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The Impact of Participating in a STEM Academy on Girls' STEM Attitudes and Self-efficacy

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ABSTRACT

The purpose of this mixed methods study was to examine the influence of participating in a STEM Academy (STEMA) on girls' mathematics, science, engineering, and technology self-efficacy and STEM attitudes. Twenty-eight sixth grade girls participating in a STEMA were individually matched with sixth grade girls not participating in a STEMA. Both participant groups were administered the *Student Attitudes toward STEM* (S-STEM) – *Middle and High School Survey* and the STEMA group also participated in a focus group. The results indicated that the STEMA program did positively influence girls' mathematics and science self-efficacy but not their engineering, technology, or STEM self-efficacy. Self-efficacy perceptions were positively influenced by their participation and the teachers in the STEMA program.

Keywords: engineering self-efficacy, mathematics self-efficacy, science self-efficacy, STEM self-efficacy, STEM Academy, STEM careers, technology self-efficacy

Introduction

Gender stereotypes often interfere with girls enrolling in advanced science, technology, engineering, and mathematics (STEM) courses and women entering STEM majors or careers (Packard & Wong, 1999). Historically, women across the globe have been perceived as more suited for specific jobs (generally those with a nurturing component or perceived to be more feminine, such as teaching and nursing). Men on the other hand, have been perceived as more suited for jobs that include management, supervision, and STEM, or those often perceived to be masculine.

Related to gender stereotyping in STEM is perceived STEM confidence. Boys tend to be more confident in their mathematics and science abilities compared to girls (Libarkin & Kurdziel, 2003). Building girls' STEM self-esteem and STEM confidence will improve their STEM performance, increasing the likelihood that they might realize that science, technology, engineering, and mathematics may be viable career choices (Frize, Frize, & Faulkner, 2009).

Research Purpose and Questions

The purpose of this study was to examine the influence of participating in a STEMA on girls' STEM self-efficacy. This study addressed the following research questions:

1. Does participation in a sixth grade STEM Academy influence girls' self-efficacy in mathematics?
2. Does participation in a sixth grade STEM Academy influence girls' self-efficacy in science?
3. Does participation in a sixth grade STEM Academy influence girls' self-efficacy in engineering and technology?
4. Is there a statistically significant mean difference in girls' STEM self-efficacy between pre- and post-survey data in the STEM Academy?
5. How does participating in a sixth grade STEM Academy affect girls' perceptions of STEM self-efficacy?

Theoretical Framework

The theoretical framework for this study was based on Bandura's *Social Cognitive Theory* (1986). Social cognitive theory (SCT) relates to how an individual thinks and processes information and reacts to a given environment (Bandura, 1986). Individuals' cognitive ability to understand and process information directly relates to how they respond to the environment they are in. According to Bandura (1999), human behavior can be explained using a triadic reciprocal causation. In this model, personal factors, behavior, and environmental factors interact seamlessly to influence one another. One component of Bandura's Social Cognitive Theory (SCT) is self-efficacy. Bandura (1999) explained that self-efficacy is critical in SCT because of how people are able to change their behaviors or actions according to what they believe. As such, he stated that "efficacy beliefs influence how people, feel, think, motivate themselves, and behave" (Bandura, 1993, p. 118). Self-efficacy is formed through the interaction of personal factors, behaviors, and environmental factors. Bandura (1994) defines self-efficacy as the belief an individual has related to his or her abilities to complete a given task. Generally, individuals are likely to perform only as well as they expect. As such, individuals' internal personal factors, behavior, and environmental factors influence their self-efficacy. This triadic reciprocal causation helps to construct an individual's self-efficacy. For example, a student may have a lower self-efficacy in a certain subject (personal factor) and may avoid or drop out of a class (behavior) if the class is made up of one specific demographic (environmental factors).

Perceived self-efficacy can also play a role in Social Cognitive Theory (SCT). Bandura (1989) stated that how people perceive they will do on a task influences the degree to which the task is completed or if the task is completed. Perceived self-efficacy is formed when the triadic reciprocal causation components interact with one another. Individuals who perceive themselves to have a higher self-efficacy typically take on more challenging tasks, while those with a lower perception of self-efficacy may avoid them (Bandura, 1989). As such, perceived self-efficacy can influence individuals' actions or behaviors based on the environment they are in.

Social Cognitive Theory (SCT), specifically the concept of self-efficacy, is selected as the theoretical framework for this study because research demonstrates the predictive influence self-efficacy has on confidence in academic tasks and making decisions such as career choices. Because SCT elucidates and foresees learned behaviors, it is a natural fit for this study. According to Fenema (2000), boys are more confident than girls in specific subjects, like mathematics and science. Girls typically have a lower self-efficacy than boys, which correlates with Bandura's research on self-efficacy. The triadic reciprocal causation that Bandura mentions is instrumental in girls' self-efficacy because it is that interaction among their personal, behavioral, and environmental factors that helps to construct their self-efficacy. In the study of girls' self-efficacy in STEM, Bandura's triadic reciprocal causation relates. Each of the factors are intertwined where they interact with one and influence one another.

The behavioral and environmental factors influence each other and in turn, influence girls' self-efficacy in STEM. An individual's thoughts, beliefs, and self-perceptions are all parts of their personal factors (Bandura, 1977). Specific to this study, a girl's self-perceptions and beliefs in her abilities to achieve or perform a STEM task or activity are all personal factors for her. An individual's skills and actions relate to his or her behavior (Bandura, 1977) so a girl's skills or abilities in a STEM task are part of her behavioral factors. Environmental factors can be either externally physical or social in nature (Bandura, 1977). This study focused on the social aspect of the environment where girls participated in a STEMA.

Literature Review

Gender Inequality in STEM

The underrepresentation of girls in advanced STEM courses and women in STEM fields is a global problem that has not been significantly altered in decades, despite multiple initiatives across all developmental levels (National Science Foundation [NSF], 2017). This problem occurs even in countries that have achieved high levels of gender equality, such as Finland, Norway, and Sweden (Stoet & Geary, 2018). In Western Europe and Canada, women hold approximately 30% of STEM jobs and globally, women hold around 28% of these positions.

Gendered Stereotypes in STEM

Stereotypes related to STEM and gender can begin in early childhood and progress into adulthood. Bian, Leslie, and Cimpian (2017) found that even as early as the age of six, children can possess the misconception that boys are intellectually superior to girls in STEM subjects, which can influence girls' decisions regarding advanced STEM course enrollment and career selection. When girls are simply aware of the existence of such stereotypes, that awareness can undermine their "sense of belonging in STEM and their ability to perform at their best" (Boston & Cimpian, 2018, p. 198).

Teacher Influence on STEM Self-Efficacy

According to Rowan-Kenyon, Swan, and Creager (2012), teacher influence has a significant impact on students' STEM confidence and interest. Teachers' own STEM self-efficacy beliefs are a predictor of their teaching practices (Schiefele & Schaffner, 2015). Thus, a teacher who is highly confident in his/her own STEM abilities is more likely to provide more frequent and higher quality science experiences for students (Appleton & Kindt, 1999).

Girls' Science Self-Efficacy

Stoet and Geary (2018) examined the 2015 Programme for International Student Assessment (PISA) data set for sex differences in science attitudes, interest levels in science, and enjoyment of science between boys and girls in 72 countries and determined that boys' science self-efficacy was higher than girls in 58% of countries, that boys demonstrated a greater interest in science than girls in 76% of countries, and that boys reported enjoying science more than girls in 43% of countries. Moreover, Stoet and Geary (2018) determined that in 49% of countries, boys overestimated their science self-efficacy where girls only did so in 7% of countries.

Girls' Mathematics Self-Efficacy

Like girls' science self-efficacy, girls' mathematics self-efficacy is reflective of their low competence beliefs related to their ability to do well in mathematics, and often emerge during the middle school years (Midgley, Feldlaufer, & Eccles, 1989). During middle school, many students demonstrate preference for specific academic subject areas, and these preferences are formed based on their perceived capabilities or lack of capabilities in the different subject domains, based on past failures and successes, their comparison of self to peers, and teacher and parental feedback (Bandura, 1997). In elementary school, both boys and girls report equal levels of mathematical confidence, but by middle school, boys often rate themselves higher in mathematics self-efficacy than do girls (Butz & Usher, 2015) while girls, particularly gifted girls, are more likely to report lower levels of mathematics confidence (Pajares, 2005), and these low levels do not tend to improve with time beyond middle school (Herbert & Stipek, 2005).

Girls' Technology Self-Efficacy

Like mathematics and science, girls tend to demonstrate lower levels of technological self-efficacy than do boys (Alvarado, Dodds, & Libeskind-Habas, 2012). However, several studies revealed no gender differences in technology related achievement or that females outperform males. In particular, Lau and Yuen (2009) determined that high school females performed better than males on a programming performance test and Sullivan and Bers (2016) revealed boys and girls performed equally well in basic programming tasks at the kindergarten level.

Girls' Engineering Self-Efficacy

The research literature is limited regarding girls' engineering self-efficacy. However, Sullivan and Bers (2015) investigated the influence a seven-week robotics curriculum had on the attitudes of children aged 5-7 toward engineering and found that participation in the robotics program elicited a statistically significant positive change in girls' desire to be an engineer.

The Impact of Informal STEM Opportunities on Girls' STEM Self-Efficacy

Informal STEM education (optional STEM experiences occurring outside of normal school hours) does not focus on learning outcomes, but rather emphasizes hands on experiences with science process skills, involvement in science practices, learning how to apply science content, and building identity as STEM learners (Bell, Lewenstein, Shouse, & Feder, 2009). For informal STEM experiences to positively impact girls, they must be optional and cumulative (Bell et al., 2009). Girls must choose to participate in STEM experiences to receive the greatest benefit from those experiences and choice seems to be tied to competency beliefs (beliefs about one's abilities) (Pajares, 2002). In addition, to improve STEM self-efficacy, girls must participate in multiple, cumulative informal STEM learning experiences (Bell et al., 2009).

Methods

Participants

A total of 56 sixth grade girls from a large urban school district in southeast Texas were invited to participate in this study. Twenty-eight sixth grade girls participating in the STEMA were individually matched with 28 sixth grade girls not participating in a STEMA. Participants were individually matched on the following criteria: race/ethnicity, economically disadvantaged, at-risk, English Language Learners, and a passing grade of 70 or more in all subjects in the previous school year in fifth grade. Table 1 provides the demographics for the matched samples.

Table 1. *Participant Demographics: STEMA vs non-STEMA*

	STEM Academy (n)	STEM Academy (%)	Non-STEM Academy (n)	Non-STEM Academy (%)
1. Race/Ethnicity				
African American	8	28.6	8	28.6
American Indian	1	3.6	1	3.6
Asian	4	14.3	4	14.3
Hispanic	14	50.0	14	50.0
White	1	3.6	1	3.6
2. Economically Disadvantaged	26	92.9	26	92.9
3. At-Risk	25	89.3	25	89.3
4. English Language Learners	4	14.3	4	14.3
5. Passing Grade of 70 or more				
Mathematics	28	100.0	28	100.0
Reading	28	100.0	28	100.0
Science	28	100.0	28	100.0
Social Studies	28	100.0	28	100.0
Writing	28	100.0	28	100.0

Instrumentation

The *Student Attitudes toward STEM* (S-STEM) – *Middle and High School Students (6-12th grades) Survey* was used to examine whether or not STEMA participation affects girls' self-efficacy in STEM. The survey was designed and validated by the Friday Institute for Educational Innovation at North Carolina State University (2012) and consists of three content self-efficacy constructs: (a) mathematics self-efficacy (8-items), (b) science self-efficacy (9-items), and (c) engineering and technology (9-items). Participants were asked to rate a variety of comments concerning their self-efficacy using a 5-pt Likert scale (1 = *Strongly Disagree* to 5 = *Strongly Agree*). The overall Cronbach's Alpha's reliability coefficient for the instrument was 0.86, mathematics self-efficacy was 0.90, science self-efficacy was 0.86, and engineering and technology self-efficacy was 0.82.

Data Collection and Analysis

The S-STEM Survey was administered at the beginning of the semester and again at the end of the semester using Google Forms. The qualitative component of the study included two 60-minute focus groups with 10 girls in the STEMA program prior to the start of the STEMA program and at the end of the fall semester. Participants were asked open ended questions about their attitudes and self-efficacy related to STEM and the STEMA program.

All quantitative data were analyzed using IBM SPSS. An Analysis of Covariance (ANCOVA), independent t-test, and paired t-tests were conducted to determine if participation in a sixth grade STEMA influenced girls' self-efficacy. Statistical significance was measured using a *p*-value of 0.05 and Cohen's *d*, r^2, and η^2 were used to calculate effect sizes. Qualitative data obtained from the focus groups were analyzed using a thematic analysis approach. The researchers looked for trends and patterns in each of the participant's responses. Next, participants' responses were grouped according to those themes. Results were organized, categorized, and subcategorized based on the themes that emerged. Validity was assured through member checking, peer debriefing, and triangulation.

Results

Mathematics Self-Efficacy

Prior to the start of the STEMA program, baseline equivalence was measured between the two groups of participants. Results of an independent t-test indicated that girls who intended to participate in the STEMA program had a higher mathematics self-efficacy than girls not intending to participate in the STEMA program, $t(54) = 2.935$, $p = 0.005$. As a result, an ANCOVA test was conducted to determine if a statistically significant mean difference existed between program participation on mathematics self-efficacy controlling for mathematics self-efficacy prior to participation. Results indicated a statistically significant mean difference between groups in terms of mathematics self-efficacy when controlling for prior mathematics self-efficacy, $F(1, 53) = 8.41$, $p = 0.005$, $\eta^2 = 0.12$ (see Table 2). Students in the STEMA program (M = 28.9) had a higher mathematics self-efficacy than those not in the STEMA program (M = 24.2). Twelve percent of the variation in mathematics self-efficacy can be attributed to program participation. A paired t-test was also conducted to determine if a statistically significant mean difference existed in the STEMA girls' mathematics self-efficacy from prior to program participation to the end of the semester. Results of the paired t-test indicated there was not a statistically significant mean difference between pre- and post-mathematics self-efficacy, $t(27) = -0.313$, $p = 0.757$ (see Table 3).

Table 2. *Type of Program's Influence on Mathematics Self-Efficacy*

Type of Program	N	M	SD	F-value	df	*p*-value	η^2
1. STEM Academy	28	28.93	6.92	8.41	1,53	.005*	.12
2. Non-STEM Academy	28	24.21	6.04				

*Statistically significant (p < .05)

Table 3. *Self-Efficacy of STEMA Participants*

	N	M	SD	*t*-value	df	*p*-value
1. Pre-survey	28	28.36	5.91	-0.31	27	.757
2. Post-survey	28	28.93	6.92			

*Statistically significant (p < .05)

Differences were evident when comparing those participating in the STEMA to those not participating. For example, 21.4% of participants in the STEMA program agreed/strongly agreed that mathematics is their worst subject, while more than twice (49.9%) the participants not in the STEMA program agreed/strongly agreed with this statement. Approximately 57.0% of the participants in the STEMA program responded that they agreed/strongly agreed to consider a career that uses mathematics, while only 25.0% of participants not in the STEMA program said they would consider it. While 50.0% participants in the STEMA program agreed/strongly agreed that they do well in mathematics, only 32.1% participants not in the STEMA agreed/strongly agreed. Finally, 60.7% participants in the STEMA program agreed/strongly agreed that they felt they could do advanced work in mathematics, while 39.3% participants not in the STEMA program agreed/strongly agreed. Table 4 displays the participant responses.

Table 4. *Responses to Mathematics Self-Efficacy (%)*

Survey Item	Type of Program	Type of Survey	Strongly Disagree /Disagree	Agree /Strongly Agree
1. Math has been my worst subject.	STEM Academy	Pre	35.7	17.9
		Post	64.3	21.4
	non-STEM Academy	Pre	28.6	50.0
		Post	32.1	42.9
2. I would consider choosing a career that uses math.	STEM Academy	Pre	17.9	50.0
		Post	21.4	57.1
	non-STEM Academy	Pre	35.7	25.0
		Post	28.6	25.0
3. Math is hard for me.	STEM Academy	Pre	50.0	32.1
		Post	50.0	25.0
	non-STEM Academy	Pre	35.7	46.4
		Post	28.6	46.4
4. I am the type of student to do well in math.	STEM Academy	Pre	14.3	46.4
		Post	14.3	50.0
	non-STEM Academy	Pre	32.1	32.1
		Post	35.7	32.1
5. I can handle most subjects, but I cannot do a good job with math.	STEM Academy	Pre	60.7	28.6
		Post	67.9	21.4
	non-STEM Academy	Pre	42.9	28.6
		Post	25.0	35.7
6. I am sure I could do advanced work in math.	STEM Academy	Pre	14.3	67.9
		Post	17.9	60.7

	non-STEM Academy	Pre	46.4	25.0
		Post	21.4	39.3
7. I can get good grades in math.	STEM Academy	Pre	3.6	89.3
		Post	7.1	64.3
	non-STEM Academy	Pre	17.9	40.0
		Post	7.1	40.0
8. I am good at math.	STEM Academy	Pre	17.9	53.6
		Post	7.1	57.1
	non-STEM Academy	Pre	25.0	39.3
		Post	25.0	35.7

Differences were also seen in the STEMA girls' mathematics self-efficacy between their pre- and post-survey data. On the pre-survey, 35.7% disagreed/strongly disagreed that mathematics was their worst subject, while on the post-survey, 64.3% disagreed/strongly disagreed. On the pre-survey, 50.0% participants agreed/strongly agreed that they would consider a career that uses mathematics, while on the post-survey, 57.1% participants agreed/strongly to this statement. On the pre-survey, 89.3% participants felt they get good grades in mathematics; while on the post-survey, 64.3% participants felt they get good grades in mathematics. On the pre-survey, 67.9% participants believed they could do advanced work in mathematics while on the post-survey, 60.7% participants felt they could do advanced work in mathematics.

Science Self-Efficacy

At the beginning of the fall semester, a baseline equivalence of science self-efficacy was established concluding no difference in science self-efficacy between the groups. Results of the independent t-test indicated that participating in a STEMA did influence science self-efficacy, $t(54) = 2.42$, $p = .019$, Cohen's d = 0.67 (large effect size), $r^2 = 0.102$ (see Table 5). On average, girls participating in the STEMA (M = 36.1) reported a higher science self-efficacy than girls not participating in the STEMA (M = 32.0). Ten percent of the variation in science self-efficacy can be attributed to program participation. A paired t-test was also conducted to determine if a statistically significant mean difference existed in STEMA's girls' science self-efficacy prior to program participation and at the end of the semester. Results of the paired t-test indicated there was not a statistically significant mean difference between pre and post-science self-efficacy, $t(27) = 0.234$, $p = 0.82$ (see Table 6).

Table 5. *Type of Program's Influence on Science Efficacy*

Type of Program	N	M	SD	*t*-value	df	*p*-value	d
1. STEM Academy	28	36.07	6.51	2.42	54	0.019*	0.67
2. Non-STEM Academy	28	32.00	6.07				

*Statistically significant (p < .05)

Table 6. *Science Self-Efficacy of STEMA Participants*

Type of Survey	N	M	SD	*t*-value	df	*p*-value
1. Pre-Survey	28	36.50	5.80	0.23	27	0.82
2. Post-Survey	28	36.07	6.51			

*Statistically insignificant (p < .05)

Eighty-six percent of participants in the STEMA program felt confident in science, while only 53.6% of those not participating felt confident in science. All participants whether in the STEMA program or not, reported not feeling confident in science 3.6% of the time. While 60.7% participants in the STEMA program responded that they would consider choosing a career in science, 42.9% of the participants not enrolled in the STEMA indicated the same. Also, only 17.9% participants in the STEMA program and 10.7% participants not in the STEMA said they would not consider a career in science.

Of STEMA participants, 71.4% believed that science knowledge would help them earn a living, while 53.6% of non-STEMA participants felt the same. Additionally, 7.1% of STEMA participants disagreed that science knowledge would help them earn a living; while 14.3% of non-STEMA participants felt science knowledge would not be helpful to income. When asked if they felt they do well in science, 89.3% of participants in the STEMA program and 60.7% not in the STEMA program agreed/strongly agreed. Only 60.7% of participants in the STEMA program and 39.3% not in the STEMA program felt they could do advanced work in science. Then, 14.3% participants in the STEMA program and 10.7% participants not in the STEMA program did not feel confident in doing advanced work in science. Table 7 displays the participants' responses.

Table 7. *Responses to Science Self-Efficacy (%)*

Survey Item	Type of Program	Type of Survey	Strongly Disagree /Disagree	Agree /Strongly Agree
1. I am sure of myself when I do science.	STEM Academy	Pre	0.0	89.3
		Post	3.6	85.7
	non-STEM Academy	Pre	7.1	60.7
		Post	3.6	53.6

2.	I would consider a career in science.	STEM Academy	Pre	14.3	53.6
			Post	17.9	60.7
		non-STEM Academy	Pre	10.7	57.1
			Post	10.7	42.9
3.	I expect to use science when I get out of school.	STEM Academy	Pre	7.1	64.3
			Post	10.7	71.4
		non-STEM Academy	Pre	7.1	57.1
			Post	7.1	53.6
4.	Knowing science will help me earn a living.	STEM Academy	Pre	7.1	71.4
			Post	7.1	71.4
		non-STEM Academy	Pre	10.7	53.6
			Post	14.3	53.6
5.	I will need science for my future.	STEM Academy	Pre	7.1	82.1
			Post	10.7	71.4
		non-STEM Academy	Pre	10.7	71.4
			Post	10.7	60.7
6.	I know I can do well in science.	STEM Academy	Pre	0.0	85.7
			Post	0.0	89.3
		non-STEM Academy	Pre	3.6	67.9
			Post	3.6	60.7
7.	Science will be important to me in my life's work.	STEM Academy	Pre	14.3	75.0
			Post	10.7	57.1
		non-STEM Academy	Pre	3.6	71.4
			Post	10.7	42.9
8.	I can handle most subjects well, but I cannot do a good job with science.	STEM Academy	Pre	89.3	3.6
			Post	89.3	3.6
		non-STEM Academy	Pre	53.6	10.7
			Post	50.0	21.4
9.	I am sure I could do advanced work in science.	STEM Academy	Pre	14.3	71.4
			Post	14.3	60.7
		non-STEM Academy	Pre	17.9	39.3
			Post	10.7	39.3

Differences were also seen in girls' science self-efficacy between their pre- and post-survey data in the STEMA. On the pre-survey, 64.3% of participants believed they would use science when they got out of school while on the post-survey, 71.4% agreed. On the pre-survey, 82.1% participants said they would need science in the future while 71.4% agreed on the post-survey. On the pre-survey, 53.6% participants would consider a career in science while on the post-survey 60.7% said they would consider it. Then, 85.7% of participants felt on the pre-survey, that they do well in science and 89.3% felt that they do well in science on the post-survey. On the pre-survey, 71.4% of participants believed they could do advanced work in science while only 60.7% of participants agreed/strongly agreed on the post survey.

Engineering and Technology Self-efficacy

At the beginning of the fall semester, a baseline equivalence of engineering and technology self-efficacy was established concluding no difference in engineering and technology self-efficacy between the groups. Results of the independent t-test indicated that participating in the STEMA did not influence engineering and technology self-efficacy, $t(54) = 1.655$, $p = 0.104$ (see Table 8). A paired t-test was also conducted to determine if a statistically significant mean difference existed in STEMA's girls' engineering and technology self-efficacy prior to program participation and at the end of the semester. Results of the paired t-test indicated there was not a statistically significant mean difference between pre- and post-engineering and technology self-efficacy, $t(27)$, = -0.115, p = 0.91 (see Table 9).

Table 8. *Type of Program's Influence on Engineering and Technology Self-Efficacy*

Type of Program	N	M	SD	*t*-value	df	*p*-value
1. STEM Academy	28	34.75	6.74	1.67	54	.10
2. Non-STEM Academy	28	21.57	7.60			

*Statistically insignificant (p < .05)

Table 9. *Engineering and Technology Self-Efficacy of STEMA Participants*

	N	M	SD	*t*-value	df	*p*-value
1. Pre-Survey	28	34.54	6.94	-0.12	27	0.91
2. Post-Survey	28	34.75	6.74			

*Statistically significant (p < .05)

Regarding STEMA participants, 60.7% agreed/strongly agreed that they liked to imagine creating new products while 57.1% of participants not in the STEM Academy program agreed/strongly agreed. Only 17.9% of participants in the STEM Academy program disagreed/strongly disagreed that they liked to imagine creating new products while 10.7% of participants not in the STEM Academy program disagreed/strongly disagreed to this statement. Then, 46.4% of participants in the STEM Academy program and not in the STEM Academy program agreed/strongly agreed that they are good at building and fixing things. While 10.7% of participants in the STEM Academy program disagreed/strongly disagreed with feeling like they were good at building and fixing things, only 14.3% of participants not in the STEM Academy program disagreed/strongly disagreed. Then, 53.6% of participants in the STEM Academy program and 17.9% of participants not in the STEM Academy program were interested in what makes machines work. Only 3.6% of participants in the STEM Academy program and 17.9% of participants not in the STEM Academy program were not interested in what makes machines work.

Next, 53.6% of participants in the STEM Academy and not in the STEM Academy programs were curious about how electronics work. While 25.0% of participants in the STEM Academy program were not curious about how electronics work, 21.4% of participants not in the STEM Academy program were also not curious how electronics work. Only 78.6% of participants in the STEM Academy program said they would have the desire to use creativity and innovation in their future work while 57.1% of participants not in the STEM Academy program agreed/strongly agreed to this statement. Then, 3.6% of participants in the STEM Academy program and 14.3% of participants not in the STEM Academy program disagreed/strongly disagreed to wanting to use creativity and innovation in their future work. Additionally, 64.3% of participants in the STEM Academy program believed that knowing how to use mathematics and science together will allow them to invent useful things while 57.1% of participants not in the STEM Academy program agreed/strongly agreed to this statement. Only 3.6% of participants in the STEM Academy program and 10.7% of participants not in the STEM Academy program did not believe that knowing how to use mathematics and science together will allow them to invent useful things.

Table 10. *Responses to Engineering & Technology Self-Efficacy (%)*

Survey Item	Type of Program	Type of Survey	Strongly Disagree /Disagree	Agree /Strongly Agree
1. I like to imagine creating new products.	STEM Academy	Pre	10.7	78.6
		Post	17.9	60.7
	non-STEM Academy	Pre	10.7	64.3
		Post	10.7	57.1
2. If I learn engineering, then I can improve things that people use every day.	STEM Academy	Pre	7.1	71.4
		Post	10.7	78.6
	non-STEM Academy	Pre	7.1	60.7
		Post	17.9	60.7
3. I am good at building and fixing things.	STEM Academy	Pre	25.0	50.0
		Post	10.7	46.4
	non-STEM Academy	Pre	21.4	50.0
		Post	14.3	46.4
4. I am interested in what makes machines work.	STEM Academy	Pre	21.4	46.4
		Post	3.6	53.6
	non-STEM Academy	Pre	32.1	46.4
		Post	17.9	17.9

5.	Designing products or structures will be important for my future work.	STEM Academy	Pre	10.7	71.4
			Post	14.3	60.7
		non-STEM Academy	Pre	7.1	46.4
			Post	25.0	39.3
6.	I am curious about how electronics work.	STEM Academy	Pre	0.0	75.0
			Post	25.0	53.6
		non-STEM Academy	Pre	7.1	71.4
			Post	21.4	53.6
7.	I would like to use creativity and innovation in my future work.	STEM Academy	Pre	3.6	78.6
			Post	3.6	78.6
		non-STEM Academy	Pre	7.1	71.4
			Post	14.3	57.1
8.	Knowing how to use math and science together will allow me to invent useful things.	STEM Academy	Pre	0.0	75.0
			Post	3.6	64.3
		non-STEM Academy	Pre	7.1	71.4
			Post	10.7	57.1
9.	I believe I can be successful in a career in engineering.	STEM Academy	Pre	28.6	53.6
			Post	10.7	67.9
		non-STEM Academy	Pre	14.3	35.7
			Post	21.4	46.4

Differences were seen in girls' engineering and technology self-efficacy between their pre- and post-survey data in the STEMA. On the pre-survey, 78.6% of participants in the STEMA program liked to imagine creating new products and 60.7% agreed/strongly agreed to this statement on the post-survey. Next, 25.0% of participants on the pre-survey and 10.7% participants on the post-survey said they were not good at building and fixing things. On the pre-survey, 75.0% of participants said they were curious about how electronics worked, while on the post-survey, 53.6% participants agreed. On the pre-survey, 28.6% of participants disagreed/strongly disagreed to believing they would be successful in a career in engineering, while 10.7% of participants on the post-survey disagreed/strongly disagreed.

STEMA Girls' Perceptions

To determine how participation in the STEMA impacted participating girls' perceived STEM self-efficacy, focus groups were conducted prior to the start of the STEMA program and at the end of the semester. The questions asked at the start of the program can be found in the Appendix A and the questions at the end of the semester can be found in Appendix B. The main thematic categories that emerged from the qualitative data were the following: (a) content related perceptions; (b) perceptions related to failure and asking for help from the teacher; (c) perceptions related to success in engineering; (d) future STEM course and career selection; (e) perceptions of gender disparity; and (f) teacher influence on self-perception. Within these main thematic categories, subcategories were created to gather a more insightful analysis of students' perceptions of STEM self-efficacy.

Content Related Perceptions

Participants were asked questions related to specific subjects and their feelings and perceptions related to these subject areas. Responses analyzed and grouped together in similar subject areas to form subcategories: (a) perceptions of mathematics self-efficacy; (b) perceptions of science self-efficacy; (c) perceptions of engineering self-efficacy; and (d) perceptions of technology self-efficacy. (see Table 13)

Table 13. *Girls' Perceptions in Self-Efficacy*

Content Related Perceptions in Self-Efficacy (Do I Think I'm Good at It?)					
		Mathematics	Science	Engineering	Technology
Student	A	Yes	Yes	Yes	No
	B	Yes	Yes	Yes	Yes
	C	Yes	Yes	Yes	Yes
	D	No	Yes	Yes	Yes
	E	No	No	Yes	No
	F	Yes	No	Yes	No
	G	No	Yes	Yes	Yes
	H	Yes	Yes	Yes	Yes
	I	No	Yes	Yes	No
	J	Yes	No	Yes	No

Perceptions of Mathematics Self-Efficacy

During a pre- and post- STEMA interview, participants were asked about their perceptions of mathematics and how capable they perceived they were in mathematics. The months these female students spent in mathematics class in the STEMA did not change their feelings regarding mathematics. Responses from the girls implied that those who felt they were good in mathematics felt that way before participating in the STEMA. For instance, Student A's initial response, "I feel like I am good at math, but I don't really like it. There's a lot that you have to remember, and I find myself getting stressed out until I get the answer right," was similar to her post-interview response. After participating in the STEMA program, these girls still perceived their mathematics self-efficacy positively. As a result, it is evident that girls' perceptions of the mathematical abilities were not initially affected by the STEMA. Likewise, on the pre-interview, Student B stated, "I am not good at math, but I enjoy the class." Similarly, on the post-interview, the same student responded, "I hate math because it is too hard, and I never know any of the answers. How can I be good at something that I just don't understand, and it doesn't make sense to me?" The girls who did not feel confident in their mathematical abilities prior to participating in the STEM Academy did not demonstrate a change in their perceptions after participating in the program. Both situations suggest that the STEM Academy did not affect their perceptions of their mathematical self-efficacy. (see Table 13)

Perceptions of Science Self-Efficacy

During a pre- and post- STEMA interview, participants were asked about their perceptions of science and how capable they perceived they were in science. Most of the students felt confident in their abilities to complete scientific tasks and assignments. Responses from the girls suggest that those who felt they were good in science felt that way before participating in the STEMA. After participating in the program, these girls still perceived their science self-efficacy positively. As a result, it is evident that girls' perceptions of their science abilities were not initially affected by the STEMA. However, the STEMA may have maintained their positive self-perception in their science abilities.

On the contrary, some students perceived their abilities a little less favorably. For instance, in the pre-interview, Student G stated, "Science is very easy for me right now. I have never struggled in science, so I have been always been good at it. But, I am worried that now that I am going to the sixth grade, it will be harder to understand but I will still try my best." But, during the post-interview, the student responded, "I am struggling for the first time in science and I don't like it." Some students did not believe that science was fun and it was a difficult class for them. For instance, Student F's initial response, "I feel like I'm not very good at science. I understand some of it but some other parts I feel clueless and I don't understand." was similar to her post-interview response, "This year is getting harder in science and there's more and more that I don't understand. I'm still trying hard, but I really don't think I'm doing well. The girls who did not feel confident in their science abilities prior to participating in the STEMA did not demonstrate a change in their perceptions after participating in the program. This suggests that the STEMA did not affect their perceptions of their science self-efficacy. (see Table 13)

Perceptions of Engineering Self-Efficacy

During the interviews, students were asked questions related to their self-efficacy in engineering. Responses from the students suggest that the girls that entered the program with a prior positive perception in their engineering abilities were a result of their prior experiences. Participating in the STEM Academy continued to positively influence their perception in their engineering self-efficacy. For instance, Student C responded in the pre-interview, "I was in a STEM camp last summer and I love to design and build things. I really enjoyed problem solving and troubleshooting with other people in my group." During the post-interview response, the students stated, "I love it! The PBL really made me look at engineering in a different way from what I learned during the STEM camp." This implies that the STEM Academy did affect their perception of their abilities by continuing to grow their self-efficacy in engineering. Similarly, Student A's initial response, "I think I am good at engineering because I like to take things apart and put them back together." was like her post-interview response, "The PBL (in the STEMA) we completed was amazing, and I hope I get to do more!" The girls who did not have prior experience with engineering tasks demonstrated a positive perception in their self-efficacy by participating in the STEM Academy. (see Table 13)

Perceptions of Technology Self-Efficacy

During the interviews, students were asked questions related to their self-efficacy in technology. Responses from the girls implied that those who initially felt they were good in using technology programs or devices for instructional usage did so because of prior experiences. For example, Student G stated, "I really enjoy learning to code and I wonder if I will get more opportunities in the STEMA to continue to learn." This positive perception was also observed in the post-interview where the student responded, "Our STEM block teacher teaches us how to code and

I have learned much more. I have coded a program to draw snowflakes and that was amazing!" After participating in the program, most of the girls still perceived their abilities in technology positively. As a result, it is evident that the girls' perceptions of their self-efficacy in technology may have been maintained with their experience in the STEM Academy.

However, some of the girls who initially did not feel confident in their abilities to use technology programs and devices did not show an increase in their self-efficacy after participating in the STEM Academy. For example, Student I initially stated, "I hate technology. I wish everything was paper and pencil." During the post-interview, the student stated, "They never taught me how to use the apps and wanted us to just play around with the app, which I hated. I needed them to stop and show me how to use it and why one is better than the other." This suggests that the STEM Academy did not affect their perceptions of their technology self-efficacy. (see Table 13)

Perceptions of Failure and Seeking Help from the Teacher

Students were asked how they perceived failure in various situations and learning environments and how they felt about asking for help. Responses indicate that some of the girls may not know how to address their frustrations and their concerns in the STEMA. For instance, Student A's initial response, "If I don't understand a math problem, I will keep trying until I figure it out," was similar to her post-interview response, "I don't want to ask a lot of questions because my [STEMA] teacher gets annoyed with students who do this in class." Likewise, Student C stated in the pre-interview, "I get frustrated when I fail at something because I should have been able to do it. I don't ask for help because I get embarrassed and afraid the other kids will make fun of me." In the post-interview, she responded, "I have been trying not to get frustrated during class because getting mad will not help you be successful, only persistence and understanding will." Both situations suggest that the students do not feel that the teacher is capable or willing to help them sort through their frustrations.

Perceptions of Success in Engineering

This thematic category stemmed from responses related to how the participants felt when they succeeded in an engineering task or assignment. Participants were asked questions related to this during both focus groups, prior to the start of the STEMA program and at the end of the fall semester. Most of the participants stated that if they were successful on an engineering task, they would feel proud of themselves and happy. For instance, Student B initially stated, "A successful design would make me happy because I know I did a good job." This is similar to Student H, I, and J who stated they would feel proud when they successfully accomplish a task. It was evident that the participants took great pride in accomplishing difficult tasks. For example, at the post-interview, Students A-J were consistent about their feelings regarding success and their accomplishments in building and designing in the STEMA. This suggests that the girls felt confident in their abilities to complete engineering challenges in the STEM Academy and they had positive perceptions of their successful completion.

Teacher Influence on Self-Perception

Participants were asked numerous questions regarding how teachers influenced how they perceived specific subjects, helped build their confidence in specific subjects, and if teachers changed the way participants viewed their abilities in these subjects. Student responses varied from negative on how their teacher influenced their confidence and perception of different subjects to more positive where students perceived their ability more in a supportive and encouraging manner. For instance, Student A stated, "My fifth-grade teacher made math look easy, so I was able to really learn how to solve the problems because he broke everything down in a simple, understandable way." This suggests that girls' self-confidence and self-efficacy was cultivated by teachers. In the same way, Student B responded, "My fourth-grade teacher really helped me with my self-confidence in math. She would say, "It's okay if you don't get the answer right. The important thing is to try and keep working on it, no matter what." These students had a teacher who helped build their self-confidence and perception of their own abilities and skillset. Both situations suggest their teachers helped to shape the girls' self-perceptions of their abilities and influence them in different ways.

Future STEM Course and Career Selection

Participants were asked during both focus group times if they believed they would pursue a STEM career or major in a STEM field in college. There were a variety of responses during the pre-STEMA interview from wanting to choose STEM as a course pathway to not being interested at all. Out of the ten participants, six students expressed interest in majoring in STEM when they go to college during the pre-STEMA interview. During the post-STEMA focus group, six participants voiced interest in pursuing a STEM career. Careers mentioned included working for NASA, building prosthetics, engineer on an oil rig, computer programmer, architect, pediatric oncologist, and physician. This suggests that the STEMA was a positive influence and program in helping girls possibly choose STEM as a course selection or as a career in the future. Or if they already had an interest in STEM careers, the STEMA program maintained that interest in the girls. The other four participants were interested in careers unrelated to STEM. This suggests that the STEMA program did not have any influence on the girls to pursue a STEM related career.

Perceptions of Gender Disparity

Before and after the STEMA, participants were asked several questions related to gender disparity such as "*How would you feel if you heard someone say that boys are smarter than girls?"* All students felt this was unacceptable. Many of them responded that they would be angry hearing that males are better at achieving specific tasks than females. For instance, Student I stated, "That's such a sexist thing to say and I don't agree at all!" Their responses suggest that the girls had great confidence in themselves and knew that their abilities are not defined by their gender. The girls perceived themselves to be just as qualified or smart as the boys, and were willing to challenge anyone who said or thought any different.

Discussion

Girls' Science Self-Efficacy

The results of this study revealed that participation in a sixth grade STEMA positively influenced girls' self-efficacy in science when compared to girls' in a non-STEMA program. In addition, STEM girls' responses to interview questions related to science self-efficacy centered on feelings of accomplishment experienced after completing science tasks and how they perceived their ability to be successful in their science classrooms. Overall, STEMA girls demonstrated favorable perceptions of their abilities to engage in science and complete science related assignments and tasks. Results also suggest that the STEMA is a place for girls to feel confident and successful during their science learning, which corroborate Wallace and Hattingh's (2014) study that suggested a safe learning environment is needed for girls to develop and experience positive gains in their STEM self-efficacy, as demonstrated by the students in the STEMA.

Girls' Mathematics Self-Efficacy

The current study found that participation in a sixth grade STEMA positively influenced girls' self-efficacy in mathematics when compared to girls in the non-STEMA program. During focus group interviews, several STEMA participants stated that their previous (prior grades) high levels of mathematics self-confidence were beginning to falter. This is consistent with the literature, which states that girls' low mathematics self-efficacy often emerges during the middle school years (Midgley, Feldlaufer, & Eccles, 1989).

Girls' STEM Self-Efficacy

The current study did not find a statistically significant mean difference in girls' STEM self-efficacy between pre- and post- survey data in the STEMA. This implies that the girls, as a whole, prior to participating in the STEMA, already had a pre-existing high self-efficacy in STEM. The six girls in the STEMA program who had moderate self-efficacious levels in STEM experienced an increase in their STEM self-efficacy, but it was not enough to show significance for the group as a whole. This suggests that girls' STEM self-efficacy is not influenced by participation in a STEMA program. Consequently, other literature refutes this as Hizieak-Clark et al.'s (2015) findings reflected an increase in participants' self-efficacy in mathematics due to participation in a STEM program.

Girls' Technology and Engineering Self-Efficacy

The results of this study revealed no significant difference between STEMA girl participants' technology or engineering self-efficacy as compared to the participants not enrolled in the STEMA prior to the inception of the program. Self-efficacy scores between STEMA girl participants and non-STEMA girl participants post program were also not significantly different, thus participation in the STEMA did not influence girls' technology or engineering self-efficacy.

Girls' Perceptions of Gender Stereotypes in STEM

Students expressed their feelings about gender disparity and stereotypes during focus group interviews. All participating students consistently expressed disdain for anyone who believed that boys were smarter than girls in any specific subject area. Many students felt that the perception of one gender being smarter or superior to the other was inaccurate and stereotypical. The participants' familiarity with STEM gender stereotypes suggests they have witnessed or experienced such stereotypes.

The literature indicates that children grow increasingly aware of stereotypes over time and that those stereotypes have an increasing influence on the beliefs of children as they age, often resulting in children endorsing such stereotypes and expecting others to do so as well (Kurtz-Costes et al., 2014). As children enter puberty, they experience increased pressure to conform to society's perceptions of gender and associated occupational roles (Gottfredson & Lapan, 1997). The results of this study suggest that the sixth-grade female participants were likely just entering puberty and may have just begun to experience pressure to conform to female roles if at all, therefore they were very free in expressing their outrage over STEM stereotypes that served to limit their STEM aspirations.

Limitations of the Study

In this study, there were a number of limitations. First, this study may not be replicated because of the population and sample of the participating school district. Results from this study may not be generalizable to other school districts based on the participating school districts' demographics. Second, according to the Texas Education Agency (TEA, 2016), this school district was designated as an Industry Cluster Innovative Academy (ICIA). The school district consisted of 45 schools (24 elementary schools, six intermediate schools, six middle schools, and nine high schools) with a student population of approximately 46,223 students. One high school was designated as the ICIA school and eight schools (two middle, two intermediate, and four elementary schools) were designated to include a STEM Academy as part of their campus. This study may not be able to be replicated because other districts or schools may not be identified as STEMA. Thus, caution should be taken when considering implementing this study in other school districts as the results may not be generalizable to other school districts.

Third, prior to enrolling in the STEM Academy, students in this study may have participated in a STEM program, during school, after school, on weekends, or in the summer. This could potentially impact the validity of the responses to the survey and interviews because students' self-efficacy may have been influenced by one of these programs, not the STEM Academy program. Therefore, future studies should be made aware of students' prior engagement in STEM opportunities as a reason to enroll in a STEM Academy. Fourth, another limitation is the sole selection of the participating school. For this study, only one of the eight schools within this district that had a STEM Academy on campus was selected to participate. The other seven schools were not selected because they did not meet the following criteria: (a) administrative and teacher support, (b) proximity to the researcher's office, (c) availability of the students to participate in the study, (d) meeting state standards on the state assessments, and (e) larger population of girls enrolled in the STEM Academy. Due to these reasons, only one school with a STEM Academy was selected to participate in the study.

Fifth, the participants may come to the STEM Academy program already with a high self-efficacy in mathematics, science, engineering, technology, and STEM. This could invalidate findings because they already had a high self-efficacy. A sixth limitation occurred between the first and second administration of the survey. One student participating in the STEM Academy program moved to another school district, thus the researcher had to identify another student to replace her. A seventh limitation is that the students applied to be in the STEM Academy program, they were not randomly selected. As such, participants would already have an interest in STEM thus driving them to apply. This could invalidate results because they already had a high self-efficacy in STEM or an interest which contributed to their participation. Next, the district science leadership team planned the two required Project Based Learning (PBL) curriculum for the STEM Academy teachers. As a result, these were the only guaranteed hands-on experiences that the students may have received. The PBL's were designated for three weeks in the fall semester and three weeks in the spring semester. For the remainder of the weeks of school instruction, the teachers were expected to follow the district science curriculum and integrate additional PBL's of their own. This could pose to be a limitation because there were different degrees of comfortability with teachers of embedding their own hands-on PBL's with students. As a result, STEM Academy students received the required two district PBL's but anything additional was left up to the teacher. Finally, the last limitation was that the sample size of matched participants was small, consisting of 28 students which prevented from the researcher analyzing a larger data collection. A larger sample size may result in different findings.

Implications

Implications for School Administrators

School administrators can include principals, assistant principals, or even campus content support specialists. It is critical to ensure that teachers are appropriately utilizing the two PBL curricula the district has provided so school administrators should regularly monitor and assess teachers for implementation and effectiveness in their use of the curricula. They should observe classes to make sure that teachers are, in fact, utilizing the PBL curricula as it is intended and that is being implemented in a manner that will cultivate student STEM growth and success. It will be equally important for the campus content support specialists to be available and assist STEM academy teachers in planning additional PBL lessons, thus providing more hands-on and critical thinking opportunities for the students. It is also essential that school administrators also only hire qualified teachers who are willing and able to provide a learning environment centered on STEM. When recruiting students for the STEM Academy Program, administrators also need to take in consideration the demographics of the students so the program will enlist a diverse population of students, not only students who are interested in STEM.

Implications for Teachers

Teachers must be able to provide a positive learning environment in which students have the confidence to take risks and ask for help when needed. This study revealed girls who were afraid to ask for help for fear of being laughed at by their classmates. Teachers should also know how to promote positive self-efficacy in their female students and be able to engage them through hands-on STEM learning and real-world scenarios. Teachers must also have training and coaching experience to better equip their female students in rejecting misconceptions and gender stereotypes. Teachers also need to take advantage of the plethora of professional development sessions that the district offers for STEM. If STEM Academy teachers take more STEM professional development sessions it may increase their knowledge and skillset in implementing additional PBL's with their students. Teachers should increase the number of STEM and PBL lessons that are done with their students.

Conclusion

There is a plethora of research on girls' self-efficacy in the literature, yet few studies exist related to girls' self-efficacy in a STEM Academy program. Researchers suggest that STEM programs designed for girls will help increase their self-efficacy in mathematics, science, engineering, and technology (Chatman et al., 2008; Hizieak-Clark et al., 2015). Girls tend to have a lower self-efficacy than boys in mathematics and science, so it is imperative to provide opportunities for girls to increase their self-efficacy in STEM to ensure they are just as motivated to consider and possibly pursue STEM careers as their male counterparts. The results of this study could potentially provide districts and schools a way to better support, grow, and promote more girls in STEM, thus increasing the number of women who enter STEM related fields.

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Appendix A

Focus Group Interview Questions for the Start of the Program

AUGUST STUDENT INTERVIEW QUESTIONS

Pseudonym Name: ID #:

Date:

Gender Specific Careers

1.

Draw a scientist. Draw an engineer

Draw someone working with technology. Draw a mathematician.

2. Tell me about the scientist you drew.
    a. What is the gender of your scientist? Why did you pick that gender?
    b. Why did you or did you not draw yourself?

3. Tell me about the engineer you drew.
    a. What is the gender of your engineer? Why did you pick that gender?
    b. Why did you or did you not draw yourself?

4. Tell me about the technologist you drew.
    a. What is the gender of your technologist? Why did you pick that gender?
    b. Why did you or did you not draw yourself?
5. Tell me about the mathematician you drew.
    a. What is the gender of your mathematician? Why did you pick that gender?
    b. Why did you or did you not draw yourself?

6. Look at the other person's drawings. Describe how you would feel if everyone drew men each of those jobs.

Favorite Subject

7. Tell me about your favorite subject.

8. On a scale from 1 to 10, (1 being the lowest and 10 being the highest), rate how you feel about your performance in your favorite subject.

9. Why did you give it that rating?

Mathematics Self-Efficacy

10. When it is math time, tell me how it makes you feel.

11. Do you feel you are good at math? Why or why not?

12. What do you struggle with the most in math?

13. How do you feel when you get stuck in math learning?

14. Think about your math teachers. Have any of them changed the way you feel about math? Tell me about it.

15. How do you feel about asking your teacher for help if you don't understand the concept?

16. How would you feel if you heard someone say that boys are better at math than girls?

Science Self-Efficacy

17. Tell me how you feel about science.

18. Do you feel you are good at science? Why or why not?

19. What do you struggle with the most in science?

20. How do you feel when you get stuck in science learning?

21. Think about your science teachers. Have any of them changed the way you feel about science? How?
22. How do you feel about asking your teacher for help if you don't understand the concept?

23. How would you feel if you heard someone say that boys make better scientists than girls?

Engineering Self-Efficacy

24. Tell me how you feel about building and designing things like an engineer?

25. What types of things do you like to build and design or have you built and designed?

26. Do you feel like you are good with your hands to build and design things?

27. How do you feel when what you are building doesn't work?

28. How do you feel when what you are building does work?

29. Growing up, were you permitted to build, construct, and design things either at home or at school?

30. How would you feel if you heard someone say that boys are better at building things than girls?
31. On a scale from 1 to 10, (1 being the lowest and 10 being the highest), rate how you feel about your performance in building and designing things with your hands.

32. Why did you give yourself that rating?

Technology Self-Efficacy

33. Tell me about your experiences with working with technology, at home or at school.

34. What types of technology instruction do you prefer?

35. Do you feel you work well with technology? Why?

36. Tell me about your experience with coding.

37. Tell me about your experience with robotics.

38. Tell me about your experience with 3D printing.

39. Tell me your experience with producing a product using a web 2.0 tool or app.
40. How would you feel if you heard someone say that girls don't make good computer programmers?

41. On a scale from 1 to 10, (1 being the lowest and 10 being the highest), rate how you feel about your performance in using technology.

42. Why did you give yourself that rating?

STEM Self-Efficacy

43. This is your first year in the STEM Academy. On a scale from 1 to 10, (1 being the lowest and 10 being the highest), rate how you feel you will do with the coursework in the STEM Academy this year.

44. Why did you give yourself that rating?

45. Tell me about your expectations of what you think it will be like.

46. Do you think it will be different than another classroom not in the STEM Academy? Why or why not?

47. Tell me what you know about STEM?
48. Describe your feelings about learning STEM in your classes.

49. In eighth grade, you have the opportunity to choose STEM as a pathway or track. Would that be something you would like to pursue? Why or why not?

50. Would you be interested in majoring in science, technology, engineering, or mathematics in college? Why or why not?

51. Have you participated in any STEM programs before (after school, during school, summer)?
    a. Describe that experience.
    b. Did those programs help you feel better about math, science, engineering, or technology? Why or why not?
    c. Because you previously participated in a STEM program, do you feel like it changed the way you felt about STEM? Why or why not?

52. What made you decide to apply for the STEM Academy?
    a. How do you feel about being a part of the STEM Academy?
    b. What do you like about it?
    c. What do you struggle with?
    d. If you participated in STEM programs before this, did those STEM programs influence your decision to apply for the STEM Academy? How?

Appendix B

Focus Group Interview Questions for the End of the Semester

DECEMBER STUDENT interview QUESTIONS

Pseudonym Name: ID #:

Date:

Gender Specific Careers

1.

Draw a scientist.	Draw an engineer
Draw someone working with technology.	Draw a mathematician.

Favorite Subject

2. What is your favorite subject? Why?

Mathematics Self-Efficacy

3. Do you feel you are good at math? Why or why not?
4. How do you feel when you get stuck in math learning?
5. How do you feel when your teacher calls on you to answer a question?

Science Self-Efficacy

6. How do you feel when your teacher calls on you to answer a question?
7. Do you feel you are good at science? Why or why not?
8. How do you feel when you get stuck in science learning?

Engineering Self-Efficacy

9. Tell me how you feel about building and designing things like an engineer?
10. What types of things do you like to build and design or have you built and designed?
11. Do you feel like you do a good job building and designing things?
12. How do you feel when what you are building doesn't work?
13. How do you feel when what you are building does work?

Technology Self-Efficacy

14. Do you feel you work well with technology? Why?

15. How do you feel when you have to use an iPad to create a product in class?

16. Tell me about your experience with coding, robotics, and/or 3D printing.

17. Tell me about your experience with using a web 2.0 tool or app.

STEM Self-Efficacy

18. This is your first year in the STEM Academy. How do you feel you are doing in the subjects?

19. Describe your feelings about learning STEM in your classes.

20. When you did your PBL, tell me how it made you feel during the whole learning process?

21. Do you think you would like to choose STEM as a pathway in 8th grade? Why or why not?

22. Would you be interested in majoring in science, technology, engineering, or mathematics in college? Why or why not?