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Factors Impacting Women's Participation in STEM Fields

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FACTORS IMPACTING WOMEN'S PARTICIPATION IN STEM FIELDS

A Thesis Presented

by

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to

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I. Introduction

Women are highly underrepresented in STEM (Science, Technology, Engineering, and Mathematics) field professions (Beede, Julian, Langdon, McKittrick, Khan, & Doms, 2011). This has been a persistent issue since the study of mathematics and science has begun. The problem is well documented by research and there have been several efforts to remedy this issue, yet men are still dominant forces in the STEM world (Eccles, 1994; Xie & Shauman, 2003; Roberts & Ayre, 2002).

As of 2009, men made up 52% of the workforce in the United States, and women made up 48% (Kimmel, Miller, & Eccles, 2012). This difference seems small, but when looking at STEM jobs in particular, a larger gap is seen. Men hold 76% of STEM jobs and women only hold 24% of STEM jobs (Szelényi, Denson, & Inkelas, 2013). Women's professional participation is cut in half when looking at STEM fields and is not representative of the overall employment of women. Thus, women are largely entering fields that are not STEM related.

One might wonder whether this difference could come from variations in levels of education. However, the percentage of college-educated female workers has increased from 46% to 49% between 2000 and 2009, while the percentage of college-educated women in STEM professions has remained constant (Beede et al. 2011). So, an increasing amount of women are receiving college educations, yet the amount of women entering STEM professions has not changed.

Further, in both STEM and non-STEM jobs, there is a notable wage difference between men and women. Focusing on STEM jobs as of 2009, there is a 14% gender

wage gap, where women make $0.86 per hour for every dollar that a man makes (Beede et al. 2011). Women are making less money than men for doing the same job with the same number of qualifications.

The gender difference in STEM fields is an issue of equity. While some have suggested that women choose not to pursue careers in STEM because of a lack of interest, overwhelming evidence indicates that women are socialized away from STEM (Johnson, 2007; Sadker & Sadker, 1994; Hall & Sandler, 1982). In other words, sexism is a real current issue that cannot be ignored. Sexism makes it difficult for women to pursue a career about which they are interested. Having more women in STEM fields would also "lessen occupational segregation and reduce the level of gender inequality in the labor force" (Xie & Shauman, 2005, p. 4). Therefore, it is likely that STEM fields will become a warmer and more welcoming climate, as it would not be abnormal for women to be working as STEM professionals.

From a financial point of view, STEM jobs are currently amongst the fastest growing and highest paying careers (Preston, 2004). With more women in STEM fields, the national wage gap would likely shrink. Social status is often associated with a greater fiscal income, and professions in the STEM fields are seen as more prestigious within the labor force. This contributes to the divide of social status between men and women because there are currently far less women with these occupations than men (Xie & Shauman, 2005).

The gender imbalance in STEM fields also has implications for the quality of STEM work in general. In the United States, there are often concerns that other countries are surpassing us academically and producing better technological achievements. It is

argued that this problem could be remedied if there were more people entering the STEM workforce. Having more women in STEM fields would be beneficial to the United States by providing a new source of STEM workers (Moss-Racusin, Dovidio, Brescoll, Graham, & Handelsman, 2012). A recruitment of passionate and capable women along with other minority populations would increase the STEM workforce and help the U.S. compete with the rest of the world as a technological power.

It is clear that we need more women in STEM professions, but in order to make this happen, we need to determine what factors impact their participation. This thesis analyzes the way the media, stereotype threat, education, and the work environment impact women in STEM, and it concludes with some ideas for the future.

II. Factor 1: Biology

Many people believe that the gender gap in STEM fields can be explained by biological differences between men and women. As technology develops, there is growing research on this topic, which has led to varying conclusions.

In her book *What's math got to do with it*, Jo Boaler explores some of the findings from different studies of the brain. First, it should be noted that on average men's brains are larger than women's (Boaler, 2008). This could lead many to believe that men are thus innately smarter than women. However, men and women on average have the same amount of brain cells, meaning that they are equally intelligent (Boaler, 2008). There is no biological explanation for intelligence variations between the sexes.

Where sex differences in the brain come into play is through how the brain functions. During pregnancy, there is a testosterone rush that kills some of the male fetus's brain cells in the communication centers (Brizendine, 2006). This gives women an edge when it comes to communication, particularly in areas of language and hearing. Furthermore, brain studies have shown that men only use the left side of the brain for language, whereas women access both sides of the brain in a more balanced manner (Boaler, 2008).

In a study with newborns, it was found that girls are more likely than boys to pay attention to a face as opposed to a mobile (Boaler, 2008). Similarly, when looking at emotionally charged images, women's brains were accessing and using nine different sections, but men only used two. All of these different studies lead to the idea that men and women are biologically suited to excel in different areas. For women, this means being more inclined to shine in disciplines about communication and making connections. For many, this would prove that men are naturally better at math and science. However, if this were true, then we would expect to see a trend in gender achievement gaps across countries, which we do not (Guiso, Monte, Sapienza, & Zingales, 2008; Ceci, Williams, & Barnett, 2009).

In their study, Guiso et al. (2009) tested 15-year-old students from 40 countries in order to explore culture and gender. The mathematics tests used were identical and were designed to be free of cultural biases. They found that the size of the gender gap in math performance varies between countries, and these differences can be explained by the country's measure of gender equality. This measure was calculated using a variety of methods: the World Economic Forum's Gender Gap Index, the World Values Surveys,

female economic activity, and the political empowerment index as computed by the World Economic Forum. The study found a correlation between gender equality and the gender gap in mathematics, where an increase in gender equality showed a diminishing gender gap. For example, Turkey was given one of the lowest scores for gender equality, and also found to have one of the largest gender gaps at the expense of women. However, Iceland received one of the highest scores for gender equality, and testing showed that girls outperformed boys in mathematics. Sweden was found to have the highest equality scores, and though women underperform compared to men, the gap is almost absent and not significant. This study supports the idea that cultural factors impact math achievement more than biology. It also shows that when gender equality is accepted as a cultural norm, the gender gap diminishes. Therefore, it is important to examine sociocultural factors and not just biological factors in order to fully understand the underrepresentation of women in STEM fields (Ceci et al., 2009).

III. Factor 2: Stereotypes, Media, and Society

Although many believe that biology plays a significant role in the mathematics achievement gap between men and women, there is more evidence that social factors have a more of an impact. We are surrounded by media signals telling girls that they are not expected to be good at math. From comic strips and news reports, to T-shirts and toys, the message is the same: girls are bad at math. These messages are incredibly

detrimental to girls' success and achievements in math and science, which likely impact women's participation in STEM fields.

Dumas (2011) describes articles of clothing that perpetuate the stereotype of women and math. Both Forever 21 and JC Penney faced controversy and backlash over the text on their shirts. Forever 21 released a shirt saying "ALLERGIC TO ALGEBRA" and JC Penney sold a shirt saying "I'm too pretty to do homework so my brother has to do it for me" (Dumas, 2011, p.1). This sexist fashion is even more shocking given that a large demographic of both retail companies is young girls. These were in the girls' departments, but there were no similar items available for boys. This trend also carries through to adulthood, as Dumas points out, with higher quality and more expensive shirts. The block design on a $112 silk blouse looks innocent enough, until the consumer reads the description: "Just because you failed 11th grade math class doesn't mean you can't bring some geometry into your life with this Tetris print blouse" (Dumas, 2011, p.1). The implication of these sayings, whether blatantly written on a shirt or written on a website, is that women are not good at math, and it is ok if they do not try. For a girl who enjoys her math class, such signals from media can be devastating.

Girls are also sent messages from the media through toys that aim to reach different genders. Toys that are aimed at boys are quite different than toys aimed at girls. Bussey and Bandura (1999) explored the impact of this idea and found that gender-linked toys prime children to fall into traditional gender roles. Looking into a child's room at what the parents have provided, one can see the gender differences. Boys' rooms often have toy vehicles and sports equipment, while girls' rooms are likely to have dolls, dollhouses and other domestic items (Bussey & Bandura, 1999). These toys prepare boys

for activities and interests outside of the home, and prepare girls for homemaking and childcare. The toys are reinforcing traditional gender roles at young ages. The toy market is not entirely to blame, however, because parents could always buy toys for their children that are gender-nontraditional. Nevertheless, parents are also victims to societal norms. When their children request a toy, parents are unlikely to purchase the toy if it is gender-nontraditional (Bussey & Bandura, 1999).

Stereotypes affect children starting at their homes. Parents' beliefs about their child's math aptitude can greatly impact that child's achievement. By middle school, and carrying through high school, students' parents tend to believe that boys have greater math ability than girls (Gunderson, Ramirez, Levine, & Beilock, 2011). As found by Gunderson et al. (2011), adults' stereotypes regarding math and gender shape their expectations for boys and girls, which results in varying attitudes and achievements for boys and girls in math. When their children pick up on this belief held by adults, the stereotype that girls are bad a math begins to form.

The impact of mothers' perceptions are particularly significant to students' abilities. A study by Jacobs and Eccles (1992) looked at the effects of mothers' perceptions in various domains, including mathematics and found that students' self-perceptions were highly influenced by their mothers' perceptions (Jacobs & Eccles, 1992). Thus, mothers have the potential to significantly influence their children's math achievement. If the mothers are being exposed to stereotypes about women's math abilities through the media, they are likely going to create negative perceptions about their daughters' math abilities.

Teachers' attitudes towards mathematics also influence students' math achievement. Beilock, Gunderson, Ramirez, and Levine (2010) found that when female elementary school teachers had high math anxiety, their female students specifically were negatively affected. Given that over 90% of American elementary school teachers are female (Beilock et al., 2010), this poses a significant problem for girls' math achievement in school. Likely, the teachers' math anxieties come from a history of being told that girls are not good at math, and reinforcement that they can be successful in life without being good at math. While it is true that some people can get by in life without an adequate set of math skills, this is not the case for educators who can greatly impact their students. Girls' math achievement is suffering because of the anxieties of their teachers, which could likely be avoided if societal stereotypes were dismantled.

Stereotypes about women and math send damaging messages to girls and create a culture around this recurring issue that women will have to address. The following section discusses studies which show that there is frequently an observed bias from teachers against women, creating a chilly climate in education.

IV. Factor 3: "Chilly Climate"

One of the many reasons women may not choose to enter into STEM fields is because they are male-dominated and not welcoming to women. There are several factors that make careers in STEM more challenging for women. These include the impact of negative stereotypes on women's abilities to perform math and science, attitudes from educators and peers, and assumptions of employers. These factors create an uninviting or

"chilly climate" for women, contributing to the impact on women's participation in STEM fields.

a.) Stereotype threat

   As previously discussed, women are historically stereotyped as being inadequate at math and science. Women face this stereotype throughout years of schooling in math and science classes as well as in the workplace, which impacts their participation in math and science professions. Given that men do not face a similar negative stereotype, we would not expect men to be as hindered as women, and would not be as likely to worry that they are being judged, critiqued, and evaluated by their peers based on an unwarranted negative stereotype. The pervasive stereotypes about women in society can have a negative impact on their math and science achievement, and cause them to underperform (Spencer, Steele, & Quinn, 1999); this is the consequence of *stereotype threat*. Stereotype threat is a term defined by Steele and Aronson (1995) as "being at risk of confirming, as self-characteristic, a negative stereotype about one's group" (p. 797).

   For women as it pertains to this review, this means that they are at risk of confirming an inferiority in math and science compared to their male counterparts. Stereotype threat places added pressure on women to either overcome the stereotype or reinforce it, and this pressure can often lead to self-fulfilling the stereotype after all (Spencer, Steele, &Quinn, 1999). This added pressure causes women to underperform on math assessments and not live up to their full potential. Therefore, "women bear the extra burden of having a stereotype that alleges a sex-based inability" (Spencer, Steele, & Quinn, 1999, p.6) whenever they are exposed to a situation requiring math skills. These

situations could be more high-pressure, like a math test, or low-pressure, like calculating a tip at a restaurant. More seriously, this stereotype can lead women and men alike to feel that women do not have a place in the STEM community, which makes stereotype threat one of the most important factors impacting women's participation in STEM fields (Spencer, Steele, & Quinn, 1999).

Every person holds many social identities and considers some more important than others. If women deem their female identity as irrelevant, will stereotype threat still affect them? Schmader's study (2002) explored the idea of identity association as it relates to women and stereotype threat in mathematics. The study came to many conclusions, two of which both point to the same ultimate idea: identity association does affect the ramifications of stereotype threat. For women with a strong sense of identity towards gender, stereotype threat negatively impacted their test grades in math. But for women with less of an association with gender, stereotype threat was not effective and did not lead to lower test grades. Just because a woman holds an identity negatively associated with mathematics does not necessarily indicate that she will be prone to stereotype threat. However, when a woman puts an importance and value on her identity as a female, she is more at risk of falling into the trap of stereotype threat.

Although the effect that stereotype threat has on a woman's career is important, it is also crucial to look at the effect it has on the woman herself. A study by Pronin, Steele, and Ross (2004) found that stereotype threat often causes some women to change different characteristics about themselves in order to fit in the male dominated fields. In their study, they coin the term "identity bifurcation," meaning that members of a group will selectively disidentify with certain aspects that are negatively linked to their field of

study, but will simultaneously hold onto other aspects that are not negatively linked. The study suggests that women experience this identity bifurcation when also experiencing stereotype threat in STEM fields, and they will disidentify with traits thought of as feminine and conflicting with math achievement (Pronin, Steele, & Ross, 2004). These conflicting characteristics include wearing makeup, being flirtatious, and wanting to raise children, while non-threatening characteristics include sensitivity or empathy (Pronin, Steele, & Ross, 2004). Women with more of a math background, who had spent more time in an environment where stereotype threat would be present, experienced this bifurcation more than women with less of a math background; these women would disidentify with the conflicting characteristics, but the non-threatening characteristics were retained (Pronin, Steele, & Ross, 2004). This study shows that women in STEM fields feel the need to alter their identities because of stereotype threat. As long as women have to change themselves in order to be accepted and appreciated colleagues, it is unlikely that there will be gender equality in STEM fields. An alternative is to evaluate women based on the quality of their work, not on aspects like appearances and family-oriented goals.

Some studies (Spencer, Steele, & Quinn, 1999; Steel & Aronson, 1995) theorized that stereotype threat could be dismantled if the group was made aware that the negative stereotype existed. However, the opposite proved true, and the group was actually more susceptible to the effects. Similarly, a study by Spencer et al. (1999) came to the conclusion that anxiety is increased when participants know that gender differences play a role on test performances. When the idea of a gender bias was acknowledged, participants who would be disadvantaged had an increase in anxiety. This shows that

stereotype threat and anxiety are linked. When women experience stereotype threat in math and science activities, this increased anxiety can cause women to shy away from the subjects.

On the other hand, another study designed by Johns, Schmader, and Martens (2005) suggests that going even further and addressing the whole idea of stereotype threat to women in math and science classes offers a way of minimalizing the negative effects that could occur. Because stereotype threat is becoming a more common phrase, the study aimed to discern whether teaching women about stereotype threat and its potential impacts would further hinder women's math performance, or if it would give them a tool to succeed. The findings showed the latter hypothesis; women were not impaired by gendered stereotypes when they were educated about stereotype threat. When women know that their anxieties about math performance could be related to stereotype threat rather than their actual ability, the anxiety is reduced and they do not underperform. Thus, one method of increasing women's participation in STEM fields is to educate women about the idea of stereotype threat.

b.) Education

All too often neither faculty nor students are aware of these patterns of behavior—and it is then that they can do the most harm. Without knowing precisely why, individual women students may come to feel and to behave as though they are marginal participants in the academic enterprise, (Hall & Sandler, 1982, p. 8).

The following section aims to explore the chilly climate experienced by women in math and science during schooling, from elementary through post-secondary. The discussion aims to constitute the notion that women and men have different educational experiences.

While we hope that most educators, male and female, aim to try to act with fairness towards all students, regardless of race, sex, religion, age, etc., even those who make strides to combat prejudices are still likely to unintentionally convey societal limits based on sex (Hall & Sandler, 1982). This process as it happens in the classroom is subtle, and many educators are likely to be unaware of their actions and consequences. This could happen in simple conversation; for instance, if an educator uses examples where a male is in the more dominant profession, and the female is the assistant or client (Hall & Sandler, 1982), like a doctor and nurse being a male and female respectively. Studies have shown that children as young as 2-years-old are conscious of and influenced by gender role stereotypes (Bauer, 1993; Ruble, Martin, & Berenbaum, 2006; Martin, Ruble, & Szkrybalo, 2002). Thus, when educators also use societal gender roles in classroom examples, they are reinforcing the idea that women are not seen in authoritative positions.

Another way educators in primary and secondary schools inadvertently set limits for their students is through the questions they ask. As noted in the research of Hall and Sandler (1982), gender-biased incidents could happen that are drastically obvious, or they could be understated. In extreme cases, educators' prejudice is overt and they will only call on male students to answer questions. In less obvious yet more studied cases,

educators will look to male students to answer questions as if not expecting women to have the abilities to respond, or will call on men more often than women (Duffy, Warren, & Walsh, 2001; Eccles & Blumenfeld, 1985). Eccles and Blumenfeld (1985) also found evidence that teachers will offer feedback about a wrong answer to boys more frequently than to girls. Educators may, unintentionally, offer a boy additional resources if he got a question wrong ("look at page 65," for example), while only telling a girl that she got the problem wrong (Sadker & Sadker, 1994). Therefore, boys are given a sort of "head start" advantage through teacher feedback.

Even if an educator calls on men and women with equal frequency, it is important to consider the types of questions that each gender receives, as this is perhaps the least noticed way to discriminate in the classroom based on sex. Firstly, it is important to look at the content of the questions asked. As noted by Sadker and Sadker (1994), boys are asked questions of academic content particularly more than girls (as cited in Wimer, Ridenour, Thomas, & Place, 2001). Often, men are asked the "higher order" questions that require analysis and critical thought, while the women are left to answer the "lower order" questions, like recalling facts (Hall & Sandler, 1982).

Applying this to a math classroom, an educator might call on a female student to answer a question such as "What is the area of a square with a side length of 3 inches?" Then, the educator might call on a male student to answer a question such as "If we double the side length of the square, do we also double the area? Why or why not?" The latter question requires critical thinking, as opposed to just using a formula, and these types of questions are often reserved for the male students. Higher order questions are important because they "enable students to make sense of, reason about, solve, predict,

and apply mathematics" (Wimer et al., 2001, p.90). In the simple ways that educators ask questions, they are impacting the opportunities for women to learn by discouraging participation and critical thinking, thus creating a chilly climate for students.

In addition to varying the frequency and levels of questions asked for men and women, there are many other actions educators take that serve to engage men more often than women. For instance, as early as in primary school, teachers may regularly speak to boys regardless of proximity, but only to girls when they are close (Hall & Sandler, 1982). This encourages boys to demand attention from the teacher anywhere in the classroom, while also promoting more quiet and well-mannered behaviors in girls. These patterns ultimately create two different educational narratives for men and women (Eccles & Blumenfeld, 1985). By the time students arrive at post-secondary schools, women have been conditioned to accept this inconsistency as the norm. In discussions at the post-secondary level, women are likely to remain quiet, allowing their male classmates to dominate the conversation (Johnson 2007; Sadker & Sadker, 1994). Typically, women are accustomed to the expectations of being "well-mannered" and have little practice being verbally assertive. Seymour and Hewitt (1997) observed that there is also often a stigma associated with women who ask questions in class, as men interpret this as incompetence and a reduction of status (as cited by Johnson 2007). Further more, when women do participate, they are interrupted far more frequently by both the educator and their male classmates (Hall & Sandler, 1982).

The issue of sexism continues to deepen when university and college faculty treat women and men differently based on preconceived ideas. Moss-Racusin et al. (2012) were very clear about their conclusions: science professors, regardless of gender,

perceive a female student to be less competent than her identical male counterpart. This is likely linked to cultural stereotypes about women and STEM. When parents, classmates, teachers, and supervisors know that women are socially believed to be less talented at math, it affects women trying to get an education and trying to get hired in a STEM field (Jacobs & Eccles, 1992). Moss-Racusin et al. (2012) found that faculty members showed a bias in favor of men when looking to hire a science laboratory manager. In the study, the professors evaluated applications for a science laboratory manager position. The only factor that was changed on these applications was the gendered name of the applicant. When qualifications were identical for male and female undergraduate students, professors still ranked men as more worthy of being hired. The consequences also included a disparity favoring men in starting salary and career mentoring. A lack of mentoring is especially significant because it implies that women will not receive guidance and assistance towards achieving their goals in STEM careers after college.

The faculty's bias was "independent of their gender, scientific discipline, age, and tenure status [suggesting] that it is likely unintentional, generated from widespread cultural stereotypes" (Moss-Racusin et al., 2012). The impact of cultural stereotypes is echoed by Wimer, Ridenour, Thomas, and Place (2001), who suggest that "cultural and media messages promote female appearance rather than mathematics ability" (p. 86). Similarly, it was also found that when employers only knew what the candidate looked like, men were hired twice more often than women (Reuben, Sapienza, & Zingales, 2014). These professors and employers were making decisions based off of gender more than any other factor.

Women at the post-secondary level face more difficulties as faculty members have been noted to use more sexist remarks and humor (Hall & Sandler, 1982; De Welde & Laursen, 2011). In a study conducted by De Welde and Laursen (2011), over one third of female PhD students responded by saying they felt sexually objectified by male professors and peers. Women in the study also noted that men often made comments implying either that women had only been accepted into the program because of their gender, or that other colleagues had greatly helped them. These types of comments undermine women's independent abilities and accomplishments. Similar to primary educators' unawareness of asking questions in class in a manner that benefits boys, faculty members at the post-secondary level are also often likely to be unaware of the sexism conveyed in their comments. However, other times faculty members recognize the sexism but believe that the comments are commonplace and established parts of conversation (Hall & Sandler, 1982). Humor may also be used with the intention of creating a sense of camaraderie between the professor and student. However, the impact is detrimental to women's academic contributions as sexist jokes further demean women's abilities and achievements (Hall & Sandler, 1982). Whatever the reasoning, sexist comments and humor persistently create a chilly climate for women in STEM fields.

It is also important to give attention to the significant difference in STEM participation between women of color and White women. As of 2005, the National Science Foundation reported that Black, Latina, and American Indian women received only 3.2% of all doctorates in the natural sciences in 2001, while White men received 50% (Johnson, 2007). Women of color are especially impacted by previously discussed

factors, as they have multiple subordinate identities: a double jeopardy. Historically, women of color have faced both sexism and racism in schooling, adding considerable challenges to learning and achievement, especially in the science setting (Johnson, 2007).

The culture of post-secondary academic science could be described as rigorous, independent, and historically a "boy's club," particularly for White males. This culture does not lend itself to be easily accessible to women of color, and thus they are at a disadvantage no matter how prepared and intelligent they are (Johnson, 2007). Because science courses are so rigorous, success requires a level of natural comfort in speaking up and having a voice in order to ask questions and showcase talent by answering questions. However, women of color generally do not have their voice heard in science classes. As previously discussed, women are often quieter during discussions than men, perhaps because they have been socialized to be "well-mannered" and less assertive. For women of color, this reluctance is enhanced by a sense of already feeling conspicuous in a predominately White setting, and wanting to reduce that feeling of being anomalous (Johnson, 2007). If they choose not contribute to class discussions, they can remain unnoticed and more comfortable, but at the cost of learning and advancement.

To meet the demands of some of the fastest growing careers, the country needs more workers that are trained and capable in STEM fields. One way to improve this is to recruit women and minority students. It is unlikely that this will happen as long as women of color continue being systematically discouraged at the post-secondary level.

c.) Work Place

As a result of the factors discussed previously, women are less likely to continue to pursue and enter STEM fields than men. At a time when they would be professionalizing their talents, women are not as confident about their abilities, and look to other occupations (Eccles, 1994). Yet even for women who choose to join the STEM community professionally, there are still gendered challenges to face.

It appears that for women it is incredibly difficult to have a successful career, social life, and family life without compromising one or more aspects. Firstly, it is typical that women in STEM fields who want to raise a family have to make sacrifices to their career more commonly than men who have children (Eccles, 1994; Ceci et al., 2009). Social norms dictate that men are the breadwinners and women are the caregivers. Even though modern family structures are redefining these roles, there is still a conservative nature and stigma surrounding women in the workforce and men staying at home. For this reason, this paper will focus on how family life affects mothers, though it should be noted that all parents are affected and that changes would benefit fathers as well. Sacrifices made by mothers are seen in wages, rate of advancement, and stress (Eccles, 1994). The dual role of being traditionally feminine and in a traditional science field is not societally commonplace enough to warrant professional policies that would ensure women do not have to make compromises in this manner. Such policies include paid parental leave, flexible schedules, and time working at home (Glass, Sassler, Levitte, & Michelmore, 2013). These policies could benefit both men and women who want to dedicate time to their families and not just to work.

Even when these accommodations are provided, however, parents face scrutiny of being seen as less dedicated and less motivated to succeed in their field (Glass et al.,

2013). Thus, mothers may feel pressured not to accept the accommodations, or to work more hours afterwards so as to make up for time spent on maternity leave. Simply having the policies in place is not enough to provide women with balanced career and family lives while the stigma of being a caregiver exists in male-dominated fields.

Family matters are not the only factor impacting women's presence in the STEM workplace. For many women, dissatisfaction with lower salary and lack of advancement prospects were more influential than familial limitations in decisions to exit their careers (Glass et al., 2013; Roberts & Ayre, 2002). A study of women's retention in the engineering workforce by Roberts and Ayre (2002) found that "76% of men described a managerial component to their work compared with 45% of women" (p. 148), showing that more often men hold positions with more responsibilities. This implies that men are being promoted more frequently than women, and with the promotion often comes a salary increase. A gender gap in managerial position is likely to lead to a gap in the rate of pay. As long as men continue to be favored over women for promotions, women will continue to leave the STEM workforce with more frequency than men.

Women are more likely to leave their positions than men because of the chilly climate they experience in the STEM workplace. In fact, Preston (2004) found that women not only leave STEM professions at higher rates than men, but that they then choose to join non-STEM fields at higher rates than men (as cited in Glass et al., 2013). The chilly climate in the STEM workforce is negatively impacting female participation.

V. Conclusion

Women are highly underrepresented in STEM field professions. Many would credit this to biological differences between men and women, like brain size and functions (Boaler, 2008). However, there is more evidence that societal factors are to blame. Some of these factors include stereotypes, media messages, and the chilly climate of math and science fields.

Historically, women have been stereotyped as being untalented at mathematics. This unwarranted stereotype still exists, and greatly impacts women's interest and pursuit of math and science subjects. This starts early on in a women's life, as girls are gently pushed and pressured away from careers and interests in STEM fields. These stereotypes are ingrained in society because they are promoted by the media through toys, clothing, news reports, etc. Girls internalize these messages from the media, and start to believe that women are not expected to be good at math. When girls enter school with these ideas, they are at risk of stereotype threat, which can lead to increased anxiety and decreased achievement in math and science. The media messages also reach educators, who in turn perpetuate the stereotype in the classroom. Finally, by the time women reach the workforce, they are still affected by the stereotypes of their employers. The stereotypes about women and math create an unwelcoming, chilly climate for women in STEM education and STEM professions. Thus, women are socialized away from STEM fields, and are largely underrepresented.

There are many factors to address in order to fix this issue, and it is beyond the scope of this thesis to provide a comprehensive solution. Instead, I will examine some interventions and restorative strategies that are making a positive impact on women in STEM. Starting at the beginning, there are ways to use the media to change the ideas

held by society about women and math. Presented earlier were examples of articles of girls' clothing with text that was unsupportive of mathematics (Dumas, 2011). An easy solution would be to create clothes with math positive messages. Toys were also influential towards girls' negative math attitudes (Bussey & Bandura, 1999). Luckily, there are already movements starting to remedy the problem. In fact, this is the main goal of many new toy innovators, including the company GoldieBlox. Their online mission includes the following statement:

> "In a world where men largely outnumber women in science, technology, engineering and math, girls lose interest in these subjects as early as age 8. Construction toys develop an early interest in these subjects, but for over a hundred years, they've been considered "boys' toys." GoldieBlox is determined to change the equation," (Sterling, 2015).

GoldieBlox is a company that understands the importance of the media and toys in inspiring interest. By aiming their construction toys at a demographic of young girls, GoldieBlox is making significant efforts to counteract other negative societal messages about women in STEM fields.

Many celebrities also recognize their influence and are using their status in popular culture to help fight for women's equality. Recently, Beyoncé gained international attention for her feminist ideals by sampling Chimamanda Ngozi Adichie's TED Talk titled "We should all be feminists" in her 2013 song "***Flawless" (May, 2013). The song uses Adichie's quote to define a feminist as "the person who believes in the social, political, and economic equality of the sexes." Beyoncé was able to spread her message about female equality given her international fame.

Actresses Emma Watson and Patricia Arquette did the same, as they used their fame to spread the feminist message via speeches. Emma Watson gave a speech at the United Nations in 2014 about feminism and the "He For She" campaign designed to recruit men to help fight for equality. Patricia Arquette won an Oscar for Best Supporting Actress in 2015, and used her time to give a speech as an opportunity to address women's rights (Staff, 2015). Also recently, supermodel Karlie Kloss has been learning to code and has joined Code.org to campaign and encourage girls to pursue their interests in computer science (Rodriguez, 2014).

A change in the media could mean a change in messages received by both children and their parents. If parents change their perceptions of their children's math abilities, they could influence girls and stop them from underperforming in math assessments. Teachers at all levels of education could also change their beliefs and perceptions, which would similarly impact female students.

There are many different changes that could happen during girls' education that could help to increase women's participation in STEM fields. As discussed, there are various things educators do to promote male students over female students, but the educator may not be aware of them. Some of these patterns include showing favoritism to boys (Sadker & Sadker, 1994), frequency, content, and rigor of questions asked, (Wimer et al., 2001), and more. Simply being mindful of these patterns could help educators take actions to make a change. Changing the classroom environment could better support women in math and science courses as well. Instead of a harsh, unwelcoming, independent setting, students could benefit from an atmosphere of

cooperation and support (Perna, Lundy-Wagner, Drezner, Gasman, Yoon, Bose, & Gary, 2008).

Perhaps this is why many African American women are drawn to historically Black colleges and universities (HBCUs), where their attendance would not be seen as conspicuous. HBCUs create an environment for students where they are set up to succeed, because they offer students support and resources (Perna, Drezner, Gasman, Yoon, & Gary, 2008). When African American students attend historically White colleges and universities (HWCUs), they more frequently report experiencing "social isolations, alienation, personal dissatisfaction, and overt racism" (Perna et al., 2008, p. 16) than their counterparts at HBCUs. At HBCUs, the culture tends to be more nurturing in order to promote achievement academically; the challenges that women of color face are acknowledged and addressed in a progressive manner that is not commonly seen at HWCUs (Perna et al., 2008; Harper, Carini, Bridges, & Hayek, 2004). Science tracks at HBCUs show that without a chilly climate, women are more likely to remain in and graduate from STEM majors.

Employers are also impacted by the media and the stereotypes regarding women and mathematics, and they have a significant influence on women's futures in STEM fields. Recognizing these biases could increase the rate at which women get hired. Once women are in the STEM workplace, there are various strategies that could increase female retention, like more family-oriented policies for parents with young children. However, in order to fully reach a level of equality in the workplace, the stigma of being an outsider and the societal stereotypes need to be dismantled.

Because female STEM professionals are currently underrepresented, girls have few female role models, which can be very discouraging for them (Marx & Roman, 2002). However, as more women enter these fields, the hope is that this will change. With more women working in STEM fields, there will be more female role models for girls interested in math and science. When girls see someone who is like them and who has overcome stereotypes to be successful in her field, they are less likely to be affected by stereotype threat and they will have higher math achievement (Shapiro & Williams, 2012).

The underrepresentation of women in STEM fields is an important issue, and addressing this problem is critical. Having more women working in STEM fields could greatly benefit technological developments globally and lessen the gender gap in the U.S. There is already a great deal of research surrounding the factors impacting women's participation, and understanding the issue is the first step in finding a solution. It is complex, and there is not going to be one straightforward answer, but there have been some improvements over the past few decades. The next step is to implement the various strategies outlined previously in order to fully execute a change. If these changes happen, then the future will look optimistic for increased female representation in STEM fields.

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