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Gender Bias in the Classroom: An In-Service to Create Change

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by

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Abstract

Female students are not often treated the same way as male students in the elementary classroom. Teachers bring their gender bias into their daily practices and unknowingly encourage male student towards STEM subjects and female students away from STEM subjects. This results in a gender gap in STEM careers. This project aims to combat gender bias by holding an in-service. Research supports the idea that once bias has been addressed in individuals, they are less likely to hold on to their bias. Participants will take a test to discover their bias, be presented with relevant research, read an article on gender bias, and create a plan for their own classrooms. By addressing gender bias in their classrooms, participants will be part of the systemic change needed to reduce the gender gap in STEM careers.

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Chapter One: Introduction

Problem Statement

Women are, simply put, underrepresented in science, technology, engineering, and mathematics (STEM) careers (Ing, 2013). Women possess all the requisite abilities to pursue STEM careers, according to a study by Beekman (2015) that looked at mathematics exams in Indiana as an indicator of how educators approach college-bound women entering STEM careers. According to the National Science Foundation, in the 1990s and 2000s women represented 30% or less of those being awarded engineering and computer science degrees (Ing, 2013). If the number of doctorates that are awarded in STEM careers are used as a measure of representation, some disturbing figures emerge. Only 46.2% of total doctorates were awarded to women (Beekman). In 2013, woman earned 28.5% of the doctorates awarded in physical sciences and 22.4% of those in engineering. Furthermore, while 48% of jobs are held by women, only 24% of women hold STEM positions (U.S. Department of Commerce, Economics and Statistics Administration, 2011).

Importance and Rationale of the Project

As the areas of STEM become more important in modern society, the need for equality of opportunity and presence becomes ever more important. The data continues to show that that women are underrepresented in STEM fields and unfortunately, there is a gap in the number of women who hold STEM positions both vocationally and in higher education. Girls possess the abilities to pursue STEM careers but are underrepresented in STEM-related fields (Beekman, 2015). By not

being encouraged to pursue STEM activities in the classroom during the early years of their lives, girls are more likely to pursue careers that are not STEM related (Ing, 2013). Many factors contribute to this; among them are educators' reinforcement of assumptions about female capabilities (Ceci, 2010).

Cultures in which gender stereotypes are higher (leading to gender bias), have smaller gaps in math performance; math performance is an indicator of success in STEM careers (Carlana, 2019). Teachers' stereotypes can be communicated to their students and negatively affect those students' academic self-concept. Teacher bias can (and has) led to assumptions that math is more difficult for girls than it is for boys. By having these biases, teacher unknowingly create a self-fulfilling prophecy where math becomes more difficult for the girls in their classroom, furthering the gender gap (Carlana, 2019).

Having a workforce that is knowledgeable in STEM fields is necessary for continued growth. The demand for STEM positions is only going to rise, according to the U.S. Department of Commerce, Economics, and Statistics Administration (2011). This study found that in the first decade of the 21st century, there has been three times the growth in STEM positions as compared to non-STEM positions. It becomes a matter of economic responsibility to encourage students to pursue STEM positions. Rebecca Blank (2011), at the time Acting Secretary of Commerce, stated in the same report that "closing the gender gap in STEM degrees will boost the number of Americans in STEM jobs (para. 10). Solving this gender gap in STEM careers can help contribute to filling the positions in STEM that this country will inevitably see.

Background of the Project

There have been multiple studies that have explored different demographics in STEM positions. Quantifying these differences has allowed researchers to draw conclusions about ways to bridge the gaps that exist. The participants in these studies vary in age, from elementary school students all the way to those pursuing tenure-track positions.

The gender gap can often be explained in a historic context (Vantieghem, 2014). Women were more likely to be homemakers in the first half of the last century and an obvious gap appeared once women started to enter the workforce and higher education, since boys historically had more chances at education. A multitude of factors contributed to girls "catching up to boys" and this historic disadvantage has been mostly resolved in industrialized countries (Vantieghem, 2014).

Women are not as likely to be awarded tenure-track positions as men are (Pollack, 2013). In mathematics, the statistics are dramatic; tenure-track positions held by women are between 9%-16% in the top 100 U.S. universities (Robelen, 2012). This supports the proposition that there exists a gap between males and females in our higher education STEM positions. According to Ceci and Williams (2010) the result of women not participating in higher level STEM careers and the dearth of tenured professors is primarily the result of two factors. These factors are that women are restricted by their biology and society. There is a choice not to pursue careers that are mathematics related. Despite scores that show there is no difference in ability levels, women often choose to pursue careers outside of mathematics more

often than not. When these careers are chosen it is more likely that women are restricted by their biology and decide to go into child-rearing, this choice is less often demanded of men.

Pollack (2013) may agree with this but points out other factors that may be restricting women from pursuing careers in STEM related fields. She notes that boys and girls perform equally well in mathematics and science during elementary school but chose to not continue on in science related fields. This choice is a result of cultural signals that affect students' ability and interest. "The most powerful determinant of whether a woman goes on in science might be whether anyone encourages her to go on" (Pollack, 2013, para. 25).

Continuing Pollack's thoughts on encouragement, Moss-Racusin (2018) found that one of the causes of underrepresentation of women in STEM is due to gender bias. This gender bias led to women choosing not to participate in STEM as often as their male counterparts. The study determined that when this bias was removed, women participated equally in STEM related fields. This gender bias also extends into specific subjects. STEM subjects are typically seen as masculine while subjects that are unrelated to STEM are often seen as more feminine. These gender biases begin in a child's early life and lead to women being more likely to switch to majors outside of STEM (Wajngurt, 2019). Teachers may be the first to blame. Biased teachers' expectations may lower the bar that they set for girls in their classroom, leading to girls never reaching their full potential and furthering the gender gap in STEM (Carlana, 2019).

This problem has been corroborated through a plethora of studies and formal research. Data from the National Assessment of Educational Progress (NAEP) found gaps between boys and girls on STEM-related standardized assessments. In 2011, NAEP researchers found that 37% of eighth grade boys scored "proficient" or higher in science compared to only 29% for girls (Robelen, 2012). NAEP data indicates achievement gaps in older grades, as well. There is consistent data since 1996 that shows that girls are lagging behind boys in science. When high performing middle-schoolers were given the SAT, boys outperformed girls in mathematics 13 to 1 (Pollack, 2013).

Another indicator of the gender gap are advanced placement (AP) tests in STEM areas. There are ten AP tests in STEM areas. When one looks at this data one finds a consistent gap of boys outperforming girls (Robelen, 2012). Whether it be calculus or computer science, males are more likely to participate in STEM related AP classes and are more likely to perform better (Pollack, 2013).

There is also a history of trying to rectify this problem. Several solutions have been proposed by the authors of previously cited studies. One study has found that direct intervention has had an effect in increasing female interest in matters related to STEM areas (Naizer, 2014). This study followed a program that was implemented in two different school systems in Texas. This study found that a two-week summer program, aimed at increasing motivation in technological areas, showed a growth in motivation in female students. By focusing on motivation, and not on high academic ability, this study's unique take showed motivational growth in females.

Statement of Purpose

The purpose of this project is to create a teacher in-service that will inform elementary school teachers about what they can do to curb the trend of women not going into STEM related fields. It will aim to identify bias in elementary teachers and, by addressing it, hope to have elementary teachers encourage all genders to pursue STEM subjects. By showing relevant research and explaining how one can address these issues in the elementary classroom, teachers will address their own bias and change their practice to better address this issue.

This project includes a detailed description of an in-service for elementary school teachers. The information the in-service will be providing will be justified by relevant research. After presenting the relevant information to the teachers, there will be an application phase where teachers will examine their own bias in order to affect change in their classroom. Finally, this project will include a plan for implementation that will describe how the in-service should be carried out and how the findings would be shared with others.

This proposed in-service will directly combat the problem stated above by asking teachers to be more aware of how they are bringing their gender bias into their classroom. By understanding the stereotypes that exist in one's own classroom, one can begin to address them and make sure that they do not exist. For instance, a teacher that is informed of gender bias in the classroom might begin to change how they operate in their own classroom and vary practice based on this information. This might have a lasting effect on those children that are called on during math that didn't

used to be called on as much. By addressing one's own stereotypes in STEM related classes and one's own stereotypes in gender roles, one can more adequately set all students up for success in STEM related education.

Objectives of the Project

The first objective of the in-service is to have teachers understand the relevance of the problem. This objective will be reached by presenting the information through a PowerPoint that explains the current gender gap in STEM. The relevance of any issue is vital to affecting change.

By addressing this gender gap with elementary school teachers, there is a greater likelihood for them to address their own bias in their classrooms. This identifying of one's own bias is the second objective of the in-service. This will be addressed by using self-evaluations and a short quiz that is meant to identify bias.

The final objective would be to have teachers participating in this in-service to affect change in their classrooms. This in-service will give teachers the opportunity to create plans for how they are going to address their own bias and the systemic bias in their classrooms.

The main goal of this project is to begin the systemic change of having more female students pursue STEM majors and careers. The reason that an in-service seems the best way is based on how teachers typically approach new information. The idea of creating a piece of literature that highlights gender bias may potentially reach more teachers in a district, but the effect will be smaller on those teachers who bother

to read the literature. An in-service will allow those teachers who participate to be more affected by the research.

Definition of Terms

As stated earlier STEM is an acronym for Science, Technology, Engineering, and Mathematics education. These subjects are thought to be similar in nature and are thus lumped together. Several agencies are cited in this project. NAEP stands for The National Assessment of Education Progress and focuses on assessing American students and creating reports on the results.

The last term that is relevant is an in-service. In the scope of this project it means a forty-five minute to hour presentation in a staff development setting where teachers are trained to discuss their work in their peer group.

Scope of the Project

The scope of this project is to address elementary teachers' gender bias in STEM related subjects by creating an in-service. This project will not extend beyond those teachers whom it addresses directly in the in-service. This project will also not pretend to imagine that it will create a systemic change in our nation. It has a small area of affect only affecting one school in Kentwood Public School that will, nonetheless, make a change in those who play a part in it.

There are several factors that will affect the results of this in-service. The greatest factor is the idea of "teacher buy-in." If the in-service does not convince the teachers present that the problem of gender gaps in STEM related fields are a direct result of gender bias in STEM related subjects at an early age, then no change will

happen in their classrooms. The problem needs to be summarized in a way that teachers will want to be part of the needed change. If they are helped to understand the problem, they will be more likely to participate in the ways that the in-service will suggest they change their classrooms. This in-service's success also relies on administrative support. If the administration doesn't support the in-service it is doubtful that time will be set aside to address the issue.

This project will not include any follow-up studies to determine if the in-service was a success. That extends beyond the scope of this particular project. It would be possible to find a relevant test that assess gender bias in a pretest/posttest situation, but that will not be carried out by this particular project.

Chapter Two: Literature Review

Introduction

This chapter will first introduce the theory that posits that bias training leads to systemic change. This theory on gender bias training will lead to the research portion of the chapter. The research portion will present relevant information that will confirm a need for a professional development to address gender bias. The first section of the research will address bias training. Bias training can refer to a professional development or training that informs participants about institutional or personal bias. The research will look at bias training as a potential tool to combat bias. Following this section will be research that looks at gender bias in STEM. This section will look at multiple studies that use implicate bias tests in order to determine if gender bias exists in STEM fields. The next section of research will look at studies that link gender bias training to involvement in STEM. By looking at relevant research between gender bias training and involvement in STEM, there will be a clearer understanding of the use of training. The next set of research will examine the specific capabilities of males and females in STEM subjects and how there is a need for more STEM involvement in the United States.

After presenting the relevant research, the chapter will conclude with a brief summary of the theory behind gender bias training and a review of presented research. Finally, conclusions will be drawn from the research that will influence creation of a professional development that addresses gender bias training.

Theory/Rationale

Over the years, many attempts have been made to reduce the gender gap that exists in STEM. Gender gaps are both the difference in educational achievement between girls and boys (Vantieghem, 2014) and the difference in representation of men and women in certain careers (Ing, 2013). Gender gaps continue to be prevalent in STEM related fields with only about one-quarter of women in the workforce holding STEM positions (U.S. Department of Commerce, Economics and Statistics Administration, 2011). One of the greatest causes for these gender gaps is the existence of gender bias (Moss-Racusin, 2018). Gender bias is "any one of a variety of stereotypical beliefs about individuals on the basis of their sex, particularly as related to the differential treatment of females and males" (American Psychological Association, n.d., para. 1). Gender bias has been identified as the greatest obstacle for gender equality in STEM (National Academy of Sciences, 2006). By fixing the underrepresentation in STEM careers there is an opportunity for economic growth (Global Gender Gap Report, 2015).

Research/Evaluation

The research shows that bias training plays a role in reversing the bias in an individual. The research narrows further to focus on how addressing gender bias in STEM can lead to further STEM involvement.

Bias Training

The most common type of bias training is Diversity Training. A meta-analysis by Bezrukova (2016) examined 260 different studies that honed in on the effects of

diversity training. Bezrukova and her team tested seven different hypotheses that ranged in scope. The meta-analysis only looked at studies that contained a pre-test and a post-test where participants engaged in diversity training of some kind. These studies needed to have valid research designs in order to be included. Any study that was overly specific for one organization, examined only an organizations response to training, made recommendations about how to have successful diversity training, or only used surveys instead of a pre-test and post-test were not included.

Bezrukova's analyses of the pre-test and post-test results of the 260 studies were intended to look at cognitive, behavioral, and attitudinal learning. Cognitive learning is learning that is meant to study how a participant acquires knowledge. Behavioral learning is learning that is meant to study how a participant uses or acquires skills. Attitudinal learning is meant to understand a participant's attitude towards diversity. The meta-analysis supported several of the hypotheses, the most valuable being that "diversity training will have stronger effects on participants' reactions relative to cognitive, behavioral, and attitudinal learning" (Bezrukova, 2016, p. 1229). This hypothesis gives credence to the idea that diversity training, as a broad term, is an effective tool for changing attitudes towards diversity.

Alhejji (2016) also carried out a systemic literature review examining the literature on diversity training that found a need for further research. This research examined whether diversity training was an effective tool in combating bias. The diversity training outcomes examined were from organizational settings. By analyzing over 60 papers from roughly 50 journals, Alhejji was able to build a

database that aggregated the results of much of the research on diversity training. He concluded, “studies suffer from significant limitations including small sample sizes, poor use of diversity-training measures, too much reliance on self-report measures and little longitudinal investigation of outcomes” (Alhejji, 2016, p. 140). This conclusion shows that even though diversity training may currently be used as a tool in combating bias, it does have its limitations. Alhejji found that because of these limitations and there is great need for further research on the effectiveness of diversity training; further research could be effective at identifying best practices.

Gender Bias in STEM

Even though there has been little to no evidence that supports the idea that men and women have differing abilities when it comes to STEM subjects (Blažev, 2017), there is still a significant gender gap in those who pursue STEM careers (World Economic Forum, 2018) with only 28% of science researchers being female worldwide (UNESCO, 2015).

Fleming (2020) examined implicit gender stereotypes in the STEM fields by using the Implicit Relation Assessment Procedure (IRAP) as well as a career suitability rating scale. The IRAP is a test that has participants match both male and female faces with careers that fall in either STEM or the Arts fields. This is used to determine the implicate bias a participant may have with certain genders. The career suitability rating scale has participants rate the suitability of males and females in non-STEM and STEM university subjects. This also aims to determine the gender bias of participants towards STEM careers. The authors recruited 37 college students,

21 female and 16 male, to participate in taking both the IRAP and the career suitability rating scale. By breaking the IRAP up into two versions (one with images of children and one with adults), the results showed that participants were more apt to designate a pro-male-STEM and an anti-female-STEM association when shown adults rather than when shown children. Regardless of age, participants (both male and female) showed a gender bias (pro-male-STEM and an anti-female-STEM) according to the IRAP and the career suitability rating scale. The authors concluded that gender bias did exist in their participants when looking at STEM careers. The authors concluded that this bias has, and will continue, to result in the underrepresentation of women in STEM.

Another researcher also used the IRAP in order to examine gender bias in STEM. Farrell (2017) had roughly 60 participants take the IRAP and the Implicit Association Test (IAT) and compare it to previous data. The IAT is similar to the IRAP in that its aim is to identify bias in the individuals taking the test but differs in that it uses word association instead of pictorial associations. The study examined gender bias in specific groups of participants, i.e. males in STEM, males not in STEM, females in STEM, and females not in STEM. By having participants take both the IRAP and the IAT, Farrell and her team were able to compare a participant's scores to see the relationship between the biases. Every group that took the IAT showed a tendency towards pro-male-STEM and pro-female-arts. The results affirmed previous research that participants showed a bias towards males being better suited for STEM related subjects. Interestingly, the IRAP did find that there was a

slight bias towards females belonging in STEM from female participants who were currently in STEM related fields. Farrell gives hope to the idea that female participants in STEM could be part of the solution and lends credence to the idea that the gender gap is a result of gender bias.

One research project aimed to highlight how parental and teacher bias may play a role in children's interest and attitude towards math. Gunderson (2011) hypothesized that math achievement scores can be used as an indicator of involvement with STEM careers. By looking at early-developing math attitudes, Gunderson hoped to point out that parental and teacher gender bias plays a role in involvement with STEM careers. Gunderson conducted a meta-analysis that highlighted different causes of gender bias in mathematical attitudes and different strategies to avoid gendered mathematical attitudes. One such strategy was direct teaching. Gunderson found that when teachers refer to students in gender categories it can reaffirm gender stereotypes. Direct teaching and other strategies can create and reinforce gendered attitudes in children. Gunderson concluded that mathematical attitudes in children form from their environment and that teachers play a major role in creating that environment. When teachers bring bias into their teaching, students are more likely to have gendered beliefs about their math abilities, and are less likely to participate in STEM related careers.

Bench (2015) found that gender gaps might not only come from underestimating the abilities of women in math, but also the overestimation of the ability of men in math. Math scores are often used as indicators of STEM

involvement (Beekman, 2015). Bench included 100 undergraduate participants and had them complete two sets of seven math questions. Bench and his team studied the difference between the participants' scores and how the participants think that they scored. The results showed that both groups of participants, males and females, performed equally well on the math questions that they were given. However, the results also showed that the group of men believed that they had scored better on the test than their female counterparts. By comparing these results with the gender of the participants, Bench was able to determine that men's overestimation of their math performance may play a role in the gender gaps in the STEM fields.

Addressing Gender Bias Leading to STEM Involvement

Students are more likely to pursue STEM majors if they have confidence in academic subjects related to STEM (Moakler, 2014), and therefore need to be encouraged in STEM.

A study conducted by Moss-Racusin (2018) focused on this specifically. The study included two different experiments. The first experiment was designed to look at participants' sense of belonging, attitudes, and aspirations of pursuing a career in STEM. By utilizing an online marketplace for data collection (MTurk), Moss-Racusin was able to include 322 participants (180 female and 142 male) who were at least 18 years old. Of these participants, 75% were white, 8% were black, 6% were Hispanic, and 11% were Asian or Pacific Islander. Of the participants, 93% had completed at least some college. The researchers separated participants into three groups. The first group read an article that pointed out evidence of gender bias in STEM. The second

group read an almost identical article that found no evidence of gender bias in STEM. The final group was a control group that did not read an article at all. After participating in the study, participants filled out surveys to measure participants' sense of belonging, attitude, and aspirations of pursuing a career in STEM. The results of the experiment showed that women feel less of a sense of belonging in STEM, a more negative attitude towards STEM, and lower aspirations of pursuing a career in STEM. Moss-Racusin found that the data from the surveys support they hypothesis that the existence of gender bias leads to gender gaps in STEM.

The second experiment that Moss-Racusin (2018) performed aimed to confirm their findings from the first experiment while simultaneously exploring if knowledge of systemic efforts to address gender bias made participants more comfortable in STEM. Similar to the first experiment, Moss-Racusin was able to include 429 participants (224 female and 201 male) who were at least 18 years old. Of these participants, 80% were white, 6% were black, 4% were Hispanic, and 10% were Asian or Pacific Islander. Of the participants, 80% had completed at least some college. They removed the control group since the first experiment had already confirmed the results of the control group. The second experiment confirmed the findings of the first experiment by having participants examine a fake university chemistry department's reaccreditation documents. The participants were told to read a summary of re-accreditation of a chemistry department. This summary was broken up into four sections, one of which was "Department Climate." This section contained fake results that showed a completion of a gender bias training based on either a

routine review or a result of discrimination complaints. By having participants look at the two different summaries, Moss-Racusin was able to have them fill out surveys that included items such as “This chemistry department would inspire me to do the very best job that I can.” The results of these surveys reaffirmed that exposure to gender bias is likely to make participants feel less of a sense of belonging in STEM, a more negative attitude towards STEM, and lower aspirations of pursuing a career in STEM. The second experiment’s surveys found that knowledge of an organization addressing gender bias increased perceived attitudes towards STEM. This suggests that organizational training on gender bias may address the gender gap in STEM. The author concluded that continued gender bias training could lead to gender equality if STEM communities continue to strive for, and work for, gender equality.

Carlana (2019) also looked at how teacher bias and stereotypes towards gender can affect student achievement. He had roughly 1400 Italian middle school mathematics and reading teachers take the IAT. By taking the IAT, teachers were scored on their response times, giving Carlana an indication of a participant’s bias. Carlana looked at the scores of the teachers’ students on a standardized test in Italy and defined gender gap as the boys’ scores minus the girls’ scores. The study not only looked at scores on standardized tests but also more closely looked at which track students picked. Because Italy offers self-selection in their track system, it can be used as a good indicator of interest in STEM. In 2015, 80% of graduates in STEM had come from a technical or academic track (Carlana, 2019). He concluded that when girls were students of teachers who had a greater bias (according to the IAT), it

led to female students underperforming in math when compared to their male counterparts. In addition, even with ability levels overlapping, teachers often stereotyped their students by associating reading with females and associating math with boys. The data also showed that female students were self-selecting high schools that were not as academically strenuous and were not focused on STEM. This conclusion, that the higher gender bias of a teacher leads to worse scores for females and less involvement in STEM, is one that warrants concern.

A multi-year longitudinal case study conducted by Lubienski (2013) looked at qualitative data from following one specific Kindergarten Class of 1998-99. The researchers collected data after the students' kindergarten, first grade, third grade, fifth grade, and finally eighth grade years in the spring of 2007. By following this class, Lubienski was able to investigate how attitudes towards mathematics shifted as the years progressed. Through conversations, surveys, and assessments, the gender gap in mathematics continued to grow as the children grew. The confidence in mathematics was higher for boys, boys had higher interest in mathematics, and boys had better scores in mathematics. The author found that teachers tend to underrate their female students who are achieving at similar levels to their male classmates. The conclusion of the author is that mathematical intervention to address the gender gap needs to start in the elementary years because these gender gaps appear while children are so young.

Moss-Racusin's (2018) research does point out the limitations of gender bias training. She looked at how diversity training (gender bias training) influences not

only the participants, but also the downstream impact of this training. In other words, Moss-Racusin examined how people who were not participants were affected by those who did participate in diversity training. This showed the impact on women in institutions who did not participate in the training. The shortcomings were that diversity training, and specifically gender bias training, could lead to a false sense of security about how an institution is handling gender bias. When participants learned that an institution was making efforts towards fixing gender bias, the participants were more willing to forgive the institutional bias that may already exist (Moss-Racusin, 2018). Because of this, gender bias training must not be looked at as the only solution for systemic gender bias.

Growth of Female STEM Involvement

Schmader (2004) studied women's attitudes towards gender as an indicator of mathematical performance. She created two studies in which she looked specifically at how women viewed gender bias and how that bias affects self-perception and career choices. Schmader collected data from 86 female undergraduates who were majoring in STEM related fields. These students filled out surveys that measured self-perception, gender bias towards math, and attitudes towards the status differences in society. She concluded that women's own gender bias plays a major role in how they perceive their own ability. This perception has implications; women are less likely to pursue STEM careers when they believe they are less likely to be successful than their male counterparts (Schmader, 2014). Schmader suggests that there is a need for

students to understand that there is no scientific basis for thinking that men have greater skills in math than women.

A study by Beekman (2015) looked at Indiana's Statewide Testing for Educational Progress (ISTEP). This study cited the President's Council of Advisors on Science and Technology, who called for an increase in the number of graduates with STEM degrees to increase by one million students. By looking at the ISTEP data, Beekman was able to conclude that there was the existence of a gender gap when specifically looking at mathematical data. The existence of the gap reduced the number of possible graduates that will go into STEM related fields. Beekman concluded that by encouraging females to pursue STEM subjects, this could help the United States reach the goal of having more students pursue STEM careers.

Summary

The gap in STEM is a result of gender bias (Moss-Racusin, 2018). Bezrukova (2016) stated that bias training is an effective tool for changing attitudes towards diversity. Alhejji (2016) found that though diversity training may currently be used as a tool in combating bias, it does have its limitations and warrants further research.

Blažev (2017) found no difference in abilities between men and women but a gender gap existed nonetheless (World Economic Forum, 2018). Fleming (2020) found that regardless of age, participants (both male and female) showed a gender bias (pro-male-STEM and an anti-female-STEM) that will continue to result in the underrepresentation of women in STEM. Farrell (2017) determined that study participants showed a bias towards males being better suited for STEM related

subjects and added support to the idea that the gender gap is a result of gender bias. Gunderson (2011) found that when teachers bring bias into their teaching, students are more likely to have gendered beliefs about their math abilities, and are less likely to participate in STEM related careers. Bench (2015) determined that men's overestimation of their math performance may play a role in the gender gaps in the STEM fields.

Other research showed that when gender bias was addressed, it resulted in a reduction of the gender gap in STEM. Carlana (2019) found that the higher the gender bias of a teacher, the worse female students did on standardized test scores and the less involved they were in STEM. A study conducted by Moss-Racusin (2018) concluded that continued gender bias training could lead to gender equality. Lubienski (2013) found that intervention at younger ages is necessary because gender gaps start to present themselves while children are young. Affirming Alhejji (2016), Moss-Racusin (2018) also warns that gender bias training is not the only solution to systemic gender bias.

The research points to how addressing gender bias has broad implications. Schmader (2014) points out that women are less likely to pursue STEM careers when they believe they are less likely to be successful than their male counterparts; if they believe they will be successful they are more likely to pursue STEM careers. Beekman (2015) concluded that encouraging females to pursue STEM subjects could help the United States reach the goal of having more students pursue STEM careers.

Conclusion

The presented research confirms the need for more people to join STEM related fields. There are different theories about how to get more people into STEM fields but one of the most prominent is to reduce the gender gap that exists in STEM. By having more women join STEM, reducing the gender gap, the need for people in STEM will have been fulfilled.

The problem becomes how to encourage more women to join STEM fields when there continues to exist a significant gap in those who pursue it. The research from the previous sections point to gender bias being a significant cause of the gender gap. When teachers bring their gender bias into their classrooms, they are likely to perpetuate gender norms that discourage women from pursuing STEM careers. This is one major cause of the gender gap. The previous sections also point to the power of bias training. Bias training (and specifically gender bias training) has been shown to be an effective tool in combating the gender gap in STEM.

All of this leads to the conclusion that there needs to be gender bias training in schools that address how one genders students in relation to STEM subjects. By having teachers confront their gender bias about subjects like math, they are more likely to equally encourage students to follow STEM related subjects. By organizations, like schools, focusing on addressing gender bias, participants are more likely to work towards addressing their bias. These will, in turn, close the gender gap and reduce the deficit of not enough people in STEM fields.

Based on the need for gender bias training, this project will develop a professional development. The research has shown how bias training can be an effective tool in combating gender bias. This project will address gender bias by sharing a professional development that specifically addresses the gender bias teachers may have. Teachers participating in the project's professional development will have the opportunity to understand their own bias, see how that bias affects their students, and will be given strategies to ensure that any gender bias does not negatively affect the students in their classrooms.

Chapter Three: Project Description

Introduction

Gender bias has resulted in underrepresentation of women in STEM careers. The main goal of this project is to begin the systemic change of having more female students pursue STEM majors and careers. The first objective of this project's in-service is to have teachers understand the relevance of the problem and identify one's own bias. By addressing the bias of teachers in the in-service, this project will aim to affect change in participants' classrooms by giving teachers the opportunity to create plans. This will increase the scores and involvement in STEM subjects for female students at Townline Elementary.

This chapter will first introduce the different components that are part of the project. These components will reference the appendices that comprise the project. After the different components are explained, there will be a brief explanation of how the project will be evaluated. This section is followed by the conclusions of the entire project and the chapter concludes with plans for implementations.

Project Components

Women are underrepresented in STEM careers (Ing, 2013) resulting in a gender gap. There are several objectives within the project to help begin the systemic change of having more female students pursue STEM majors and careers: having teachers understand the relevance of the problem, identifying of one's own bias, and affecting change in their classrooms. As stated earlier, by not being encouraged to pursue STEM activities in the classroom during the early years of their lives, girls are

more likely to pursue careers that are not STEM related (Ing, 2013). This in-service will aim to address this issue.

There are several different components within the scope of the in-service. These components are framed by a Microsoft PowerPoint presentation. The first component is a pre-survey (see Appendix A) and following that participants will take the Gender-Science IAT (see Appendix B). Next, participants will listen to the definition and history of gender bias (see Appendix C). Following that, there will be several stories (see Appendix D) and an article (see Appendix E) that will all be discussed. Participants will meet in small groups (see Appendix F) before creating a plan (see Appendix G) to enact change in their own classroom. After a brief review of the relevant data (see Appendix H), participants will finish with a post-survey (see Appendix I). Later on in the year, participants will fill out a follow-up survey (see Appendix J).

The pre-survey (see Appendix A) is a valuable piece of the in-service because it gives insight into the effectiveness of the entire project. By knowing where teachers began their understanding of gender bias, it points to the value of the entire in-service. This survey will gauge the teachers' understandings of gender bias.

Teachers will follow-up this pre-survey by taking the IAT (see Appendix B). This test's purpose is to see if the participants have gender bias when it comes to STEM careers. These results will be private. Participants' understanding of these results will allow them to engage with the material more effectively. A teacher who

finds that they have bias on the IAT is more likely to care about the upcoming information.

After teachers are engaged by seeing their results on the IAT, they will be informed of relevant history and data behind gender bias in STEM (see Appendix C). This data will come from the research section in Chapter Two. By showing teachers the relevant information, participants will be able to understand the importance of enacting change in their own classroom.

The first chance to see how gender bias may appear in the real world will come from participants reading and discussing a few stories (see Appendix D). These stories will share examples of gender bias and discrimination for older students and scientists in STEM. These will add to the teachers' own results from the IAT and the history and relevance of the previous portion of the in-service. After the discussion about the stories, participants will read an article by Carly Berwick (see Appendix E). This article further points to the relevance of addressing gender bias towards STEM in the classroom.

Based on what the participants have been exposed to so far, there is now time set aside for discussions on how change can happen in individual classrooms (see Appendix F). Participants will break into small groups to first ideate about what one can do to avoid letting gender bias enter STEM subjects. After a whole group share-out, participants will take time to come up with specific plans for their classroom (see Appendix G). These plans are the most important part of the in-service because these are what participants are taking away and bringing into their classrooms. These plans

will create change in students' lives and will hopefully lead to greater STEM involvement for female students.

The in-service will finish with a brief review of some of the relevant data (see Appendix H). The purpose of this is to reiterate the importance of participants making specific changes in their classroom and following through with their plans they created in Appendix G.

Finally, participants will take a post-survey that will be used to check the effectiveness of the in-service (see Appendix I). Later in the school year participants will take a follow-up survey (see Appendix F) that will determine the lasting effects of the in-service. Both of these surveys are important aspects of the in-service because they point to the change that is happening in classrooms.

Project Evaluation

The effectiveness of this project will come from surveys (Appendix A and I) that are given at the beginning and end of the in-service. The pre-survey (Appendix A) will both give the presenter an understanding of where their participants think their bias is, and will gather information to be compared to the post-survey. The post-survey (Appendix I) will be compared to the pre-survey and allow for the effectiveness of the in-service to be evaluated. There will also be a follow-up survey (Appendix J) that will be given at the end of the year to assess how teachers implemented the ideas of the in-service throughout the year.

Since the goal of the project is, ultimately, to affect change in students, this project will also look at standardized scores of the female students whose teachers

participated in the in-service. The standardized scores are from i-Ready, which is an online assessment in reading and mathematics that Kentwood Public Schools uses. The standardized growth scores of teachers who participated will be compared from previous years in order to check the effectiveness of the in-service and plans that the teachers made for themselves in Appendix G.

Project Conclusions

The problem stated in Chapter One of this project is that there is a shortage of people following STEM careers in America (U.S. Department of Commerce, Economics and Statistics Administration, 2011) and an underrepresentation of women in STEM related careers (Ing, 2013). Despite there being no difference in ability levels in STEM (Beekman, 2015), women are often not encouraged in the same way that men are (Bench, 2015). Teachers bring their gender bias (towards STEM) into the classroom and this plays a role in the gender gap in STEM careers (Carlana, 2019). The goal of this project is to create an in-service that addresses this problem. Teachers participating in this in-service will address the gender bias that they bring into the classroom. By addressing one's own bias, teachers will change their practice. This means they will equally encourage female students towards STEM subjects. This will be a small part of the change that needs to happen within our country and within our world.

This project does not answer questions about greater systemic solutions needed to address the gender gap in STEM. For instance, this project does not answer questions about hiring practices, pay gaps, or gender bias outside of a school setting.

This project also does not answer questions about how often, or to what extent, someone needs to address their bias in order for long-term change to happen. Though there are many questions about the broader implications of gender bias towards STEM, this project will be part of the change that is needed.

Plans for Implementation

This project will be implemented at Townline Elementary; it will be part of an in-service that Kentwood Public Schools provides at the beginning of the school year. The leader of the in-service will guide the discussions and make sure that participants are gleaning what they can. In regards to STEM, participants will learn about their individual gender bias, the ramifications of gender bias, and ways that gender bias can be combated in the classroom. These experiences will result in specific plans for each individual participant to take with them. Success will be determined by examining student scores on standardized tests in STEM areas and survey results. The goal is that any gender gap will be reduced at Townline.

By examining the surveys collected, the effectiveness of the in-service will be evaluated. The hope is that those who participate in the in-service will not only change their practice but also share their results with others and encourage them to make changes of their own. These best practices for reducing gender bias in STEM will allow teachers to reduce the gender gaps that may exist in their classrooms. Even though the scope of this project is small, every person who is affected by it will benefit.

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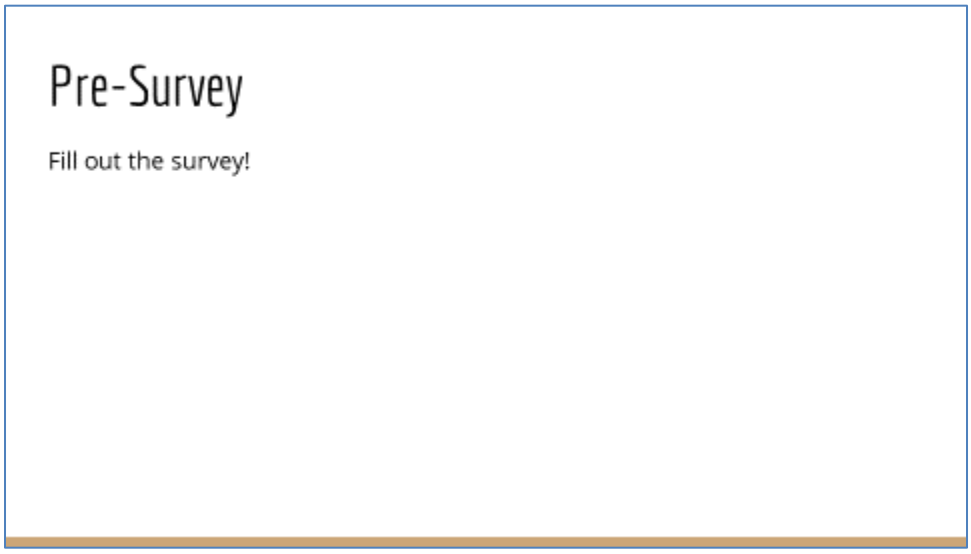
Appendix A



Gender Bias in Education—Pre-Survey

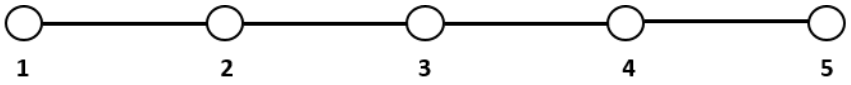
Please answer all the questions below.

1. **What is Gender Bias?**

   _____
   _____
   _____
   _____
   _____
   _____

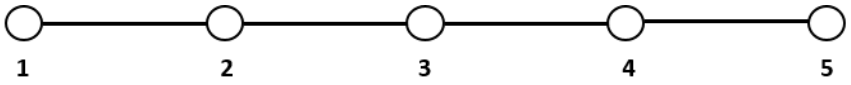
2. **How important is gender bias in your everyday teaching?**

   Not important — Very important

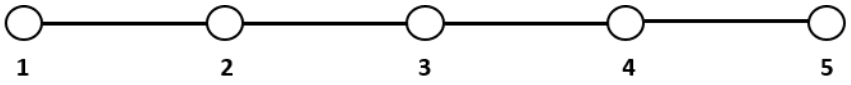
3. **Who is best at math in your classes?**

   Boys — Equal — Girls

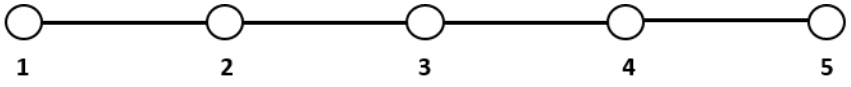
4. **Is gender bias an important issue in your school?**

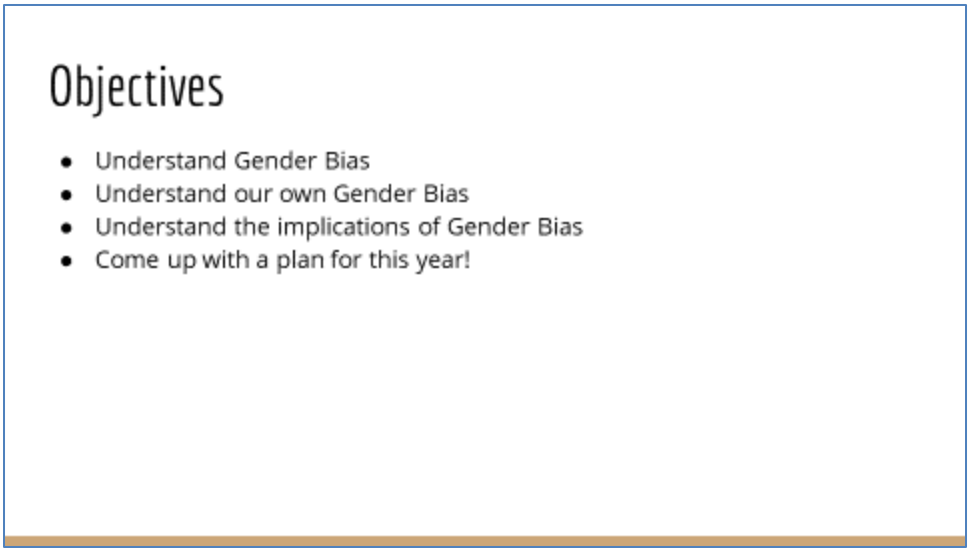
   Not at all — Very

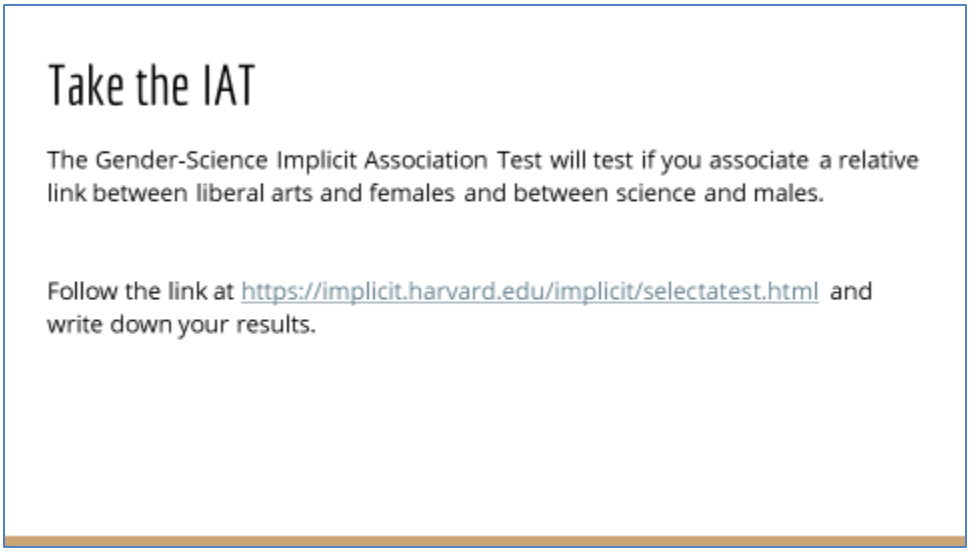
5. **Is gender bias an important issue in America?**

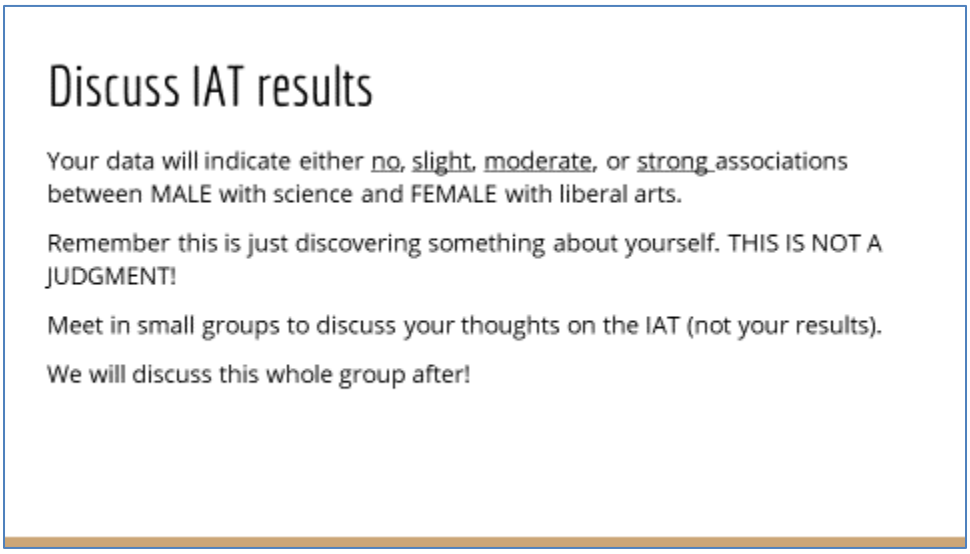
   Not at all — Very

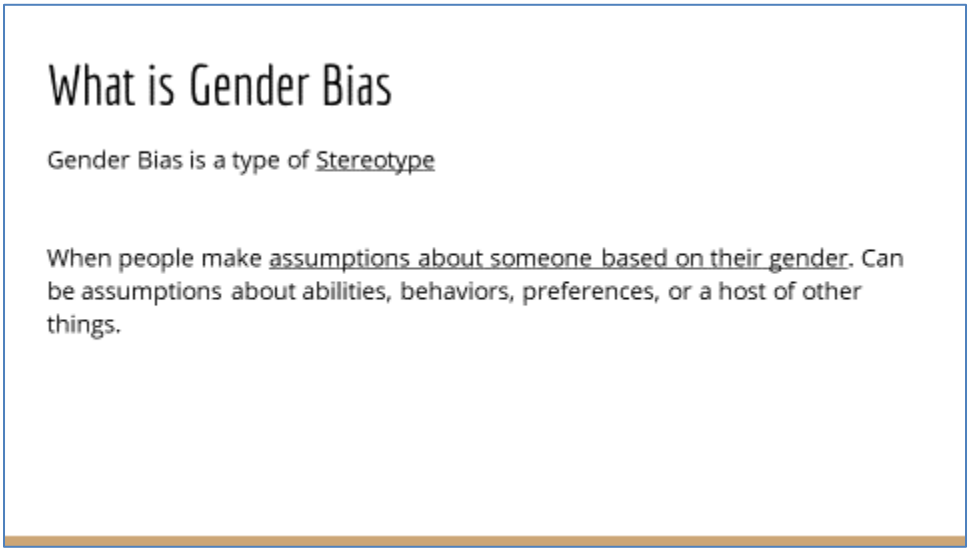

Objectives
Understand Gender Bias
Understand our own Gender Bias
Understand the implications of Gender Bias
Come up with a plan for this year!

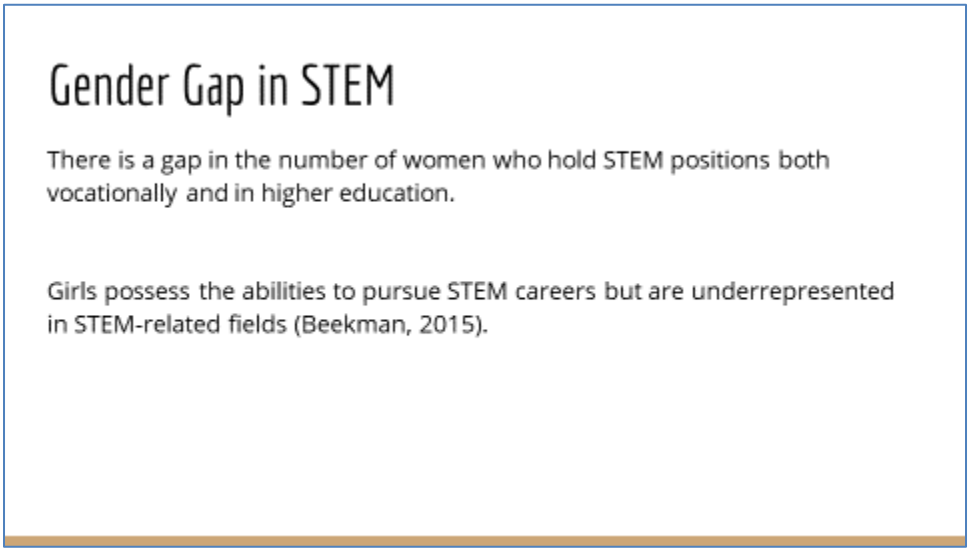
Appendix B


Take the IAT
The Gender-Science Implicit Association Test will test if you associate a relative link between liberal arts and females and between science and males.
Follow the link at https://implicit.harvard.edu/implicit/selectatest.html and write down your results.


Discuss IAT results
Your data will indicate either no, slight, moderate, or strong associations between MALE with science and FEMALE with liberal arts.
Remember this is just discovering something about yourself. THIS IS NOT A JUDGMENT!
Meet in small groups to discuss your thoughts on the IAT (not your results).
We will discuss this whole group after!

Appendix C


What is Gender Bias
Gender Bias is a type of Stereotype
When people make assumptions about someone based on their gender. Can be assumptions about abilities, behaviors, preferences, or a host of other things.


Gender Gap in STEM
There is a gap in the number of women who hold STEM positions both vocationally and in higher education.
Girls possess the abilities to pursue STEM careers but are underrepresented in STEM-related fields (Beekman, 2015).

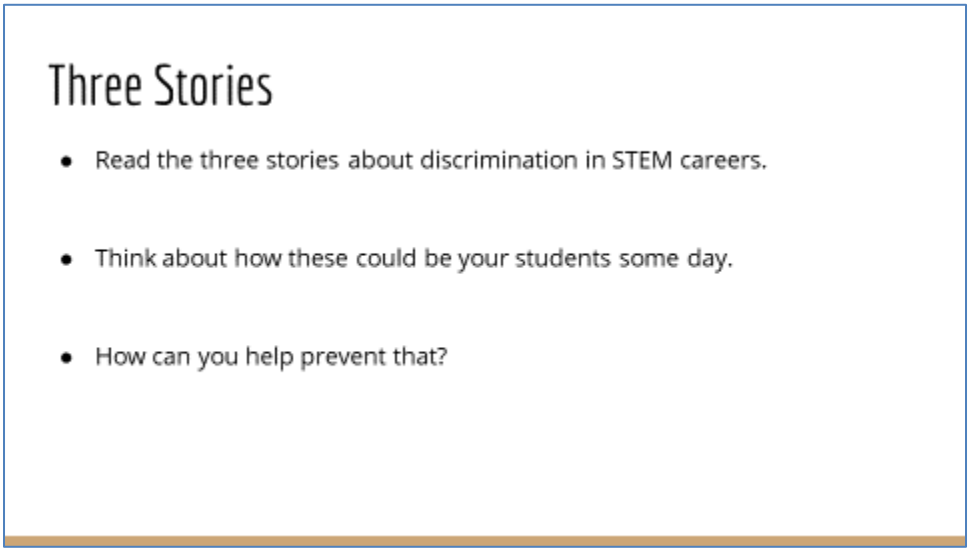
How Gender Bias leads to Gender Gaps

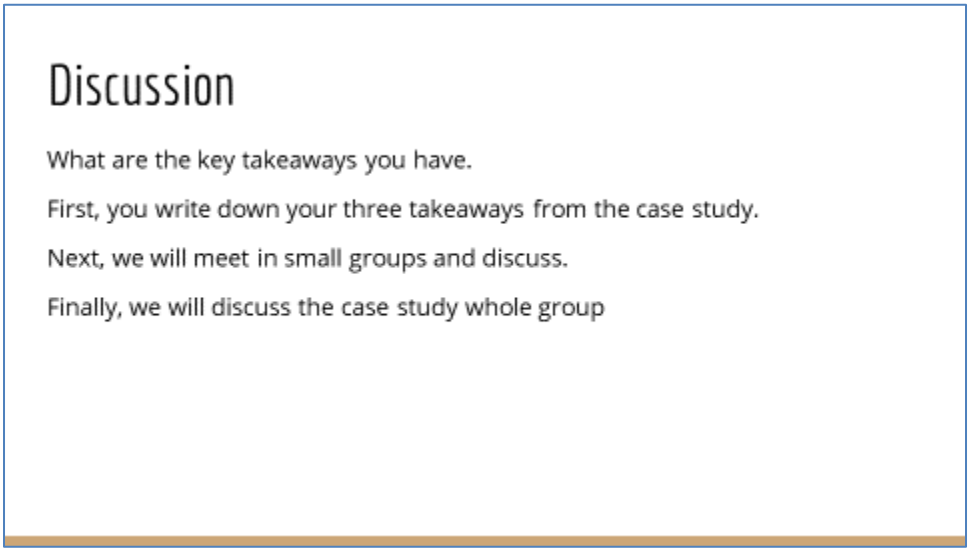
- Teachers' stereotypes can be communicated to their students and negatively affect those students' academic self-concept.
- Teacher bias can (and has) led to assumptions that math is more difficult for girls than it is for boys.
- By having these biases, teacher unknowingly create a self-fulfilling prophecy where STEM becomes more difficult for the girls in their classroom, furthering the gender gap (Carlana, 2019).

Gender Gap Ramifications

- Gender bias leads to gender gaps, gender gaps lead to fewer women following STEM careers
- The demand for STEM positions is only going to rise (U.S. Department of Commerce, Economics, and Statistics Administration,2011). This study found that in the first decade of the 21st century, there has been three times the growth in STEM positions as compared to non-STEM positions.
- Closing the gender gap in STEM degrees will boost the number of Americans in STEM jobs.
- Solving this gender gap in STEM careers can help contribute to filling the positions in STEM that this country will inevitably see.

Appendix D


Three Stories
Read the three stories about discrimination in STEM careers.
Think about how these could be your students some day.
How can you help prevent that?


Discussion
What are the key takeaways you have.
First, you write down your three takeaways from the case study.
Next, we will meet in small groups and discuss.
Finally, we will discuss the case study whole group

Three Stories

The stories below are from scientistas who have had experiences dealing with science in which their gender felt like a hindrance. The point of sharing these stories is not to gather pity, but rather to help raise awareness; discrimination in science still does exist. It's real, and many times, the stories are unbelievably disturbing. The Scientista Foundation is still working to combat gender discrimination in the sciences--one scientista at a time. Keep reading to see what motivates us to continue doing what we do.

Story One

Our new post-doc was young, blond and pretty. She was also a brilliant scientist. She worked in the room next to me, but would often stop in to chat with me about my project and life. One day she told me about her previous job where she had faced sexual harassment by her former PI. "I almost did not report it because I was afraid of the backlash that might result. My PI and another lab member treated me terribly after, but I am glad that I spoke out."

After she left the room, I saw two young male post-docs in my room roll their eyes. "She is such a drama queen. She wasn't *harassed*. She just can't take a joke," one said. "She only got hired because of her boobs anyway. Everyone knows he [the PI] only hires hot women," said the other before breaking into hysterical laughter.

It was the first time I encountered subtle gender discrimination in science, but I will never forget it. Soon after, my own post-doc, also a female, quit after an argument over who was getting credit for her work. After weeks of watching her come into work with red eyes, she finally informed me that she was leaving for another lab. Before she left she told me, "Sometimes you just have to let go and realize when you can't take it anymore."

Story Two

When I was a freshman in college, I knew I wanted to concentrate in the sciences but I didn't know what specific field. In high school, science was simple – chemistry, physics, and biology. Now, I was suddenly confronted with such options as Organismic and Evolutionary Biology, Human Evolutionary Biology, Neurobiology, Earth and Planetary Sciences, etc.

My college held a fair for the freshman to talk to different advisors about each major. As a freshman, I had yet to take a class in one of the fields, but I was very interested in the subject, so I went to talk to one of the advisors. I explained to her my interests and goals and why I was interested in her major. She looked me over and then got this cramped look on her face before telling me, “Perhaps you would do better to look at some of the softer sciences, like Psychology.”

Despite feeling like an arrow had been shot through my chest, I thanked her for her time and quickly turned away. I was stunned and hurt. Not only had she insulted another field for no reason (I think Psychology is a great major), but she had also insulted my intelligence without even knowing me for five minutes. I hadn’t said anything or acted idiotic. And yet, from a two-minute conversation, she had decided that I was not smart enough for her major.

I was hurt, but I came to realize I must have thicker skin. I also realized that sometimes, a sad fact in the sciences is that one of the biggest barriers to the advancement of women aren’t men or history but rather other women. We attack each other and pick on each other simply because we are consumed by the idea that if another female does well it means less opportunities for us.

I am now officially majoring in that field that I was so harshly pushed away from (I am purposefully refraining from remarking on the major because I don’t want it to reflect badly on the advisor). I have learned to have a thicker skin about the things scared people say, and I have learned to stop the cycle by encouraging those around me who are in the sciences. Trust me, there is enough out there in the world to research and investigate that if one person does well it isn’t going to leave less for everyone else to discover.

And while I have had negative experiences like this—from advisors telling me I wasn’t doing enough research as a freshman to girls in sciences classes laughing in my face when I asked for help—nothing compares to the passion I feel for science and to the incredible opportunities I have had. So the next time someone tells you to look into a ‘softer science’, just smile and laugh it off–you know yourself better than they do.

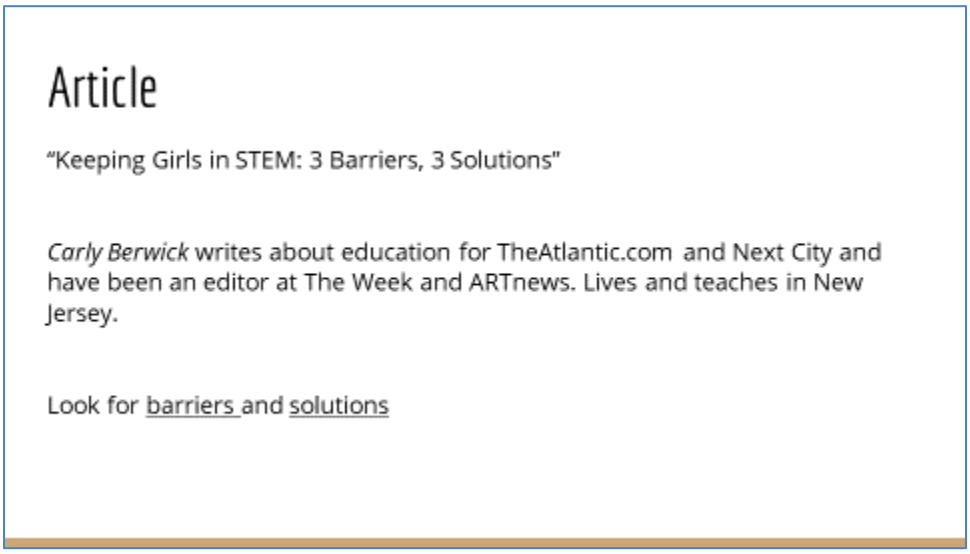
Story Three

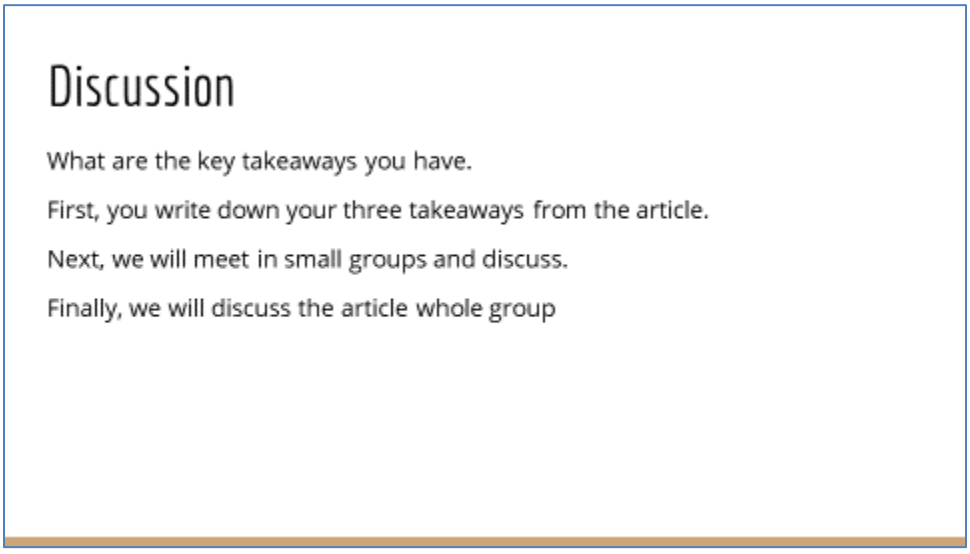
It was another day in my upper-level, male-dominated math class. As usual, I walked in and sat down in the front row. Male after male filled up the seats around me, with another girl sitting down on occasion. I looked around and took out my notebook as the female instructor began her lecture for the day, thinking, “Yeah, that’s right, I’m sitting in the front row.”

Later that evening, it was time to do problem sets. I didn’t know many people in the class, so I found someone to check problem sets with. It wasn’t the best arrangement. I could tell he had an air of arrogance, but he was nice when he needed to check homework.

One night, as we were checking our homework, we came across a problem I had done incorrectly. Sitting across from me he said, smirking but flirtatious, “Looks like I’ll have to help you brush up some of your math skills.” A few problems later, it was his turn to be wrong. The daring part of me called him out on it. But he brushed it off as being a hard problem. Needless to say, after the course and our problem sets ended, he stopped talking to me altogether.

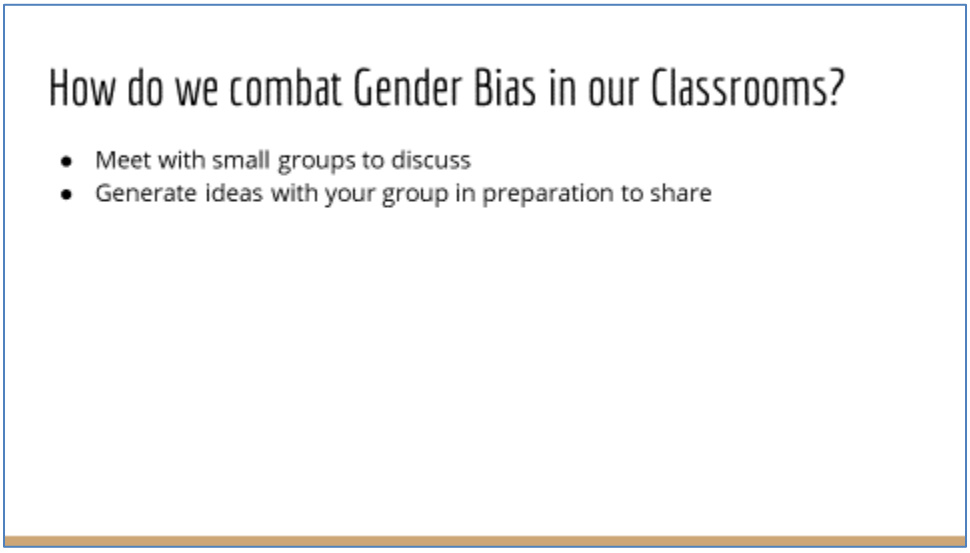
Appendix E


Article
"Keeping Girls in STEM: 3 Barriers, 3 Solutions"
Carly Berwick writes about education for TheAtlantic.com and Next City and have been an editor at The Week and ARTnews. Lives and teaches in New Jersey.
Look for barriers and solutions


Discussion
What are the key takeaways you have.
First, you write down your three takeaways from the article.
Next, we will meet in small groups and discuss.
Finally, we will discuss the article whole group

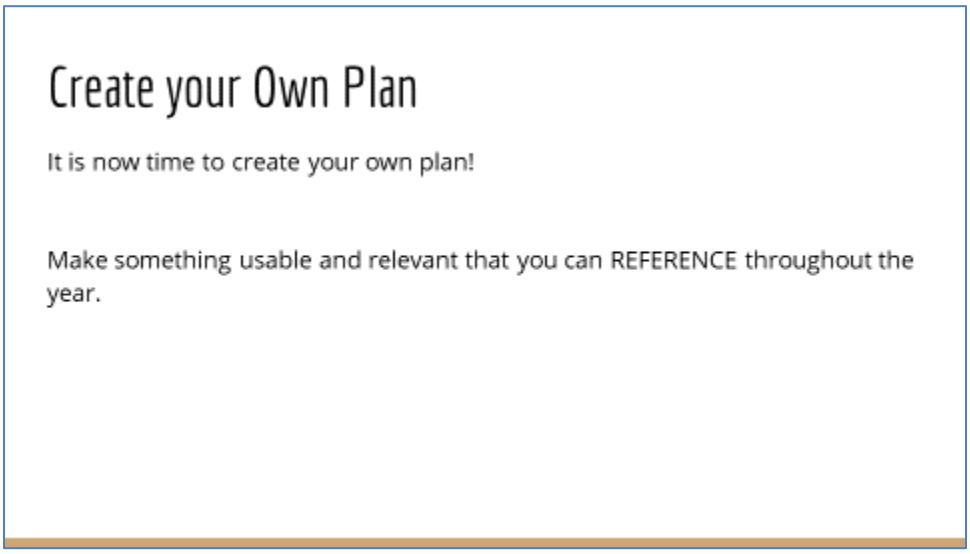
In the original submitted Master's Project, Appendix E (pages 47-53) included the full text of the following article: Berwick, Carly. (2019 March 12). Keeping girls in STEM: 3 barriers, 3 solutions. This article is freely available for personal and educational use from Edutopia Technologies at https://www.edutopia.org/article/keeping-girls-stem-3-barriers-3-solutions.

Appendix F

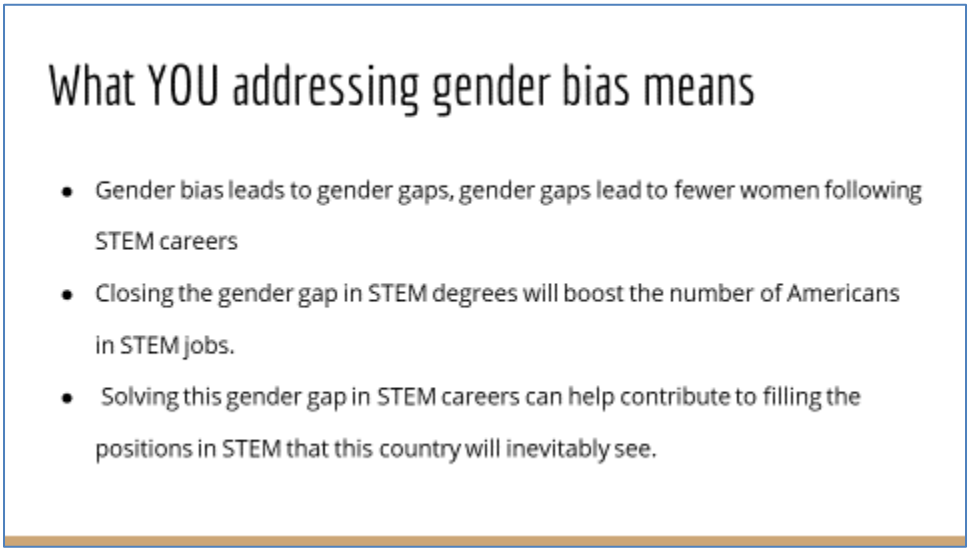

How do we combat Gender Bias in our Classrooms?
Meet with small groups to discuss
Generate ideas with your group in preparation to share


Suggestions
Gender-neutral materials
Call equally on boys and girls
Be free of stereotyping in the classroom
Address your students equally.
Avoid separating children based on gender.
Learn about children as individuals.
Evaluate the way you greet students.
Toys and colors are for everyone.
Encourage mixed gender friendships.
Work on your own anti-bias and stereotyping outside of the classroom

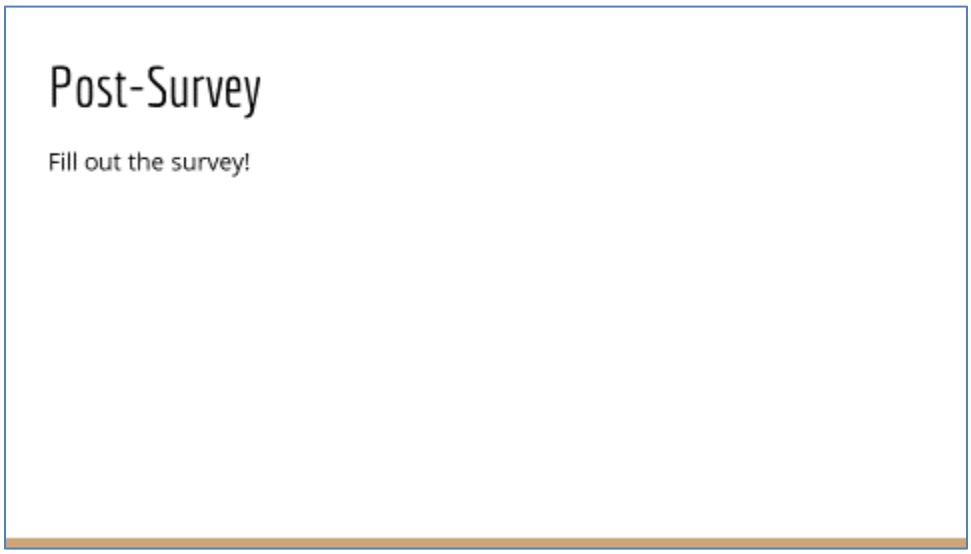
Appendix G



Appendix H



Appendix I



Gender Bias in Education—Post-Survey

Please answer all the questions below.

1. **What was one thing that you were able to take-away from the in-service today?**

   _____
   _____
   _____
   _____
   _____

2. **Will you change your teaching habits based on today's in-service?**

   Never YES!

   1 2 3 4 5

3. **How relevant did you find that material presented today?**

   Not Relevant Very Relevant

   1 2 3 4 5

4. **What, from your plan, are you most excited about? Why?**

   _____
   _____
   _____
   _____
   _____

5. **What else do you need to help you accomplish your plan that you created?**

   _____
   _____
   _____
   _____
   _____
   _____

Appendix J

Gender Bias in Education—Follow-Up-Survey

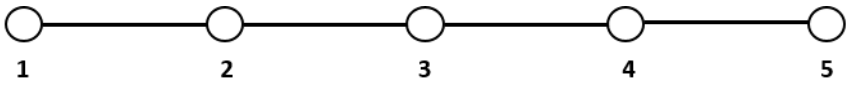
Please answer all the questions below.

1. **What is Gender Bias?**

   _____
   _____
   _____
   _____
   _____
   _____

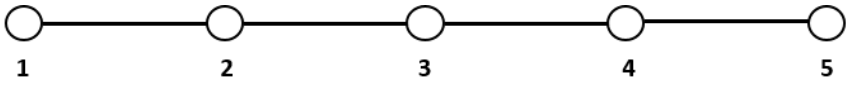
2. **How important is gender bias in your everyday teaching?**

   Not important — Very important

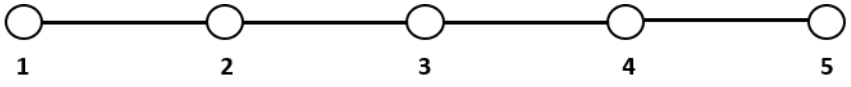
3. **Who is best at math in your classes?**

   Boys — Equal — Girls

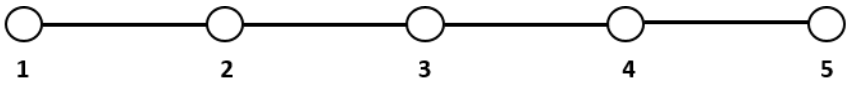
4. **Is gender bias an important issue in your school?**

   Not at all — Very

5. **Is gender bias an important issue in America?**

   Not at all — Very

6. **How have you changed your practice so far this year?**

7. **What has been the most important noticing you have had this year based on the information from the in-service?**

8. **Have you talked about what you learned with anyone else?**

9. **What extra support do you need?**

Appendix K – Copyright Permissions

David Schmidt <david.schmidt@kentwoodps.org>
to contact

Fri, Jul 30, 11:02 AM (1 day ago)

Hello,

My name is David Schmidt and I am currently enrolled in the Grand Valley State University (GVSU), Advanced Studies in Education Program, and I am writing a Master's Project for the completion of my Master's Degree in Education. My project is entitled "Gender Bias in the Classroom: An In-Service to Create Change." May I receive permission to include in the appendixes of my Master's Project a copy of the following item?

Bhanji, Shaira. (2012 December 22). Untold stories: Discrimination in STEM. The Scientista Foundation. http://www.scientistafoundation.com/harvard/untold-stories-discrimination-in-stem

Your response confirms your ownership of the above item. The inclusion of your copyrighted material will not restrict your re-publication of the material in any other form. Please advise if you wish a specific copyright notice to be included on each page. My project may be cataloged in the GVSU library and will be available to other students and colleges for circulation.

Sincerely,
David Schmidt

PERMISSION IS GRANTED to David Schmidt to include the requested material in his GVSU Master's of Education Project.
Name: _____
Date: _____

Lauren Koenig <lauren@scientistafoundation.org>
to me

Fri, Jul 30, 8:13 PM (15 hours ago)

Hi David,

Thanks for reaching out to let us know you'd like to use this article for your Master's. You're welcome to include "Untold stories: Discrimination in STEM" in your project.

PERMISSION IS GRANTED to David Schmidt to include the requested material in his GVSU Master's of Education Project.
Name: Lauren Koenig
Date: July 30, 2021

Good luck!
Lauren Koenig
Editor-in-Chief
The Scientista Foundation

GRAND VALLEY STATE UNIVERSITY

ED 693/695 Data Form

NAME: David Schmidt

MAJOR: (Choose only1)

_____ Adult & Higher Ed	_____ Ed Differentiation	_____ Library Media
_____ Advanced Content Spec	_____ Ed Leadership	_____ Middle Level Ed
_____Cognitive Impairment	_____ Ed Technology	_____ Reading
_____CSAL	__X__ Elementary Ed	_____ School Counseling
_____ Early Childhood	_____ Emotional Impairment	_____ Secondary Level Ed
_____ ECDD	_____ Learning Disabilities	_____ Special Ed Admin
		_____ TESOL

TITLE: Gender Bias in the Classroom: An In-Service to Create Change

PAPER TYPE: (Choose only 1) **SEM/YR COMPLETED:** SUM/2021

__X__ Project

_____ Thesis

SUPERVISOR'S SIGNATURE OF APPROVAL_____

Using key words or phrases, choose several ERIC descriptors (5 - 7 minimum) to describe the contents of your project. ERIC descriptors can be found online at:

http://www.eric.ed.gov/ERICWebPortal/Home.portal?_nfpb=true&_pageLabel=Thesaurus&_nfls=false

1. gender bias
2. gender gap
3. STEM
4. gender stereotypes
5. STEM attitudes
6. STEM careers
7. gender differences
8. bias
9. diversity training
10. implicit stereotypes