SELF-EFFICACY AND SCIENCE IDENTIFY

OF SECOND GRADE GIRLS IN STEM CLUB

by

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ABSTRACT

Second grade girls were invited to participate in an after-school STEM club. These students were identified because they would benefit from a STEM program, by both their teacher and our STEAM teacher. Girls in STEM fields are severely lacking in today's job market, and many programs target girls who are in upper elementary or middle school. This program was designed to catch girls at a younger age and give them exposure to science-based fields, so that positive experiences with science could keep them engaged throughout their elementary science career. This STEM club was jobs-based (and included jobs such as microbiologist, coder, aerospace engineer, forensic scientist, and geologist) and included mentors. Mentors were women, chosen from the community who had a specific interest in that science topic. Girls met the mentors and asked them about their jobs, hobbies, and goals. Girls came for one hour after school, two times a week. Girls were asked to be present for most, if not all, the STEM club dates. Students were assessed on their feelings of science identify and self-efficacy twice, once before the program began and once after the program had ended. These girls' scores were then compared to one another as well as the whole of second grade (both boys and girls), to determine importance. Girls in the STEM club were more likely to think of themselves as scientists, more likely to love science, more likely to have a belief that they can do any science and were more likely to believe that science came easy to them. Girls in the STEM club were also more likely to be familiar with science jobs and what they were more likely to believe that both boys and girls were good at science, or even that girls were better than boys at science. The girls in the STEM club were equally likely to want to be a scientist when they grew up as other second grade students.

INTRODUCTION AND BACKGROUND

Located 26 miles north of Seattle, Mukilteo School District includes the cities of Mukilteo, Mill Creek, and south Everett. With a district population of more than 14,600 children, it is a small, densely packed district with 13 elementary schools (including one kindergarten center), four middle schools, and two high schools. With 677 students enrolled, Horizon Elementary School is one of the biggest elementary schools in the district.

I teach kindergarten at Horizon Elementary and am also our school's science representative. I initially became interested in science when I was in first grade, and that love of science has continued with me throughout my school experience and teaching career. Giving girls role models and a feeling of success in science is key to creating a life-long love of science, as well as greater confidence in their own capabilities.

Currently, the Mukilteo School District is searching to adopt a new science curriculum. The low proficiency numbers that we see at Horizon are consistent across the district and are now considered a serious problem. I have a Bachelor of Science in General Science and Elementary Education from Western Washington University and am certified K-8 teacher. I am an active member of the National Science Teachers Association (NSTA) and attended the 2019 conference in Seattle, Washington. I have spent all four years of my teaching career at Horizon Elementary School teaching kindergarten. In previous years I have led a modified STEM club after school for students who wanted to, in conjunction with our technology teacher.

Demographics

In terms of population, Horizon is 54% Hispanic, 21% white, and 8% African American. Of Horizon's population, 80% of the students have been identified as "low-income," which makes Horizon a Title One School. Our district has a distinct divide in Socio-Economic Status between the two sides of the district. While the west side of the district is relatively wealthy (with many families living on the shores of Puget Sound, and family members working at Boeing), the east side of the district sees much more gang violence and transient families and has a much lower SES. In Washington State, students take math and reading proficiency tests in grades three, four, and five. Students also take a science test in grade five. On those standardized tests, 33% are meeting standards in reading and math, while only 25% are meeting the standard in science.

Horizon Elementary is located off Casino Road in Everett and, as such, it sees significant problems with gangs. In the past few years, while there has been a decrease in violent crime~~s~~, there has been a significant increase in prostitution. Many students from this area do not finish high school, let alone the science courses required of them.

Context

My concern was that young girls do not feel successful in science and without that feeling of success will drop out of science and math courses in middle school and high school. Even at this young age, girls are starting to feel that they are different in science and math than boys. Giving girls success and the tools to succeed young makes them more likely to finish school and pursue various career options.

My primary goal in this project was to provide second-grade girls with a jobs-based learning in STEM (Science, Technology, Engineering and Math), exposing them to careers such as microbiology, coding, aerospace engineering, wildlife biology, forensic science, and geology. Matching these girls with role models/mentors also helps to provide them with a solid background and a sense of “I can do this too!” This led me to the research question and subsequent sub-questions that I will be explored this school year.

Research Questions

Research question: How does jobs-based science learning and mentorship from women in the field influence science identity and self-efficacy for second-grade girls?

Sub-Question 1: How does jobs-based science learning and women-led mentorship effect science identity in girl students?

Sub-Question 2: How does jobs-based science learning and women-led mentorship effect self-efficacy in girl students?

CONCEPTUAL FRAMEWORK

There is a large amount of research on the topic of girls in STEM. Retaining girls in science classes past the middle school level is a problem that many researchers are tackling, and while research is ongoing to ascertain a solution, there is no singular "fix-all" to the problem. However, there does exist a plethora of ideas, many of which I utilized in my capstone.

Current State of Girls In STEM

The United Nations has made STEM for girls one of their top 2030 priorities. In their research brief *Cracking The Code: Girls' and Women's education in science, technology, engineering and mathematics (STEM)* they identify STEM education as "imperative from the human rights, scientific and developmental perspective" (Cracking the code: Girls' and Women's education in science, technology, engineering and mathematics (STEM), 2017) They note that several cognitive predictors of STEM learning include written language capacity and spatial skills.

When looking into the reasons why girls are less engaged in science than boys, some interesting patterns emerge. In Huebner's article *Encouraging Girls to Pursue Math and Science* [2009], the research team found that boys and girls have very little achievement gap in science topics in the upper grades of elementary school. The team also found that girls tend to rate themselves lower than their male counterparts when it comes to math and science. The UNESCO also finds that on the Program for International Student Assessment (PISA) exam, many girls seem to have a lower self-efficacy score than boys in math and science, however in many countries their science score (at least in elementary school) remains the same (Cracking the code: Girls' and Women's education in science, technology, engineering and mathematics (STEM), 2017)

Girls tend to view their understanding of science differently. Parents of girls also view their daughters' understanding differently. Parents were more likely to rate their sons higher in math and science than they were their daughters, even if there was no difference in academic achievement (Huebner, 2009). There is also a significant lack of science-based educational materials in the homes of girls as compared to the homes of boys. With more boys' families watching science programs on TV, visiting science-based websites, or reading about science topics. (Cracking the code: Girls' and Women's education in science, technology, engineering and mathematics (STEM), 2017).

In a typical classroom, boys are more likely to be called on than girls, and more likely to receive attention from teachers. Boys are more likely to play with the tools (in a science classroom) in an inventive way (Vanmali & Abell, 2009). Indeed, in science camps that are tailored to girls the use of materials is highly sought after with experiences such as "using a microscope, and a video flex camera, and outdoor activities, such as hiking and learning nature survival trips" was found to reveal "significantly more positive attitudes towards science after attending the camp than before it" (Moore, 2003). These more positive attitudes included surveys on student's confidence and their anxiety levels relating to science. In addition, in programs such as FIRST robotics (an after-school program centered around creating robots for competition) girls "who saw themselves as being more directly involved with programming were more likely to rate highly in terms of motivation to pursue additional programming experiences." However, if they did not have this access to hands-on tools, they were less like to identify themselves as "someone who codes" (Witherspoon, Schunn, Higashi, & Baehr, 2016).

Women Pursuing STEM Degrees

The number of girls who pursue STEM classwork is a serious issue, since in the most recent data, only 24% of all STEM jobs belong to women (Figure 1). This problem is perpetuated by the number and type of degrees that women obtain, as opposed to men, in STEM fields. Typically, the majority of Bachelors, Master's and Doctoral degrees in STEM jobs are held by men.

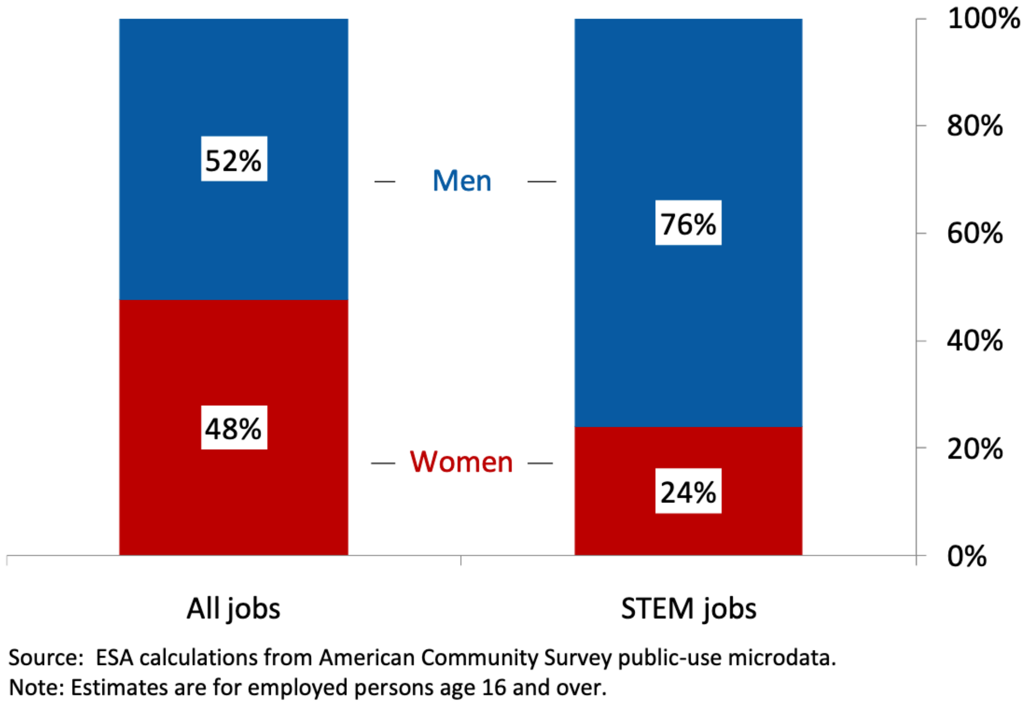


Figure 1. Gender Shares of Total and STEM Jobs, 2009 executive summary. (Beede, David; Julian, Tiffany; Langdon, David; McKittrick, George; Khan, Beethika; Doms, Mark, 2011).

The majority of women's degrees in science are in the physical and life sciences, while men typically go into engineering. In addition, there is also a significant gender gap in student in Computer Science (CS) degrees, with a significant underrepresentation by women in the science, a gap that is continuing to widen (Witherspoon, Schunn, Higashi, & Baehr, 2016) this is best illustrated in Figure 2.

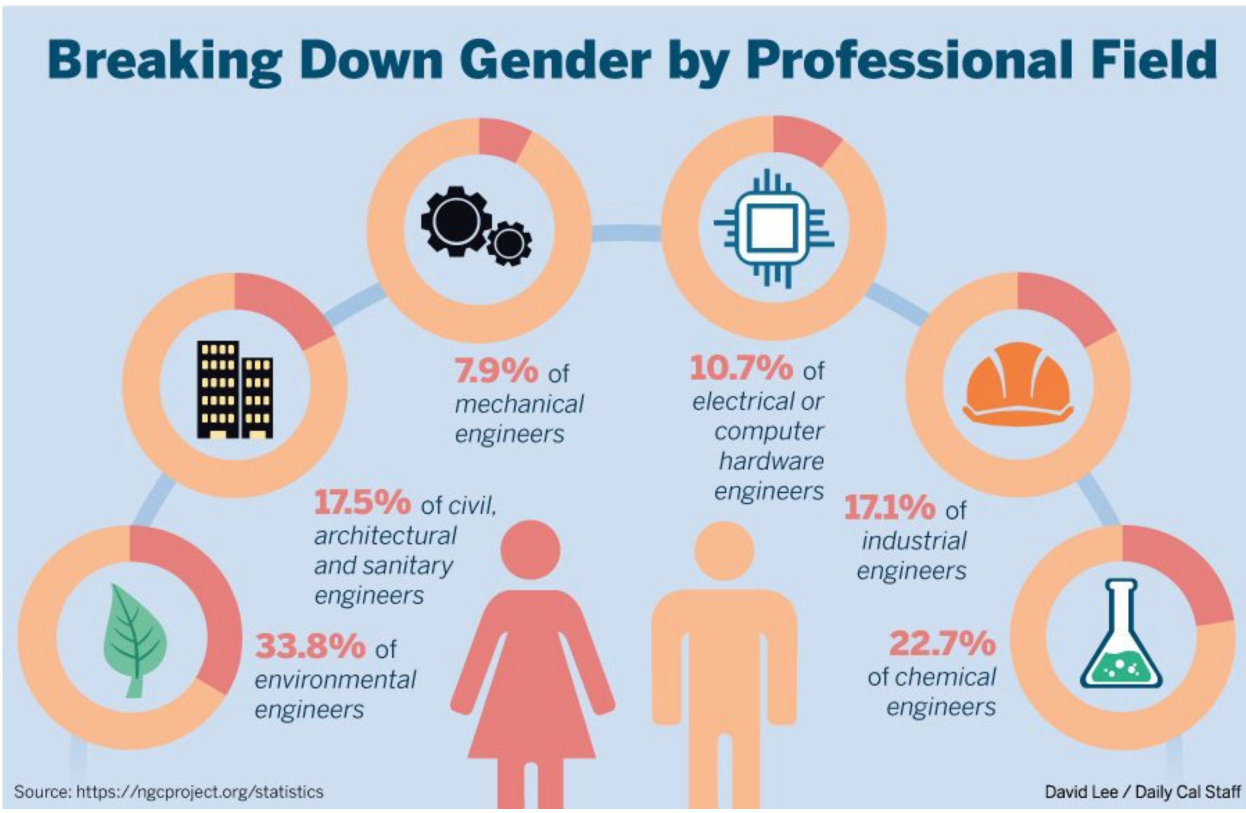


*Figure 2***.** Breaking Down Gender by Professional Field Serpa, P. (2017).

<u>Working with Girls in STEM</u>

There are various methods that are suggested when working with girls in STEM. Promoting student learning—especially girls' learning—in science education is something that has been thoroughly researched, and the research is ongoing. In the book *Girls in Science,* the authors mention a triad framework for promoting girls in STEM. This triad includes "Student Goals," "Teaching Goals," and "Science Goals." Student goals include the confidence to explore, familiarity with tools, persistence through confusion, resilience to failure, and defending a position. Teaching goals, which include encouraging student voices, maintaining high expectations, delegating responsibilities, making equity explicit, and reflecting to improve practice. The science goals include promoting wonder about the natural world, doing science to learn science, thinking critically, logically and skeptically, using evidence to predict, explain and model, and finally, building a community of scientists (Chatman, 2009).

In *The Psychology of Learning Science* (Glynn, Yeany, & Britton, 2015) the authors discuss the importance of students understanding science in the 21st century. The authors emphasize how science teachers need to make sure that the quality of science teaching is the focus--not the quantity. One of the points that resonated with me was that "'Hands on' learning will not, by itself, increase students' understanding of science. What is additionally needed is a 'minds on' emphasis" (Glynn, Yeany, & Britton, 2015, p. 4). Having a "minds on" approach for engaging in science talk and engaging in science learning is an essential part of science education.

In addition to having the "minds on" approach, teachers must ensure one essential understanding: that students realize that science is applicable to their daily lives. Yang (2010) discussed the interest of science out of school. The purpose of Yang's study was to determine if students had a life-long interest in science, as evidenced by students wanting to learn science outside of school. The majority of students who found science interesting, related to their life. Those who didn't find science interesting, didn't think it related to their lives at all. The study also discovered that students who were not interested in science didn't think that science could help people (Yang, 2010). Since my capstone includes both girls who have stated that they were interested in science and girls who stated that they were not interested in science, finding the balance between interesting and applicable will be essential to engaging them in STEM.

Equitable Access

Socio-economic status is also one of the determining factors of women going into science. “Many girls from a lower socio-economic background don’t find it ‘thinkable’ about going into the ‘masculine’ world of science” (Cracking the code: Girls' and Women's education in science, technology, engineering and mathematics (STEM), 2017 p. 43). These girls also have inequitable access to STEM related materials and are less likely to expect themselves to go into a career in science.

Additional research has also concluded that minority students are also at a higher risk of leaving the science fields. These students cite a lack of “feeling of belonging” and a lack of “interpersonal relationships” as the biggest reasons for why they were leaving the profession (Rainey, Dancy, Mickelson, Stearns, & Moller, 2018).

Finally, one of the main things that is essential to establish for girls in STEM is a sense of interpersonal relationships. “Female teachers can positively influence girls’ education in STEM by dispelling myths about sex-based, innate abilities among boys and by acting as role models for girls” (*Cracking the code: Girls' and Women's education in science, technology, engineering and mathematics (STEM)* 2017, p.50). In addition, female role-models can help to negate any negative stereotypes around females in science. In fact, “An afterschool club for girls in an intervention strategy that can help to alleviate these problems [a lack of interest in science]” and “inviting female with careers in science to speak at club meeting is a simple yet effective way to provide exposure for appropriate role models” (Eccleston, 1999,p. 22). Having teachers and role models that embody self-efficacy in science can translate into students sensing this self-efficacy and, in turn, can be a predictor of persistence and achievement (Talley, & Ortiz 2017). This establishment of interpersonal relationships in teacher and role models for girls translates into a feeling of self-efficacy. Giving girls the tools, they need to succeed includes giving girls equitable access to role models and teacher leaders.

What the research makes apparent is that young girls (early elementary school) do have an interest in science. However, they (and society) often rate themselves lower in science understanding. This has translated into a lack of women seeking degrees in the science fields, especially in the field of engineering. These girls need to be given the tools to succeed: high expectations, an understanding—and exposure to—science tools, and a "hands-on/minds-on" approach to science learning.

METHODOLOGY

Keeping in mind the various ways to support female learners, access to high-quality mentors, interpersonal relationships, access to tools and material, and a feeling of belonging; I began planning a program for girls in STEM. When looking at the proposed treatment plan for students, twelve students were selected to join an after-school STEM program for girls. Students were selected based off of two criteria, first a survey given to girls pertaining to their interest in science as opposed to other fields, and secondly at the recommendation of our schools' STEAM (Science, Technology, Engineering, Art and Math) teacher.

For the project, 12 second grade girls were selected from the entire Horizon Elementary second grade population. Every Tuesday and Thursday these students were in class for an hour. Each month covered a different science topic. During this time students were working on solving problems that scientists in the field were solving. They were learning to use tools to enhance their understanding of science concepts. Finally, there were interacting with scientists in their field to truly understand what it is that scientists do. This project has been reviewed and granted exemption by the Montana State University IRB board.

From the 12 girls selected, the student in STEM club consisted of 11 students (ten who began the project from the beginning and one who came in halfway through the project). These girls were a mix of races with 50% being Hispanic, 33% white/Caucasian, 8% African American and 8% Asian. The majority of the girls in the program are ESL students, meaning that English is their second language, and they were spread out in terms of reading and writing ability.

My research question was *How does job-based science learning and female mentorship influence science identity and self-efficacy for female 2nd grade students.* The intent of this research question is to determine if job-based science learning in conjunction with mentorship by women scientists provides girls with the idea that they are scientists and boost their confidence in their science abilities.

When looking at the essential questions that I had for my action research, I found that many students are already internalizing societal messages. I already saw that second-grade girls were internalizing the message that they are not as good as boys at science. When analyzing my data, I was hopeful that the change occurred and can be represented. (5 Best Practices of Survey Analysis & Reporting, 2019). Results from the data were separated into four categories: Self-Efficacy Changes, Self-Efficacy as Compared to the Whole, Assessment Probes, and Qualitative Analysis.

For this program, each month there was a job-specific question that was posed to the girls, which students spent the next three weeks to one month investigating. Each question centered around a specific job (Table 1) and had various role models who came in to talk to the students each month. The goal of these role models was to provide real-life examples of females who have succeeded in these fields. Providing girls the opportunity to ask these role-models questions about their successes and failures gave the girls the ability to relate to their role models.

Table 1
A Breakdown of STEM Club Topics by Month.

Month	Topic
October	Microbiology
November	Wildlife Biology
December	Coding/Robotics
January	Aerospace Engineering
February	Forensics
March	Geology

Students met twice a week for five months and used materials including (but not limited to) microscopes, robots, rock identification kits, rocket building kits, and forensic materials. One of the main goals was to get these materials into the hands of learners as quickly as possible. Providing these girls this opportunity greatly increases their chances for engagement with the materials in that science field.

I used a survey, group interviews, and informal checklists and assessments as data collection tools to answer my driving research questions (Table 2).

Table 2
Research Sub-Questions and Their Associated Data Collection Instruments

Sub-Questions	Data Collection Instruments		
How does job-based science learning and female mentorship affect science identify in female students?	Survey	Group Interview	Checklists/Assessments
How does job-based science learning and female mentorship effect self-efficacy in female students?	Survey	Group Interview	Checklists/Assessments

Initially students were given an interest survey (Appendix A) at the beginning and end of treatment. This interest survey was also given to girls who did not participate in the program to judge the effectiveness of the program. It evaluated students' perceptions of science have changed and what they learned.

Students were asked to rank themselves on science criteria to give a hint as to their "self-identity" in science education. When analyzing this data, I looked for changes from their beginning ranking to the ending ranking. This change in opinion was best represented in a bar graph format at the end of the program. I also looked at how this compared to their peers who didn't participate in the program. I used a Welsh's T-test to analyze this comparison as my data could not be assumed to be parametric. This T-Test analysis helped me to determine if the program had the desired effect.

One of the things that is important to me as a teacher is understanding how each student learns. Each student at the beginning of the program filled out a "How Do You Learn Survey" (Appendix B) letting me know their perceptions on learning and what skills they believe they had as learners going into this experience. It also allowed me to know if students enjoy working in groups or if they feel more successful working alone. While this survey wasn't pertinent to the final data collection of my capstone, the information that it garnered helped me tailor the program to suit students' individual needs.

At the beginning and end of each new job students were encouraged to complete an assessment probe (Appendix C). These probes monitored student's engagement over time and how their learning has changed over the course of the month. These probes did not go towards any final grade, instead they were used to monitor changes in thinking.

In addition, each assessment probe was administered at the end of each "job" or topic and included a set of questions about what students felt they have learned (Appendix D). The goal of the assessment probes was to determine if there was growth in their learning. These assessments had a specific rubric that was outlined for students at the beginning and end of the unit of study. Students were aware of the criteria that they were being scored on and will be doing their best to match this criterion. Their scores from the beginning and end of each unit were then be compared and represented in a bar graph. These were included in their assessments on what they felt they had learned, what they enjoyed learning about and the impact of mentors on their learning.

In addition to students interpreting their learning, I also kept notes of students who participated, keeping track of how often students share ideas, how often they are engaging with the materials, and in general how they seem to be feeling when they come in to STEM club. These notes helped me in my analysis of the materials and evaluation of how students engaged with the material.

At the end of the project, students reassessed their feelings towards science using a true/false rating in a survey, these results were then compared to their starting baseline. The survey was conducted by an external teacher.

Finally, each student participated in an exit interview. This took place at the end of the treatment. The basic questions are included in Appendix E. These questions were not set in stone and can be changed depending on the nature of the conversation. The purpose of the exit interview was to better understand the students' answers on the final "Interest Survey."

The timeline below was the initial proposed timeline for the pilot project (Figure 3). Unfortunately, in March 2020 school district throughout the United States closed due to the COVID-19 (Coronavirus) pandemic. As a result of the closure of the Mukilteo School District and Horizon Elementary not all assessment probes could be completed as planned.

Proposed Timeline
October 2019-July 2020

November 2019

Topic: Slime and Wildlife Biology

Data Collection Instruments:
- Assessment probe
- Checklist of hands on activities.

January 2020

Topic: Rocketry

Data Collection Instruments:
- Assessment probe
- Checklist of hands on activities.
- Mid-program survey

March 2020

Topic: Rocks/Minerals

Data Collection Instruments:
- Assessment probe
- Checklist of hands on activities.
- Final survey
- Exit interviews

End Date: March 19

June/July 2020

Write up:
- Edited project professional paper (June 1-to science reader)
- Final Virtual Poster (June 7-D2L)
- PowerPoint presentation (June 15-project advisor)
- Formal Presentation: (Week of July 3-7)

October 2019

Start date: October 15

Topic: Microbiology

Data Collection Instruments:
- Initial survey
- How do you learn survey
- Assessment probe
- Checklist of hands on activities.

December 2019

Topic: Robotics and Coding

Data Collection Instruments:
- Assessment probe
- Checklist of hands on activities.

To Committee: Project Proposal and Virtual Poster
Confer on data collection methods

February 2020

Topic: Forensics

Data Collection Instruments:
- Assessment probe
- Checklist of hands on activities.

April/May 2020

Interpretation of data: What worked? What didn't work? What are some trends I noticed? How could this be improved.

Write Up:
- Begin writing up project analysis (to be done by the last week of April-to project advisor)
- Symposium program project information (May 1-To MSSE office)
- Draft of paper-formatting check (May 31-Formatting Advisor)

Figure 3. Proposed project timeline, including data collection instruments each month.

The majority of students in second grade are not taught science until the spring. Every six days students are able to take a STEAM class provided through our school. However, this type of target instruction in science and science careers, isn't typically done. With the data collected, I was able to see if these methods worked in boosting science identity and self-efficacy for second grade girls.

DATA ANALYSIS

Before beginning the data analysis, it was important to take a look back at the research questions for this pilot project. These research questions asked if the girls are more likely to have a greater sense of self-efficacy and science identity after they have gone through the program.

Research question: How does jobs-based science learning and mentorship from women in the field influence science identity and self-efficacy for second-grade girls?

- Sub-Question 1: How does jobs-based science learning and women-led mentorship effect science identity in girl students?
- Sub-Question 2: How does jobs-based science learning and women-led mentorship effect self-efficacy in girl students?

Based on the research questions, results from the data were separated into four categories: Self-Efficacy Changes, Self-Efficacy as Compared to the Whole, Assessment Probes, and Qualitative Analysis.

Self-Efficacy Changes

Self-Efficacy is the belief in one's self capacity or, in this case, the belief that students think of themselves as scientists, and their capacity to learn and understand science (Bandura, 1994). At the beginning and end of the project, students were asked about their opinions of themselves as scientists. They were asked to either agree or disagree with the following statements:

- I think science is fun!
- Science is something that comes easy for me
- I think I am a scientist
- I believe I can do any science
- I want to be a scientist when I grow up

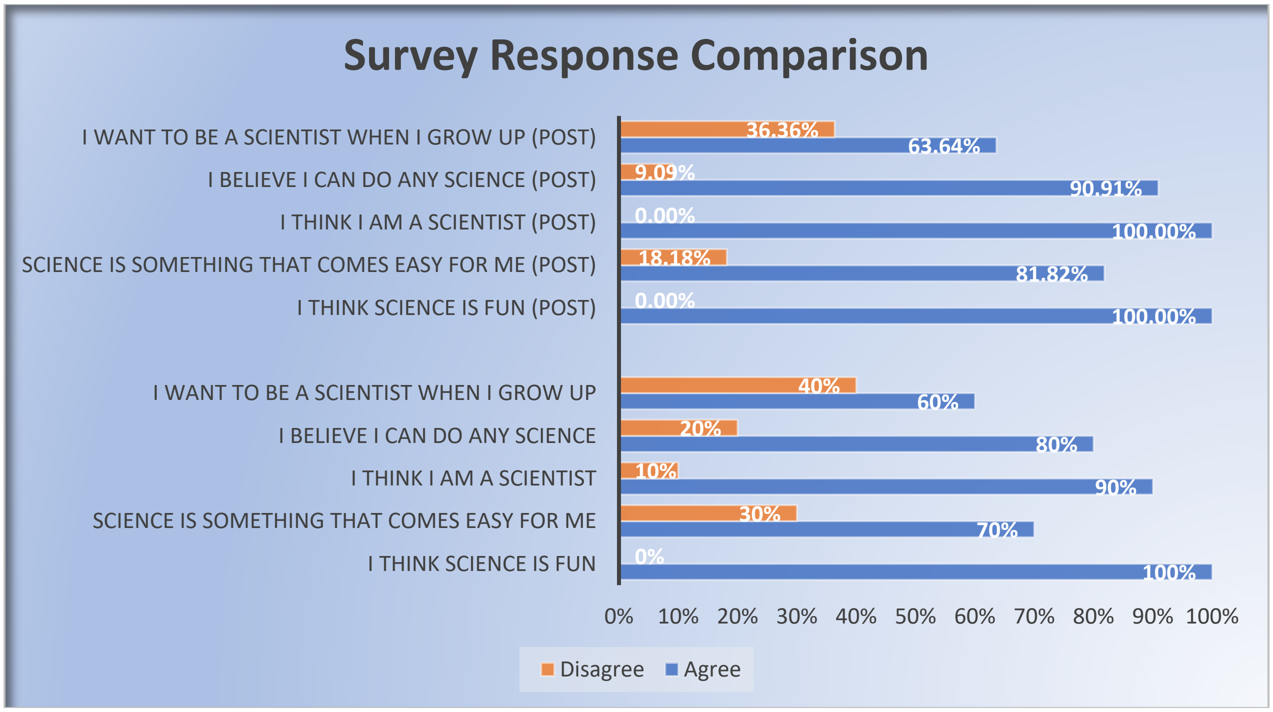


Figure 4. Survey responses on self-efficacy shown in percentages. (Pre-program responses are shown in the lower section while post-program responses are shown in the top section of the figure).

When looking at the essential questions on the interest survey, all students both pre- and post-project held the belief that “science is fun.” This belief was maintained at 100% throughout the entire experience. At the beginning of the project, 70% of students held the belief that “science comes easy for me.” As the experience progressed, students rated themselves higher, with almost 82% of students believing at the end that “science comes easy for me.” This is an increase 12% of students who were in the program. When asking students about whether they feel like they are scientists, 90% on the pre-program survey stated that they believed that they were scientists. At the end of the treatment, 100% of students felt like they were scientists. This is an increase of 10% of students, which translates to two out of the 11 students changing their opinions of themselves as scientists. When asked if students believe they could do any science, 80% of the pre-program students said that they felt they could, while 91% of the post-program students said they could.

Finally, when asked if they wanted to be scientists when they grew up, 60% of students on the pre-program survey said they wanted to be scientists, while 64% on the post-program survey said they wanted to be scientists. Of the remaining students, two of them stated that they wanted to teach science but didn't believe the desire to teach science made them scientists.

When looking at the data, on average 2 to 3 students changed their perception of science from the pre-program to the post program survey. The exception to this came from the statement: "I want to be a scientist when I grow up." The change from 60% to 64% came from the addition of a student, rather than a change in perception.

Self-Efficacy as Compared to the Whole

In addition to comparing students to themselves at the beginning of the program and the end of the program, student data was also compared to the other students in their grade. This compared both boys and girls in the second-grade population to the girls in the STEM club. All students were asked to fill out a survey indicating is they felt the statements applied to them. For this comparison, a two sample t-test assuming unequal variance was done to determine the differences between the two sample populations and the degree of accuracy with each question. Answers were scored as either one or zero; with one meaning "I agree" and zero meaning "I disagree." Students were asked the same questions and the probe was given to students during their STEAM class, as a way to get all student responses.

The first question students were asked was if they agree or disagree with the following statement: "I think science is fun!" (Table 3). Variable one is the student who are in STEM club, while variable two is the rest of the second grade population. The null hypothesis is that the two populations would be the same.

Table 3

Comparing Responses for Students in STEM Club vs. Other Students in Second Grade When Agreeing or Disagreeing With the Statement "Science Is Fun!"

	Students in STEM club	Students not in STEM club
Mean	1	0.875
Variance	0	0.111
Observations	11	56
Hypothesized Mean Difference	0	
df	55	
t Stat	2.803	
P(T<=t) one-tail	0.003	
t Critical one-tail	1.673	
P(T<=t) two-tail	0.007	
t Critical two-tail	2.004	

100% of girls in STEM club agreed with the sentiment "science is fun!" at the end of the program. In comparison, 87.5% of the total student population agreed with the sentiment. When evaluating the degree to which the results are significant (P(T<=t) one tail), it is well below the anticipated 0.05 that it takes for the results to be statistically significant. This not only rejects the null hypothesis that the two populations would be the same, but also it suggests that on average students in STEM club were more likely to agree that "science is fun!"

The second statement asked students if they agreed or disagreed with the statement "Science comes easy for me." Students could either mark one or the other and were asked to give their opinion on the statement (Table 4). Agreeing statements were represented by a 1 and disagreeing statements were represented by a 0.

Table 4

Comparing Responses for Students in STEM Club vs. Other Students in Second Grade When Agreeing or Disagreeing With the Statement "Science Comes Easy for me."

	Students in STEM Club	Students not in STEM club
Mean	0.818	0.393
Variance	0.164	0.243
Observations	11	56
Hypothesized Mean Difference	0	
df	16	
t Stat	3.068	
P(T<=t) one-tail	0.004	
t Critical one-tail	1.746	
P(T<=t) two-tail	0.007	
t Critical two-tail	2.120	

Again, the null hypothesis is that due to the age of the subjects, the two populations should be relatively similar. Indeed, this is not the case. In the STEM club population, approximately 81% of students agreed that science came easy for them, while students who weren't in STEM club had only 39% of participants agreeing that science came easy for them. The p-value is well below the 0.05 mark meaning that these results are statistically significant. It can be determined to a reasonable degree that students in STEM club were more likely to feel that science was something that came easy for them as opposed to students who weren't in STEM club.

For the third statement students were asked to agree or disagree with the following statement: "I think I am a scientist." Table 5 shows the results for students who are in STEM club compared to those who are not in STEM club. (Again, this assumes that an "agree" answer is worth 1 point and a "disagree" is worth 0.)

Table 5
Comparing Responses for Students in STEM Club vs. Other Students in Second Grade When Agreeing or Disagreeing With the Statement "I Think I am a Scientist."

	Student in STEM Club	Students not in STEM club
Mean	1	0.536
Variance	0	0.253
Observations	11	56
Hypothesized Mean Difference	0	
df	55	
t Stat	6.904105059	
P(T<=t) one-tail	2.708E-09	
t Critical one-tail	1.673	
P(T<=t) two-tail	5.416E-09	
t Critical two-tail	2.004	

In this question, 100% of the students in STEM club agree with the statement "I think I am a scientist," while only 53% of students who weren't in STEM club agree with the statement. Again, the results are significant because the significant factor needs to be less than 0.05, meaning that students in STEM club are more likely to feel as though they are a scientist as compared to their peers who are not in STEM club.

The fourth statement that students were asked to agree or disagree with was whether they felt as though they could do any science. Students again were asked to agree (1 point) or disagree (0 points). Again, I used the significance level of 0.05 (Table 6).

Table 6

Comparing Responses for Students in STEM Club vs. Other Students in Second Grade When Agreeing or Disagreeing With the Statement "I can do any Science."

	Students in STEM club	Students not in STEM club
Mean	0.909	0.554
Variance	0.091	0.252
Observations	11	56
Hypothesized Mean Difference	0	
df	23	
t Stat	3.148	
P(T<=t) one-tail	0.002	
t Critical one-tail	1.714	
P(T<=t) two-tail	0.005	
t Critical two-tail	2.069	

Students in STEM club were more likely (approximately 91% compared to 55%) to agree that they felt they could do any science. Again, the data is significant because it is lower than the designated significance level of 0.05.

The final agree/disagree statement for students in the second grade was to determine if they wanted to become scientists when they grew up. For this question agree was 1 and disagree was 0. The significance level was 0.05 (Table 7).

Table 7

Comparing Responses for Students in STEM Club vs. Other Students in Second Grade When Agreeing or Disagreeing With the Statement "I Want to be a Scientist When I Grow up."

	Students in STEM club	Students not in STEM club
Mean	0.636	0.661
Variance	0.255	0.228
Observations	11	56
Hypothesized Mean Difference	0	
df	14	
t Stat	-0.148	
P(T<=t) one-tail	0.442	
t Critical one-tail	1.761	
P(T<=t) two-tail	0.885	
t Critical two-tail	2.145	

Looking at the results of this question, students in STEM club were less likely to want to be a scientist when they grew up, with only 63% of students in STEM club agreeing. Meanwhile, 66% of students who were not in STEM club wanted to be a scientist when they grew up. When looking at the significance level or "P(T<=t) one tail," it is well above the threshold of the 0.05 significance level. This means that the null hypothesis, in this case, was not rejected and that there is no significant difference between students in STEM club and students not in STEM.

The next question students were asked on the survey was who they thought was better at science: boys, girls, or no difference. In the data analysis if a student said they thought girls were better at science, they were assigned a 1 value; if they thought that boys were better at science they were assigned a -1 value; and if they thought both were the same, they were assigned a value of 0. The null hypothesis assumes that both groups, since they are the same grade and attending the same school should technically be the same (Table 8).

Table 8

Comparing Responses for Students in STEM Club vs. Other Students in Second Grade When Determining who is Better at Science, Boys, Girls or Both are the Same.

	Students in STEM club	Students not in STEM club
Mean	0.273	-0.071
Variance	0.218	0.286
Observations	11	56
Hypothesized Mean Difference	0	
df	16	
t Stat	2.179	
P(T<=t) one-tail	0.022	
t Critical one-tail	1.746	
P(T<=t) two-tail	0.045	
t Critical two-tail	2.120	

This question asked students to determine who they thought was better at science—boys, girls, or both are the same. If every student in STEM club had stated that both are the same, the number would have been closer to 0. If every student in STEM club had stated that boys were better, the number would have been closer to -1. Finally, if every student in STEM club had stated that girls were better, the number would have been closer to 1.

Students in STEM club were more skewed toward girls being better (with a mean of 0.27) at science or both being the same. In comparison, students who weren't in STEM club were more skewed toward boys being better at science with a mean of -.071. Again, with the significance level being at 0.05, the results are significant and reject the null hypothesis that these two groups of students would be the same. This suggests that students in STEM club were more likely to think that girls are better at science, or at least equal to boys than students who weren't in STEM club.

The final question asked students to check if they knew what scientists did for six different science jobs. These were the six science jobs that students participated in while in

STEM club. They received one point for every science job that they knew of and the total could go up to six (Table 9).

Table 9
Comparing Job-Based Knowledge for Students in STEM Club as Compared to Students not in STEM Club.

	Students in STEM club	Students not in STEM club
Mean	4.818	0.929
Variance	1.564	1.995
Observations	11	56
Hypothesized Mean Difference	0	
df	15	
t Stat	9.225	
P(T<=t) one-tail	7.14E-08	
t Critical one-tail	1.753	
P(T<=t) two-tail	1.43E-07	
t Critical two-tail	2.131	

When looking at the differences between students in STEM club and students not in STEM club, we can see that students in STEM club knew, on average, five jobs while students who were not in STEM club knew on average one science job. This disputes the null hypothesis that the two groups would be the same and asserts that students in STEM club on average knew more science jobs than students who were not in STEM club.

Assessment Probe

Each lesson had a corresponding assessment probe, which I designed. Students completed the assessment probe at the beginning of the program and again at the end of the program. When looking at an assessment probe for the "Aerospace Engineering" job, the students were scored on the following rubric (Table 10). They were evaluated on the assessment probe twice, once at the beginning on the Aerospace Engineering job and once at the end. (Please note that due to COVID-19 and the related school closures, more assessment probes were scheduled to be completed but we were not able to complete them.)

Table 10

Rubric Designed to Assess Student Comprehension Towards the Aerospace Engineering Job

Drew a Design	/1
Added Labels	/1
Followed the Design Process	/1
Explained Design (including explanation of parts and why they were chosen)	/3
Total	/6

Students were given a set of expectations for what they were supposed to turn in for each section. A large part of the grade was the use of explanations to guide design. Students were graded on their ability to describe why they chose a particular material, not just their ability to name the material. The emphasis on this particular section stemmed from some students having the ability to reason through their design out loud but struggling to write down their answers (Figure 5).

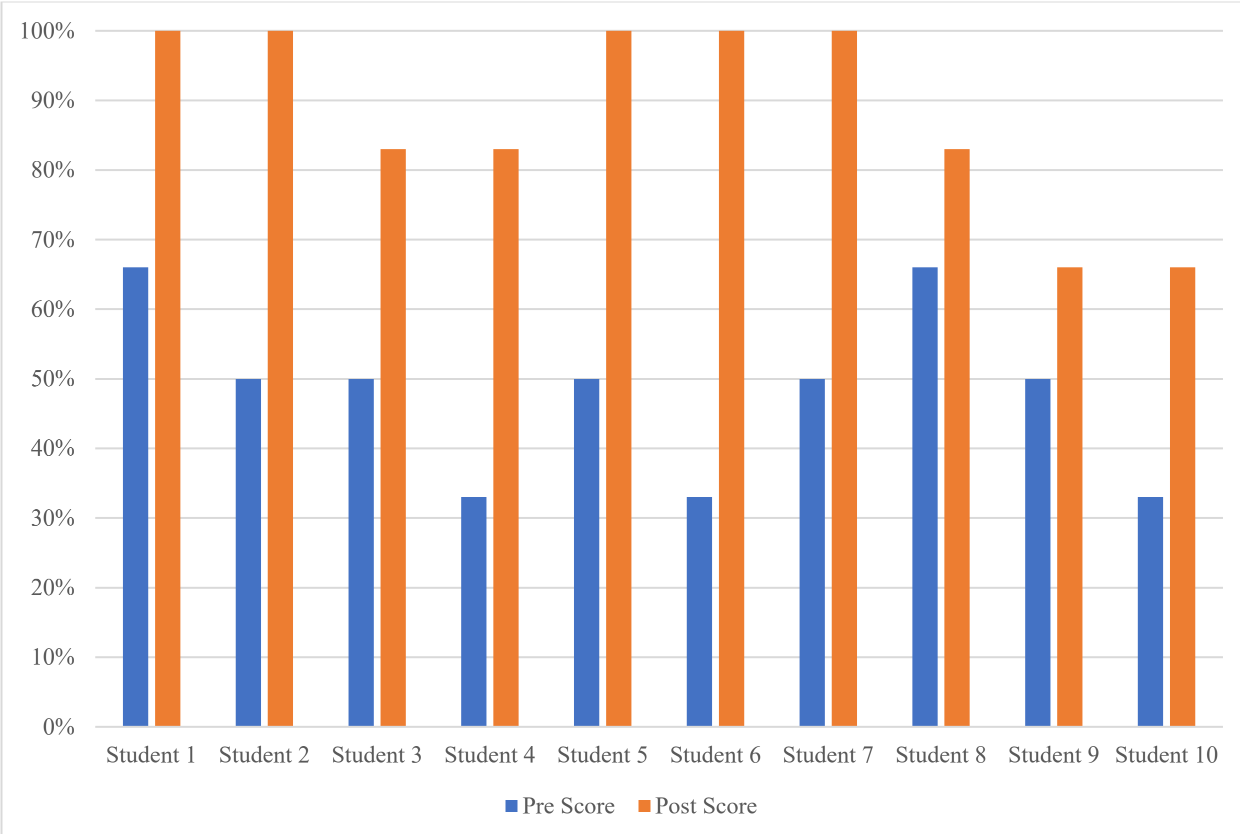


Figure 5. Students pre and post-assessment rubric scores compared by student for the Aerospace Engineer probe.

When looking at student growth between a pre-assessment and a post-assessment, the percentages are listed in Figure 5. From the pre-test to the post-test, every student made growth. They were working on adding their labels, and their explanations of what they did and why improved. The average percentage growth on the rubric for every student ranged from 17% to 67%, with the average growth being 40% from the pre to the post-assessment.

<u>Qualitative Analysis</u>

Every student in STEM club took part in an exit interview. During this interview they were asked the same questions (listed below) to standardize results.

- What did you learn in STEM club, if anything?
- Was there something that was valuable to you about STEM club? What was it?

- Would you describe yourself as a scientist? Why or why not?
- Are you more or less interested in science now than you were before? Why?
- If you could add one thing to what you learned, what would it be?
- What else would you like me to know about your experience in STEM club?

These questions were picked in order to learn what students found valuable about the club, and their opinions about themselves as scientists. I recorded the answers as students talked and wrote down what they said. This was due to the need to give every student the opportunity to voice their opinions and not be limited by vocabulary or writing ability. Each answer given for the first four questions has been sorted into three different categories: subject matter interest, self-efficacy, and relational (which relates to peer relations, mentor/teacher relations, and familial relations). The purpose of these categories is to sort answers that students gave to determine which section has a higher influence on students.

Table 11
Qualitative Analysis of Student's Assessment of Learning

Question: What did you learn in STEM club, if anything.	
"I learned about lots of things, but the most thing I learned about is mysteries. You can solve them, and you can have lots of tools to solve them."	Subject Matter Interest
"Let me think…I learned science and things like when we made the liquid. I learned new things every time we had STEM club. I want to have STEM club forever."	Subject Matter Interest/ Self-Efficacy
"That crystal rocks can grow and some robots you can train them to do what you want."	Subject Matter Interest
"That when you use fingerprints. You can solve mysteries."	Subject Matter Interest
"I learned that we can do science."	Self-Efficacy
"I learned that the moon is a piece of earth."	Subject Matter Interest
"I learned that you can make stuff out of things, and you can make a robot move by doing the directions, and you can make big robots."	Subject Matter Interest
"I've learned about fingerprints."	Subject Matter Interest
"I learned that science is one of my favorites now because we learned about animals, germs, and human body parts."	Subject Matter Interest/ Self-Efficacy
"I learned that it can be hard and easy to do it. And everything is a different section of what you have to do."	Self-Efficacy

In this question, there were numerous subject matter interest answers. Students cite solving mysteries, building robots, learning about the moon, etc. as things that they learned in STEM club. Some students had answers that fell into the categories of both subject matter interest and self-efficacy. Some cited science becoming one of their favorite subjects and their feelings that science can be easy or hard.

Table 12

Qualitative Analysis of Perceived Value in STEM Club

Question: Was there something that was valuable to you about STEM club? What was it?	
"The most important thing is that you can learn and be cool [learning]. The funnest thing is everything!"	Self-Efficacy
"Making the slime."	Subject Matter Interest
"Robots were the most fun."	Subject Matter Interest
"Ms. Shaw."	Relational
"When got to play with the robots."	Subject Matter Interest
"I liked when we solved the mystery of who stole the queen's tarts."	Subject Matter Interest
"The slime."	Subject Matter Interest
"When we learned how to be detectives."	Subject Matter Interest
"The most valuable thing was minerals and fossils, because I know I have fossils as home."	Subject Matter Interest
"I like the crystals the most."	Subject Matter Interest

When asked about the most valuable thing, many of the girls cited a personal experience that they found enjoyable. These experiences were mostly subject matter interest and included slime, robots, and solving mysteries. The few outliers on this question came with the student who said that she thought that learning science could make you fun and cool, as well as the student who cited the teacher, "Ms. Shaw," as being the most valuable things about the club. These two students were thinking about their own perception of science and about the relationships that had been formed in STEM club.

Table 13

Qualitative Analysis of Student Responses to "Are You a Scientist?"

Question: Would you describe yourself as a scientist? Why or why not?	
"Yes, I think I am because I have learned a lot about science, so I think I am one."	Self-Efficacy
"Yeah, I think I'm a scientist because when we make a new project, mine turns out good. Like my egg survived."	Self-Efficacy
"Kinda, cause I love science."	Self-Efficacy
"No, because something when I solve things, I don't always know the answer, but that's science so yes actually."	Self-Efficacy
"A little bit, because I make things that are squishy."	Self-Efficacy
"Yeah, because I'm really good at figuring things out."	Self-Efficacy
"Yes, because we learned how to build stuff and we got to control robots. "	Subject Matter Interest
"Almost, but not yet, because I don't always understand the things we are doing yet."	Self-Efficacy
"Yes, I think I'm a scientist and I do experiments at home and know how to make things at home like glow in the dark fizzy water."	Self-Efficacy/ Relational
"Yes, cause I feel like in my brain I need to know more stuff, and I can tell my family everything I know."	Self-Efficacy/ Relational

The question "Would you describe yourself as a scientist? Why or Why not?" began to tackle the self-efficacy and students' opinions of themselves as scientists. Indeed, most of the answers related to the self-efficacy category with students thinking about their position in science. Some students answered with a resounding "yes," and then went on to cite reasons such as, "I'm good at figuring things out" or "I have learned a lot about science." Some students answered with "kinda" or "almost" and would state that they love science, but they might not understand everything yet. One student began by stating that she didn't think of herself as a scientist, but when thinking about the nature of science changed her mind and said that she actually thought she was a scientist. Two students cited a relational reason in addition to the self-efficacy, both these students talked about their families and wanting to be able to teach their families science or doing science with other people in their households.

Table 14

Qualitative Analysis of Student Responses to "Are You More or Less Interested in Science?"

Question: Are you more or less interested in science now than you were before? Why?	
"More, because it looks cool and sounds cool and I still have a lot of questions."	Self-Efficacy
"More interested because I don't know all the answers yet."	Self-Efficacy
"More, because I don't know where I got my scientist gene, probably from my dad. It made me enjoy engineering."	Relational
"More, because when I first got here, I thought it would be boring, but we did fun stuff."	Self-Efficacy
"More, I had more fun. I like about science that we do things together, and we get to do things like scientists do."	Self-Efficacy
"More, cause I just really like math and science."	Self-Efficacy
"More, because I thought it was more cooler."	Self-Efficacy
"More, because when we go to STEM club, we learn about stuff that makes us scientists."	Self-Efficacy
"I'm more interested because I can learn more about science and I can tell my friends and family what I learned."	Self-Efficacy/ Relational
"More interested because science is something that can be hard but fun to do. You can do fun stuff and experiments."	Self-Efficacy

With this question every student felt like they were more interested in science. When asked "are you more or less interested in science", students cited their perception of science when talking about the fact that they were more interested in science now as opposed to before. Their reasoning included, "I have more questions now," "I really like math and science," "it was more cooler," and "I thought it would be boring but it wasn't." One student said that she thought she was more interested because she "got my engineering gene from my dad."

The final two questions were more for my own personal knowledge rather than data collection. I wanted to know what students wanted me to consider adding, and if they had anything else they wanted me to know. The answers are listed below (for inclusion); they are not classified in the same way as the previous questions.

Table 15

Student Response to "What Would You Add to STEM Club?"

Question: If you could add anything what would it be? Do you have anything else you want me to know?	
• "Boys" • "Puppies and more slime" • "Explosions" • "Seeds and growing things" • "Flowers" • "3rd graders should also do it next year"	• "More math" • "Making Rockets" • "More experiments" • "Seeing human bones, and bugs" • "Vinegar dissolving things"

In STEM club students were more likely to see themselves as scientists, that science came easy for them, that they could do any science, and that science was fun. In their interview responses, most of their comments could be classified as "subject matter interest" meaning that they were interested in what they were learning. Another classification for student comments was "Self-Efficacy" or that they had a belief in their capacity to learn science. Finally, student comments could also be classified as "relational" meaning that these students saw the value in science through the relationships formed.

When looking at the overall conclusions of the data, the girls in STEM club were more likely to believe that they were scientists and that they could do any science than before the program began. Compared to the entirety of second grade the girls in STEM club were more likely to have a more positive science identify and self-efficacy than those who were not in STEM club. Also, as compared to their peers, the girls in STEM club were more likely to know, and have experience with various science jobs. Finally, when looking at their qualitative responses most of the girls' responses fell into the areas of "subject matter interest," "relational" interactions or "self-efficacy changes."

INTERPRETATION AND CONCLUSIONS

For this research project, I looked at four categories: Self-Efficacy Changes, Self-Efficacy as Compared to the Whole, Assessment Probes, and Qualitative Analysis. With those, the data leads to some conclusions toward the overarching research question: How does jobs-based science learning and mentorship from women in the field influence science identity and self-efficacy for second-grade girls?

When looking at Self-Efficacy Changes, more girls throughout the course of the program agreed with the statements: "Science is something that comes easy for me," "I think I am a scientist," "I believe I can do any science," and "I want to be a scientist when I grow up." For the remaining statement, "I think science is fun," 100% of students agreed both times the survey was taken. This indicates a positive change in science identity and self-efficacy between the start of and the end of the program. One possible reason for this finding could be the hands-on experience that was incorporated into the program. Many of the girls cited certain tools when explaining why they liked STEM club, for example many of the girls found the robots, or the egg drop to be interesting to them. As Vanmali and Abell (2009) claimed, boys were more likely to be exposed to and be inventive with tools, a possible lead into their interest in science.

When looking at Self-Efficacy as Compared to the whole class, a similar pattern occurs. Students in STEM club were more likely to find the "science is fun," "Science comes easy for me," "I think I am a scientist," and "I can do any science" to be true for them. This was significant because in comparison to the entire second-grade class. The P-values from the T-test for these specific questions were 0.003, 0.004, 2.70E-9, and 0.002, all of which were below the statistically significant value that was pre-determined at 0.05. The only area where the results were not significant was in response to the question, "I want to be a scientist when I grow up" indeed in this specific circumstance the P value was 0.442, which is above the 0.05 threshold and therefore makes it not statistically significant. All these statements show that students were more likely than their peers to have a scientific identify and self-efficacy surrounding science. Again the reason for this could be the exposure to tools, (Vanmali & Abell, 2009), the relationship for girls to the job they were doing (Witherspoon, Schunn, Higashi and Baehr, 2016) or the interpersonal relationships that were established in the club (Cracking the Code: Girls' and Women's Education in Science, Technology, Engineering and Mathematics (STEM), 2017)

In addition, the girls in STEM club were more likely to say that girls were just as good (and sometimes better) than boys at science, while a comparison to the whole of second grade shows the opposite skew. Compared to research, this is significant because by the time girls are in the later grades of elementary school, they already have a perception that boys are better at science (Huebner, 2009).

Finally, girls in STEM club were more likely to be familiar with the types of jobs that are common in science and were able to explain them in detail, demonstrating an understanding of the jobs past the base knowledge. On average, girls in STEM club knew five out of six jobs and were able to build their knowledge from an average score of 44% to 89% on an assessment probe. Comparatively, students who were not in STEM club, were able to only identify one out of the six jobs listed. The students in STEM club, were able to see the direct correlation from the job title to the job that they were doing in STEM club just like in Witherspoon, Schunn, Higashi and Baehr's study (2016). This connection from the project to the job, was able to help students explain the job to someone else and kept their familiarity with the job alive.

When looking at the Assessment Probe section, there are some key differences. Due to this section of the program being cut short by COVID-19, we only had time to complete one final assessment probe. In the assessment probe (about engineering) that students were much more comfortable "acting like engineers" toward the end of the program as opposed to the beginning. Though understanding of concepts was not assessed in past assessment probes, there was a difference between students' prior thinking and their final thinking. After being taught the skill to be an engineer, the girls in STEM club were more comfortable stepping into the role of engineer, showing a change in their science identity. Giving these girls the tools that they needed to succeed in being an engineer helped them feel more comfortable in their role and opened up their learning opportunities. Research has shown that students who have family members in science or whose family members encourage science learning are more likely to feel comfortable stepping into a science role themselves (Cracking the Code: Girls' and Women's Education in Science, Technology, Engineering and Mathematics (STEM), 2017).

Finally, when categorizing all the comments that students made about the program in Qualitative Analysis, some standouts occur. First, students had distinct tools that drew them to particular subject matters. Research has shown that giving students the tools they need to try on a topic is essential in boosting students' science identity (Moore, 2003). Second, many students had a change in their feelings of self-efficacy and what it means to be a scientist. Third, students valued and were influenced by relationships, both in and out of STEM club; this relates back to research, where we have seen that minority students needed to feel that connection to others in the science field. This draws on prior knowledge about the importance of mentors, family, and the group itself (Cracking the Code: Girls' and Women's Education in Science, Technology, Engineering and Mathematics (STEM), 2017).

In terms of implications for teaching, looking at what went well and what could be improved is important. Students in STEM club were very consistent about attending. Many of the girls were constantly asking their teachers if it was Tuesday or Thursday (club meeting days). Every day they came in with a high level of excitement and anticipation. The girls were equally willing each week to try something new or to continue their progress from the week before. Throughout every lesson the girls were engaged. Whether we had a guest speaker coming in or they were working with tools, they threw themselves into the project and had a great deal of questions and wonderings. They asked about what the guest speaker did, what their life was like, and things that the guest speaker liked to do as a kid. Not only did this help students to draw parallels between their lives and the mentor's life, it also helped them to realize that mentors had a life and interests outside of their day job. This type of enthusiasm was essential in making this program work and is inspiring to watch.

Part of the success of this program came from girls being willing and ready to try new things. Each girl had a willingness to go with the flow and "try on" a different topic. The girls worked well together and were given freedom to choose ways to work that suited them. There were some who wanted to work on their own for every project and there were some who always wanted to work as a partnership. These partnerships occurred throughout their time during STEM club, during forensics they worked together to solve a mystery, in Aerospace Engineering they were able to partner up with others in order to make their egg survive. These partnerships strengthened their relationships within their peer groups and made the idea of "messing up" not as scary. Throughout it all, students were respectful and created a welcoming community for each other. When one student struggled, another would come over and help out. They bounced ideas off of each other and were patient and understanding. This dynamic made the club incredibly enjoyable and a safe space for all students to make mistakes and learn.

The girls had clear expectations of how they would be expected to behave. From the beginning they agreed that making mistakes was fine but failing to try wasn’t. They relied on each other and fed off each other’s energy and enthusiasm.

One of the struggles encountered had more to do with finding and maintaining mentors. Most speakers were willing to come in to talk with students at least once, but it was difficult for them to come in and mentor the students in a regular, more detailed role. However, there were several teacher mentors who came in and worked with the girls during club time. Sometimes we would have second-grade teachers stop by (previous first-grade teachers), and our English Language (EL) teachers would come in and ask students questions and listen to their ideas.

Adding a more in-depth mentor role next time would be beneficial. Mentors are one of the things that keeps women and girls interested in science. When mentors did come in, girls were encouraged to ask them questions about their lives, such as: “Where do you live,” “What do you like to do in your spare time?” and “What do you like to eat?” This helped to humanize the mentors and provided insights for the girls. Having a few consistent mentors in science fields would be beneficial and would give girls the opportunity to interact with mentors on a regular basis.

Finally, time was a major constraint. In thinking long term about this project, it might be important to change the time that students come in. Often, after a long day of being in school, students would take a while to settle down. In addition, the COVID-19 pandemic cut short not only the data collection but put an end to our plan to have a genius hour project or science fair for students to showcase some of their learning.

This jobs-based program gave girls a more in-depth view of different science jobs. It increased their science identity, making them feel more like a scientist (or engineer), and it increased their self-efficacy by giving them the confidence to try new things. The mentors helped to humanize the professions and should have their role expanded during the next year. Since the results of the data were significant, doing another program next year to further research will continue to occur.

VALUE

When looking at the value of this action research project, it is important to revisit the conceptual framework. A key aspect of this program was the idea of keeping girls interested in science. This was done through providing them with hand-on tools (that have meaning and purpose), creating relationships between peers and mentors, and introducing students to various science jobs/careers.

Intervention programs, such as this one, are essential in engaging girls outside of the classroom. In a classroom setting, girls often get overlooked, and sometimes science isn't taught in every classroom every day. In an after-school program, this is less likely to happen. The small group setting and the emphasis on STEM gives girls the opportunity to really experiment with tools and roles. Early intervention is critical in keeping students engaged in science (Cracking the Code: Girls' and Women's Education in Science, Technology, Engineering and Mathematics (STEM), 2017). By the time girls are in middle school, they are more likely to have feelings of inadequacy toward science and math. Research has shown that these attitudes can begin as early as elementary school, and in my early research, I noticed that indeed around 20% of girls felt that boys were better at science.

When looking into the perspective influences on my school community and myself, one of the things that really stuck out to me was how engaged other staff members have become in the process. More and more staff members are excited to participate next year, and I have hope that we can expand this to many other grade levels with the help of other teachers who are interested in science! For me personally, I will be moving from my kindergarten position at my school into a third-grade role. In implementing this project I noticed that I fell in love with teaching students who were a bit older. Student interest in science expands as they get older and many of the students that I had this year have asked to come back next year and participate again. Bringing science to slightly older students is something that I am excited to share in the coming years.

In my next steps for the program, in coming years, I think the expansion of mentor roles and the mentor program will increase the girls' feelings of belonging. My goal is to continue this program for several years and possibly expand it to other schools to determine if these results are truly significant.

This program increased student confidence and their ability to think of themselves as scientists. It made students feel more comfortable with science and feel that they could take on any science project. The program increased students' capacity to "think like a scientist" and to place themselves into the role of scientist or engineer. Finally, and perhaps most importantly, it got girls excited about and engaged in science!

REFERENCES CITED

5 Best Practices of Survey Analysis & Reporting. (2019). Retrieved from https://www.qualtrics.com/experience-management/research/analysis-reporting/

Alber, R. (2017). Fire up your class with student-interest surveys. Retrieved from https://www.edutopia.org/blog/fire-up-class-student-interest-surveys-rebecca-alber

Bandura, A. (1994). Self-efficacy. In V. S. Ramachaudran (Ed.), *Encyclopedia of human behavior* (Vol. 4, pp. 71-81). New York: Academic Press. (Reprinted in H. Friedman [Ed.], *Encyclopedia of mental health*. San Diego: Academic Press, 1998).

Beede, David. Julian, Tiffany. Langdon, David. McKittrick, George. Khan, Beethika. Doms, Mark. (2011). *Women In STEM: A Gender Gap to Innovation. (*ESA Issue Brief #04-11.) Department of Commerce.

Chatman, L. (2009). *Girls in Science: A Framework for Action*. Arlington, VA: NSTA Press.

Eccleston, J. (1999). Girls only, please. *Science and Children*, 21–26

Glynn, S. M., Yeany, R. H., & Britton, B. K. (Eds.). (2015). *The Psychology of Learning Science*. Routledge.

Huebner, T. A. (2009). Encouraging girls for pursue math and science. *Teaching for the 21st Century, 67*(1), 90-91. Retrieved March 28, 2019.

Moore, J. E. (2003). Girls in science rule! *Science and Children*, 38–41.

Rainey, K., Dancy, M., Mickelson, R., Stearns, E., & Moller, S. (2018). Race and gender differences in how sense of belonging influences decisions to major in STEM. *International Journal of STEM Education*, *5*(1). doi: 10.1186/s40594-018-0115-6

Serpa, P. (2017). Discrimination toward women in engineering can manifest in subtle ways. Retrieved from https://www.dailycal.org/2017/03/12/discrimination-toward-women-in-engineering-can-manifest-in-subtle-ways/

Talley, K. G., & Ortiz, A. M. (2017). Women's interest development and motivations to persist as college students in STEM: a mixed methods analysis of views and voices from a Hispanic-Serving Institution. *International Journal of STEM Education*, *4*(1). doi: 10.1186/s40594-017-0059-2

Cracking the Code: Girls' and Women's Education in Science, Technology, Engineering and Mathematics (STEM) (2017). Paris, France: United Nations Educational, Scientific and Cultural Organization.

Vanmali, B. H., & Abell, S. K. (2009). Perspectives: Finding a place for girls in science. *Science and Children,* 62-63.

Witherspoon, E. B., Schunn, C. D., Higashi, R. M., & Baehr, E. C. (2016). Gender, interest, and prior experience shape opportunities to learn programming in robotics competitions. *International Journal of STEM Education*, *3*(1). doi:10.1186/s40594-016-0052-1

Yang, L. (2010). Research and teaching: toward a deeper understanding of student interest or lack of interest in science. *Journal of College Science Teaching,* 68-77.

APPENDICES

APPENDIX A

INTEREST SURVEY

Name:____

For this first section you are going to circle whether you agree or disagree with each statement.

Statement		
I think science is fun!	I Agree	I Disagree
Science is something that comes easy to me	I Agree	I Disagree
I think I am a scientist I believe that I can do any science	I Agree I Agree	I Disagree I Disagree
I want to be a scientist when I grow up	I Agree	I Disagree
I think girls are just as good at science as boys	I Agree	I Disagree

What is a science job you would want?

Check all the science jobs that you are familiar with.

___ Microbiologist

___ Wildlife biologist

___ Coder

___ Aerospace Engineer

___ Forensic Scientist

___ Paleontologist

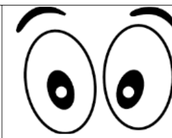
If you checked one of the jobs above please explain what you think people who do that job do…

APPENDIX B

HOW DO YOU LEARN SURVEY

Name:___________________________________

I want to get to know how you learn. Please circle how you like to learn (you can circle more than one).

				
Hands on	Movement	Listening to the teacher	Songs	Seeing things done

Explain your answer

Do you like to work in groups? Why or why not?

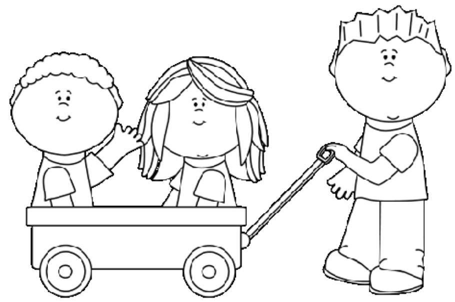
Is there anything else you would like me to know about you as a learner?

APPENDIX C

ASSESSMENT PROBES

Name:________________________

Three friends were talking about ways that people in their class could get sick.



Joshua: My mom always tells me to not get my hair wet when I go outside. You can catch a cold from going outside when it is cold. The cold particles get in through your skin and make you sick.

Jamie: My dad says that you catch a cold when you don't get enough sleep and exercise. When you get those things you are healthier and therefore you don't catch a cold.

Julia: I disagree, my mom says that you catch a cold from tiny little things called germs. We can't see them but they can still make you sick!

Which student or students do you agree with? Explain your thinking.

____

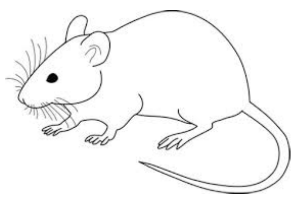
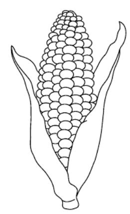
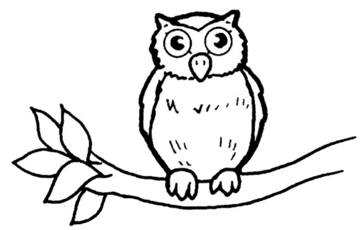
____

____

____

Name:________________________

How are these things connected?

Explain your thinking…

Name:______________________________

Check which things you would consider "technology"?

___ A computer 

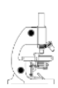
___ A cell phone 

___ A pencil 

___ A leaf 

___ A flashlight 

___ A bag 

___ A microscope 

Explain why you checked the ones that you did. How are they technology?

____

____

____

____

Name:____________________________________

Draw a design that will keep Iggy the Egg safe from a fall!

Explain your design

____

____

____

____

____

Name:______________________________

What are some things that detectives use to solve cases?

___ hair 

___ magnifying glass 

___ fingerprints 

___ dust 

___ dogs 

___ clothes 

___ writing 

Explain your reasoning

____

____

____

____

____

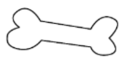
Name:______________________________

During a fossil hunt with their teacher, the 2nd graders at Horizon Elementary found some interesting things. Check which ones are fossils.

___ A stick 

___ A shell 

___ A rock with a plant in it 

___ A bone 

___ A colorful rock 

___ A dinosaur footprint 

Which ones are fossils? Explain your reasoning…

____

____

____

____

APPENDIX D

SAMPLE END OF UNIT ASSESSMENT

Name:______________________________

Topic:______________________________

What did you learn?

What was your favorite part?

What was your least favorite part?

Did you enjoy learning from a role model? Why or Why not?

Would you consider being a Microbiologist?

APPENDIX E

EXIT INTERVIEW QUESTIONS

Student:______________________________________

Participation in this research is voluntary and participation or non-participation will not affect a student's grade or class standing in any way.

Do you feel your ideas about science have changed?

What was one of the most valuable things about this club to you?

If you could add anything what would it be?

Would you describe yourself as a scientist?

Are you more or less interested in science now than you were before? Why?

What else would you like me to know?

APPENDIX F

IRB APPROVAL LETTER

INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165

MONTANA STATE UNIVERSITY

2155 Analysis Drive
c/o Microbiology & Immunology
Montana State University
Bozeman, MT 59718
Telephone: 406-994-4706
FAX: 406-994-4303
E-mail: cherylj@montana.edu

Chair: Mark Quinn
406-994-4707
mquinn@montana.edu
Administrator:
Cheryl Johnson
406-994-4706
cherylj@montana.edu

MEMORANDUM

TO: Kathryn Shaw and Marcie Reuer

FROM: Mark Quinn Mark Quinn cyj
Chair, Institutional Review Board for the Protection of Human Subjects

DATE: October 30, 2019

RE: *"Self-Efficacy and Science Identity of Second Grade Girls in STEM Club" [KS103019-EX]*

The above research, described in your submission of October 29, 2019, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

_X_ (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

_X_ (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation; and (iii) the information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review to make the determination required by section 16.111(a)(7).

___ (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

___ (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

___ (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

___ (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.