of geographic and denominational diversity” (Schick, 2014, p. 1). Nationwide, 40% of Jewish day schools have fewer than 100 students. This study focused on a small subsection within an already small population and only included mothers of middle school-aged children. An individual was eligible to
participate in the study if she was the mother of a male or female student in the sixth, seventh, or eighth grade at one of the selected Jewish day schools. Only female participants (mothers) were included in the workshop because of research suggesting that women may be better served by environments that are either non-competitive or in which they are surrounded by a greater number of female peers (Sax, 1994).

Selection of Jewish day schools as the research sites was significant for three reasons. First, some argue that the Jewish religion and culture is centered on the mother, both with respect to religious roots and cultural identity as well as educational and religious upbringing. Some men and women within Jewish communities have even adopted the “middle-class view that women are responsible for inculcating moral and religious consciousness in their children and within the home more generally” (Hyman, 1995, p. 27). This includes a child’s educational upbringing, which is intertwined with religious studies and moral development. In many homes, Jewish mothers are the primary caregiver tasked with helping to educate the child. The weight of such a task, such as educating a child, certainly has the potential to cause anxiety and pressure. Second, while there is limited empirical evidence to suggest that Jews, or Jewish mothers, are somehow more anxious than any other population, the idea has cultural momentum, making this population a compelling demographic group to study (Rosmarin et al., 2009). Third, there is a dearth of literature about Jewish day schools, and the findings can contribute to the field of Jewish education.

Although the students at Jewish day schools share a common religion, one of the key elements of Jewish day school life is the denominational and ethnic
diversity of attendees and their families. The schools mirror the religious diversity within the broader Jewish community and include Solomon Schechter (Conservative) and community schools. Jewish day schools also contain a wide array of ethnic diversity, with Israeli, Persian, European/American, Russian, and Moroccan Jews represented.

The first iteration of the parent education workshop took place at the Shalom School,¹ a Los Angeles school that includes early childhood through Grade 8. The middle school contained a total of 98 students. The school is affiliated with a Conservative synagogue and boasts a rich dual curriculum that teaches students to be serious and committed Jews and responsible American citizens. The school prides itself on the balanced development of the whole child, valuing both intellectual growth and social and emotional development.

The second and fourth iterations of the parent education workshop took place at Kavod Academy, which is located in the Los Angeles area and includes transitional kindergarten through Grade 6. The school is also affiliated with a Conservative synagogue. It had a total of 110 students, with 14 students in the sixth grade. Its mission states that through Jewish vision and values, the school raises up students who know themselves, serve others, and act to improve the world.

The third iteration of the parent education workshop took place at Ahava Day School, located in Northern California. The school is committed to promoting academic excellence, community responsibility, and vibrant Jewish living. It is a community school, which means that it does not affiliate with one particular

¹ All school sites in this study were given pseudonyms.
² "Or beyond" was added based on participant feedback and was not included in the first iteration.
synagogue or one particular denomination of Judaism. Ahava Day School had 106 students in its middle school.

I worked closely with the school site principals and heads of school in order to ensure that I had permission and access to each site. I presented the study as an opportunity to discuss how mothers can help their children be successful in a society where math-gender stereotype threat and math anxiety are pervasive. Working with the principals and heads of school, I arranged for the schools to send out an email to all potential participants, and ensured that they understood that their participation was voluntary and that my research stemmed out of a desire to impact the greater Jewish day school community.

**Demographic Data**

A total of 22 participants attended the four different iterations of the parent education workshops. As I describe in a later section of this chapter, I collected demographic data from all participants on the pretest survey. Due to the small sample size at each iteration, demographic data were not disaggregated and are instead presented as a whole.

As shown in Table 1, the majority of participants identified as White (European). Seventy-seven percent of participants reported an annual household income over $150,000 (see Table 2). All but one participant was married. Eighty-two percent (18 of 22) reported that they had earned at least a bachelor’s degree, and 76% of married participants (16 of 21) reported that their husbands had done the same (see Table 3). Fifty percent of participants (11 of 22) reported that calculus (or beyond) was the highest level of math education they had completed,
and 71% of married participants (15 of 21) reported that their spouses had done so (see Table 4).

Table 1:

*Participants’ Ethnicity*

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>% (#) of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>White (European)</td>
<td>64% (14)</td>
</tr>
<tr>
<td>Israeli</td>
<td>27% (6)</td>
</tr>
<tr>
<td>Persian</td>
<td>5% (1)</td>
</tr>
<tr>
<td>Latino (specified Mexican)</td>
<td>5% (1)</td>
</tr>
<tr>
<td>Asian</td>
<td>0% (0)</td>
</tr>
<tr>
<td>African American</td>
<td>0% (0)</td>
</tr>
<tr>
<td><strong>TOTAL PARTICIPANTS</strong></td>
<td><strong>100% (22)</strong></td>
</tr>
</tbody>
</table>

Table 2:

*Participants’ Household Income*

<table>
<thead>
<tr>
<th>Combined Household Income</th>
<th>% (#) of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over $350,000</td>
<td>36% (8)</td>
</tr>
<tr>
<td>$250,000–$349,999</td>
<td>14% (3)</td>
</tr>
<tr>
<td>$200,000–$249,999</td>
<td>9% (2)</td>
</tr>
<tr>
<td>$150,000–$199,999</td>
<td>18% (4)</td>
</tr>
<tr>
<td>$100,000–$149,999</td>
<td>18% (4)</td>
</tr>
<tr>
<td>$75,000–$99,999</td>
<td>5% (1)</td>
</tr>
<tr>
<td>$50,000–$74,999</td>
<td>0% (0)</td>
</tr>
<tr>
<td>Under $50,000</td>
<td>0% (0)</td>
</tr>
<tr>
<td><strong>TOTAL PARTICIPANTS</strong></td>
<td><strong>100% (22)</strong></td>
</tr>
</tbody>
</table>
### Table 3:

*Highest Level of Education Completed by Participants and Their Spouses*

<table>
<thead>
<tr>
<th>What is your highest level of completed education?</th>
<th>% (#) of participants</th>
<th>What is your spouse’s level of completed education?</th>
<th>% (#) of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>High school graduate</td>
<td>0% (0)</td>
<td>High school graduate</td>
<td>5% (1)</td>
</tr>
<tr>
<td>Some college</td>
<td>18% (4)</td>
<td>Some college</td>
<td>19% (4)</td>
</tr>
<tr>
<td>Bachelor’s degree</td>
<td>23% (5)</td>
<td>Bachelor’s degree</td>
<td>14% (3)</td>
</tr>
<tr>
<td>Some graduate school (no degree)</td>
<td>9% (2)</td>
<td>Some graduate school (no degree)</td>
<td>0% (0)</td>
</tr>
<tr>
<td>Master’s degree</td>
<td>36% (8)</td>
<td>Master’s degree</td>
<td>24% (5)</td>
</tr>
<tr>
<td>Doctoral degree</td>
<td>9% (2)</td>
<td>Doctoral degree</td>
<td>10% (2)</td>
</tr>
<tr>
<td>Professional degree (i.e., MD, JD, or Rabbinic ordination)</td>
<td>5% (1)</td>
<td>Professional degree (i.e., MD, JD, or Rabbinic ordination)</td>
<td>28% (6)</td>
</tr>
</tbody>
</table>

**TOTAL PARTICIPANTS** 100% (22)  **TOTAL PARTICIPANTS** 100% (21)

### Table 4:

*Highest Level of Math Education Completed by Participants and Their Spouses*

<table>
<thead>
<tr>
<th>What is your highest level of completed math education?</th>
<th>% (#) of participants</th>
<th>What is your spouse’s highest level of completed math education?</th>
<th>% (#) of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algebra</td>
<td>0% (0)</td>
<td>Algebra</td>
<td>0% (0)</td>
</tr>
<tr>
<td>Geometry</td>
<td>14% (3)</td>
<td>Geometry</td>
<td>0% (0)</td>
</tr>
<tr>
<td>Algebra 2/Trigonometry</td>
<td>14% (3)</td>
<td>Algebra 2/Trigonometry</td>
<td>10% (2)</td>
</tr>
<tr>
<td>Pre-calculus</td>
<td>23% (5)</td>
<td>Pre-calculus</td>
<td>10% (2)</td>
</tr>
<tr>
<td>Calculus (or beyond)</td>
<td>50% (11)</td>
<td>Calculus (or beyond)</td>
<td>71% (15)</td>
</tr>
<tr>
<td>I don’t know</td>
<td></td>
<td></td>
<td>10% (2)</td>
</tr>
</tbody>
</table>

**TOTAL PARTICIPANTS** 100% (22)  **TOTAL PARTICIPANTS** 100% (21)

Most participants (91%, or 20 of 22) reported that English was their primary spoken language. Seventy-three percent (16 of 22) reported that they were native English speakers, and the remaining 27% (6 of 22) reported that they were fluent
in English. Of the 17 participants (77%) who reported working outside of the home, 11 (65%) were working full time (see Table 5).

Table 5:
Participants’ Occupations and Their Full-Time or Part-Time Status

<table>
<thead>
<tr>
<th>Full-time Status</th>
<th>Part-time Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admissions Director</td>
<td>Compliance and Operations</td>
</tr>
<tr>
<td>STEM Teacher</td>
<td>Psychotherapist</td>
</tr>
<tr>
<td>Software Engineer</td>
<td>Attorney</td>
</tr>
<tr>
<td>CEO of Non-Profit</td>
<td>Business Owner</td>
</tr>
<tr>
<td>Educator</td>
<td>Diamond Dealer</td>
</tr>
<tr>
<td>Writer/Editor</td>
<td>Nutrition Consultant/International Affairs Commentator</td>
</tr>
<tr>
<td>Business Owner (Skincare Line)</td>
<td></td>
</tr>
<tr>
<td>Teacher</td>
<td></td>
</tr>
<tr>
<td>Educational Therapist</td>
<td></td>
</tr>
<tr>
<td>Healthcare Management</td>
<td></td>
</tr>
<tr>
<td>Nurse Practitioner</td>
<td></td>
</tr>
</tbody>
</table>

Parent Education Workshops

Each parent education workshop was scheduled for a total of 90 minutes. The workshop contained approximately 60 minutes of content, with an additional 30 minutes at the beginning of the session for participants to complete the pretest survey, review the study information sheet, and partake in light refreshments. The workshops took place on campus at the various school sites and each included between three and 10 participants. In keeping with the design-based research process, I revised each iteration of the parent education workshop based on
participants’ feedback and retrospective analysis prior to delivering the workshop again to a different group of participants.

As previously discussed, the workshops were designed to provide participants with scientific research about math anxiety and math-gender stereotype threat as well as the ways in which mothers’ perceptions of their math ability and attitudes toward math might impact their children. Ultimately, the goal of the parent education workshop was to provide participants with explicit strategies to use when assisting their children with math. Toward these ends, I presented workshop participants with empirical research regarding societal beliefs about women and math and gave them the opportunity to make meaning of the research by situating it within the context of each of their own “math stories,” or experiences with math. Participants also discussed a hypothetical vignette about how they might assist their children with math homework. The content of each iteration of the parent education workshop and the changes made to each iteration are discussed in detail in Chapter 4.

Data Collection

Workshop participants were given a pretest survey before the start of the workshop and were sent a posttest survey one week later. Given the sensitive nature of asking people to provide demographic data about their occupations and socioeconomic status and to reflect on their own and their children’s math ability and attitudes, an online survey was the most appropriate method of data collection. Participants were provided with an ID code so that their pre- and posttest surveys could be matched and compared during the analysis process. Participants were more likely to share their honest opinions, without giving socially desirable
responses, if they did not have to provide their answers through an in-person interview (Creswell, 2014). By employing a design-based research approach that included a pre–post design, I was able to gain insight into changes needed for subsequent iterations of the parent education workshop.

**Pretest Survey**

I emailed a link to an online pretest survey to each participant as soon as she signed in and entered the parent education workshop. (As described in the findings chapter, the exact procedure changed following the first workshop.) Participants were instructed not to talk to other participants about their answers to the survey questions and were required to complete the survey prior to the start of the workshop.

The survey took approximately 15 minutes to complete. It was designed to determine participants’ levels of math anxiety and beliefs about math-gender stereotype threat as well as their perceptions of their own and their middle school-aged child’s math ability and attitudes toward math. I also used the pretest survey to determine the initial scope of participants’ strategies for assisting their child with math.

Thirty-four statements regarding perceptions of math (nine pertaining to attitudes and eight pertaining to abilities) were drawn from the Attitude Toward Mathematics Inventory (ATMI; Tapia, 1996). An additional set of statements related to parental involvement in math and math beliefs were created for the purposes of this study and were not drawn from pre-existing instruments. The specific categories of questions are described in the remainder of this section. (See Appendix A for the complete survey.)
**Demographic information.** In the demographic information section of the pretest survey, participants were asked several screening questions to confirm that each was the mother of a middle school-aged child. They were also asked about how many children they had as well as the gender of the middle school-aged child they were considering as they answered the survey. If a participant had more than one middle school-aged child attending the site school, she was asked to complete the survey for her daughter. If a mother had more than one middle school-aged daughter attending the site school, she was asked to complete the survey for a middle school-aged daughter at random. Forty-five percent of participants (10 of 22) completed the survey with respect to a middle school-aged son, while 55% (12 of 22) completed the survey with respect to a middle school-aged daughter.

The pretest survey also asked participants about their marital status, ethnicity, highest level of education completed, highest level of math completed, primary spoken language, level of English proficiency, level of Jewish observance, and average combined household income. They were also asked about their spouse’s highest level of education and highest level of math education. Finally, they were asked whether they worked outside the home, what their occupation was, and whether the position was part-time or full-time.

**Vignette.** The pretest survey contained one open-ended question in the form of a vignette. Each participant was asked to describe her response to a hypothetical scenario in which her child asked for assistance with math. The vignette and its accompanying open-ended question were created for this study and were not drawn from pre-existing instruments. In the pretest, the question read as follows:
Your middle school-aged child comes home from school and begins working on a homework assignment. Your child instantly becomes frustrated and remarks out loud, “This is so confusing! I have no idea how find the slope using any two ordered pairs on the line! What do x- and y-intercepts even mean? Mom, can you help me?”

**What might you say to help your child in this hypothetical scenario?**

**Participant’s perceptions of math (ability and attitudes).** Participants were asked to respond to eight statements related to their math ability. These statements included: “I am good at mathematics”; “Mathematics comes easily to me”; and “As a child, I was able to complete math homework without assistance.” Each statement contained a Likert response scale that ranged from 1 (completely disagree) to 5 (completely agree).

Participants also responded to nine statements regarding their attitudes toward math. These included: “Mathematics is a very worthwhile and necessary subject”; “I get a great deal of satisfaction out of solving a math problem”; and “Mathematics was one of my most dreaded subjects in school.” Once again, each statement contained a Likert response scale that ranged from 1 (completely disagree) to 5 (completely agree).

**Child’s math ability and attitudes.** The survey included eight statements related to participants’ perceptions of their middle school-aged child’s math ability and nine statements related to the child’s attitude about math. These statements were identical to the statements about participants’ own math abilities and attitudes, except the wording began “My child feels...” and “My child thinks...” Each statement contained a Likert response scale that ranged from 1 (completely disagree) to 5 (completely agree).
Involvement in child’s math education. The survey included five multiple-choice questions related to participants’ involvement in their child’s math education. These statements included: “I am the person who helps my child with math homework”; “My spouse is the person who helps my child with math homework”; “My child works with a math tutor outside of school”; “I am aware of the concepts covered in my child’s math class”; and “I am aware of how my child is scoring on math assessments.” Participants responded to each statement using a 5-point Likert scale where 1 = never and 5 = always. For the purposes of this study, only the first three statements listed were analyzed.

Participant’s math beliefs. Fourteen statements related to participants’ own math beliefs. These statements included: “I believe that girls/women are innately good at math”; “Society believes that boys/men are innately good at math”; “I would encourage my child to pursue a career in the STEM (science, technology, engineering, math) field”; “My beliefs about my math ability influence my child’s beliefs about his/her own math ability”; “My attitude towards math influences my child’s attitude towards math”; and “My belief in math-gender stereotypes influences my child’s belief in math-gender stereotypes.” As with the questions about the participant’s math beliefs, each of these statements contained a Likert response scale that ranged from 1 (completely disagree) to 5 (completely agree).

Aspirations for child. The four questions in this section were: “How far would you like your child to advance in mathematics?”; “How far would you like your child to advance in their education?”; “How far do you think your child will advance in mathematics?”; and “How far do you think your child will advance in
their education?” The multiple-choice options for questions related to advancement in mathematics were: algebra, geometry, algebra 2/trigonometry, pre-calculus, and calculus or beyond\(^2\). The multiple-choice options for questions related to advancement in education were: some high school (no diploma), high school graduate, some college (no degree), bachelor’s degree, some graduate school (no degree), master’s degree, doctoral degree, and professional degree (MD, JD, or Rabbinic ordination).

**Posttest Survey**

The posttest survey was emailed to participants exactly one week after the parent education workshop. Participants then had one week to complete the survey online before it was closed. The posttest survey began with a reminder to participants to answer the questions thinking of the same child they thought of when completing the pretest survey. The pre- and posttest surveys were identical, with the exception of the following: (a) the posttest survey instructions read: “After participating in the parent education workshop, please fill out your responses to the following statements”; (b) the posttest survey did not contain demographic questions; (c) the pretest and posttest surveys contained slightly different hypothetical vignette scenarios (see below); and (d) the posttest survey asked participants to name the top three strategies they learned from the parent education workshop.

Once again, the vignette and its accompanying open-ended question were created for this study and were not drawn from pre-existing instruments. In the posttest, they read as follows:

\(^2\) “Or beyond” was added based on participant feedback and was not included in the first iteration.
Your middle school-aged child comes home from school and begins working on a homework assignment. Your child instantly becomes frustrated and remarks out loud, “This is so confusing! I have no idea how to solve a two-variable equation! How do you do that? Mom, can you help me?”

After participating in the parent education workshop, what might you say to help your child in this hypothetical scenario?

The purpose of the posttest survey was to measure any changes in beliefs and attitudes following the workshop, and to determine the scope of participants’ strategies for helping their middle school-aged child with math after workshop participation. This information was also used to create subsequent iterations of the parent education workshop. (See Appendix B for the full posttest survey.)

Data Analysis

I analyzed the survey data using Qualtrics software. Because of the small sample size, data were not disaggregated by site.

Vignettes

The vignettes on the pre- and posttest surveys each contained an open-ended question asking participants how they would help their middle school-aged child in the given hypothetical scenario. I coded responses based on four recurring themes: (a) responses that included specific math content, (b) responses about individuals, other than the mother herself, who might be able to assist the child, (c) responses that included open-ended questions, asked by the mother herself, and (d) responses where the mother reported a willingness to try to help the child herself and/or a response where the mother suggested a resource she and her child could use together to solve the math problem.
**Perceptions of Math**

The 34 statements about perceptions of math (ability and attitudes) with respect to the participants and their children were coded into four subscales: (a) participants’ perceptions of their math ability; (b) participants’ attitudes toward math; (c) participants’ perceptions of their child’s math ability; and (d) participants’ perceptions of their child’s attitude toward math.

I reverse coded responses as needed, summed them across the subscale, and then divided by the number of statements on that particular subscale. I also calculated the mean and standard deviation of each pre- and posttest subscale.

**Involvement in Child’s Math Education**

Participants were asked to respond to five statements about their involvement in their child’s math education. I used Qualtrics to analyze the number of participants who selected each option (never, rarely, sometimes, often, always) on the Likert scale.

**Participant’s Math Beliefs**

As noted, the statements in the math beliefs section were created for the purposes of this study. In reviewing the data and participants’ responses to this section on both the pre- and posttest surveys, I determined that the responses, or perhaps the questions themselves, were invalid. I had difficulty determining the numerical value of each response and also believed that participants were unclear about what the statements were referencing. Accordingly, I have not included findings related to math beliefs in the findings chapter.
**Aspirations for Child**

Participants were asked to respond to four multiple-choice questions regarding their aspirations for the child’s future advancement in education, in general, and their future advancement in mathematics education, specifically. I used Qualtrics to analyze the number of participants who selected each multiple-choice option.

**Main Strategies Learned from the Parent Education Workshop**

The open-ended statement that prompted participants to name three strategies they learned at the parent education workshop was coded based on six themes: (a) ask open-ended questions; (b) remove judgments about your own math ability/you don’t need high levels of math content knowledge to help your child; (c) put the onus back on your child to answer a math problem; (d) stop using self-deprecating language and/or be more mindful of the language used when speaking with a child about math; (e) be willing to help your child/engage in the process; and (f) have an awareness of math-gender stereotypes.

**Role Management and Ethical Considerations**

In order to manage my role as a principal and head of school-elect, and to reduce the risk that parents might feel pressure to participate in the study or provide socially desirable responses, I focused on my role as a graduate student in UCLA’s Educational Leadership Program. I reiterated to participants that my role as a graduate student researcher was to identify means of combating math anxiety and to address math-gender stereotype threat in middle school-aged students, and not to judge whether parents were adept at math.
Given the sensitive nature of the types of questions I asked of the participants, this study posed some ethical concerns. Because participants were asked to provide demographic data about their occupations and socioeconomic status, as well as to reflect on their own and their children’s math ability and attitudes, it was important to assure them that their answers would not be shared with anyone outside the study. I reminded them that I would have access to their answers as well as identifying information, but only for the purposes of matching their pretest and posttest surveys during the data analysis stage. In order to better protect the confidentiality of the research participants, I utilized study codes. Each participant had a unique code on her participation email and was asked to insert that code into a specified field in the online survey. Additionally, I reminded participants that participation was voluntary, and they could withdraw from the study at any point.
CHAPTER 4:

FINDINGS

This chapter reports the findings of a design-based research study that engaged mothers of middle school-aged students at Jewish day schools in parent education workshops designed to teach them about the impact of math anxiety and math-gender stereotype threat on their children, and to provide them with strategies for assisting their children with math. I discuss the specific content of the workshops, the strengths of the different iterations, and the changes made to each iteration following the first. In this chapter, I also report the results of pre- and posttest survey closed-ended responses about mothers’ perceptions of math, involvement in their children’s math education, and aspirations for their children, as well as open-ended responses to the questions about the vignettes and strategies learned.

The Research Design Process: One Iteration at a Time

Iteration 1 (Shalom School)

The first iteration of the parent education workshop was conducted at the Shalom School. The workshop took place at 7:30pm, in order to accommodate working parents. Ten participants attended the workshop—six completed the survey with respect to a daughter and four completed the survey with respect to a son.

Participants were seated in a conference room at two large round tables. A separate table was set up for refreshments and I used a projection screen and projector to display the presentation. In this first iteration, participants completed a pretest survey using a Google form. Because of a malfunction with the Google
form, the pretest survey took longer than planned, and participants spent 40 minutes on it prior to beginning the actual workshop. Participants initially attempted to complete the survey using Chromebooks from a mobile technology cart, but ultimately utilized their own mobile devices.

Following the pretest survey, the workshop began with a brief five-minute introduction and explanation of my motivation for conducting the study. I showed participants a brief clip of the 1992 Teen Talk Barbie that said, "Math class is tough" (Heybaddog, 2009) as well as images from a Google search of “women and math.” I presented the stereotype that women are not good at math and described it as a pervasive problem in our society. In this iteration—and, in fact, in all subsequent iterations—100% of the participants raised their hand when asked who had ever heard a woman remark that she was not good at math.

Participants then listened to my “math story” prior to sharing their own math stories with a partner. In telling my own math story, I modeled what I wanted participants to reflect on in their own discussions. I shared my beliefs about my math ability as a child and how those beliefs developed into adulthood, as well as my observations of the male and female role models in my life with respect to their math ability and attitudes toward math. I also discussed my mother’s beliefs about her own math ability and the ways in which her perceptions of her own math ability, and her perceptions of my math ability, influenced me.

After participants shared their math stories with a partner, I spent 10 minutes summarizing key studies from my literature review. I specifically referenced research by Maloney et al. (2013) and Ramirez et al. (2013) to introduce the term “math anxiety” and to explain that it is not synonymous with
poor math ability but rather describes a phenomenon where a student’s math performance is impeded by feelings of anxiety. I also discussed Steele and Aronson’s (1995) seminal work on stereotype threat, which showed that women’s math performance may be inhibited under threat not because of insufficient talent or ability, but because women feel threatened at the possibility that their negative performance will confirm a negative stereotype associated with their social group.

In this portion of the parent education workshop, I reinforced the idea that when a mother says she is “not good at math” or “was not good at math as a child,” it impacts her daughter’s perceptions of her own math ability because the daughter views her mother as a role model for her own predicted success and math ability. I noted that this language can also impact a mother’s son, in that he may view his mother’s math ability as a representation of all women’s math ability.

Next, I showed participants a portion of a TED Talk by Stanford Professor Jo Boaler, entitled “How You Can Be Good at Math and Other Surprising Facts about Learning,” and then introduced the concept of growth mindset (TEDx Talks, 2016; see Appendix C for a transcript of Boaler’s talk). After Boaler introduced a math problem, I paused the video so that participants could engage with a partner in that math activity. They were asked to comment only on how they saw a set of shapes growing without using an algebraic equation or function to explain the growth (see Figure 2). Once they had a chance to discuss the activity with a partner, participants watched the remainder of the video clip.
Figure 2. Math activity—How do you see the shapes growing?

Following the Boaler video, I asked participants to revisit the vignette from the pretest survey and to discuss possible strategies they could use to assist their middle school-aged child with the homework assignment referenced in it. I initially asked them to discuss this with a partner, and then opened up the conversation to a whole group discussion, which lasted roughly eight minutes. Participants then participated in a “give one, get one” protocol. They walked around the room until I said stop, at which point they turned to the participant closest to them and proceeded to “give” one fact that they learned from the workshop and “get” one fact that the other participant learned. Participants engaged in three rounds of this protocol and had the option to repeat their same fact from the first round or select another fact that they learned. The purpose was to help them remain engaged through physical movement, and also to solidify the content covered.

Once participants returned to their seats, I explained the importance of completing the posttest survey, and said I would email it to them one week from the date of the workshop. I also explained that they would have a one-week window to complete the posttest survey. I then asked them to reflect on anything
they would change for the next iteration and thanked them for attending the workshop. See Table 6 for a summary of this first iteration of the parent education workshop.

Table 6:

Parent Education Workshop Outline—Iteration 1 (Shalom School)

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
</table>
| 40 minutes | • Participants signed in; had light refreshments  
• Took pretest survey on digital device  
• Read over study information sheet in greater depth |
| 5 minutes | • Gave introduction/explanation of my motivation for doing the study |
| 2 minutes | • Showed Teen Talk Barbie clip—“Math class is tough” |
| 5 minutes | • Explained pervasive problem in our society  
  o Introduced the stereotype that women are not good at math/showed slide with images from Google search for “women and math”  
  o Showed of hands—“Who has heard a woman say that she isn’t good at math?” |
| 5 minutes | • Shared my math story  
• Participants shared their math stories with a partner |
| 10 minutes | • Orally presented research on math anxiety  
  o Fear/worry takes up working memory, not a lack of ability  
  o How to combat math anxiety (writing exercises; knowledge about it)  
• Discussed math-gender stereotype threat in my own words |
| 4 minutes | • Watched Jo Boaler video (Paused at 4:00) |
| 2 minutes | • Asked participants to turn to a partner and discuss patterns noticed in the video |
| 4 minutes | • Watched remainder of Jo Boaler video showing pattern explanations |
| 10 minutes | • Discussed responses to vignette from the pretest survey with a partner  
• Engaged in whole group discussion about strategies for assisting child with homework  
  o Presented research on adverse effects of counter-stereotypic role models |
| 5 minutes | • Used “give one, get one” protocol to share what was learned |
| 1 minute | • Shared next steps—the importance of completing the posttest survey |
| 6 minutes | • Asked participants what they might change or suggest for a future iteration |
| 1 minute | • Thanked participants for attending the workshop |
| 100 minutes | TOTAL TIME: 40 minutes devoted to pretest survey completion/reading over study information; 60 minutes of content |
Strength of Iteration 1/Changes for Iteration 2

The primary strength of the first iteration of the parent education workshop was that participants reported being aware of the pervasive stereotype that “girls and women can’t do math” and noted that this stereotype was problematic and harmful. Several participants shared later that they could not stop thinking about the session and that, after the workshop, they began noticing how many women casually say they are not good at math in everyday conversation and use self-deprecating language when describing their math ability. One participant sent me an unsolicited email following the workshop and said, “Last night, I was helping [my son] with his science project and I couldn't stop thinking about this session with you….I didn't want [my son] to think that only [his father] could help him with this!” This participant’s remark suggested her willingness to be the one to help her child.

Based on participants’ posttest survey responses and verbal feedback, as well as retrospective analysis, I made four primary changes to the next iteration: (a) I used a different data collection tool for the pretest survey; (b) I included additional instructional videos; (c) I included additional research from my literature review; and (d) I changed the placement and timing of the group discussion. I describe the rationale for these and other, smaller-scale changes in this section.

Participant feedback indicated that the Google form was not sufficiently user friendly, and there was a glitch with the multiple rows in the Likert scale. In order to prevent this error from occurring in the future, I administered the pretest survey for the second, third, and fourth iterations using Qualtrics. Participants noted that the Qualtrics interface was cleaner, more intuitive, and easier to use on a mobile
device. In addition, as I analyzed the results of the pretest and posttest surveys, I noted that I had not required answers to all questions, which resulted in nine blank responses on the question that asked for three learned strategies from the workshop. Therefore, I adjusted the survey so that all fields were required in the subsequent iterations.

Participants remarked that they appreciated the TED Talk video with Jo Boaler about growth mindset and found it engaging. Several participants suggested that I utilize additional short videos to explain math-gender stereotype threat instead of verbally explaining this concept and orally sharing the highlights of my literature review. This was consistent with my own observations regarding participants’ body language during this section of the workshop (e.g., looking down at their mobile devices, fidgeting, etc.) and also indicated that another medium might prove more effective in capturing their attention. With this in mind, subsequent iterations included additional video clips.

Based on my own retrospective analysis, I incorporated a significant piece of research from my literature review that I had neglected to include in the first iteration. I highlighted the study by Betz and Sekaquaptewa (2012), who discussed that although a female STEM role model is a well-intentioned attempt to counter negative stereotypes, she may be more contradictory or unexpected, so she may seem unmatchable to students who are struggling the most with math. Moreover, these female role models can cause students to feel threatened, leading to negative self-evaluations and distancing from the role model’s field of success. Additionally, middle school girls in the study reported that female adult scientists were outliers who were “too good” or “too smart” to be feasible role models.
Lastly, I received a great deal of feedback in terms of whether or not to allow participants the opportunity to share their thoughts out loud with the group throughout the workshop. Participants said they appreciated the opportunity to share their insights with a partner throughout the workshop, but were concerned about the whole group discussion in the middle of the workshop because there was no way to prevent a participant from “taking over” the session. Participants suggested that the whole group discussion be limited to the end of the workshop, after the “give one, get one” activity, and that it be kept to a minimum in order to help me better facilitate the workshop. I took this under advisement and altered this aspect of the workshop in the next iteration.

**Iteration 2 (Kavod Academy)**

The second iteration was conducted at Kavod Academy. I followed a similar protocol to the one used in the first workshop—including, for example, showing the video of Jo Boaler’s TED Talk (TEDxTalks, 2016) and having participants share their own math stories—but also made the changes listed in the previous section. These changes included additional video clips to illustrate key concepts.

For example, after sharing my own math story, I showed a video to demonstrate math anxiety—a clip from the game show *Who Wants to Be a Millionaire?*, where contestant Patricia Heaton expresses anxiety over mathematical calculations. (In Iteration 2, I showed this clip twice, with some discussion in between; See Appendix D for a transcript of the clip.) I also showed a *Facing History and Ourselves* (2013) video where Claude Steele explains stereotype threat. In the clip, Steele describes how telling a group of women who were skilled at math, “You may have heard that women are not as good at difficult standardized
tests, but that’s not true for this particular standardized test. The test that you’re taking today is a test in which women always do as well as men,” caused the women’s performance, which had previously been depressed as a result of stereotype threat, to match that of equally skilled men. A written transcript of this video clip is included in Appendix E.

Finally, at the conclusion of the workshop, I shared a video clip of a red carpet interview with actress Mayim Bialik. A reporter asks her if people assume she can do calculus simply because she is on the show *The Big Bang Theory*. Mayim Bialik calmly responds, “I actually was trained in calculus for several years. Yeah, I’m a neuroscientist so… you may not have known that” (SAG Awards, 2014; see Appendix F for the transcript). I told participants that I included this clip as a way to look to the future and see a world in which it is socially acceptable for women to be skilled at math and where a woman who is skilled at math is not seen as an outlier.

In addition, as I noted above, I incorporated discussion of additional research from my literature review, and participants discussed strategies related to the vignette with a partner, but I did not open the conversation up for a whole group discussion. This kept the workshop more focused and limited the unpredictability associated with unstructured whole group discussion.

This iteration of the parent education workshop took place at 8:15am. Kavod Academy assisted in the organization of the workshop and sent out a Doodle poll to all eligible participants, on my behalf, in order to get a better sense of participants’ availability. School officials noted that they typically had more success with parent events scheduled in the morning, so I kept that in mind when scheduling this
iteration. Fourteen individuals were eligible based on study criteria, and five attended the workshop. Three participants completed the survey with respect to a daughter, and two participants completed the survey with respect to a son.

Participants sat in a conference room on chairs and a couch surrounding a coffee table. I sat on another couch across from the participants and utilized a mobile technology cart to show my presentation. This comfortable setting lent itself to greater conversation among participants at the end of the workshop and created a more intimate experience, as opposed to a more formal presentation.

As participants reached the portion of the pretest survey asking them to reflect on their math ability, one participant remarked out loud, “Are we supposed to answer this honestly?” Another participant chuckled and said, “Seriously! I have anxiety just thinking about it.” I reminded participants once again not to speak with each other while taking the pretest survey and asked them to answer the survey honestly, reminding them that I would be the only person privy to their answers. It took participants 20 minutes to sign in, help themselves to refreshments, complete the pretest survey, and read over the study information sheet in greater detail.

This iteration of the parent education workshop contained 63 minutes of content. Of note, when I showed participants the TED Talk by Jo Boaler (TEDxTalks, 2016) and informed them that we would be engaging in a math activity, two participants appeared visibly apprehensive and remarked, “Oh God, we’re doing math problems?” I quickly attempted to reassure the participants that they would not be asked to complete math problems and asked them to continue watching the video.
Following the workshop, three out of the five participants stayed for an additional 22 minutes to engage in an impromptu dialogue where they shared strategies they had learned. During that conversation, one participant shared, “I learned to stop judging myself on how quickly I figure out a problem. To help doesn’t mean do it.” Another participant noted that she learned to “teach my kids how to find their own resources and take away the pressure of judging yourself.” The third participant reflected that help means “helping [my daughter] realize she does know how to do it and then having her talk it through.” When discussing how helping a child might mean serving as a sounding board, but not necessarily needing to explain the problem step by step, the second participant shared a story about her older daughter:

I actually have this experience with my other child, my tenth grader, and math. She’ll say, “I just need you to stand there. I need to talk at you. Don't even try to answer me,” which is perfect because she’s in honors pre-calculus and I have no clue. But in the end, she’ll say, “I got it!” and I’ll joke and say, “I’m glad I could help you!”

During the course of the 22-minute conversation, participants’ notions of what it means to help their middle school-aged child with math began shifting from algorithms and specific math content to more open-ended questions that could be used to guide their child toward answering the problem on his or her own. See Table 7 for an overview of the second iteration of the workshop.

**Table 7:**

Parent Education Workshop Outline—Iteration 2 (Kavod Academy)

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 minutes</td>
<td>• Participants signed in; had light refreshments</td>
</tr>
<tr>
<td></td>
<td>• Took pretest survey on digital device</td>
</tr>
<tr>
<td></td>
<td>• Read over study information sheet in greater depth</td>
</tr>
<tr>
<td>Time</td>
<td>Activity</td>
</tr>
<tr>
<td>-------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>3 minutes</td>
<td>• Gave introduction/explanation of my motivation for doing the study</td>
</tr>
<tr>
<td>2 minutes</td>
<td>• Showed Teen Talk Barbie Clip—“Math class is tough”</td>
</tr>
<tr>
<td>5 minutes</td>
<td>• Explained pervasive problem in our society</td>
</tr>
<tr>
<td></td>
<td>o Introduced the stereotype that women are not good at math/showed slide with images from Google search for “women and math”</td>
</tr>
<tr>
<td></td>
<td>o Show of hands—“Who has heard a woman say that she isn’t good at math?”</td>
</tr>
<tr>
<td>5 minutes</td>
<td>• Shared my math story</td>
</tr>
<tr>
<td></td>
<td>• Participants shared their math story with a partner</td>
</tr>
<tr>
<td>5 minutes</td>
<td>• Watched Who Wants to be a Millionaire? clip (asked participants not to comment)</td>
</tr>
<tr>
<td></td>
<td>• Paused video; told participants we would come back to it later and reflect on it</td>
</tr>
<tr>
<td>3 minutes</td>
<td>• Orally presented research on math anxiety</td>
</tr>
<tr>
<td></td>
<td>o Fear/worry takes up working memory; not a lack of ability</td>
</tr>
<tr>
<td>6 minutes</td>
<td>• Briefly discussed math-gender stereotype threat and stereotype threat in general in my own words</td>
</tr>
<tr>
<td></td>
<td>o How to combat math anxiety/math-gender stereotype threat (writing exercises; knowledge about it)</td>
</tr>
<tr>
<td></td>
<td>• Showed Claude Steele video on stereotype threat; recapped it in my own words</td>
</tr>
<tr>
<td>4 minutes</td>
<td>• Watched Jo Boaler video (Paused at 4:00)</td>
</tr>
<tr>
<td>2 minutes</td>
<td>• Asked participants to turn to a partner and discuss patterns noticed in the video</td>
</tr>
<tr>
<td>4 minutes</td>
<td>• Watched remainder of Jo Boaler video showing pattern explanations</td>
</tr>
<tr>
<td>1 minute</td>
<td>• Continued explaining my “math story”</td>
</tr>
<tr>
<td></td>
<td>o Included a discussion of how my mindset shifted from fixed mindset in childhood to more of a growth mindset in adulthood and specifically referenced how teaching math to students impacted this belief</td>
</tr>
<tr>
<td>7 minutes</td>
<td>• Discussed responses to vignette from the pretest survey with a partner</td>
</tr>
<tr>
<td></td>
<td>• Developed strategies that could be used to assist their child with math</td>
</tr>
<tr>
<td>2 minutes</td>
<td>• Presented research on adverse effects of counter-stereotypic role models</td>
</tr>
<tr>
<td>6 minutes</td>
<td>• Watched Who Wants to be a Millionaire? clip again</td>
</tr>
<tr>
<td></td>
<td>• Discussed what was happening to her in this moment (math anxiety/math-gender stereotype threat)</td>
</tr>
<tr>
<td></td>
<td>• Brainstormed how strategies in video related to strategies we discussed in terms of helping with math homework</td>
</tr>
<tr>
<td>5 minutes</td>
<td>• Used “give one, get one” protocol to share what was learned</td>
</tr>
<tr>
<td>1 minute</td>
<td>• Shared next steps—the importance of completing the posttest survey</td>
</tr>
<tr>
<td>1 minute</td>
<td>• Showed Mayim Bialik interview clip</td>
</tr>
<tr>
<td>1 minute</td>
<td>• Thanked participants for attending the workshop</td>
</tr>
</tbody>
</table>

**TOTAL TIME:** 20 minutes devoted to pretest survey completion/reading over study information; 63 minutes of content. (Three participants stayed for an additional 22 minutes of informal discussion following the workshop.)
Strengths of Iteration 2/Changes for Iteration 3

The primary strengths of the second iteration included: (a) the physical setting of the workshop and the ways in which it lent itself to deeper conversation and a less formal atmosphere; (b) the inclusion of additional media and instructional videos; (c) the limited whole group discussion that occurred during the workshop itself; (d) the impromptu conversation that occurred after the formal workshop had ended; and (e) an acknowledgment from participants that “help” might have a different definition than simply knowing the algorithm associated with a problem.

Based on participants’ posttest survey responses, as well as their written and verbal feedback, I made several changes for the third iteration. The main changes were: (a) I added an option for “calculus or beyond” in questions regarding level of completed math education, spouse’s level of completed math education, aspirations for child’s math education, and thoughts on how far the child would likely advance in math education; (b) I showed the Who Wants to Be a Millionaire? clip only once (but in two segments); and (c) I did not share in advance that participants would be asked to engage in a math activity.

Iteration 3 (Ahava Day School)

The third iteration of the parent education workshop was conducted at Ahava Day School and took place at 8:30am. Four participants attended—three completed the survey with respect to a middle school-aged son and one completed the survey with respect to a middle school-aged daughter. Participants were seated in a conference room surrounding a large boardroom table. I stood at the head of the table while giving the presentation on a large projection screen.
As participants reached the portion of the pretest survey asking them to reflect on their math ability, two different participants shared out loud that they had completed math courses beyond calculus (one had a doctorate in math and another worked as a software engineer). I acknowledged their comments but reminded them not to speak with each other while taking the pretest survey. I was concerned that their comments might influence the other participants.

As was the case in the previous iteration, it took participants 20 minutes to sign in, help themselves to refreshments, complete the pretest survey, and read over the study information sheet in greater detail.

This third iteration of the parent education workshop contained 56 minutes of content. I followed a similar protocol to the one used in the previous workshops, although I modified the order and duration of the video clips. In this iteration, I once again showed participants the clip from *Who Wants to Be a Millionaire?* (Pumpirony, 2009). After receiving feedback in the previous iteration of the parent education workshop that the clip did not need to be shown twice, I opted to only show the clip once, pausing for discussion at the point where the host of the show, Regis Philbin, begins to utilize strategies to help Patricia Heaton solve the math problem. I told participants that we would pause the video clip and watch the duration of the video at a later point in the workshop, where I would discuss these strategies.

In addition, given the comments from participants in the second iteration about their concern for having to “do math problems,” I opted not to notify participants in advance that they would be working on a math activity. Instead, they watched the video of Jo Boaler’s TED Talk (TEDxTalks, 2016), and I paused it
so they could engage in discussion about the math problem with a partner. I approached this portion of the workshop in a very matter of fact way and did not provide the time or space for participants to comment on whether they wanted to participate in this portion or whether they had fears about it. Participants were asked to comment strictly on what they saw visually without explaining the algebraic equation or function.

In this iteration I once again reinforced the idea that when a mother says she is “not good at math” or “was not good at math as a child,” it impacts her daughter’s perceptions of her own math ability because she views her mother as a role model for her own predicted success and math ability. As in previous iterations, I also noted that a mother’s son is impacted in that he views his mother’s math ability as a representation of all women’s math ability. I again highlighted the study by Betz and Sekaquaptewa (2012), which notes that although a female STEM role model is a well-intentioned attempt to counter negative stereotypes, she may be contradictory or unexpected, so she may seem unmatchable to students who are struggling the most with math.

In the third iteration, this led to a conversation about how mothers who are adept at math and feel confident in their math ability might tell their child that a homework assignment is easy, and this might actually cause the child to have increased math anxiety or a negative attitude toward math. One participant in this iteration noted on the pretest survey that she would help her son by saying, “Let’s do it. It’s not that hard.” After reflecting, she mentioned that saying a problem is not hard might not be helpful at all and might “cause math anxiety in a child who doesn’t find the problem easy.” On the posttest survey, the same participant
indicated that she would help her son by saying, “I would ask questions and see if he can find the answer himself. I will not mention that it’s easy, even if I think it is.” Another participant who had strong perceptions of her math ability and a positive attitude toward math shared,

I love math and I’m good at it. I have a Ph.D. in computer science and I’m a software engineer. My daughter doesn’t like math though. When she asks me for help, I tell her it’s easy. After seeing that video, I wonder if math-gender stereotype threat plays a role in our interactions because she knows I’m good at it, but she doesn’t want to be the one who has trouble with it and confirm the stereotype. She also wants to be cool with her friends, and the other girls in her class don’t think it’s cool to do math. Only I do!

See Table 8 for a timeline of the third iteration of the parent education workshop.

Table 8:

**Parent Education Workshop Outline—Iteration 3 (Ahava Day School)**

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
</table>
| 20 minutes | • Participants signed in; had light refreshments  
• Took pretest survey on digital device  
• Read over study information sheet in greater depth                                      |
| 2 minutes  | • Gave introduction/explanation of my motivation for doing the study                                                                    |
| 2 minutes  | • Showed Teen Talk Barbie clip—“Math class is tough”  
• Show of hands—“Who has heard a woman say that she isn’t good at math?”                  |
| 3 minutes  | • Explained pervasive problem in our society  
  ○ Introduced the stereotype that women are not good at math/showed slide with images from Google search for “women and math” |
| 2 minutes  | • Watched first portion of *Who Wants to be a Millionaire?* clip (asked participants not to comment and to pay attention to what she was saying and doing while trying to figure out the answer)  
• Paused video; told participants we would come back to it later and reflect on it         |
| 6 minutes  | • Shared my math story  
• Participants shared their math story with a partner                                                                                       |
| 3 minutes  | • Orally presented research on math anxiety  
  ○ Fear/worry takes up working memory; not a lack of ability                                                                                   |
<p>| 6 minutes  | • Briefly discussed math-gender stereotype threat and stereotype threat in general in my own words                                           |</p>
<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
</table>
| 4 minutes | • How to combat math anxiety/math-gender stereotype threat (writing exercises; knowledge about it)  
|         | • Showed Claude Steele video on stereotype threat; recapped it in my own words |
| 2 minutes | • Watched Jo Boaler video (Paused at 4:00)                                |
| 4 minutes | • Asked participants to turn to partner and discuss patterns noticed in the video |
| 4 minutes | • Watched remainder of Jo Boaler video showing pattern explanations         |
| 5 minutes | • Discussed how mothers who are adept at math and feel confident in their ability might tell their child a homework assignment is easy, and this may cause math anxiety in the child or lead the child to have a negative attitude toward math |
| 6 minutes | • Discussed responses to the vignette from the pretest survey with a partner  
|         | • Developed strategies that could be used to assist their child with math   |
| 4 minutes | • Watched remainder of Who Wants to be a Millionaire? clip                 |
| 1 minute  | • Shared next steps—the importance of completing the posttest survey       |
| 1 minute  | • Showed Mayim Bialik interview clip                                      |
| 1 minute  | • Thanked participants for attending the workshop                         |

**76 minutes TOTAL TIME: 20 minutes devoted to pretest survey completion/reading over study information; 56 minutes of content**

**Strengths of Iteration 3/Changes for Iteration 4**

I made minimal changes prior to administering the fourth and final iteration of the workshop. The most significant change was related to the order of some of the components of the workshop. In particular, I showed the *Who Wants to Be a Millionaire?* video (Pumiprony, 2009) later in the workshop—after discussing the vignette from the pretest (so that parents could point out strategies they would use to help Patricia Heaton, instead of having me point them out) and after telling my own math story (to provide participants with greater context regarding my motivation for the study). Additionally, I made a logistical decision to have
participants gather in the front office of the school and then enter the parent education workshop location at the same time so that they would complete the survey at approximately the same time and spend less time at the workshop overall.

**Iteration 4 (Kavod Academy)**

The fourth and final iteration was once again conducted at Kavod Academy. Three participants attended; two completed surveys with respect to a daughter and one completed the survey with respect to a son. Although this final iteration took place at the same school site used in the second iteration, the session itself was held in a different room in the school building. Instead of the more intimate seating on the couch used in the second iteration, participants were seated at a table while I stood in front of a computer screen to present the workshop.

As I noted above, participants gathered in the front office of the school and then all entered the parent education workshop location together at 8:15am. This enabled them to complete the pretest survey at approximately the same time and spend less time at the workshop overall. In this iteration, participants spent the least amount of time on the pretest survey (15 minutes) and were then able to spend 56 minutes on the content itself.

As in previous iterations, the workshop began with a brief introduction and explanation of my motivation for conducting the study. I once again showed participants a 1992 clip of Teen Talk Barbie saying, “Math class is tough” (Heybaddog, 2009) and images from a Google search of “women and math.” I asked participants to raise their hand if they had ever heard a woman remark that she was not good at math. As was the case in all of the iterations, 100% of
participants raised their hands. I then presented the stereotype that women are not good at math and described it as a pervasive problem in our society.

Participants listened to my own math story prior to sharing theirs with a partner. In telling my story, I again modeled what I wanted participants to reflect on in their own discussions by sharing my beliefs about my math ability as a child and how those beliefs developed into adulthood, as well as my observations of the male and female role models in my life with respect to their math ability and attitudes toward math. After participants shared their math stories with their partners, I presented the most significant aspects of my literature review. As in previous iterations, I orally presented research on math anxiety and explained that the term is not synonymous with poor math ability.

Next, I showed the *Facing History* (2013) video with Claude Steele explaining stereotype threat. I also once again highlighted the study by Betz and Sekaquaptewa (2012) to explain that while a female STEM role model may be well-intentioned, she may seem unmatchable to students who are struggling the most with math and can cause students to feel threatened, leading to negative self-evaluations and distancing from the role model’s field of success.

At this point, I showed participants the first portion of Jo Boaler’s TED Talk (TEDxTalks, 2016) and introduced the concept of growth mindset. I paused the video and had participants engage in the math activity where they were asked to strictly comment on how they saw a pattern growing visually without explaining the algebraic equation or function. After discussing the patterns with a partner, participants watched the remainder of the video, which describes various ways to visualize the pattern.
During the next portion of the workshop, participants revisited the vignette from the pretest survey and discussed possible strategies they could use to assist their middle school-aged child with the homework assignment. Participants once again only discussed the strategies with their partner, as opposed to a whole group discussion, and then I repeated strategies that I overheard them discuss. Based on feedback from earlier iterations, I did this to limit whole group conversation and maintain control over the direction of the workshop. As in the previous iterations, this technique was successful in limiting whole group discussion and keeping the workshop on track. I also reinforced the idea that when a mother says she is “not good at math” or “was not good at math as a child,” it can impact her children’s perceptions of their own ability and that of their peers.

Participants then watched a portion of the *Who Wants to Be a Millionaire?* video (Pumpirony, 2009). They identified that Patricia Heaton was experiencing math anxiety and noted how math-gender stereotype threat may have played a role in her inability to initially answer the question for fear of confirming the stereotype that women are not good at math. Participants noted her self-deprecating language and reflected on the ways in which the show’s host, Regis Philbin, helped her arrive at the correct answer to the math problem, just as they might help their own child with a math problem.

Participants then participated in multiple rounds of the “give one, get one” protocol. The purpose was once again to help participants remain engaged through physical movement and to solidify the content covered. Once participants returned to their seats, I explained the importance of completing the posttest survey, which would be emailed to them one week from the date of the workshop. I also
explained that they would have a one-week window to complete the posttest survey and made sure to mention that up until this point, I had a 100% response rate from pretest to posttest, and I wanted their help to continue the streak. To close the workshop, I shared the video clip of Mayim Bialik’s red carpet interview (SAG Awards, 2014) and explained that I included the clip as a way to look to the future and see a world in which it is socially acceptable and not unusual for women to be skilled at math. I then thanked the participants for attending the workshop. The fourth iteration of the parent education workshop is outlined in Table 9.

Table 9:

**Parent Education Workshop Outline—Iteration 4 (Kavod Academy)**

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
</table>
| 15 minutes | • Participants signed in  
• Took pretest survey on digital device  
• Read over study information sheet in greater depth                                      |
| 2 minutes | • Gave introduction/explanation of my motivation for doing the study                                                                     |
| 2 minutes | • Showed Teen Talk Barbie Clip—“Math class is tough”                                                                                     |
| 4 minutes | • Explained pervasive problem in our society                                                                                               
  o Introduced the stereotype that women are not good at math/showed slide with images from Google search for “women and math”  
  o Show of hands—“Who has heard a woman say that she isn’t good at math?”                                                                 |
| 5 minutes | • Shared my math story  
• Participants shared their math story with a partner                                                                                   |
| 3 minutes | • Orally presented research on math anxiety                                                                                               
  o Fear/worry takes up working memory; not a lack of ability  
  o How to combat math anxiety (writing exercises; knowledge about it)                                                                     |
| 4 minutes | • Briefly discussed math-gender stereotype threat, and stereotype threat in general, in my own words  
• Showed Claude Steele video on stereotype threat                                                                                         |
| 2 minutes | • Presented research on adverse effects of counter-stereotypic role models                                                               |
| 4 minutes | • Watched Jo Boaler video (Paused at 4:00)                                                                                               |
| 2 minutes | • Asked participants to turn to partner and discuss patterns noticed in the video                                                        |
| 4 minutes | • Watched remainder of Jo Boaler video showing pattern explanations                                                                      |
8 minutes
• Discussed responses to the vignette from the pretest survey with a partner
• Developed strategies that could be used to assist their child with math

2 minutes
• Watched first portion of the Who Wants to be a Millionaire? clip (Stopped at 5:19)

4 minutes
• Discussed what was happening to Patricia Heaton in this moment
• Brainstormed strategies participants would employ to help her solve the problem

2 minutes
• Watched remainder of Who Wants to be a Millionaire? clip

5 minutes
• Used “give one, get one” protocol to share what was learned

1 minute
• Shared next steps—the importance of completing the posttest survey

1 minute
• Showed Mayim Bialik interview clip

1 minute
• Thanked participants for attending the workshop

**71 minutes**  TOTAL TIME: 15 minutes devoted to pretest survey completion/reading over study information; 56 minutes of content

**Strengths of Iteration 4**

As previously mentioned, I made minimal changes between the third and fourth iterations; however, the changes that were made were effective. The primary strengths of the fourth iteration included: (a) participants gathering in the front office prior to the start of the workshop so that they could complete the pretest survey at approximately the same time; and (b) a revised order of the video clips so that participants could use the strategies learned earlier in the workshop to suggest potential strategies that might help Patricia Heaton in the featured video. In changing the order of the video clips, participants were able to make meaning for themselves and relate the new information learned to a new context and experience. Based on retrospective analysis and posttest data, I deemed the fourth iteration of the parent education workshop to be successful. In Chapter 5, I discuss changes I might make if I were given the opportunity to present another iteration of the parent education workshop in the future.
Survey Results

In this section I describe the findings from the pretest surveys, which were administered at the workshops, and the posttest surveys, which were administered approximately one week later.

Perceptions of Math

As described in Chapter 3, the pre- and posttest surveys included 34 statements about perceptions of math that were coded into four subscales: (a) participants’ perceptions of their math ability; (b) participants’ attitudes toward math; (c) participants’ perceptions of their middle school-aged child’s math ability; and (d) participants’ perceptions of their middle school-aged child’s attitude toward math. Participants responded to each statement using a 5-point Likert scale (1 = completely agree, 2 = disagree, 3 = neutral, 4 = somewhat agree, and 5 = agree). Responses were reverse coded as needed, summed across the subscale, and then divided by the number of statements on that particular subscale. Both the mean and standard deviation of each pre- and posttest subscale were also calculated.

As shown in Tables 10 and 11, the participants scored a 3.69 on the pretest and a 3.65 on the posttest when asked about their perceptions of their own math ability. With respect to their attitudes toward math, participants scored an average of 4.0 on the pretest survey and a 3.91 on the posttest survey. They reported an average score of 3.95 on the pretest and 3.89 on the posttest when asked about their perceptions of their child’s math ability. Finally, participants reported an average score of 3.98 on the pretest and 4.0 on the posttest when asked about their perceptions of their child’s attitude toward math.
Table 10:

*Participants’ Perceptions of Math (Pretest)*

<table>
<thead>
<tr>
<th>Perceptions of Math (Subscales)</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mothers’ Perceptions of Their Math Ability</td>
<td>3.69</td>
<td>0.91</td>
</tr>
<tr>
<td>Mothers’ Attitude Toward Math</td>
<td>4.00</td>
<td>0.64</td>
</tr>
<tr>
<td>Mothers’ Perceptions of Their Child’s Math Ability</td>
<td>3.95</td>
<td>0.60</td>
</tr>
<tr>
<td>Mothers’ Perceptions of Their Child’s Attitude Toward Math</td>
<td>3.98</td>
<td>0.55</td>
</tr>
</tbody>
</table>

Table 11:

*Participants’ Perceptions of Math (Posttest)*

<table>
<thead>
<tr>
<th>Perceptions of Math (Subscales)</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mothers’ Perceptions of Their Math Ability</td>
<td>3.65</td>
<td>0.81</td>
</tr>
<tr>
<td>Mothers’ Attitude Toward Math</td>
<td>3.91</td>
<td>0.69</td>
</tr>
<tr>
<td>Mothers’ Perceptions of Their Child’s Math Ability</td>
<td>3.89</td>
<td>0.50</td>
</tr>
<tr>
<td>Mothers’ Perceptions of Their Child’s Attitude Toward Math</td>
<td>4.00</td>
<td>0.50</td>
</tr>
</tbody>
</table>

**Involvement in Math Education**

Pre- and posttest surveys included a series of statements about the mothers’ involvement in their child’s math education. In this section, I present findings from questions pertaining to how often workshop participants help their middle school-aged child with homework, how often their spouses do so, and how often their middle school-aged child works with a math tutor outside of school. Findings are presented in Tables 12 and 13.

**Helps child with homework.** Across all iterations, six participants (27%) reported in the pretest that they are never the person who helps their middle school-aged child with math homework, four (18%) reported they are rarely the
person who helps with math homework, nine (41%) reported that they are sometimes the person who helps this child with math homework, and three (14%) reported that they are often the person who helps this child with math homework.

On the posttest survey, two participants (9%) reported that they are never the person who helps their middle school-aged child with math homework, six (27%) reported that they are rarely the person who helps this child with math homework, nine (41%) reported that they are sometimes the person who helps this child with math homework, four (18%) reported that they are often the person who helps this child with math homework, and one participant (5%) reported that she is always the person who helps this child with math homework.

**Spouse helps with homework.** Eleven participants across all iterations (50%) reported in the pretest that their spouse is sometimes the person who helps their middle school-aged child with math homework, and only three (14%) said their spouse often or always did so. In the posttest data, 11 participants (50%) reported that their spouse is sometimes the person who helps their child with math homework, and two (9%) said their spouse often or always did so.

**Child works with math tutor.** In the pretest, 14 participants (64%) reported that their child never works with a math tutor outside of school. Results were largely the same on the posttest, where 13 participants (59%) reported that their child never works with a tutor.
Table 12:
Participants’ Involvement in Child’s Math Education (Pretest)

<table>
<thead>
<tr>
<th>I am the person who helps my child with math homework.</th>
<th>% (#) of participants</th>
<th>My spouse is the person who helps my child with math homework.</th>
<th>% (#) of participants</th>
<th>My child works with a math tutor outside of school.</th>
<th>% (#) of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>27% (6)</td>
<td>Never</td>
<td>18% (4)</td>
<td>Never</td>
<td>64% (14)</td>
</tr>
<tr>
<td>Rarely</td>
<td>18% (4)</td>
<td>Rarely</td>
<td>18% (4)</td>
<td>Rarely</td>
<td>9% (2)</td>
</tr>
<tr>
<td>Sometimes</td>
<td>41% (9)</td>
<td>Sometimes</td>
<td>50% (11)</td>
<td>Sometimes</td>
<td>18% (4)</td>
</tr>
<tr>
<td>Often</td>
<td>14% (3)</td>
<td>Often</td>
<td>9% (2)</td>
<td>Often</td>
<td>9% (2)</td>
</tr>
<tr>
<td>Always</td>
<td>0% (0)</td>
<td>Always</td>
<td>5% (1)</td>
<td>Always</td>
<td>0% (0)</td>
</tr>
<tr>
<td>TOTAL PARTICIPANTS</td>
<td>100% (22)</td>
<td>TOTAL PARTICIPANTS</td>
<td>100% (22)</td>
<td>TOTAL PARTICIPANTS</td>
<td>100% (22)</td>
</tr>
</tbody>
</table>

Table 13:
Participants’ Involvement in Child’s Math Education (Posttest)

<table>
<thead>
<tr>
<th>I am the person who helps my child with math homework.</th>
<th>% (#) of participants</th>
<th>My spouse is the person who helps my child with math homework.</th>
<th>% (#) of participants</th>
<th>My child works with a math tutor outside of school.</th>
<th>% (#) of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>9% (2)</td>
<td>Never</td>
<td>9% (2)</td>
<td>Never</td>
<td>59% (13)</td>
</tr>
<tr>
<td>Rarely</td>
<td>27% (6)</td>
<td>Rarely</td>
<td>32% (7)</td>
<td>Rarely</td>
<td>14% (3)</td>
</tr>
<tr>
<td>Sometimes</td>
<td>41% (9)</td>
<td>Sometimes</td>
<td>50% (11)</td>
<td>Sometimes</td>
<td>18% (4)</td>
</tr>
<tr>
<td>Often</td>
<td>18% (4)</td>
<td>Often</td>
<td>9% (2)</td>
<td>Often</td>
<td>9% (2)</td>
</tr>
<tr>
<td>Always</td>
<td>5% (1)</td>
<td>Always</td>
<td>0% (0)</td>
<td>Always</td>
<td>0% (0)</td>
</tr>
<tr>
<td>TOTAL PARTICIPANTS</td>
<td>100% (22)</td>
<td>TOTAL PARTICIPANTS</td>
<td>100% (22)</td>
<td>TOTAL PARTICIPANTS</td>
<td>100% (22)</td>
</tr>
</tbody>
</table>

Aspirations for Child

Participants were asked to respond to four multiple-choice questions regarding their aspirations for their middle school-aged child’s advancement in
education in general and in mathematics specifically. On the pretest survey, across iterations, a majority of participants (77%) wanted their child to advance to calculus or beyond, and 81% believed that their child would, in fact, do so. All participants (100%) wanted their child to earn at least a bachelor’s degree and 100% believed their child would do so (see Tables 14 and 15).

On the posttest survey, on average across the iterations, a majority of participants (73%) once again wanted their child to advance to calculus or beyond, and 77% believed that he or she would do so. Once again, 100% of participants wanted their child to earn at least a bachelor’s degree and believed their child would do so (see Tables 16 and 17).

Table 14:

Participants’ Aspirations for Child’s Math Education (Pretest)

<table>
<thead>
<tr>
<th>How far would you like your child to advance in mathematics?</th>
<th>% (#) of participants</th>
<th>How far do you think your child will advance in their education?</th>
<th>% (#) of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculus or beyond</td>
<td>77% (17)</td>
<td>Calculus or beyond</td>
<td>81% (18)</td>
</tr>
<tr>
<td>Pre-calculus</td>
<td>18% (4)</td>
<td>Pre-calculus</td>
<td>5% (1)</td>
</tr>
<tr>
<td>Algebra 2/Trigonometry</td>
<td>5% (1)</td>
<td>Algebra 2/Trigonometry</td>
<td>9% (2)</td>
</tr>
<tr>
<td>Geometry</td>
<td>14% (3)</td>
<td>Geometry</td>
<td>5% (1)</td>
</tr>
<tr>
<td>Algebra</td>
<td>0% (0)</td>
<td>Algebra</td>
<td>0% (0)</td>
</tr>
<tr>
<td><strong>TOTAL PARTICIPANTS</strong></td>
<td><strong>100% (22)</strong></td>
<td><strong>TOTAL PARTICIPANTS</strong></td>
<td><strong>100% (22)</strong></td>
</tr>
</tbody>
</table>
Table 15:
Participants’ Aspirations for Child’s Overall Education (Pretest)

<table>
<thead>
<tr>
<th>How far would you like your child to advance in their education?</th>
<th>% (#) of participants</th>
<th>How far do you think your child will advance in their education?</th>
<th>% (#) of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional degree (i.e., MD, JD, or Rabbinic ordination)</td>
<td>27% (6)</td>
<td>Professional degree (i.e., MD, JD, or Rabbinic ordination)</td>
<td>32% (7)</td>
</tr>
<tr>
<td>Doctoral degree</td>
<td>0% (0)</td>
<td>Doctoral degree</td>
<td>0% (0)</td>
</tr>
<tr>
<td>Master’s degree</td>
<td>59% (13)</td>
<td>Master’s degree</td>
<td>45% (10)</td>
</tr>
<tr>
<td>Some graduate school (no degree)</td>
<td>0% (0)</td>
<td>Some graduate school (no degree)</td>
<td>0% (0)</td>
</tr>
<tr>
<td>Bachelor’s degree</td>
<td>14% (3)</td>
<td>Bachelor’s degree</td>
<td>23% (5)</td>
</tr>
<tr>
<td>TOTAL PARTICIPANTS</td>
<td>100% (22)</td>
<td>TOTAL PARTICIPANTS</td>
<td>100% (22)</td>
</tr>
</tbody>
</table>

Table 16:
Participants’ Aspirations for Child’s Math Education (Posttest)

<table>
<thead>
<tr>
<th>How far would you like your child to advance in mathematics?</th>
<th>% (#) of participants</th>
<th>How far do you think your child will advance in their education?</th>
<th>% (#) of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculus or beyond</td>
<td>73% (16)</td>
<td>Calculus or beyond</td>
<td>77% (17)</td>
</tr>
<tr>
<td>Pre-calculus</td>
<td>23% (5)</td>
<td>Pre-calculus</td>
<td>9% (2)</td>
</tr>
<tr>
<td>Algebra 2/trigonometry</td>
<td>0% (0)</td>
<td>Algebra 2/trigonometry</td>
<td>9% (2)</td>
</tr>
<tr>
<td>Geometry</td>
<td>5% (1)</td>
<td>Geometry</td>
<td>5% (1)</td>
</tr>
<tr>
<td>Algebra</td>
<td>0% (0)</td>
<td>Algebra</td>
<td>0% (0)</td>
</tr>
<tr>
<td>TOTAL PARTICIPANTS</td>
<td>100% (22)</td>
<td>TOTAL PARTICIPANTS</td>
<td>100% (22)</td>
</tr>
</tbody>
</table>
Table 17:

Participants’ Aspirations for Child’s Overall Education (Posttest)

<table>
<thead>
<tr>
<th>How far would you like your child to advance in their education?</th>
<th>% (#) of participants</th>
<th>How far do you think your child to advance in their education?</th>
<th>% (#) of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional degree (i.e., MD, JD, or rabbinic ordination)</td>
<td>22% (5)</td>
<td>Professional degree (i.e., MD, JD, or rabbinic ordination)</td>
<td>32% (7)</td>
</tr>
<tr>
<td>Doctoral degree</td>
<td>14% (3)</td>
<td>Doctoral degree</td>
<td>18% (4)</td>
</tr>
<tr>
<td>Master’s degree</td>
<td>45% (10)</td>
<td>Master’s degree</td>
<td>36% (8)</td>
</tr>
<tr>
<td>Some graduate school (no degree)</td>
<td>5% (1)</td>
<td>Some graduate school (no degree)</td>
<td>0% (0)</td>
</tr>
<tr>
<td>Bachelor’s degree</td>
<td>14% (3)</td>
<td>Bachelor’s degree</td>
<td>14% (3)</td>
</tr>
<tr>
<td><strong>TOTAL PARTICIPANTS</strong></td>
<td><strong>100% (22)</strong></td>
<td><strong>TOTAL PARTICIPANTS</strong></td>
<td><strong>100% (22)</strong></td>
</tr>
</tbody>
</table>

Vignettes

The vignettes on the pre- and posttest surveys each contained an open-ended question asking participants how they would help their middle school-aged child in a hypothetical scenario. Responses were coded based on four recurring themes: (a) responses that included specific math content; (b) responses about individuals, other than the mother herself, who might be able to assist the child; (c) responses that included open-ended questions asked by the mother herself; and (d) responses where the mother reported a willingness to try to help the child and/or a response where the mother suggested a resource she and her child could use together to solve the math problem.

**Specific math content.** On the pretest survey, three participants (14%) indicated they would help their child by explaining specific math content. Their responses included: “x- and y-intercepts are the points where the line cross. The
place they meet. And slope is like the angle of the line, its steepness”; “Let me show you what those intercepts are, using a graph”; and “x crosses the x axis and y crosses the y axis.” Notably, in the posttest none of the responses focused on the specific math content or algorithm associated with the problem.

**Help from others.** Five participants on the pretest (23%) referenced someone other than themselves who might be able to help. Examples of responses coded under this theme include: “Wait until your sister gets home”; “I can’t remember how to do this. Can you call a friend?”; “Do you need me to schedule a session with the tutor?”; and “I will ask my husband.”

On the posttest survey, two participants mentioned another individual who might be able to help the child with math homework. In both cases, however, the mother’s response indicated that she was willing to try to help her child before mentioning the other person. For example, one mother said she would say, “Let me try and help you before you wait to ask your sister.” Another indicated she would respond as follows:

Please read me the questions aloud. Let’s look over your notes from class today and yesterday. Let’s look at your textbook/website for the class. Then you can phone a friend, email teacher...make a plan to go to office hours tomorrow.

**Open-ended questions.** Three participants on the pretest (14%) indicated they would ask their child an open-ended question to help with the homework. These responses included: “Take a deep breath. Okay, what do you remember from class?”; “Can you please read the problem out loud?”; and “What did you do in class?”
On the posttest, six participants (27%) indicated they would ask their child an open-ended question to help with their math homework. These responses included: “Have you done any problems like this already?”; “What exactly is confusing for you?”; “Think back to class. What did you learn today?”; “Can you read the problem to me aloud?”; and “Can you show me what you’re working on?”

**Willingness to help.** Eleven of the participants in the pretest (50%) were willing to help the child and/or suggest a resource they could use together to solve the problem. For example, these responses include: “Calm down, and let’s look at it together”; “Let’s look at your book or your notes together”; “Let’s take a look at the book together and see if we can figure out what to do”; and “Sure, let’s look at it together.”

In the posttest, 14 participants (64%) were willing to help their child and/or suggest a resource they could use together to solve the problem. For example: “Let’s look at the book together and see how they suggest solving this”; “Let’s look at your notes and see how you did this in class”; “Let’s take a moment and talk through what you learned in class”; and “I might help her look on the internet to find an answer.”

**Strategies Learned in the Workshop**

Participants were asked to name three strategies they learned at the parent education workshop they attended, and their open-ended responses were coded into six themes: (a) ask open-ended questions; (b) remove judgments about your own math ability/you don’t need high levels of math content knowledge to help your child; (c) put the onus back on your child to answer a math problem; (d) stop using self-deprecating language and/or be more mindful of the language used when
speaking with a child about math; (e) be willing to help your child/engage in the process; and (f) have an awareness of math-gender stereotypes.

Out of a total of 66 possible responses (22 participants multiplied by three strategies), nine responses were left blank. As I mentioned previously, this field was not required in the first iteration, which resulted in several participants leaving one or two strategy fields blank. This field was required in subsequent iterations. Percentages in this section have therefore been calculated out of a total of 57, instead of 66.

**Open-ended questions.** Seven responses (12%) indicated that participants learned to ask their child open-ended questions. Examples of these responses included: “Ask questions; do not give solutions”; “Ask child to talk it through”; “Ask child to read problem aloud”; and “Have her talk it through.”

**Remove judgment.** Six responses (11%) referenced removing judgments about participants’ own math ability and not needing high levels of math content knowledge to help a child with math homework. For example: “Don’t project your insecurities onto your child”; “I learned to stop judging myself on how quickly I figure out a problem”; “It’s not always necessary to understand the math in order to help my kids with their homework”; “Take away pressure of judgment...”; and “You don’t need to know high level math to figure out problems.”

**Put onus on child.** Six responses (11%) referenced having learned to place the onus on the child to answer a math homework problem. Responses for this coding theme included: “Teach kids how to find their own resources”; “Help her to realize she does know how to do it”; and “Help the child go step by step so she’ll figure it out.”
**Mindfulness about language.** Ten responses (18%) indicated that participants learned not to use self-deprecating language and/or were more mindful of the language used when speaking with their child about math. Examples of these types of responses included: “Don’t say you’re bad at something”; “What we say about our abilities matter”; “Positive self-talk”; “To not be self-deprecating about my math ability”; “To be conscious of my comments about math around my kids”; “Removing self-deprecating language when communicating our own math aptitude with our children”; and “I learned to be more careful when speaking to my child about math.”

**Willingness to help.** Six responses (11%) indicated that participants learned to be willing to engage in the process of helping their child with math. Responses included: “I learned to encourage my daughter in math” and “I learned to offer to help my child.”

**Awareness of stereotypes.** Seven responses (12%) indicated that participants learned about math-gender stereotype threat from the parent education workshop. These responses included: “I have an awareness of math-gender stereotypes”; “As a woman, don’t downplay your understanding of math”; “I learned to discuss stereotypes openly, to uncover unconscious bias”; and “Women shouldn’t have to work as hard to justify their role in society when it comes to math.”

Three participants (5%) shared two strategies and indicated that they could not recall a third. Responses included, “I honestly can’t remember anything new in terms of strategies,” “N/A,” and “Unsure of third [strategy].” The remaining responses were not coded according to one of the six established themes.
Conclusion

This chapter discussed the specific content of the parent education workshops, the strengths and challenges of the different iterations, and the changes made to subsequent iterations. This chapter also reported on the results of pre- and posttest survey closed-ended responses about mothers’ perceptions of math, involvement in their child’s math education, and aspirations for their child, as well as open-ended responses from vignettes and strategies learned.

After participating in a parent education workshop, participants in the study reported having concrete strategies to use when assisting their middle school-aged child with math. These strategies included asking open-ended questions and placing the onus back on the child to answer a given math problem. Additionally, posttest survey data as well as my observations suggest that participants learned about math-gender stereotype threat and learned to be aware of the language they use when discussing mathematics with their child.

The findings indicate that parent education workshops geared specifically toward mothers might be one small step in building greater awareness about math-gender stereotype threat and might help educators move toward addressing the potentially harmful stereotype that “women can’t do math.” The next chapter will outline recommendations based on these findings.
CHAPTER 5:

DISCUSSION

In this chapter, I reflect on the significance of the findings in light of previous research and consider limitations inherent in the study. I then consider the implications of this study for other researchers and school leaders as well as new research opportunities suggested by the study’s findings. I conclude with a reflection on the process of conducting this study as a whole as well as general implications for the future.

Significance of Findings

Maloney et al. (2015) suggested that schools should provide parents with instructional videos or parent education opportunities that model effective ways to assist students with their math homework, but they did not include examples of these specific tools or tell parents where to go to access them. The parent education workshop developed and outlined in this study serves as a first step toward teaching mothers how to help their children with math homework. The parent education workshop can also inform mothers about how their own math anxieties can impact their children and encourage them to be aware of the language they use when discussing math with their children.

This study builds on existing research on how school leaders and policymakers can involve parents in a necessary mathematics reform process. As described in Chapter 2, Gal and Stoudt (1995) posited that parents may not be involved in their children’s math education because they may lack the necessary content knowledge, they may feel confusion about how math is being taught in their children’s schools, and (because teachers are not trained in how to teach
other adults) they may not have the necessary training to effectively work with their children. These factors may serve as significant obstacles in mathematics reform and affect whether parents are able to help their children learn mathematics at home (Sheldon & Epstein, 2005). Sheldon and Epstein (2005) further noted that educators and policymakers may see results in mathematics reform by effectively implementing activities and parent education workshops that facilitate successful parent–child interactions. As such, my study built upon this work by providing school leaders and educational researchers with a developed and fully articulated parent education workshop.

In developing the workshop, I relied heavily on research regarding adult learning theory. This research indicates that adults benefit from learning, brainstorming, reflecting, and interacting with other adult learners, and that a collaborative learning environment helps adults later perform the skills they learn (Merriam, 2008). Merriam, Caffarella, and Baumgartner (2006) noted that adults are more open to new learning when they can relate new information to their own experiences, as opposed to the experiences of others. Additionally, research shows that adult learners in particular have a need to understand how new knowledge fits in with their pre-existing knowledge on a given topic (Merriam, 2008).

With these findings in mind, I designed a parent education workshop in which participants were presented with empirical research regarding societal beliefs about women and math as well as scientific research on math anxiety and math-gender stereotype threat. I provided participants with opportunities to understand the research by situating it within the context of their own “math stories.” Participants at each workshop were given time to describe their experiences with math and to
discuss a hypothetical vignette about how they might assist their children with math homework. This provided them with the opportunity to learn, brainstorm, reflect, and interact with other adult learners in an effort to construct meaning in a collaborative learning environment.

**Lessons Learned/Subsequent Iterations**

The collaborative learning environment created during the parent education workshop was a meaningful way to teach mothers about the impact of math anxiety and math-gender stereotype threat on their children. I appreciated the opportunity to focus on a real-world problem and offer a potential solution in the form of parent education. The research process was a humbling experience for me and the design-based research approach in particular allowed me to be self-reflective and directly apply my observations to this study. Although I thought the fourth iteration of this study was successful, I might make additional changes if given the opportunity to present another iteration of the parent education workshop in the future. It is worth noting that the short window of time in between each iteration placed some practical limits on what I could change before administering each iteration of the workshop.

In particular, I would include a more systematic means of collecting feedback from the participants about the workshop. I collected anecdotal evidence and participants orally discussed some changes they might make or some components of the workshop that they thought were particularly compelling, but if I were to administer another iteration of the workshop, I would create an opportunity to collect this feedback in writing. I would include a multiple-choice question asking participants about the components of the workshop that were most impactful to
them as well as a multiple-choice question asking participants to name one component of the workshop that they did not find compelling or engaging. I would include multiple-choice questions, as opposed to open-ended questions, because I believe that participants are more inclined to click on an option from a drop-down menu than they are to fill out a short-answer response and I would want to ensure a high percentage of survey completion from pretest to posttest.

Although I began the study thinking that an ideal parent education workshop might contain around 20-30 participants, I found that fewer participants were more manageable. I believe that an ideal workshop might have somewhere between 6–8 participants and would include an even number of participants so that they could easily pair up with a peer during the various activities and so that the researcher would not need to pair up with a participant. If I were to administer another iteration, I would aim for 6-8 participants and would have them gather in a separate room prior to entering the parent education workshop so that they could begin and complete the pretest surveys at approximately the same time.

I might also change a subsequent iteration by telling mothers to try out some of the strategies we discussed in the initial workshop over the course of a month or two and then invite the participants back for a follow-up workshop where they could check-in with other participants and discuss any questions they might have and/or receive support. A subsequent iteration could also involve the participants’ children and could potentially involve role-playing, where the mothers practice how to help their child with math homework and then hear feedback from their children or from other participants.
Research Limitations

Although this study contains novel contributions to the field, several limitations exist. One significant limitation is the profile of the mothers who agreed to participate in the study. I assumed that participants would have math anxiety and be open to sharing the extent of that anxiety. I also assumed that the majority of participants would have negative perceptions of their own math ability and negative attitudes toward math. Because mothers self-selected to participate in the study, however, some agreed to participate because of an interest in math education or a love of math, and others may not have agreed to participate precisely because of their math anxiety or their negative beliefs about their own math ability.

In response to the recruiting emails, several eligible participants said that they did not believe they were the right fit to help with this study. One mother responded, “This sounds like a wonderful topic, but I’m not available that night. Also, not sure if I’d even be helpful because I’d need my son’s help in math more than the other way around!” It is problematic that the parent education workshop topics themselves were potential deterrents to mothers with math anxiety or negative attitudes toward math—the very mothers that this study sought to provide with strategies to better assist their children with math homework.

Other limitations in this study had to do with self-reporting and the role of social desirability. Previous research has indicated that female students report higher levels of mathematics anxiety than their male counterparts, but the higher levels of reported anxiety do not translate to lower math performance or to greater mathematics avoidance (Hembree, 1990). According to Hembree, this discrepancy
can be explained by the fact that females may be more willing than males to admit their anxiety. Although this may be true in a general sense, it appears that the female participants in this study were not willing to acknowledge the extent of their anxiety on written pretest surveys.

Despite my best efforts to mitigate social desirability through the use of an online survey, several participants remarked later that they were dishonest about the extent of their anxiety on the written pretest survey. In person, at the workshops, five of the 22 total participants (23%) expressed that they were not confident in their math ability or had "math phobia,"—a term that I did not personally introduce to participants. As one mother mentioned, she was "somewhat dishonest in writing." Another participant shared,

I just feel so embarrassed that I should know how to do this and it [the embarrassment] just takes over....I definitely have math phobia. I mean, I wasn’t so honest about the extent of it in your questions when we started this whole thing, but...[nervously laughs] I have it!

It is difficult to know whether other participants felt similarly or were untruthful (or unaware) about the extent of their math anxiety on the pretest; however, it appears that I was unable to fully mitigate the effects of social desirability.

Finally, there were inherent limitations within the study in terms of the small sample size and my inability to generalize due to the specific site population. The limitation of a small sample size was also a strength, in that participants at each iteration of the workshop anecdotally remarked that they appreciated having conversations with a partner or in a small group as well as the ability to ask the facilitator questions in an intimate setting. It is unclear whether or not this study is generalizable to other populations or communities and it is imperative that school leaders gain demographic data about their potential participants prior to
administering the initial workshop. The participants in this study were all mothers of Jewish day school students. They represent a demographic with high socio-economic status, high aspirations for their children, and high levels of advanced degrees. If I were to administer this workshop to another demographic or community, I would potentially alter some of the video clips and would use the help of principals and other community members to determine which videos, celebrities, or pop-culture references might be most effective in the presentation of the workshop.

**Implications for Research**

This study generated new questions for future research. The purpose of this study was to develop a parent education workshop; however, the next logical step would be to perform a formal evaluation of the “success” of the workshop (as well as to create a definition of what that success entails). A subsequent study might ask about the extent to which a parent education workshop is effective in changing participants’ views of their own math ability and attitudes toward math, as reported on pretest to posttest survey responses. Next steps might also include subjecting this parent education workshop to a formal test of efficacy. It would also be worthwhile to include populations outside of the Jewish day school demographic.

Future research should focus more directly on the ways in which increased knowledge about math anxiety, math-gender stereotype threat, and increased strategies for assisting with math directly impact middle school-aged students. One way to do this would be to involve middle school-aged students in the pre- and posttest survey process to measure their perceptions of their own math ability and attitudes toward math, and then match those scores with their mothers’ scores.
Future research should also involve larger samples that focus on differences by children’s gender as well as research that includes separate parent education workshops for fathers.

Although it can be difficult to predict whether a particular workshop will succeed in changing a participant’s mindset or provide her with additional long-term strategies, it is advisable to begin with small trials, as is the case with this study (Wilson, 2011). As Wilson (2011) further discussed, what is important is “the realization that interventions can be tested to see what works, and if they don’t work, refined until they do” (p. 238). If promising results are found in a small study such as this one, researchers can follow up with replications and extensions to other groups of participants and eventually to large-scale implementations and longitudinal studies.

**Implications for School Leaders**

Research indicates that parents with math anxiety who help their children with math homework on a consistent basis have a negative impact on student achievement (Gunderson et al., 2012; Maloney et al., 2015). Research also indicates that women who express fear about math or display an inability to engage in math problem solving send an important message to the children for whom they serve as role models. Given that research, it would be irresponsible to encourage math-anxious individuals to help their children with math.

The purpose of this study was therefore to add to the existing research about how math anxiety can be mitigated in female role models, such as mothers, so that they can assist their children with math homework and not negatively influence their children’s math performance in the future. The purpose was to provide
mothers with explicit strategies for helping their children with math; however, in developing the parent education workshop, it became apparent that a new definition of what it means to “help” with math homework was needed. A mother can help her child with math even without a deep familiarity with a particular math algorithm. Rather, help can be understood more broadly as the willingness to engage with a child in the learning process—a willingness to ask open-ended questions, put the onus back on the child to answer the problem, and teach the child how to best use outside resources.

Because participants self-selected to be involved in this study and therefore not all parents who were eligible to participate attended, school leaders should consider mandatory parent education workshops as a way to ensure that the parents who need this education most are being served. In future parent education workshops, school leaders should discuss how best to help children with math and make sure that parents are focusing not just on specific math content but also on the importance of asking open-ended questions, putting the onus back on the children themselves, and reaffirming to children that they have the tools to solve math problems. Schools can also play a vital role in future research by hosting these parent education workshops and then allowing outside researchers to test their efficacy on a larger scale. This study can help principals and other school leaders learn about the social psychology of intervention change and can serve as a lesson study allowing other school leaders to learn from my observations as well as my mistakes.
Reflection

Tipping points are a reaffirmation of the potential for change and the power of intelligent action. Look at the world around you. It may seem like an immovable, implacable place. It is not. With the slightest push—in just the right place—it can be tipped. (Gladwell, 2006, p. 259)

One hundred percent of participants in this study raised their hand when asked if they had ever heard a woman remark that she was not good at math. It is socially acceptable for women to proclaim that they are not good at math or that they “can’t do math,” and these proclamations, or pervasive stereotypes, have negative implications for young girls, for women, and for society at large. This problem must therefore be addressed: A culture shift is needed, but how does one begin to create such change?

In his book, The Tipping Point, Malcolm Gladwell (2006) defined a tipping point as the moment of critical mass, the threshold, or boiling point. He explained that ideas spread like viruses, a sort of social epidemic, and that “a little cause can have a big effect.” My hope is that this study, and interventions informed by this study, can be that tipping point.

In Redirect, Timothy Wilson (2011) also addressed how to solve long-standing problems. His solution involves a story-editing approach, which contains three basic assumptions. First, in order to change people’s behavior, we have to see the world through their eyes. Second, their interpretations are not always set in stone and can be redirected with just the right approach. Third, small changes in interpretations can have self-sustaining effects, leading to long-lasting changes in behavior. As Gladwell (2006) noted, people can transform their behavior or beliefs “in the face of the right kind of impetus” (p. 258). The parent education workshop
outlined in this study just might serve as the right kind of impetus for change and should be subject to efficacy tests on a larger-scale.

This study builds on existing stereotype threat intervention research. Such research can provide encouraging outcomes for members of affected stereotype groups. Although institutional change may take considerable time and effort, there is a great deal that individual mothers can do to change the climate in their homes in order to mitigate the impact of stereotype threat on their children (Ryan & Branscombe, 2013). It is crucial that women understand how stereotype threat can cause math anxiety and impede concentration and working memory, and also that such impediments are not synonymous with poor math ability. Policymakers and school leaders can benefit from being informed about stereotype threat research in order to develop interventions, such as the parent education workshop detailed in this study. Our society has a lot to gain by increasing the general population’s awareness of stereotype threat research (Ryan & Branscombe, 2013). Not least of all, mothers can help their children by naming math-gender stereotypes and debunking any connection between gender and their math ability. The more people know about the influence of stereotype threat, the less the gender gap will be attributed to intrinsic gender differences in ability or interests.
APPENDIX A:
PRETEST SURVEY

ID Code: ______

DEMOGRAPHIC INFORMATION:

Are you the mother of a middle school-aged child?
  • Yes
  • No

Do you have more than one middle school-aged child?
  • Yes
  • No

NOTE:
  • If you have more than one middle school-aged child of the same gender, answer the survey for any of your children at random.
  • If you have more than one middle school-aged child of different genders, answer the survey for your daughter.

Confirm the gender of your middle school-aged child for whom you will be filling out this survey.
  • Male
  • Female

What is your marital status?
  • Married
  • Single/Never Married
  • Divorced
  • Widowed
  • Other

What is your race/ethnicity?
  • White (European)
  • Israeli
  • Persian
  • Latino (specify)
  • Asian (specify)
  • African American
  • Other: ________________
What is your highest level of completed education?
- Some high school (did not graduate)
- High school graduate
- Some college
- Bachelor’s degree
- Some graduate school (no degree)
- Master’s degree
- Doctoral degree
- Professional degree (i.e., MD, JD, or Rabbinic ordination)

What is your spouse’s highest level of completed education?
- Some high school (did not graduate)
- High school graduate
- Some college
- Bachelor’s degree
- Some graduate school (no degree)
- Master’s degree
- Doctoral degree
- Professional degree (i.e., MD, JD, or Rabbinic ordination)
- N/A

What is your primary spoken language?
- English
- Hebrew
- Farsi
- Spanish
- French
- Other

What is your level of English proficiency?
- Beginner
- Intermediate
- Fluent
- Native speaker

What is your highest level of completed math education?
- Algebra
- Geometry
- Algebra 2/Trigonometry
- Pre-calculus
- Calculus or beyond
DEMOGRAPHIC INFORMATION (continued):

What is your spouse’s highest level of completed math education?
- Algebra
- Geometry
- Algebra 2/Trigonometry
- Pre-calculus
- Calculus or beyond
- I don’t know
- N/A

What is your average household income?
- Under $50,000
- $50,000–$74,999
- $75,000–$99,999
- $100,000–$149,999
- $150,000–$199,999
- $200,000–$249,999
- $250,000–$349,999
- Over $350,000

Describe your level of Jewish observance.
- Reform
- Conservative
- Modern-Orthodox
- Orthodox
- Secular
- Other: _______________

Do you work outside the home?
- Yes
- No

If you work outside the home, is your position part-time or full-time?
- Part-time
- Full-time

If you work outside the home, what is your occupation?
________________________________________________
**VIGNETTE:**

Your middle school-aged child comes home from school and begins working on a homework assignment. Your child instantly becomes frustrated and remarks out loud, "This is so confusing! I have no idea how find the slope using any two ordered pairs on the line! What do x- and y-intercepts even mean? Mom, can you help me?"

- What might you say to help your child in this hypothetical scenario?

**PERCEPTIONS OF MATH:**

The following statements look at your perceptions of math. Please read each statement and indicate how strongly you believe in the statement about yourself or your child.

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<thead>
<tr>
<th>Statement</th>
<th>Completely Agree</th>
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<td>Completely Agree</td>
<td>Somewhat Agree</td>
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<td>Somewhat Disagree</td>
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**INVOLVEMENT IN MATH EDUCATION:**

This part of the survey consists of statements regarding your participation in your child’s math education.

<table>
<thead>
<tr>
<th>Participation Statements</th>
<th>Never</th>
<th>Rarely</th>
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This part of the survey consists of statements regarding your individual beliefs and your beliefs about society. Please read each statement and indicate how strongly you believe in the statement.

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ASPIRATIONS FOR YOUR CHILD:

How far would you like your child to advance in mathematics?
- Algebra
- Geometry
- Algebra 2/Trigonometry
- Pre-calculus
- Calculus or beyond

How far would you like your child to advance in their education?
- Some high school (no diploma)
- High school graduate
- Some college (no degree)
- Bachelor’s degree
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- Master’s degree
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- Professional degree (i.e., MD, JD, or Rabbinic ordination)
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How far do you think your child will advance in mathematics?
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APPENDIX B:
POSTTEST SURVEY

ID Code: _____

Reminder: Make sure to fill out this posttest survey keeping in mind the same child that you thought of when answering questions on the pretest survey.

VIGNETTE:

Your middle school-aged child comes home from school and begins working on a homework assignment. Your child instantly becomes frustrated and remarks out loud, “This is so confusing! I have no idea how to solve a two-variable equation! How do you do that? Mom, can you help me?”

- After participating in the Parent Education Workshop, what might you say to help your child in this hypothetical scenario?

PERCEPTIONS OF MATH:
The following statements look at your perceptions of math. Please read each statement and indicate how strongly you believe in the statement.

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**ININVOLVEMENT IN MATH EDUCATION:**

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Never | Rarely | Sometimes | Often | Always
---|---|---|---|---
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**MATH BELIEFS:**
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I would encourage my child to pursue a career in the STEM (science, technology, engineering, math) field.

Society encourages women to pursue a career in the STEM (science, technology, engineering, math) field.

My beliefs about my math ability influence my child’s beliefs about his/her own math ability.

My attitude towards math influences my child’s attitude towards math.

My belief in math-gender stereotypes influences my child’s belief in math-gender stereotypes.

What are the top three strategies you learned from the parent education workshop?

1. ____________________________

2. ____________________________

3. ____________________________

How far would you like your child to advance in mathematics?
- Algebra
- Geometry
- Algebra 2/Trigonometry
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- Calculus or beyond

How far would you like your child to advance in their education?
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• Doctoral degree
• Professional degree (i.e., MD, JD, or Rabbinic ordination)

Would you be willing to be briefly interviewed about your experience in the parent education workshop? If so, please provide your email address below.
APPENDIX C:  
JO BOALER TED TALK TRANSCRIPT

Excerpt from talk entitled, “How You Can be Good at Math and Other Surprising Facts About Learning,” delivered by Professor Jo Boaler at TEDxStanford, Stanford, California, April 24, 2016 (TEDx Talks, 2016).

“So I’m here to tell you what you’ve believed about your own potential has changed what you have learned and continues to do that, continues to change your learning, and your experiences. So, how many people here, let’s get a show of hands, have ever been given the idea that they’re not a math person, or that they can’t go on to the next level of math, or that they haven’t got the brains for it? Let’s see a show of hands. [Hands go up.] So, quite a few of us. And, I’m here to tell you that idea is completely wrong. It is disproven by the brain science, but it is fueled by a single myth that’s out there in our society that’s very strong and very dangerous. And the myth is that there’s such a thing as a math brain. That you’re born with one or you’re not. We don’t believe this about other subjects. We don’t think we’re born with a history brain, or a physics brain. We think you have to learn those. But with math, people, students believe it, teachers believe it, parents believe it. And until we change that single myth, we will continue to have widespread underachievement in this country.

Carol Dweck’s research on mindset has shown us that if you believe in your unlimited potential, you will achieve at higher levels in math and in life. And an incredible study on mistakes shows this very strongly. So, Jason Moser and his colleagues actually found from MRI scans that your brain grows when you make a mistake in maths. Fantastic. When you make a mistake, synapses fire in the
And, in fact, in their MRI scans, they found that when people made a mistake, synapses fired. When they got work correct, less synapses fired. So making mistakes is really good. And we want students to know this, but they found something else that was pretty incredible. This image shows you the voltage maps of people’s brains. And what you can see here is that people with a growth mindset who believe that they had unlimited potential, they could learn anything. When they made a mistake, their brains grew more than the people who didn’t believe that they could learn anything. So this shows us something that brain scientists have known for a long time: that our cognition, and what we learn is linked to our beliefs and to our feelings. And this is important for all of us, not just kids in math classrooms.

If you go into a difficult situation or a challenging situation and you think to yourself, ‘I can do this. I’m gonna do it,’ and you mess up or fail, your brain will grow more and react differently than if you go into that situation thinking, ‘I don’t think I can do this.’ So it’s really important that we change the messages that kids get in classrooms. We know that anybody can grow their brain, and brains are so plastic to learn any level of maths. We have to get this out to kids. They have to know that mistakes are really good. But maths classrooms have to change in a lot of ways. It’s not just about changing messages for kids. We have to fundamentally change what happens in classrooms. And we want kids to have a growth mindset, to believe that they can grow, and learn anything. But it’s very difficult to have a growth mindset in maths if you’re constantly given short, closed questions that you get right or wrong. Those questions themselves transmit fixed
messages about math, that you can do it or you can’t. So we have to open up maths questions so that there’s space inside them for learning.

I want to give you an example. We’re actually going to ask you to think about some maths with me. So this is a fairly typical problem that’s given out in schools. I want you to think about it a bit differently. So, we have three cases of squares. In Case 2, there’s more squares than in Case 1, and in Case 3 there’s even more. And often, this is given out with the question, ‘How many squares would there be in case 100 or in case n?’ But, I want you to think of a different question now. I want you to think, without any numbers at all, or without any algebra, I want you to think entirely visually, and I want you to think about, where do you see the extra squares? If there are more squares in Case 2 than Case 1, where are they?

So, if we were in a classroom, I’d give you a long time to think about this. In the interest of time, I’m going to show you some different ways people think about this, and I’ve given this problem to many different people. And I think it was my undergrads at Stanford who said to me, or one of them said to me, ‘Oh, I see it like raindrops. Where raindrops come down from the top so it’s like an outer layer, that grows new each time.’ It was also my undergrads who said: ‘Oh no, I see it more like a bowling alley. You get an extra row, like a row of Skittles that comes in at the bottom.’ A very different way of seeing the growth. It was a teacher, I remember, who said to me, ‘It was like a volcano. The center goes up, and then the lava comes out.’ Another teacher said, ‘Oh no, it’s like the parting of the Red Sea. The shape separates, and there’s a duplication with an extra center.’
I remember this was...Sorry, this one as well. Some people see it as triangles. They see the outside growing as an outside triangle. And then there was a teacher in New Mexico who said to me, ‘Oh, it’s like Wayne’s World, Stairway to Heaven, access denied.’ And then we have this way of seeing it. If you move the squares, which you always can, and you rearrange the shape a bit, you’ll see that it actually grows as squares.

So this is what I want to illustrate with this question. When it’s given out in maths classrooms, and this isn’t the worst of questions, it’s given out with a question of ‘How many?’ And kids count. So they’ll say, ‘In the first case, there’s four. In the second case, there’s nine.’ They might stare at the column of numbers for a long time and say, ‘If you add one to the case number each time and square it, then you get the total number of squares.’ But when I give it to students and high school teachers, I’ll say to them when they’ve done this, ‘So why is that squared? Why do you see that squared function?’ They’ll say, ‘No idea.’ So this is why it’s squared. The function grows as a square. You see that squaring in the algebraic representation.

So when we give these problems to students, we give them the visual question. We ask them how they see it. They have these rich discussions and they also reach deeper understandings about a really important part of mathematics. So we actually need a revolution in maths classrooms. We need to change a lot of things.
APPENDIX D:

WHO WANTS TO BE A MILLIONAIRE? TRANSCRIPT

Exchange between host Regis Philbin and contestant Patricia Heaton on the game show Who Wants to Be a Millionaire? (Pumpirony, 2009).

Regis: Patricia, if a euro is worth $1.50... [Patricia makes a face and shakes her head no.] Patricia, stay with me. Five euros is worth what?

Patricia: I am so bad at math!

Regis: No, but wait a minute, you’ve got a shot...

Patricia: And when I get nervous... [She sighs.]

Regis: But Patricia, Ohio State.

Patricia: I know, that’s what I’m telling you! Exactly my point.

Regis: Okay, so stay with us. Five euros at $1.50 would be how much a piece?

Patricia: I can’t do the math.

Regis: Would it be 30 quarters?

Patricia: No! Oohh...

Regis: Would it be 50 dimes? Would it be 70 nickels? Or would it be 90 pennies? Patricia, just think about it.

Patricia: I put everything on credit cards, Regis! I have no idea what this is.

Regis: But 30 quarters would give you how much?

Patricia: I don’t know! I have no idea! Literally, my kids... once they got past second grade... I could not help them at all with their math. At all!

Regis: Let’s cut right to the chase. Which lifeline would you like?

Patricia: I need to call my husband...who is European.
Regis: Oh, he is?
Patricia: For my lifeline.
Regis: What’s his name?
Patricia: David Hunt.
Regis: David Hunt, alright. AT&T, David Hunt on the line immediately.
Patricia: There’s people starving in Sierra Leone, Reg! (audience laughs)
Regis: We know that.
Patricia: What are you doing?
Regis: We want to help them.
Patricia: Hello! Hi, Dave.
David: Hi, Patty. Hi, Regis.
Regis: Hi, David. How are you doing tonight?
David: I’m actually nervous now.
Regis: Well, she’s depending on you. Believe me. We’ve got a question that she just will not answer, but she feels you can help a lot. Now she’s going for $50,000 if you get the right answer. Okay?
David: Okay.
Regis: You’re going to have 30 seconds. Your time starts now.
Patricia: If a euro is worth $1.50, five euros is worth what? A) 30 quarters, B) 50 dimes, C) 70 nickels, or D) 90 pennies
David: [Silence.] Sorry run those answers again.
Patricia: [Speaking quickly.] A) 30 quarters, B) 50 dimes, C) 70 nickels, or D) 90 pennies? [Timer runs out and audience sighs.]
Patricia: I’ll throw in the other $25,000. [Audience applauds.] As long as I don’t have to tell you how many nickels it is!

Regis: No, but look, the reality is you haven’t given up and you haven’t lost yet.

Patricia: I haven’t. I’ve got a beautiful $25,000.

Regis: No, sweetheart. You can get $50,000, but you’ve got to just think about this.

Patricia: Oh! I can still answer it?

Regis: Yes!

Patricia: Ohhhh!!! I thought we were done! [Audience cheers.] Oh no!

Regis: You don’t lose until you say “final answer.”

Patricia: Okay. Okay. Wait. Hold on. Shh... Shh... I’m so nervous.

Regis: Just say it right now.

Patricia: I can’t! I gotta multiply it first in my head. A euro is worth $1.50, so five euros...five times five is 25. Carry the two. Five five...six...seven...$7.50. [Audience cheers.] So, it’s not 90 pennies. [Puts hands on head.] Ugh, I don’t know.

Regis: Now, wait a minute, you know this. Fifty dimes is how much?

Patricia: Fifty cents. [Audience laughs.]

Regis: Fifty dimes?

Patricia: Fifty dimes? Oh, it’s $5.00.

Regis: There you go. Ninety pennies.

Patricia: [Patricia laughs.]
Regis: Ninety pennies. [Patricia still doesn’t answer.] How many pennies make a dollar?

Patricia: Okay, so one hundred.

Regis: Alright! Seventy nickels.

Patricia: [Laughs.] This is the worst question you could have asked me!

Regis: Seventy nickels. How many nickels in a dollar?

Patricia: So, seven times five. That’s $3.50. [Audience cheers.]

Regis: That leaves 30 quarters.

Patricia: Okay.

Regis: How many quarters in one dollar?

Patricia: Alright, I’ll give you my answer. [Audience laughs and Regis makes an exasperated face.] My answer is A, 30 quarters. [Audience explodes into applause.]

Regis: Final answer?

Patricia: Final answer.

Regis: Yes!!!
APPENDIX E:

TRANSCRIPT OF CLAude SteELE ON MATH-GENDEr STEREOtype THREAT

Excerpt from video, “How Stereotypes Affect Us and What We Can Do: An Introduction to Stereotype Threat” (Facing History and Ourselves, 2013).

“I’m a social psychologist and experimentalist, and so we’ve done experiments to test whether or not stereotype threat can have an effect on something that we tend to think of as pretty hard-wired, like your performance on a cognitive exam or a standardized test. So, one simple experiment was to bring women and men into the laboratory one at a time and give them a very difficult math test—a math test that we knew would cause frustration. And even though everything was the same for the men and for the women—the room, the items on the test, the experimenter—for men, as they went about doing the test and experienced frustration, they could worry that they’re not as good at math as they maybe thought they were, but they wouldn’t be worried that they were confirming some group-based limitation of ability. But for women in the same situation, as they start to experience frustration, some part of their brain might worry, “Am I confirming the stereotype about women having limited math ability? Is that what’s going on here?” And that worry, since these are women who we... women and men, who we selected for being very committed to math and being very good at it, that worry for that kind of person can be upsetting and distracting. It can interfere with their performance right there in the testing situation. And that’s exactly what happened.

Women did considerably worse than the men. However, and here’s the good news, we eventually came up with an idea which would take stereotype threat out
of that situation. We simply told them the following: “Look, you may have heard that women are not as good at difficult standardized tests, but that’s not true for this particular standardized test. The test that you’re taking today is a test in which women always do as well as men.” So the subtext of that little statement is: “Look, the frustration you are having on that test has nothing to do with you being a woman.” Now we’ve taken that extra pressure that women might have in that situation, and we’ve taken it out of the situation. They are no longer under the pressure of confirming or being seen to confirm some limitation that’s out there in the stereotypes of our society about women lacking math ability. And if that’s what’s been depressing their performance earlier, now their performance should go up to match that of equally skilled men. And that’s exactly what happened!”
APPENDIX F:

MAYIM BIALIK INTERVIEW TRANSCRIPT

Excerpt from red carpet interview with actress Mayim Bialik before the 2013 Screen Actors Guild awards (SAG Awards, 2014).

Male Interviewer: Being on *The Big Bang Theory*, how many people...not that you aren’t a genius, but how many people think that you can solve calculus at the drop of a hat?

Mayim Bialik: Ummm... [Looks puzzled.] I actually was trained in calculus for several years. Yeah, I’m a neuroscientist. So, you may not have known that.

Female Interviewer: Yeah, I did not know that! [Smiles.]

Male Interviewer: [Pauses.] I knew you were...I knew you were some kind of—I knew you were scientist, not a neuroscientist.

Mayim Bialik: I’m a neuroscientist. Yeah, I can do calculus.

Male Interviewer: Okay.

Mayim Bialik: I can do that. But yeah, I think people assume that of all of us. You don’t have to have a Ph.D. in neuroscience to be on our show. I promise.

Female Interviewer: Well, a tidbit for all the audience here tonight. She is actually a neuroscientist.

Male Interviewer: I’m glad I asked!

Female Interviewer: She’s been planning for this role her whole life.

Mayim Bialik: Exactly! Well, just for 12 years, but yeah.

Female Interviewer: Just for 12 years.
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