**CHAPTER I  
Literature Review**

There is a sizeable difference, comparatively, in the average income that males and females make each year. Women make 77 cents for every dollar men make. It is estimated that, at the current rate, the wage gap will not close completely until 2059 (pay-equity.org, 2016). Although it is true that women, as a group, are not paid equally to men, the issue is more complicated than it seems. The career that one chooses to pursue greatly influences salary, with more men choosing higher paying fields than women. For instance, there are far more men than women in science, technology, engineering, and math, otherwise abbreviated as STEM, whereas women typically avoid STEM fields and choose careers which pay less (Ceci, Williams, & Barnett, 2009). Many of the influences that predispose girls to this future come from society (e.g., media), home, and school (Barnes, McInerney, & Marsh, 2005).  
**Society**

Initially, ideas about gender originating from society play a role in shaping a child’s experiences. For example, a 1979 study by Cordua, McGraw, and Drabman observed the influence that society had on preschoolers age five to six when it came to gender-labeling occupations. Children were shown videos of doctors and nurses in various gender combinations (e.g., male nurse & female doctor vs. female nurse & male doctor). Out of the four different possible combinations, the preschoolers had the strongest tendency to re-label the gender of the male nurse.

In parallel, the children did not have as strong a response to re-labeling the female doctors as they did the male nurses. The sex or age of the children did not affect their responses. Cordua et al. (1979) concluded that the participants strongly re-labeled male nurses because of prior exposure from examples in society that the participants had viewed or experienced.

Additionally, electronic and print media also shape society and play a large part in people’s lives. Does media influence a female’s career interests and therefore her career endeavors? According to a study conducted by Kennard, Willis, Robinson, and Knobloch-Westerwick (2016), the influence on women from media is quite present. In this study, women ages 21 to 35 without children or an education beyond high school were shown two different categories of media over the course of five days; 107 of the 214 women were shown media that portrayed women as stay-at-home mothers conforming to beauty standards (e.g., make-up, clothes, etc.). The other half were shown media that portrayed women in various categories of successful careers outside of the home. Three days after exposure, women answered open-ended questions. Women who had been shown gender conformative media showed a tendency to imagine their future selves as gender normative, whereas women who were exposed to non-conformative roles (i.e., having careers outside the home) imagined their future selves as more present in the workplace (Kennard et al., 2016). The influence that media exposure has on women is also demonstrated in girls who take Computer Science AP courses in high school. These girls are 10 times more likely to major in computer science (Morgan, Klaric, & College, 2007).

**Home**

The second area in which males and females experience differences in treatment regarding encouragement, responsibilities, and much more is the home. Often, children are affected by parents’ beliefs regarding the responsibilities of each gender (Bhanot & Jovanic, 2005). What it is to be a “man” or what it is to be a “woman” in the eyes of a parent can influence the beliefs, education, and careers of children (Barnes et al., 2005). According to research by the Institution of Engineering and Technology (2015), children are still being restricted regarding education and career by their parents’ gender stereotypes. This information was gathered using a sample of 501 male and 506 female parents, as well as 505 boys and 502 girls.

Parents can influence their children in positive ways, too. For example, children who become scientists often have parents who are highly educated (44.7% of 793 scientists mentioned their parents as influencers). Of those children who became scientists, females were more likely to mention their parents as having an important influence (Sonnert, 2009). Although it would seem as if the gender of the parent would influence the child’s interest, this is not the case. Possibly an artifact of there being more male scientists, fathers were mentioned more often than mothers as an inspiration for women scientists. Thus, a parent’s education can inspire a woman to pursue a career in science without regard to the gender of the parent (Sonnert, 2009).

Interestingly enough, according to Bhanot and Jovanovic (2006), parents can influence their children’s futures even through homework intrusions such as interrupting them to check and to offer help. Both boys and girls, along with their parents, were participants in a study that attempted to decipher whether or not parents’ behaviors encourage gender stereotypes in school subjects. The participants ranged from fifth to eighth grade, with an average age of 12; 60% of the participants were female, and 87% were white. The study found that parents who believed in gender stereotypes (i.e., boys being better at math and science and girls being better at English) tended to intrude on homework sessions more often than parents who did not hold similar beliefs. The study also found that although the boys and girls were intruded on equally in their study time, girls were more sensitive to the intrusions, especially in math. This sensitivity further lowered girls’ confidence in their math ability. This means that a parent’s beliefs regarding gender stereotypes have the ability to damage confidence in girls (Bhanot & Jovanovic, 2006).  
**School**

Similarly, teachers can influence pupils with their own anxieties about math and science (Beilock, Gunderson, Ramirez, & Levine, 2010; Sonnert, Fox, & Adkins, 2007). The group of people who have the most anxiety towards mathematics is female elementary school teachers. As observed by Beilock and colleagues, most elementary teachers are female (90%), and a majority of those teachers have anxiety about math. When female students see this anxiety, their own insecurities are reinforced. Even though teachers may not mean to, personal feelings towards mathematics can augment the effects of gender stereotypes, in that if girls feel anxious about math, then they are less likely to choose a math-based career. Survey studies have shown that girls under the instruction of female teachers who report feelings of math-anxiety have lower feelings of mathematics efficacy. This may subsequently negatively impact students’ math performance (Beilock et al., 2010).  
 Lower confidence, however, is not always reflected in lower math scores; girls regularly earn higher grades in math than boys throughout their scholastic careers (Brownlow, Jacobi, & Rogers, 2000). It is a reasonable assumption that higher grade performance would correlate with confidence in a subject, but interestingly enough, this is not the case. By age 11, boys rank themselves as highly competent in math and science although their grades are lower than those of girls (Rudman & Glick, 2008). On the other hand, girls rate themselves as more anxious when answering questions pertaining to math and science (LeGrand, 2013). According to Bandura’s theory of self-efficacy, those who have confidence in themselves and what they can do look at challenges positively instead of as a threat (see Bandura, 1994). Young students, who do not have confidence in their own problem-solving abilities blame difficulties with certain subjects on personal attributes. Because these students attribute their scholastic troubles on personal traits instead of a lack in practice or understanding, they do not understand that they need to simply practice more. This means that students with low confidence in math, for example, do not conclude that they should have studied more when they get a bad grade, but instead tell themselves that they are not good at math.

**Interventions**

In order to make a difference in girls’ interest in math and science, researchers have developed their own interventions in order to increase the likelihood of girls’ interest in STEM fields. In one example, a group of researchers held a 5-day long chemistry camp (Levine, Serio, Radaram, Chaudhuri, & Talbert, 2010). This camp for middle school girls included fun scientific activities, meetings with inspirational female scientists, and field trips. Change in interest in the 28 participants who completed the camp was measured by a chemistry camp survey given directly before and after the camp. Changes in interest were dramatic, especially over the 5-day span of time. Answers were measured using a 5-point Likert scale. Two of the most dramatic and meaningful changes in scores were for question 10, concerning interest in a science or engineering career (increased by .5 units) and for question 12, concerning confidence in their own intuition regarding chemistry (increased by .71 units). This was a meaningful increase in interest and confidence, indicating that the intervention worked (Levine et al., 2010).

Another intervention called Bringing Up Girls in Science (BUGS) tried to increase 12 4th and 5th grade girls’ interest in STEM fields through an after school program on environmental science (Tyler-Wood, Ellison, & Lim, 2012). The program included hands on activities, as well as meetings with female scientist role models. This group of girls showed greater gains in scores on their state-wide standardized tests compared to regular students. The researchers also followed the girls over time into college and discovered that participants’ involvement in science was significantly higher than that of other girls who were not a part of the BUGS program.

Another intervention called GUESS, or Girl’s Understanding and Exploring STEM Stuff, had girls in the 8th and 9th grade participate in hands-on STEM activities designed to be fun (Leopold & Jean, 2011). The girls who participated generally thought of STEM-related activities as too difficult. However, by the end of the program, the girls found the activities to be fun and not intimidating. Some of the girls even said that they would consider entering a STEM-related field when they previously would not have chosen a related career path.   
 Correspondingly, a 3-year intervention program with high school girls showed that interest can be increased through exposure (Bystydzienski, Eisenhart, & Bruning, 2015). The researchers took 131 participants and split the intervention into three parts over three years. The first part of the intervention included guided engineering activities, the second included self-guided engineering activities, and the third involved the girls mentoring younger girls in their activities. After the intervention, the researchers found that interest in STEM levels did increase. After the intervention, the researchers tracked the participants biannually with a face-to-face interview after the program for four years. The researchers found that although interest levels did increase, the participants did not go into engineering at a higher rate than they had expected. The participants reported that this was due to lack of funding for college or fear.   
 In these interventions (Chemistry Camp, BUGS, GUESS, and the engineering intervention), the researchers succeeded in increasing girls’ STEM interest. Although increasing interest is an important step, these studies did not consider the fact that an increase in girls’ interest could also have occurred for other reasons because they did not have control groups. Granted, data from girls from other sources could act as the control for this study, but this data is not from the same cohort. Due to the differences between the girls in the interventions and other cohorts, stricter methods of a control would be beneficial for a clearer understanding of the effects of interventions.

In this study, math and science interest profiles were obtained from 10 4th grade girls before and after their involvement in a 5-session after school STEM/Writing Club, occurring over a 3-month period of time from late September to early December 2016. A second group of 10 girls who did not participate in the after school program also completed the interest surveys at the same time. Interest profiles included questions from Legrand (2013), the STEM CIT (Milner, Horan, & Tracey, n.d.), and the Student Attitudes Toward STEM (ASEE, 2013). Surveys from both groups pre- and post-treatment were compared in order to identify changes in interest due to treatment. Girls in the after school club were expected to gain in interest, confidence, and efficacy in STEM-related fields (i.e., math and science for the purpose of this study), relative to girls in the non-treatment group (control group) over the same time period.

**Hypotheses**

1. Participants in the treatment group will show more change in math and science confidence than those in the control group over time.
2. Participants in the treatment group will show more change in math and science interest than those in the control group over time.
3. Participants in the treatment group will show more change in math and science efficacy than those in the control group over time.
4. Girls in the treatment condition will show greater interest in STEM career choices after treatment than girls in the nontreatment group.

**CHAPTER II**

**Method**

**Participants**

Participants in this study were 20 4th grade female students from College Street Elementary School in Manchester, TN. The participants’ ages ranged from 108 to 132 months old (9 years to 11 years), with mean, median, and modal age of 119 months (9 years, 11 months). Ten girls were in the STEM after school club, or treatment group, and 10 girls were in the non-treatment group. Race of the girls was closely related to the population of Manchester, Tennessee. The racial composition of the participants was 90% white and 10% Hispanic, reflecting Manchester’s population of 81% white and 19% other races (city-data, 2016). Assignment to condition was not random. The first 10 girls who returned the invitation letter were enrolled in the afterschool club. A second group of 10 girls from the same class comprised the control group. Participants in both groups were hand selected by the teacher.   
**Materials  
 Parental permission form and informed consent.** This form explained to the parents and children what the STEM/Writing club was about and served as an itinerary for the parents. It also informed the parents and children that a survey would be given at the beginning and end of the program. This form can be found in Appendix B. IRB permission to use girls’ survey responses for the purpose of this study was secured after data had been collected (see Appendix A). Girls and their parents granted this permission using an IRB approved assent process and parent informed consent letter.  
 **Qualitative survey questions**. Questions in this part of the survey were developed by the researcher to assess the girls’ future career aspirations.

The first question asks what students want to be when they grow up and why. There are also four questions regarding whether students know a mathematician, scientist, technician, engineer, or anyone else who uses related skills in their jobs; a second part of each question asks respondents whether that person is male or female. These four questions are modeled after those in Milner et al.’s STEM Interest Survey (n.d.)*.* Questions can be found in Appendix C.

**Quantitative survey questions**. The 35 questions in this part of the survey are scored on a 7-point Likert scale, from 1 = *strongly disagree* to 7 = *strongly agree*. The first question asks about respondents’ level of agreement with the statement that some subjects are for boys and some are for girls. Questions 2-6 ask how much girls like different math and science subjects. Questions 7-10 ask girls about their confidence with math, whereas questions 19, 18, and 21 ask girls about their confidence in science. Questions about math and science confidence are modeled after those from Legrand (2013). Questions 15 and 27 ask about girls’ career interests; questions are modeled after those in the STEM Interest Survey (Milner et al., n.d.). Questions 33 and 34 address girls’ interest in engineering (ASEE, 2013). Questions 16, 17, 28, and 29 are modeled on Bandura’s theory of self-efficacy (see Bandura, 1977). Last, question 12 asks girls if their parents try to help them with their homework (Bhanot & Jovanovic, 2006). Questions 8, 9, 11, 18, 20, 21, and 23 are reverse scored. All questions for this part of the survey can be found in Appendix D.

**Procedure**

Informational letters were sent home to the parents of 4th grade girls. Parents of participants in both groups returned a permission form prior to treatment completing the pre-treatment version of the survey. Two different versions of the same survey were used – one for pre-treatment and one for post-treatment. Each time, the students completed the qualitative questions first so that the quantitative questions did not influence their answers.

For girls in the treatment condition, the permission letter was part of the general consent to participate in the teacher’s after school program. Parents provided consent for their daughters to participate in the after school program and to complete the pre- and post-treatment versions of the survey as part of the after school program. Consent forms were returned to the after school program teacher. Both parts of the pre-treatment survey (Appendixes C & D) were completed on the first day of the after school program. On the last day of the program, participants completed the post-treatment survey, comprised of the first question from the qualitative part of the survey and all of the quantitative questions from the original survey.

The “treatment” was a 5-week (five sessions) after school STEM/Writing club developed by the researcher and Mrs. Dunn, the 4th grade teacher. Sessions were about an hour long and took place every other week on the same day of the week after school. In these sessions, girls participated in STEM activities that were designed to be fun.  
 **Session 1** (9/30/2016). Participants were given an interest survey (the pre-treatment survey) to obtain baseline STEM interest profiles. They were then given lab coats to wear during the sessions. The girls then did an activity called “Magic Pepper.” In this activity, the students used water, pepper, and dish soap. The students poured water into a dish and then sprinkled pepper on top. They then dipped their fingers into the water and observed that the pepper did not move. Then they dipped their fingers into dish soap and placed it into the water, and the pepper scattered. This activity demonstrated the scientific properties of surface tension.

**Session 2** (10/14/2016). In the second session, the girls reviewed the scientific method and applied it to what they thought would happen in the “non-popping balloon” experiment. In this experiment, two balloons were inflated. One was inflated with water, whereas the other was inflated with air. The two balloons were then held (by the instructor) over a lighter. The balloon with air popped, and the balloon with water did not pop. After this activity, the girls then made their own thermometers using a glass bottle, a straw, water, rubbing alcohol, food coloring, and clay. These activities demonstrated the scientific principles of heat and energy.

**Session 3** (11/4/2016). In this session, the girls use a website called *Kahoot!* A *Kahoot!* is an interactive online quiz that anyone can make. The girls participated in writing questions on the topic of women in STEM to create their own *Kahoot!* on the website and take together in class. The girls were given iPads to create a quiz on important women in STEM and afterward, played the quiz that they created. This activity demonstrated how to use technology and simultaneously provided examples of female STEM role models.

**Session 4** (11/28/2016). In this session, engineering skills were used. Using gum drops, toothpicks, paper plates, and pennies, the girls created a bridge over a six-inch gap between desks. A paper plate was then placed on the structure, and then pennies were put onto the plate one by one until the structure collapsed. The more pennies that their bridge could hold, the stronger their bridge was. Afterwards, the girls discussed what features made their structures stronger.

**Session 5** (12/11/2016). In this session, the girls created extra-large bubbles using water, dish soap, and corn syrup. They used wire to make a wand for the solution. After the activity, they then discussed what made the bubbles so strong. This activity demonstrated the chemical properties that made the bubbles so strong. At the conclusion of session 5, the girls completed the post-treatment survey.

For girls in the nontreatment condition, the permission letter and pre-treatment survey (qualitative and quantitative questions) were sent home to complete. Parents of girls in the nontreatment group condition returned the consent forms to Mrs. Dunn, giving consent for their daughters to complete the survey both times; girls returned the completed pre-treatment survey to Mrs. Dunn when the consent forms were returned. Those same girls also were given the post-treatment survey (see Appendix D) in December, at a time that corresponded with the 5th session of the after school program. They also completed the survey at home and returned it to Mrs. Dunn.

**CHAPTER III**

**Results**

The researcher used SPSS to analyze students' responses to questions on both surveys (pre-treatment and post-treatment). The research design of this study was a 2 (group: treatment vs. nontreatment) x 2 (time of survey: before treatment vs. after treatment) mixed model quasi experimental design. The between-subjects variable in this study was group (treatment and nontreatment), and the within-subjects variable in this study was time of survey. Assignment to group was not random.

All quantitative questions were examined separately and by question group. Scores from the question groups were analyzed using a series of mixed ANOVA designs and one-way ANOVAs. Question group A (question 1) assessed sex-typed attitudes towards certain subjects. Question group B (questions 2-6) assessed how much girls like different math and science subjects. Question group C (questions 7-9) assessed confidence with math. Question group D (questions 10, 18, & 21) assessed confidence in science. Question group E (questions 11-15, 19, 20, 23, 24, & 30-32) assessed career interest. Question group F (questions 3 & 34) assessed girls’ interest in engineering. Question group G (questions 16, 17, 28 & 29) assessed self-efficacy, and Question group H (question 12) asked girls if their parents tried to help them with their homework (Bhanot & Jovanovic, 2006). Preliminary analyses indicated that the two groups differed prior to treatment; thus, change scores were calculated and used to assess the efficacy of the intervention.

For hypothesis 1, it was predicted that participants in the treatment group would show more change in math and science confidence than those in the control group over time. No support was found for the change scores for math confidence, *F* (1,13) = .015, *p* = .905, or science confidence, *F* (1, 13) = 1.202, *p* = .293. Change scores and statistics for both the experimental and control groups are reported in Table 1.

For hypothesis 2, it was predicted that participants in the treatment group would show more change in math and science interest than those in the control group over time. No support was found for math interest, *F* (1, 17) = .295, *p* = .594, or science interest, *F (*1,16) = .007, *p* =.934. Change scores and statistics for experimental and control groups are reported in Table 1. There also were no significant differences in interest for the treatment group from time one to time two for interest in math, *F* (1,8) = -.533, *p* = .609, or for interest in science, *F* (1, 9) = .970, *p* = .357.

For hypothesis 3, it was predicted that participants in the treatment group would show more change in math and science efficacy than those in the control group over time. No support was found for math efficacy, *F* (1,13) = .745, *p* =.475, or for science efficacy, *F* (1,15) = .004, *p* = .953. Change scores and statistics for experimental and control groups are reported in the Table 1. There also were no significant differences in the treatment group from time one to time two for efficacy in math, *F* (1,9) = .709, *p* =.496, or efficacy in science, *F* (1,8) = 1.512, *p* = .169.

For hypothesis 4, it was predicted that girls in the treatment condition would show greater interest in STEM career choices after treatment than girls in the nontreatment group, as evidenced by changes in their career choices. There was no statistical support for this hypothesis due to the small sample size. Participants who were in the treatment group either showed a steady shift towards interest in a STEM career or stayed the same, whereas participants in the control group showed more variability over all. More information about career choice change can be found in Table 2.   
**Other Important Findings**

Due to the fact that there was no support found for the original hypotheses, other analyses were run to see if there were other interesting findings that could corroborate the results seen in other studies. It is interesting to note that out of the 20 girls’ responses, the factor that best predicted a girl’s career choice (either before or after treatment) was whether she knew a woman in a STEM field. This information was collected from the pre-treatment survey. Girls who knew more women than men in STEM careers were more likely to say they would choose a STEM-related career for themselves than those who knew more men (or didn’t know either). Due to the small sample size, Fisher’s exact test was used. Results were not found to be significant at the level of *p* < .05, *F* (1,20) = .123, *p* = .14; however, this pattern is intriguing. More information can be found in Table 3.

To explore whether efficacy was related to whether girls thought math was for boys and not for girls (see Bandura, 1977), correlations were run to determine whether scoring higher on question 1 was related to scoring lower on the efficacy questions. Questions scores were summed for math efficacy (questions 16 & 17) and science efficacy (questions 28 & 29). There was no support found for math efficacy, *r* (15) = -.036, *p* = .899, or for science efficacy, *r* (18) = .080, *p* = .752.

Again, in accordance with the theory of self-efficacy (Bandura, 1977), correlations were run to determine whether scoring higher on question 1 was related to scoring lower in confidence. Question scores were summed for math confidence (questions 7-9) and science confidence (questions 19-21). There was no support found for math confidence, *r* (15) = .311, *p* = .259, or for science confidence, *r* (16) = -.362, *p* = .169.

In addition, correlations were run to determine whether scoring higher on question 1 was related to scoring lower on interest. Question scores were summed for math interest (questions 2 & 15) and science interest (questions 4 & 27). There was no support found for math interest, *r* (19) = .267, *p* = .268, or for science interest, *r* (17) = -.460, *p* = .063, although this correlation approached significance.

Bhanot and Jovanovic (2006) found that the importance that parents place on doing well in math and science is correlated with girls’ anxieties towards math and science. To see if similar results could be found in the present sample, correlations were run to determine whether scoring high on the questions about being nervous correlated with perceived importance in math and science. Question scores were summed and then correlated for math nervousness (questions 8 & 9) and perceived importance in math (questions 13 & 14). Questions were also summed and then correlated for math nervousness (questions 20 & 21) and perceived importance in science (questions 25 & 26). There was no support found for math nervousness and perceived importance in math, *r* (18) = .040, *p* = -.873, or for science nervousness and perceived importance of science, *r* (15) = -.354, *p* = .196.

In conclusion, no supplementary correlations were significant. This is probably due to non-random sampling as well as small sample size. A few correlations did seem to approach significance and were in the expected direction towards significance, such as sex-typed beliefs and science interest as well as science nervousness and perceived importance.

**CHAPTER IV**

**Discussion**

The purpose of this study was to see if participating in a five-session STEM club would increase confidence, interest, and efficacy in math and science in fourth grade girls. Increases in these three areas could potentially lead girls to decide that they want to pursue a career in STEM when they grow up. Three hypotheses were made regarding confidence, interest, and efficacy in math and science, as well as a fourth hypothesis predicting change to a STEM career in the treatment group.

There were no significant findings for any of the first three hypotheses. This could be due to many different factors, such as the small sample size. Due to small sample size, the statistical power of this study was weak. Additionally, group assignment was not random and was determined by the teacher. This was especially problematic because responses on the pre-treatment survey show that the groups were not the same to begin with. In particular, girls in the nontreatment group reported higher confidence, efficacy, and interest in STEM than did girls in the treatment group prior to the 5-session group. Due to there not being random assignment, change scores were used instead to assess program efficacy. The fourth hypothesis also did not have statistical support. This is again probably due to small sample size because the patterns of change supported the hypothesis.

Additionally, none of the supplemental correlations were significant. This is most likely also due to small sample size. However, it is expected that the correlation between sex-typed beliefs and interest in science would be significant if there were more participants in this study. Significance would similarly be expected for science nervousness and perceived importance with more participants.

One surprising finding was that the girls did not respond according to the theory of self-efficacy (Bandura, 1977). Bandura’s theory of self-efficacy states that belief in one’s ability to perform on a task will be reflected in confidence. Confidence, in turn inspires interest. Instead, it seemed that the most important thing influencing their career choice at their age was the ratio of women to men who they knew used STEM in their jobs. This surprising finding is important when you consider that girls who are in the 4th grade are in the stage of concrete operations. The concrete operational stage is the stage in which the developing child can now think logically, but they cannot think abstractly (Piaget, 1954), and they think about things in the here and now. In adherence to this stage of cognitive development, a more effective way of introducing girls of this age group to STEM would be to provide female role models in addition to the club.

Although there were no significant findings, this study proved to be a very helpful pilot and provided much insight on helpful changes that can be made. Hopefully, through random assignment and larger sample, as well as simplifications made to the survey, future studies will show significant results.

If this study were to be conducted again, a number of improvements could be made. Initially, random assignment would be used instead of letting the teacher hand select the treatment and control groups. Also, a larger sample size would be ideal. Perhaps if this study were to be run again, participants would not be limited to one class but could come from multiple classes from multiple grade levels.

There also was a disproportionate focus on Science, Technology, and Engineering activities and little emphasis on mathematics in the activities in this study. In the future, a greater emphasis on math should be added.

Also, if this study were to be done again, a question should be added to the qualitative part of the survey asking what made participants change their choice of what they wanted to be when they grew up (if they changed their choice) or whether the after school activities changed their views on STEM careers. Coupled with random assignment to treatment condition, effects of treatment exposure on career choice change could be determined.

Additionally, the format of the quantitative survey could be improved, such that the second time the participants complete the survey, girls could rate if they thought they had improved, declined, or remained the same compared to their previous answers from time one. Many of the responses on the surveys were so high at time one, there was no room to grow, indicating regression to the mean at time two. Due to this, the survey results may not have been as accurate as previously assumed. Also, many of the questions on the survey were formulated to deeply explore confidence, interest, and efficacy towards math and science in fourth grade girls; fewer, more generalized questions would suffice for the purpose of this study.

**References**

ASEE Annual Conference & Exposition. (2013). Retrieved July 15, 2016, from [https://www.asee.org/public/conferences/20/papers/6955/view](https://www.asee.org/public/conferences/20/papers/6955/view" \t "_blank)

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavior change. *Psychological Review, 84,*191–215. doi: 10.1037/0033-295x.84.2.191Bandura, A. (1994). Self-efficacy. In V. S. Ramachaudran (Ed.), *Encyclopedia of human behavior,* *4,* 71-81. doi: 10.1007/bf02913985

Barnes, G., McInerney, D. M., & Marsh, H. W. (2005). Exploring sex differences in science enrollment intentions: An application of the general model of academic choice. *The Australian Educational Researcher, 32(2),*1-24. doi: 10.1007/bf03216817

Beilock, S. L., Gunderson, E. A., Ramirez, G., & Levine, S. C. (2010). Female teachers’ math anxiety and girls’ math achievement.*National Academy of Sciences of the United States of America, 107(5),* 1860-1863. doi: 10.1037/e634112013-097

Bhanot, R., & Jovanovic, J. (2006). Sex roles: Do parents' academic gender stereotypes influence whether they intrude on their children's homework? *Women and Language, 29(2),*64. doi: 10.1007/s11199-005-3728-4

Brescoll, V., & Moss-Racusin, C. (2007). How to walk the tightrope of “nice and able”: Overcoming workplace challenges for female bosses. *Psychology of Women Quarterly, 31(2),*217-218. doi:10.1111/j.1471-6402.2007.00354\_2.x

Brownlow, S., Jacobi, T., & Rogers, M. I. (2000). Science anxiety as a function of gender and experience. *Sex Roles, 42,* 119-131. doi: 10.1002/j.2161-0045.2015.00097.x

Bystydzienski, J. M., Eisenhart, M., & Bruning, M. (2015). High school is not too late: Developing girls' interest and engagement in engineering careers. *Career Development Quarterly, 63*(1), 88-95**.**doi: 10.1177/0894845316656445

Carli, L. L. (2001). Gender and social influence. *Journal of Social Issues, 57,* 725-741. doi: 10.1111/0022-4537.00238

Ceci, S. J., & Williams, W. M. (2010). Sex differences in math-intensive fields. *Current*

*Directions in Psychological Science. 19(5),* 275-279. doi:10.1177/0963721410383241

Ceci, S. J., Williams, W. M., & Barnett, S. M. (2009). Women's underrepresentation in science: Sociocultural and biological considerations. *Psychological Bulletin, 135(2),*218-261. doi:10.1037/a0014412

Collins, R. L. (2011). Content analysis of gender roles in media: Where are we now and where should we go? *Sex Roles, 64(3-4),* 290–298. doi:10.1007/s11199-010-9929-5

Cordua, G. D., McGraw, K. O., & Drabman, R. S. (1979). Doctor or nurse: Children's

            perception of sex typed occupations. *Child Development, 50(2),* 590-593. doi: 10.2307/1129442

Hanson, S. L. (1996). Lost talent. *Women in the sciences.*Philadelphia: Temple University Press.

Kennard, A. R., Willis, L. E., Robinson, M. J., & Knobloch-Westerwick, S. (2016). The allure of Aphrodite: How gender-congruent media portrayals impact adult women's possible future selves. *Human Communication Research, 2,*221. doi:10.1111/hcre.12072

LeGrand, J. (2013). Exploring gender differences across Elementary, Middle, and High School Students’ Science and Math attitudes and interest. *ProQuest LLC.*

Leopold, C., & Kean, K., (2011). GUESS What? This experiment is “Sick”! Girls understanding and exploring STEM stuff. *ATEA Journal, 38*(2), 16-18.

Levine, M., Serio, N., Radaram, B., Chaudhuri, S., & Talbert, W. (2015). Addressing the STEM    gender gap by designing and implementing an educational outreach chemistry camp for Middle School girls. *Journal of Chemical Education, 92(10),* 1639-1644. doi: 10.1021/ed500945g

Manchester, Tennessee. (2015). Retrieved October 23, 2017, from [http://www.city-data.com/city/Manchester-Tennessee.html](http://www.city-data.com/city/Manchester-Tennessee.html" \t "_blank)

Milner, D. I., Horan, J. J., & Tracey, T. J. (n.d.). STEM Career Interest Test. *PsycTESTS  Dataset*. doi:10.1037/t37745-000

Morgan, R., Klaric, J., & College, B. (2007). AP® students in college: An analysis of five year academic careers. Research report No. 2007-4. *College Board.*

Moss-Racusin, C. A., Molenda, A. K., & Cramer, C. R. (2015). Can evidence impact attitudes? Public reactions to evidence of gender bias in STEM fields. *Psychology of Women Quarterly, 39(2*)*,* 194-209. doi:10.1177/0361684314565777

National Committee on Pay Equity (2016). Retrieved July 29, 2016, from  [http://www.payequity.org/](http://www.payequity.org/" \t "_blank)

Parents restricting girls’ futures through outdated stereotypes of career choices.(2015).

The Institution of Engineering and Technology Retrieved July 31, 2016, from  [http://www.theiet.org/policy/media/press-releases/20150330.cfm](http://www.theiet.org/policy/media/press-releases/20150330.cfm" \t "_blank)

Piaget, J. (1954). *The construction of reality in the child.* New York: Basic Books.doi:10.1037/11168-000

Rudman, L. A., & Glick, P. (2008).*The social psychology of gender: How power and intimacy shape gender relations.* New York, Guilford.

Sonnert, G. (2009). Parents who influence their children to become scientists: Effects of gender and parental education. *Social Studies of Science, 6,* 927-941*.* [doi](http://dx.doi/" \t "_blank):10.1177/0306312709335843

Sonnert, G., Fox, M. F., & Adkins, K. (2007). Undergraduate women in science and engineering: Effects of faculty, fields, and institutions over time. *Social Science Quarterly, 88(5),* 1333–1356. doi:10.1111/j.1540-6237.2007.00505.x

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

Wigfield, A., Eccles, J. S., Schiefele, U., Roeser, R. W., & Davis-Kean, P. (2007). Development of achievement motivation. *Handbook of Child Psychology, 3,*15.

[doi](http://dx.doi/" \t "_blank): 10.1002/9780470147658.chpsy0315

*Table 1*

Mean Change and Standard Deviations by Group.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Mean Change experimental | Standard Deviation experimental | Mean Change control | Standard Deviation control |
| Change in Math Confidence | .67 | 6.08 | 1.0 | 3.22 |
| Change in Math Interest | .89 | 5.13 | -.40 | 5.19 |
| Change in Math Efficacy | -.89 | 2.26 | .50 | 3.56 |
| Change in Science Confidence | .11 | 9.60 | 5.0 | 6.23 |
| Change in Science Interest | -.90 | 2.60 | -.75 | 4.86 |
| Change in Science Efficacy | -.89 | 3.39 | -1.0 | 3.70 |

|  |  |  |  |
| --- | --- | --- | --- |
| Table 2  *Career Choice Change by Group* | | | |
|  | Experimental | Control |
| Participants who changed to STEM | 2 | 2 |
| Participants who changed from STEM | 0 | 1 |
| Pre-treatment STEM career choices | 3 | 5 |
|  | | | |

Table 3

*Participant Career Choice as Function of Men and Women Known Who Use STEM in Their Jobs*

|  |  |  |  |
| --- | --- | --- | --- |
|  | No. Girls reporting knowing a women in STEM | No. Girls reporting not knowing a women in STEM | No. Girls reporting knowing an equal proportion of women and men in STEM |
| STEM + | 4 | 5 | 2 |
| STEM - | 0 | 8 | 1 |

Table 4

*Correlations Between Sex-Typed Beliefs and Math Efficacy, Science Efficacy, Math Confidence, Science Confidence, Math Interest, and Science Interest.*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Math efficacy | Science efficacy | Math Confidence | Science confidence | Math interest | Science interest |
| Sex-typed beliefs *r* value | -.036 | .080 | .311 | -.362 | .267 | -.460 |

*Note*: All *p*s > .05.

Table 5

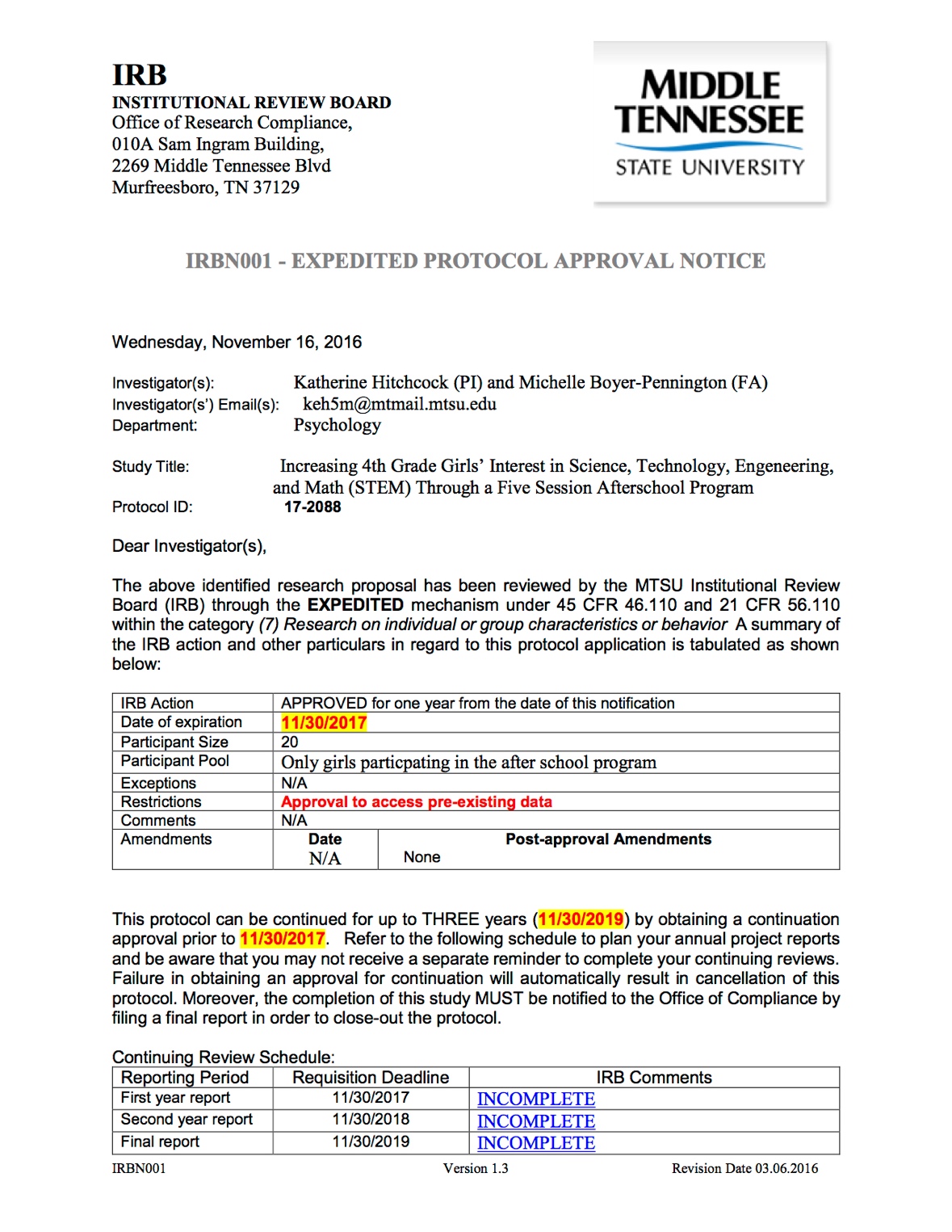
*Correlations Between Perceived Parental Importance of Math and Science and Math and Science Nervousness*

|  |  |  |
| --- | --- | --- |
|  | Math nervousness | Science nervousness |
| Math perceived importance | .040 |  |
| Science perceived importance |  | -.354 |

*Note*: all *p*s > .05.

Appendix A

IRB Approval Letter



Appendix B

Invitation and Permission Form for the After-School Program

**Your child has the opportunity to join our new after-school STEM/Writing club!**

Science, technology, engineering, and math (STEM) can be fun and fascinating to study!  In five sessions, we will touch on educational concepts that your child will find fun and interesting. We hope to encourage your child’s creativity, curiosity, and love of learning. At the end of our sessions, your child should feel more comfortable and confident in the areas of writing and technology.

**9/30/16          Session 1:**  STEM interest survey and Magic Pepper Experiment

**10/14/16      Session 2:**  Experiment “The Non-Popping Balloon!” and DIY thermometer

**10/28/16      Session 3:** Fun with Kahoots!!!

**11/04/16      Session 4:** Engineering activity “Gumdrop Bridge Challenge”

**11/11/16      Session 5:** Jumbo bubbles experiment and Concluding STEM Interest Survey

If you and your child are interested in participating and you can commit to picking your child up on these dates at 4:15, please sign and return the bottom portion of this letter. Since we want to keep the first group small, we will only accept the first ten responses this time. I look forward to seeing your child’s interests expand and grow!

Sincerely,

Mrs. Dunn

[jdunn@k12mcs.net](mailto:jdunn@k12mcs.net)

-----------------------Send this portion to Mrs. Dunn by 9/22/16---------------------

\_\_\_\_\_\_\_\_ No, my child will not be participating. Please find another candidate.

\_\_\_\_\_\_\_\_ Yes, my child, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, will participate in the STEM/writing club.  I will pick them up at 4:15. I give consent for my child to participate in a survey to be given at the beginning and end of the sessions.

Signature:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Phone: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Appendix C

The Qualitative Section of the Survey

Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Birthday\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. What do you want to be when you grow up? Why?

2. Do you know someone who uses math in their job? If so, are they a man or a woman?

3. Do you know someone who uses science as their job? If so, are they a man or a woman?

4. Do you know someone who uses technology for their job? If so, are they a man or a woman?

5. Do you know someone who builds things for their job? If so, are they a man or a woman?

Appendix D

The Quantitative Section of the Survey

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Strongly Disagree** | | | **Neither** | | **Strongly Agree** | |
| **Questionnaire** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1. Some subjects are for boys and some subjects are for girls. |  |  |  |  |  |  |  |
| 2. I like Math. |  |  |  |  |  |  |  |
| 3. I like Reading |  |  |  |  |  |  |  |
| 4. I like Science. |  |  |  |  |  |  |  |
| 5. I like Social Studies. |  |  |  |  |  |  |  |
| 6. I like English. |  |  |  |  |  |  |  |
| 7. I am good at Math. |  |  |  |  |  |  |  |
| 8. I get nervous in math. |  |  |  |  |  |  |  |
| 9. I get nervous in math when I don’t know the right answer. |  |  |  |  |  |  |  |
| 10. I am able to get good grades in math. |  |  |  |  |  |  |  |
| 11. I struggle with math homework. |  |  |  |  |  |  |  |
| 12. Someone at home tries to help me with Math. |  |  |  |  |  |  |  |
| 13. I think it is important to do good in Math. |  |  |  |  |  |  |  |
| 14. My parents think Math is important. |  |  |  |  |  |  |  |
| 15. I want to do something with Math when I grow up. |  |  |  |  |  |  |  |
| 16. How I do in Math depends on how hard I work. |  |  |  |  |  |  |  |
| 17. How I do in math depends on my personality. |  |  |  |  |  |  |  |
| 18. Math is harder for me than my other classmates. |  |  |  |  |  |  |  |
| 19. I am good at Science. |  |  |  |  |  |  |  |
| 20. I get nervous about Science class. |  |  |  |  |  |  |  |
| 21. I get nervous when I don’t know the answer in Science. |  |  |  |  |  |  |  |
| 22. I am able to get good grades in Science. |  |  |  |  |  |  |  |
| 23. I have trouble with Science homework. |  |  |  |  |  |  |  |
| 24. Someone at home tries to help me with Science. |  |  |  |  |  |  |  |
| 25. I think it is important to do good in Science. |  |  |  |  |  |  |  |
| 26. My parents think Science is important. |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 27. I want to do something with science when I grow up. |  |  |  |  |  |  |  |
| 28. How I do in Science depends on how hard I work. |  |  |  |  |  |  |  |
| 29. How I do in Science depends on my personality. |  |  |  |  |  |  |  |
| 30. I like using technology. |  |  |  |  |  |  |  |
| 31. Using technology is important. |  |  |  |  |  |  |  |
| 32. I want to do something with technology when I grow up. |  |  |  |  |  |  |  |
| 33. I like to build things. |  |  |  |  |  |  |  |
| 34. Building things Is important. |  |  |  |  |  |  |  |
| 35. I want to build things when I grow up. |  |  |  |  |  |  |  |

Appendix E

Principal Permission and Signature

