

What is the Impact of Positive, Female Role Models and Mentoring Opportunities
on the Self-Efficacy of Girls in Science?

Teri J. Wanamaker
Virginia Beach City Public Schools

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Introduction

Encouraging young girls in science has never been more important. As our ever-evolving world looks to the fields of mathematics, science, and technology to solve global issues, the job market in these fields is expanding. Students with a strong foundation in science are better prepared for a wide variety of educational and career choices.

Current research suggests that girls are prone to lose interest in science and rate their competencies lower than that of their male counterparts (Herbert & Stipek, 2005). It is a widely witnessed phenomenon: middle school girls relinquish their prowess in the fields of science for membership into the popular clique or acceptance by boys. The root of the problem can be traced to the female self-efficacy for the math and sciences.

As a teacher at the Linkhorn Park Math and Science Academy, I want to ensure that fifth-grade girls are well equipped with confidence in their aptitudes for science. In addition, I want to help my female students develop strong attitudes toward careers in science. Each year I am privileged to watch the transformation of my students from elementary students to preteens ready for middle school. I also witness the budding interest in the opposite sex, and the beginnings of cliques. I hear comments such as, "...don't go to Kemps Landing, only geeks are there." or, "...it will be easier at VB." Sadly, there is a tremendous amount of peer pressure by the end of fifth grade to stay with a familiar set of friends rather than venture out into the unknown world of advanced academic work, especially among girls. While I highly encourage all of my academy students to enroll in advanced math and science work, I have an underrepresented population of girls choosing to go to the advanced middle schools.

Literature Review

“If self-efficacy is lacking, people tend to behave ineffectually, even though they know what to do.” (Bandura, 1986, p. 425)

Research indicates that the gap between male and female students in the areas of math and science is more complex than simply, “men are better than women in math and science.” Research suggests that although through fourth grade, girls and boys say they like science and math equally, by eighth grade twice as many boys maintain an interest in science and engineering careers compared to girls. By high school, even girls with exceptional preparation in math and science are choosing science careers in disproportionately low numbers (Sally Ride Science, 2006). A longitudinal study conducted at Stanford University School of Education found that beginning in third grade, girls rated their math competencies lower than did boys, even though there was no gender difference in math achievement or in teachers’ ratings of the students’ math ability (Herbert & Stipek, 2005).

The most prominent root cause of this phenomenon appears time and time again throughout various articles. This phenomenon is known as self-efficacy toward math and science among girls. Self-efficacy is generally defined as a belief in one’s capacity to succeed at tasks. General self-efficacy refers to beliefs about one’s ability to handle tasks. Specific self-efficacy refers to beliefs about one’s ability to perform specific tasks (e.g., driving, public speaking, studying, etc.) (Neill, 2005).

“Many girls don’t picture themselves as future scientists or engineers. They don’t put a female face on these professions because they rarely see real-life or media images of female scientists” (Sally Ride Science, 2006, p. 3). According to the guide published for the U.S. Department of Education, Encouraging Girls in Math and Science, women make up nearly half

of the U.S. work force, but they make up only 26 percent of the science and engineering work force (Halpern, Aronson, Reimer, Simpkins, Star, & Wentzel, 2007). The report goes on to suggest that an important strategy to encourage girls to choose careers in science is to foster the development of strong beliefs in their abilities in science, and to develop beliefs that more accurately reflect their abilities in these fields. The report makes five specific recommendations and rates the level of evidence supporting the intervention as: Low, Moderate, or High.

The first intervention suggested is to teach students that academic abilities are “expandable and improvable (Level of Evidence: Moderate).” The second recommendation is to provide students with prescriptive, informational feedback (Level of Evidence: Moderate). Another way to encourage girls in math and science is to address girls’ beliefs about their abilities in math and science, while at the same time strengthening their perception of the participation of women in science-related careers (Level of Evidence: Low). A fourth intervention that is closely linked to the previous, is to foster girls’ long-term interest in science by choosing activities that link math and science to careers (Level of Evidence: Moderate). And finally, teachers should provide specific opportunities for students to engage in spatial skills training (Level of Evidence: Low) (Halpern, et al., 2007 pp. 6-8).

Research consistently supports the concept of female role models in the fields of science mentoring female students as a way to address the disparity. “One of the most effective interventions to help young women choose and sustain a science educational path and subsequent science is mentoring” (National Science Foundation, 2007, p. 3).

Research establishes the need for stronger, self-efficacious girls in the field of science. Mentoring programs that use female role models is a one, clear avenue for achieving that goal.

Action Research Questions

I have been involved in the Math and Science Academy at Linkhorn Park in a variety of ways. Over the course of seven years, I have acted as coordinator, gifted resource teacher, and fifth-grade teacher. As the program coordinator, I have worked hard and planned carefully in order to develop a math and science program that meets the needs of bright and curious students.

From the implementation of the first pilot class in 2003, we have struggled to attract girls into the program. In 2004, the first full-scale year of implementation, the number of female students was so small, that we clustered girls together in one classroom, leaving us with an “all-boy” class. At this point in time, I was serving as the academy coordinator and gifted resource teacher. We looked at various ways to advertise and merchandise ourselves in a way that would attract young girls. It was a “Band-aid” approach to a much larger problem.

The four academy teachers, our principal, and I began to investigate why the academy was believed to be a great option for boys, but our female application rate remained consistently sparse. We found many articles written about the prevalent stereotypes for girls in education, self-efficacy, and the gender gap in math and science. More troubling was the discovery of evidence that these issues escalate for girls when they reach middle school age.

It was at this time that I made the decision to move into the fifth-grade Math and Science Academy position. It was also at this time that I began to develop, long before I realized its practical application, my Action Research Question: **What is the impact of positive, female role models and mentoring opportunities on the self-efficacy of girls in science?**

Methodology

Considering the research related to girls in science, self-efficacy, and mentoring programs, I decided to implement a mentoring program for the girls in fifth grade. Girls participated in a variety of science and engineering tasks over a 10-week period. Women in science acting as mentors interacted with students via email, video teleconference, and face-to-face. The students engaged in conversations about careers, science current events, and experimental design. Students were also guided through a fall science experiment.

The goal of my Action Research Project was to send forth a class of girls who believe and trust in their abilities to pursue careers in science. My goal was to help young girls develop the confidence needed to combat the subtle gender differences in perceived occupational efficacy.

“The choices made during formative periods of development shape the course of lives. Such choices determine which aspects of their potentialities people cultivate and which they leave undeveloped” (Pajares & Urdan, 2006). Although the Action Research Project concluded at the end of the semester, the mentoring project will continue through the end of the 2008-2009 school year. I believe that the sustained rise in self-efficacious attitudes toward science will result in 100 percent of my girls applying to Plaza’s Middle Years Program and/or Kemps Landing Magnet School. In addition, I anticipate that 100 percent of those accepted to middle school academies will choose to attend.

The heightened level of self-efficacy was measured by a science self-efficacy scale, interview, and journal reflections (see Appendices). The mentoring project was deemed successful if all girls rated each of their science abilities at 70 percent or better or scores increased from pre- to postevaluation by 10 percent or more; the interviewer was

left with an overall positive impression of 100 percent of test population; and journal reflections were scored as 70 percent positive for each student participating.

I developed the science self-efficacy scale (SSES) after reading Albert Bandura's contribution to Self-Efficacy Beliefs of Adolescents (Pajares & Urdan, 2006). The tool was used as a pre- and postevaluation to measure the self-efficacy of students to perform specific science tasks. The SSES was administered anonymously in order to limit my perception from influencing the students' perception of capabilities (see Appendix A).

The interview was designed for me to get more qualitative data related to the impact the mentoring program had on each student. It allowed me to ask clarifying follow-up questions. It also gave each student the opportunity to voice opinions about science. Each question was given a "+" or "-" rating for a general impression of positive or negative response (see Appendix B).

Journal entries were collected throughout the project and directly after each organized event. Journal entries provided an intimate and current check of self-efficacious attitudes. Each entry was read and scored with a + or - for a positive or negative reflection (see Appendix C).

Data Analysis

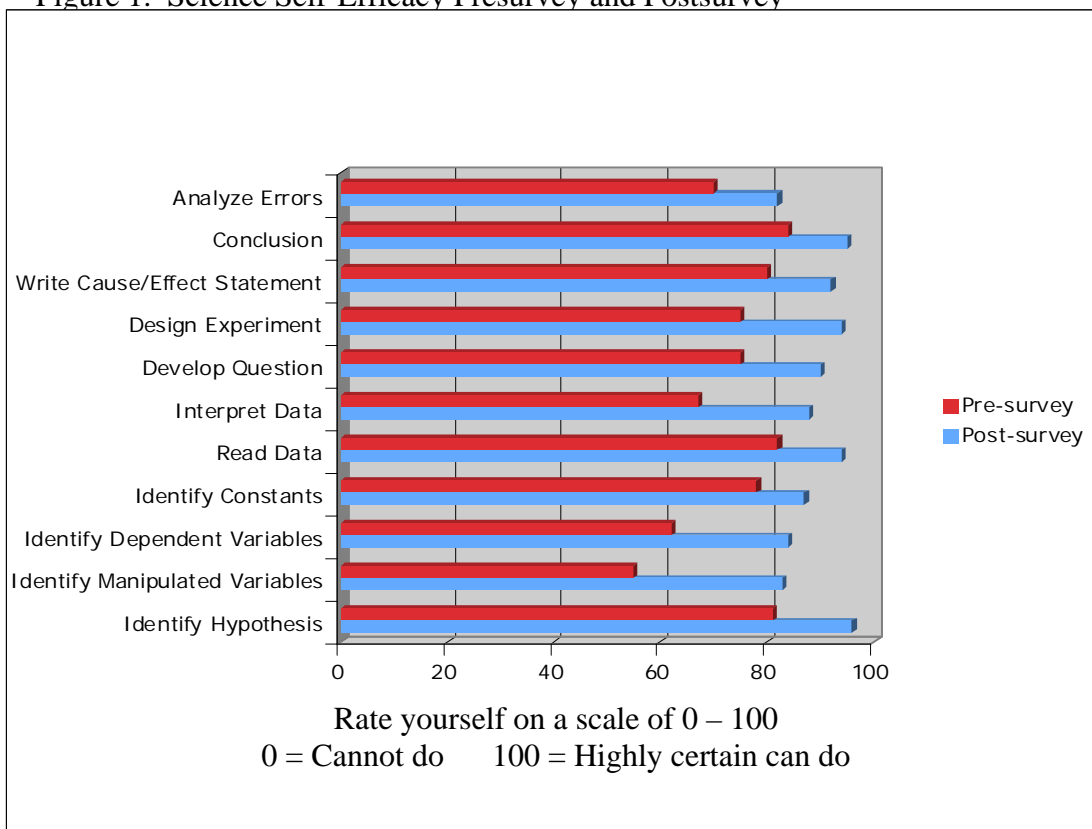
Data were collected from 25 of the 30 girls participating in the Smart Chicks Club. The 25 subjects were all fifth-grade girls from Linkhorn Park Elementary. The study group comprised of girls in the Math and Science Academy as well as girls in traditional fifth-grade classrooms. The five nonsubject students were involved in the Smart Chicks Club, but did not return the permission to participate in the study.

Both quantitative (self-efficacy rating scale and frequency of positive comments in journal entries) and qualitative (interviews) were collected. I disaggregated the data in

several ways. I looked at Math and Science Academy (MSA) girls compared to non-MSA girls. I subtracted the girls from the traditional classroom and looked at only the girls in the MSA. The final decision to use all students with permission to test in my final data was twofold. First, my effort was to isolate the participation in the Smart Chicks Club as the tested variable and not the experience of the MSA. But more importantly, the problem plaguing the self-efficacy of girls in science is not unique to girls in the MSA. Including all data collected from a variety of girls with a variety of learning experiences and abilities neutralizes the effects of activities within the MSA and speaks to a larger audience.

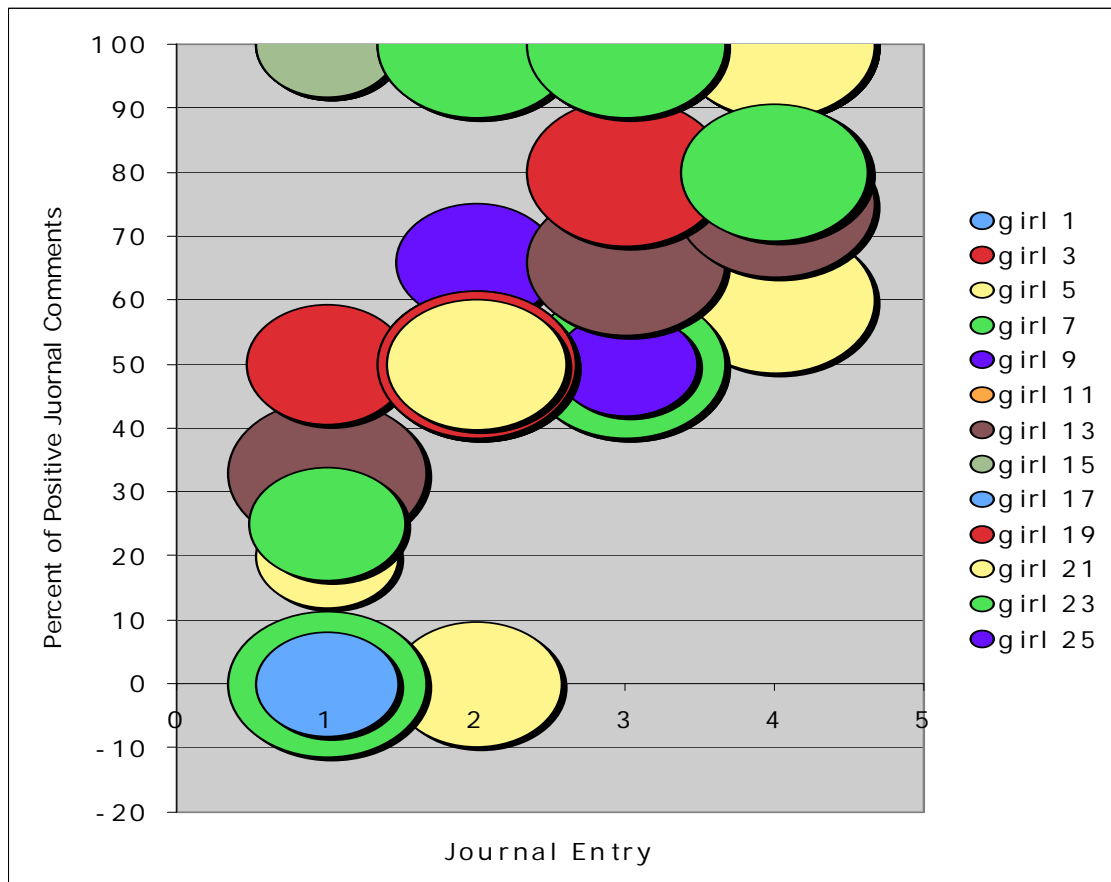
I averaged the response for each indicator in the self-efficacy survey administered in September and then again in November (see Figure 1).

Figure 1. Science Self-Efficacy Presurvey and Postsurvey



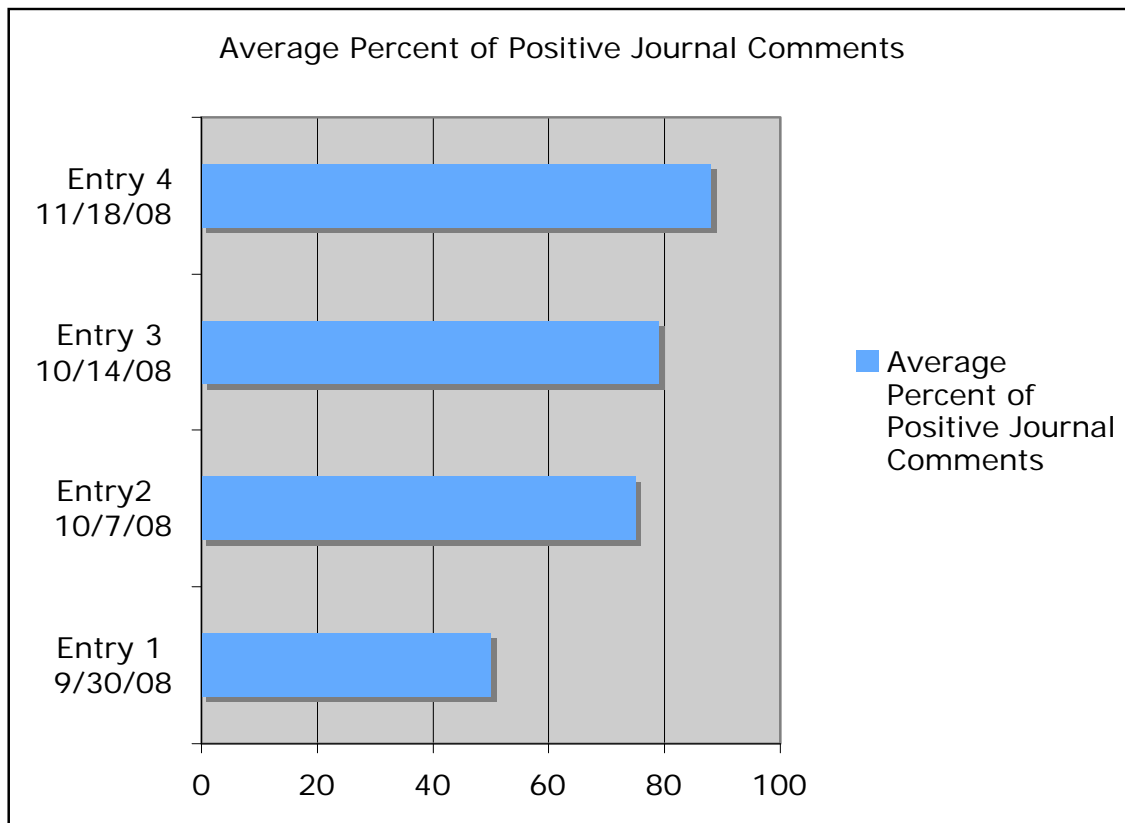
Each journal entry was read. Each statement was scored as either a negative or a positive statement about science. Statements made that were neither negative nor positive, or unrelated to science were omitted. Each journal was tracked over time for the frequency of positive comments. The scatter plot represents the individual positive comments made over time (see Figure 2).

Figure 2. Frequency of Positive Journal Comments



The bar graph represents the average positive comments of all 26 journals over time (see Figure 3).

Figure 3. Average Percent of Positive Journal Comments



Results

As I reviewed individual profiles, I was not convinced the data would reveal significant growth in the girls over the two-month period. Many journal comments appeared sporadically positive and individual growth as evidenced through the postinterview process appeared slight at best. The collective results for the Science Self-Efficacy Scale and the percent of positive journal comments told a different story.

Each indicator for the Science Self-Efficacy Scale was averaged and the postscale averages were compared to prescale averages. The results showed a consistent increase in the group's perception of their abilities in science. The smallest postscale gain was +11 points in the area of "Write a conclusion based on data." The greatest postscale gain of

+28 points was found to be in the area of “Identify manipulated variables in an experiment.” The data showed an upward trend in science self-efficacy of the girls who participated in the Smart Chicks Club. The data gains were consistent among girls in the MSA and girls in traditional classrooms.

Journal entries were collected at various times throughout the ten-week Smart Chicks Club. Journals provided insight into the immediate reaction of each girl following various club activities. Journals were read and each sentence was scored as either positive, negative, or omitted, if they were neither positive, negative, nor related to science. The group’s frequency of positive journal comments consistently increased over the ten-week period.

The qualitative data collected through the interview process were harder to interpret. The most significant finding was the response to self-efficacy question, “When you do well, (get a good grade) to what do you attribute your success?” The overwhelming response attributed good study habits for good grades. This response runs counter to the research I gathered in the spring. The research suggested that girls often attribute good grades to outside forces, and are hesitant to make the connection between their efforts and achievement. I was excited to discover this particular group of girls made the connection between their hard work and good grades: a lesson that will last a lifetime.

The trend among this group of girls appears to be an increasing self-efficacy toward science. While individual results appeared inconclusive, the collective data indicated a steady rise in both attitudes and self-efficacy toward science.

Summary and Conclusions

“I am not a scientist at all!! My science average is a B-. Also, I am horrible at math!! I need a lot of help.” (Journal entry of student 14 on 9/23/08.)

I gained the greatest appreciation for the diversity of learners within Linkhorn Park Elementary during this Action Research Project. My research started out as a way to address my classroom needs. In an effort not to exclude anyone, at my principal’s request, I invited all fifth-grade girls to participate. I learned more than I set out to learn.

Lesson 1: Relationships between girls and positive role models are extremely important. The mentorship relationship that I developed with girls outside of my classroom has proven to be very strong. My mentees approach me before and after school for additional help, to share grades, or to talk about the latest news – usually science related. The mentorship relationship has a different quality than the typical teacher: student relationship. It is more conversational.

Lesson 2: Mentorship relationships can appear where you least expect them. Our Smart Chicks Club was comprised of a diverse group of girls. Often the most valuable mentorship experiences arose when girls with higher levels of experience would advise or mentor others in need. Adult mentors were valuable. Peer mentors were priceless.

Lesson 3: It appears the attitudes of students can be influenced by a highly focused effort to do so. As a teacher, I am very focused on content, strategies, and performance. I often forget that I can impact my students’ attitudes toward learning.

I am confident that a continued effort and investment in the Smart Chicks Club could result in lasting effects.

“I feel like a scientist because I got an A in science. The reason I got an A is because I was studying cells, and I am good at cells.” (Journal entry of student 14 on 11/18/08).

Future Actions and Directions

Smart Chicks Club will resume after the holidays and continue through the end of the school year. I have had many requests for new admission into the club and the expansion into the lower grades. It has been a positive experience.

I will continue to collect data to support the benefits of positive role models on the self-efficacy of girls in science. Based on the literature review, my students will be entering a vulnerable time towards the end of the year, by 8th-grade twice as many boys maintain an interest in science and engineering careers compared to girls (Sally Ride Science, 2006). I hope to see my initial goal of “all girls accepted to academy programs choose to attend,” actualized.

The potential for my research to continue is definite. I would like to investigate whether or not increased self-efficacy translates to increased performance as measured by grades, standardized tests, performance tasks, and teacher perception. Is a positive self-efficacy always supported by positive abilities? I am also curious as to how a heightened self-efficacy in science impacts those in proximity to the individual. Does it spark curiosity in others? Could this account for the increased interest in the Smart Chicks Club? The possibilities are endless.

Reflections

The action research process has provided me with a systematic approach to solving problems within the classroom. It has been a growing experience, as it has pushed me to find answers to problems through research as oppose to using a “guess and check” type of problem solving.

The greatest discrepancy between the action plan I envisioned and the action plan that was actually implemented was the availability of mentors. Last spring while

planning for the fall program, I wanted the mentorship to be a one-on-one relationship between a female scientist and a student. It was difficult to find thirty females in the field of science who are willing to dedicate time weekly. I began to make concessions.

The first decision I made was to form a club in which girls could work on science projects, video teleconference, and interact with various guest speakers. I believed this would be a great way to involve a variety of women on a consistent schedule.

The first scheduled speaker cancelled due to an unforeseen circumstance. Of course I understood, and developed a chemistry experiment for the girls to conduct. The club continued to encounter problems with our guests and their schedules. Each week was “wait and see” with a very good plan B. Plan Bs included building a giant geodesic dome, experimenting with insulators, designing bridges, experimental design projects, engineering tasks, and a lot of teamwork. It became obvious that the girls found much more joy in the science experiments and working together than in discussions. The three adults (women of science) that led the club each week became the most valued mentors. It was not the intended program, but it was still a rich experience with positive results.

I am currently in the process of working with Ocean Lakes High School to develop mentorship opportunities for all children in the Math and Science Academy. It will provide another layer of opportunities for students to interact with others interested in and more knowledgeable of science. I believe mentoring plays an important role in the growth of self-efficacious attitudes toward science. I hope to expand the breadth of mentoring programs offered and benefit more children.

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Appendix A

Science Self-Efficacy Scale

Appendix 1

Please rate how certain you are that you can perform the various science tasks below.

Rate your degree of confidence by recording a number from 0 to 100 using the scale given below:

0	10	20	30	40	50	60	70	80	90	100
Cannot					Moderately				Highly certain	
do at all					can do				can do	

Experimental Design

Identify hypothesis in an experiment	_____
Identify manipulated variables in an experiment	_____
Identify dependent variables in an experiment	_____
Identify constants in an experiment	_____
Can read data in a scientific experiment	_____
Can interpret data in a scientific experiment	_____
Can develop testable question for experimentation	_____
Can design an experiment to test a question	_____
Write a cause and effect statement	_____
Write a conclusion based on data	_____
Analyze errors in a science experiment	_____

Appendix B
Interview Questions

Interview Questions for: _____

IB-What attracted you to math and science academy?

A-What are your dreams for the future? What do you want to be when you grow up?

A-What are your favorite subjects in school?

SE-When you do well, (get a good grade) to what do you attribute your success?

SE-Describe your abilities in science?

SE-How well do you understand the science concepts taught?

IB=Ice Breaker

A=Attitude Response

SE=Self-Efficacy Response

Appendix C
Journal Reflections

Journal Entry Stem:

Date:

Today I met with:

We discussed:

My thoughts about science: