5-2022

The Impacts of Positive Praise on Science Achievement Levels of Female Students

Sidney Hanel
shanel@unomaha.edu

The Impacts of Positive Praise on Science Achievement Levels of Female Students

University Honors Program Thesis

University of Nebraska at Omaha

Submitted by

Sidney Hanel

May 2022

Mentor: Dr. Sheryl McGlamery

Table of Contents

Abstract

To the general eye, it appears there has been an increase of women in STEM and overall female interest in science however, this is not apparent in the high school classrooms. The lowest level physics classrooms are overwhelmingly female, and the AP Physics class of twenty-five students has two female students. Society is seeing more equal numbers of males and females in biology, healthcare, dentistry, and other medical related fields. This is a wonderful advancement however many other STEM careers are being forgotten.

This study focuses on five physical science courses one of which is provided with additional feedback and verbal praise. All classes are given a pre and post survey to gauge confidence levels in the subject area. The class with the additional supports scores higher than the control classes on the end of unit exam, and the female students excelled. The observed improvement in female achievement demonstrates the impact of feedback and positive praise on female participation in science classes

The Impacts of Positive Praise on Science Achievement Levels of Female Students

To the common eye, it would appear like the numbers of women in science, technology, engineering, and mathematics (STEM) fields has been on the rise. Society now celebrates The International Day of Women and Girls in Science every year and it promotes successful female roles. When looking at science specifically, the distribution of females is not equal. The female interest in science seems to be concentrated in the biological sciences rather than the physical sciences. Females account for only 29% of the physical scientists and 16% of the engineers in the United States (National Science Foundation, 2019). This is even evident in the high school setting. In a physics class of twenty-five students, there were only two females. In a biology class on the other hand, the class is much more evenly split between male and female students. Females hold about half of the biological science and mathematics positions int the community along with a majority of the health professions (National Science Foundation, 2019). It is a great accomplishment to have many women in biological science careers but there is another part of science that females are not exploring at equal rates.

Within the science classroom, boys are more likely to complete science demonstrations. A study found that 79% of science demonstrations were conducted by boys (Tobin & Garnett, 1987). Girls volunteer less and they are more likely to take roles as the recorder during laboratory activities. In the classroom, girls may be limited as they are often placed in the traditional sex-stereotyped roles by the boys when completing groupwork (Bailey, 1993). Within the small groups, boys will often receive help from girls when they ask for it, but boys will ignore girls' requests for help (Wilkinson, Lindow, & Chang, 2013). Within mixed gender small groups, boys often take roles as the leaders and the girls seem to follow rather than taking a leadership role.

There are many stereotypes that are hindering the number of females perusing STEM careers. A study showed that, when children are asked to draw a mathematician or a scientist, female students were twice as likely to draw a man as they were to draw a woman (Picker & Berry, 2000). Their male counterparts almost always will draw a man. The constructed image of science is even more masculine than that of mathematics (Kahle & Riley, 1993). Children have a subconscious image of what scientists and mathematicians look like and it unfortunately is not female or gender neutral as some other careers. This could be a possible explanation why we have female students entering stem careers at dramatically lower rates (Corbett, 2015). It is difficult for female students to be excited about pursuing a career when there may be no one in the office or laboratory that looks like them.

Academic Achievement

Female students have the grades and high-test scores, but something is stopping them from pursuing a career in STEM. A sample taken within the United States found that boys appear to be more confident and interested than girls in all areas of science (Kahle & Riley, 1993). Boys and girls are performing at similar levels and enrolling in advanced science courses at similar levels until they reach high school (*Current State of STEM | National Girls Collaborative Project*, n.d.). Once they reach high school, something happens, and the gender gap becomes much more prevalent. The young men and women's abilities do not differ significantly, however their interests do (*Current State of STEM | National Girls Collaborative Project*, n.d.). When comparing higher education, females earn 57% of all bachelor's degrees. Unfortunately, they only earn 21% of the degrees that are earned in physics. Looking at the STEM workforce, women only make up 34%. Female students are scoring equally high, and their abilities are similar, but something is prohibiting them from pursuing a career in STEM. Something must be

done to break these stereotypes and to encourage more of our female students to take upper-level science courses and to pursue a STEM career.

Changing the Stereotypes

Teachers are the start to changing the negative stereotypes of females' interest in STEM. Psychologists believe that the stereotypes impact the student performance. The perception that a group one identifies with is not good at a task is linked to lower academic performance (*Stereotype Threat Widens Achievement Gap*, n.d.). One's internal thoughts and beliefs play a large roll in success. To debunk the stereotypes that females are not good at math and science, society needs to change how it presents STEM. Positive responses from educators tends increase the students' interest in science or the belief in their own abilities (Kahle & Riley, 1993). Simply seeing a female in a science textbook has had positive impacts on female student performance compared to females who only viewed pictures of males in their textbooks (Good et al., 2010). Countering the stereotypes alleviates the threats that they are associated with, and it boosts overall academic performance.

Materials

This study is completed in a Midwest urban area high school. Approximately 40% of the students who attend this high school qualify for free lunch and about 70% of the students identify as Caucasian. This school requires a minimum of three science courses, a total of six semesters, to graduate. The minimum course sequence is as follows: biology, physical science, and Earth and space. Students who follow this minimum course sequence are typically preparing to enter the workforce after they graduate from high school. Other science courses offered include

advanced biology, AP biology, chemistry, advanced chemistry, AP chemistry, physics, and AP physics. The classes that were used for this study were sophomore level physical science classes.

These classes typically range between 15-22 students. One class was used as the experimental class and four others were used as a control. In the experimental class, there were 16 students, two of which were freshman who transferred into the district and one student was a junior. This class has three students who qualify for special education services, three students live in two households, and one student is classified as an English Language Learner. Female students C and E are two of the three students who qualify for special education services. Student G is the student who is an English Language Learner as they entered the United States in 2019. The class is 50% male and 50% female. Data was collected from the previous semester to use as a comparison of typical achievement levels for the five different classes.

Methodology

In order to improve female achievement and interest in STEM, the students in one physical science course were given additional supports over the duration of one unit. The experimental class will be referred to as class E and the four other classes for a control are referred to as class A, class B, class C, and class D. Class E was provided with written positive feedback on each assignment that was turned in. Examples of specific feedback included “good job graphing your points” and “Way to go! You remembered your units”. The papers were passed back to the students either digitally through an academic platform or on paper. Every student was provided with positive feedback for each assignment that was turned in.

During instructional time in the classroom, there was specific positive praise given to the students for the simple things such as working well with their laboratory partners or correctly

solving problems presented. Each student was provided with at least 1-2 pieces of positive praise each class period. A list with every student name was used to record the number of times a student received positive praise in class to ensure that each student was given support. The goal of the positive praise is to see if by encouraging the students, academic performance would increase.

There was one laboratory activity that required a demonstration to the class during this unit. One of the female students was selected to assist in the demonstration where the procedures were outlined. During the duration of the study, students were assigned laboratory partners of similar ability levels with one student being slightly higher than the other. Personalities were also taken into consideration when selecting laboratory partners to help foster a welcoming discussion. For each laboratory activity, one student was assigned the role to record where the other was completing the hands-on component. The students were instructed to switch roles once they reached the halfway point of each laboratory assignment or activity. One of the laboratory assignments the students worked on was completed on paper that way contribution by both students was evident via student handwriting.

Each student was also given a pre and post survey regarding overall confidence and interest levels. The pre survey consisted of four different questions. Students were asked to rank on a scale of one to ten their level of interest in STEM along with their confidence in their science abilities and skills. Students then identified by a yes, no, or maybe if they had any interest in pursuing a STEM career. The final question on the pre survey asked the students to describe the picture that comes to mind when they think of a scientist. The survey was given to all students in each class.

After the students completed the Unit 5 exam and the exams were passed back, they completed the post survey. The post survey asked the students four questions, three of them being the same as questions listed on the pre survey. Students were again asked to rank on a scale of one to ten their level of interest in STEM along with their confidence in their science abilities and skills. Students again identified by a yes, no, or maybe if they had any interest in pursuing a STEM career. The final question on the post survey asked the students to rank how they felt they performed in Unit 5. Responses for the pre and post surveys were then compared to observe if there had been any change in self-confidence and overall interest in STEM.

Results/Data Analysis

Regarding the pre survey where students were asked to describe the picture that comes to mind when they think of a scientist, only 3% of the students surveyed mentioned anything about a female. It is also interesting to note that the only students who mentioned a female in their responses both identify as non-binary. On the contrary 35% of the students specifically mentioned a male in their descriptive picture. Of the students who mentioned a male, 54% of them are female students. A few examples of female student responses include, “old guy”, “A guy in a long white jacket”, and “weird dude with white hair”. Many of the responses that the students described talked about old people or weirdos with the crazy white hair.

If the idea that a scientist is weird, old, and has crazy hair, very few female students will be drawn to the idea of becoming a scientist. Since scientists are perceived by students as being weird, few female students will have the desire to take higher level courses where they may be required to complete some of the more typically associated science tasks. Students may refrain from taking advanced chemistry because they envision the weird old guy with white hair and a

lab coat when they think of complex laboratory experiments. The stereotypes that females are not typically scientists were very prevalent in the classes studied. Not a single female student responded with a descriptive picture of a female scientist which helps to explain why there are fewer women pursuing STEM careers.

The Unit 5 exam scores were compared in order to see if the treatment had any impact on academic performance of female students. Class E scored the best on the Unit 5 exam compared to the other four classes when comparing all students. Class A scored an average of 74%, class B scored an average of 78%, class C scored an average of 74%, and class D scored an average of 72%. The treatment was provided to all students within class E and their average score was an 83%. Class E scored at least 5% higher than the four other physical science courses. When compared to the average scores from the end of last semester, class E saw a 3% score increase. Last semester, class E was only the third highest scoring class. When compared to last semester grades, it is evident that the treatment had a positive impact on the academic performance of class E. The treatment had an impact on all students in the class, not just the female students.

The scores of just the female students were also analyzed. The female students in class E on average scored an 85%. The female student average was two percent higher than the class average which suggest that the females were able to get even more out of the experiment. The average unit exam score for the class E females was 7-15% higher than average score of their female counterparts in classes A-D. Providing positive praise, female role models, and selective groups clearly has a correlation with the increased academic performance of the female students in class E. The females in this class also improved their contributions while working with their laboratory partners. There was an increase in the male partner's handwriting in mixed sex laboratory groups as the unit progressed. The female students became more involved in the

experimental portion which likely assisted in creating a solid understanding of the concept presented. Being able to learn something hands on increases the overall understanding of the material and this is evident when looking at the female student academic achievement.

When comparing the female student in class E responses of the pre and post surveys the results showed no significant difference. Only 37% of the students' interest in STEM increased at the end of the survey and only 37% of the female students reported an increase in confidence in their science abilities. In class E, female students B, C, and F reported that their level of interest in STEM increased. Students ranked their interest on a scale of one to ten with one being not interested at all and a ten being very interested. Student B originally recorded a four and increased to a six. Student C recorded an initial three and a six in the post survey. Student F originally only indicated a one and moved up to a four at the end of the unit.

Student F showed the largest increase in the overall level of interest in STEM. Student F also had an extremely positive interaction with her laboratory partner. This student was placed with another female, student H. At the beginning, student F was not pleased with her assigned laboratory partner after the pairs were announced. There was quite a lot of push back when the students were assigned the laboratory groups. Student F even asked to work alone because she did not want to work with student H because she believed that student H did not ever do anything. Student F was informed that she was selected specifically to be partners with student H because the teachers believed in her. This female student was given a confidence boost before group work began and it ended up having a positive outcome.

Student F and student H ended up working great together. When student F was told that the teachers were proud of how well she was worked with her peer there was a huge smile that came across her face. At this moment, it is evident that student F started to believe in herself a

little bit more. Student H was also told that she had great collaboration skills during the lab. This laboratory activity also had the students utilizing roles which ensured that both partners were given the chance to engage hands on. Overall, the assigned groups went extremely well, and the students were able to explain their findings better than they had in the past. The pairing up of the students allowed individual student praise to be made and was often focused on their collaboration and communication skills.

When looking specifically at the female students in class E, their confidence did not increase significantly. Students ranked their interest on a scale of one to ten with one being not confident at all and ten being extremely confident. Three students showed an increase in confidence in their science skills and abilities. Student B showed an increase from a six to a seven. Student C showed an increase from a five to a six and student H showed an increase from a three to a four. Students A, E, D, and F remained consistent with their confidence ranking and did not report any change. Student G did report a decrease in confidence moving from a five to a four at the end of the survey. Student B reported an increase in both levels of interest and confidence in STEM. This student also reported that she did have an interest in pursuing a STEM career.

Confidence does take several months to improve. It will take time for many students to report an increase in their overall confidence in their skills. Since this study was conducted only over a short period of time, the student confidence may not have been given the chance to increase as much as it could have. If the students were studied over a longer period of time, it would be expected that the levels of confidence would have risen in more of the female students. It is surprising that three students did report an increase in confidence since the survey was only taken three weeks apart. In each case where confidence increased, it was only by one point which

is not an extremely significant jump. To obtain a better understanding of how this treatment impacts confidence in science skills and abilities, the study should be completed over a longer period of time such as the duration of a semester.

Conclusion

Positions in STEM are on the rise yet, yet women are extremely underrepresented in many STEM fields (National Science Foundation, 2019). While in high school, students are often beginning to select their career plans therefore, this is the ideal time to conduct this study. This study aimed to find if changes can be made within the high school classroom to increase female achievement and confidence in STEM courses. The findings presented suggest that positive praise can have a large impact on female academic success in science courses. These findings align with previous publications that suggest that female science efficacy is lower than that of their male classmates (National Science Foundation, 2019). At the end of the study, female efficacy had improved slightly demonstrating that it is possible to narrow the gap. Learning that females can be just as successful in science as their male counterparts can have a positive impact on test scores.

In order to further encourage female students to pursue a STEM career, it is crucial that educators make a point to refute the common stereotypes. If educators show their female students that they value their contributions and ideas to science, the student confidence will rise along with their overall interest. Educators must work to increase positive praise and debunk the stereotypes that are found within the classroom. This study saw just a snapshot of what positive reinforcements and engagement within a science classroom can do for female students. Although there were some positive results, there is still much room for improvement. The study also

showed the impact that positive praise can have on any student's achievement levels. If the students know that someone else believes in them, they begin to believe in themselves.

References

Bailey, S. M. (1993). The current status of gender equity research in American schools. *Educational psychologist*, *28*(4), 321-339.

Corbett, C. (2015). *Solving the equation: The variables for women's success in engineering and computing*. AAUW.

Current State of STEM | National Girls Collaborative Project. (n.d.). Retrieved April 23, 2022, from https://ngcproject.org/statistics

Good, J. J., Woodzicka, J. A., & Wingfield, L. C. (2010). The effects of gender stereotypic and counter-stereotypic textbook images on science performance. *The Journal of Social Psychology*, *150*(2), 132–147. https://doi.org/10.1080/00224540903366552

Kahle, J. B., & Riley, D. (1993). Gender differences in science education: Building a model. *Educational Psychologist*, *28*(4), 379. https://doi.org/10.1207/s15326985ep2804_6

National Science Foundation. (2019). *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2019.* Retrieved April 22,2022, from https://ncses.nsf.gov/pubs/nsf19304/

Picker, S. H., & Berry, J. S. (2000). Investigating Pupils' Images of Mathematicians. *Educational Studies in Mathematics*, *43*(1), 65–94.

Stereotype threat widens achievement gap. (n.d.). Https://Www.Apa.Org. Retrieved April 23, 2022, from https://www.apa.org/topics/racism-bias-discrimination/stereotypes

Tobin, K., & Garnett, P. (1987). Gender related differences in science activities. *Science Education*, 71, 91-103.

Wilkinson, L. C., Lindow, J., & Chang, C. (2013). Sex differences and sex-segregation in students' small-group communication. In *Gender influences in classroom interaction* (p. 185). Academic Press Inc.

Women, Minorities, and Persons with Disabilities in Science and Engineering: 2021 | NSF - National Science Foundation. (n.d.). Retrieved April 25, 2022, from https://ncses.nsf.gov/pubs/nsf21321/

Tables

Table 1

Female Student Unit Exam Scores Compared to Semester 1 Final Grades

Female Student	Semester 1 Grade %	Unit 5 Exam Score %
Student A	98	99
Student B	B	98
Student C	84	71
Student D	90	91
Student E	85	69
Student F	79	94
Student G	85	79
Student H	C	79

Note: Student B and Student H transferred at the semester, therefore, exact percentage for the Semester 1 grade is unknown. Instead of a percentage, a letter grade has been recorded instead.

Table 2

Average Unit Exam Scores Compared to Semester 1 Average Final Grades by Class

Class	Semester 1 Grade %	Unit 5 Exam Score %
Class A	66	74
Class B	82	78
Class C	73	74
Class D	81	72
Class E	80	83

Note: Class E is the experimental class. Semester 1 average grade percentages do not include the two students who transferred at the semester.

Table 3

Pre and Post Survey Responses for Female Students in Class E

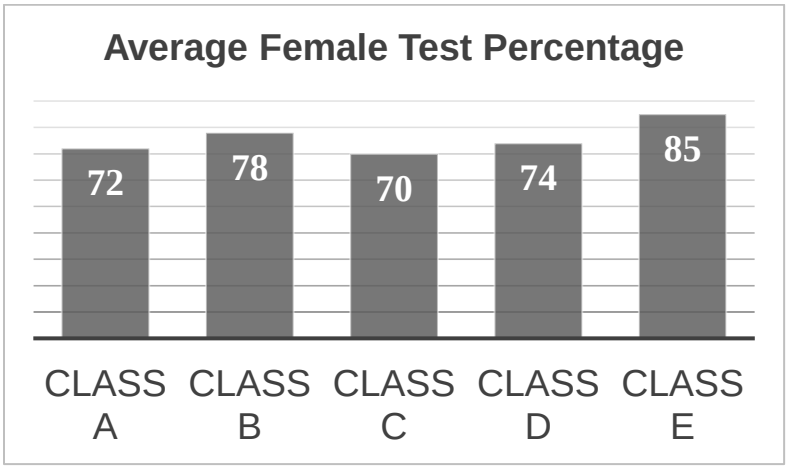
Female Student	Level of Interest in STEM Pre-Survey	Level of Interest in STEM Post-Survey	Confidence in Science Abilities Pre-Survey	Confidence in Science Abilities Post-Survey
Student A	8	3	5	5
Student B	4	6	6	7
Student C	3	6	5	6
Student D	4	4	7	7
Student E	8	4	5	5
Student F	1	4	5	5
Student G	4	2	5	4
Student H	1	1	3	4

Note: Students were provided with a scale of 1-10 for their responses. For level of interest, a 1 denoted not interested at all and a 10 denoted extremely interested. For confidence in abilities, a 1 denoted not confident at all and a 10 denoted extremely confident.

Graphs

Graph 1

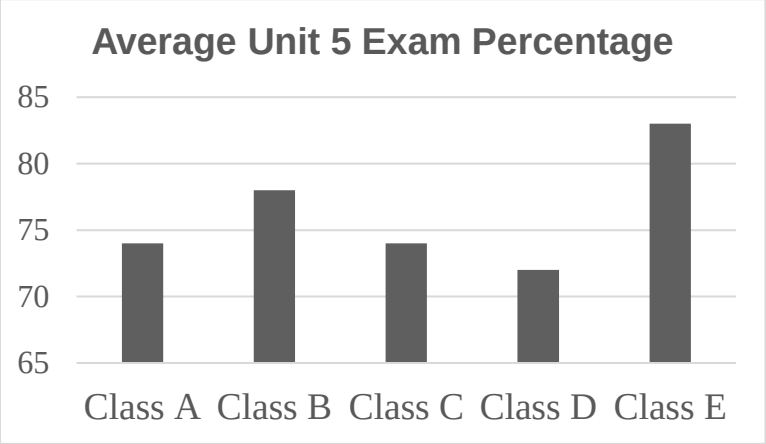
Average Female Test Score Based Upon Class



Note: Class E is the experimental class. The graph shows test scores of only the female students from every physical science class.

Graph 2

Average Unit 5 Test Score Based Upon Class



Note: Class E is the experimental class. The averages include all genders of students in the class.