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Abigail Hoskins

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First Advisor

Dyann C. Logwood, Ph.D.

Second Advisor

Megan Moore, Ph.D.

Third Advisor

Ann R. Eisenberg, Ph.D.

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SEXISM AND RACISM IN STEM: A BLEAK HISTORY AND A BRIGHT FUTURE

By

Abigail Hoskins

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Project Advisor:	Dyann C. Logwood, Ph.D.
Associate Dean of the Honors College:	Megan Moore, Ph.D.
Dean of The Honors College:	Ann R. Eisenberg, Ph.D.

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Abstract

Women and people of color have faced discrimination throughout history, and this inequity persists today. This results in low numbers of women and people of color in STEM and leads to stereotypes and bias as well as harassment, financial disparities, and erasure of their contributions. Current initiatives promote equality and equity in STEM, such as protests against discriminatory practices and after-school programs encouraging youth from marginalized groups to participate in STEM, but these are not enough. Institutional and structural changes and solutions that address the intersectional needs of women and people of color are necessary to ensure equity and equality in these fields.

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Introduction

For as long as civilization as we know it has existed, discrimination has been a part of our existence. This discrimination can be based on any difference between people in our society of which there is a majority and a minority. Two of the most common aspects that are discriminated against are race and sex. These are respectively referred to as racism and sexism. They are present in nearly every aspect of our lives, including our careers and education. This is especially true for those who work in STEM (Science, Technology, Engineering, and Mathematics) fields. These fields can include medicine, lab research, and teaching STEM courses – professions that are valuable and crucial to our society. However, they are dominated by White men, which means that women and people of color become a minority in these fields. When women and people of color become a minority, this allows racism and sexism to take place. This paper will outline the history, effects, and future of racism and sexism in STEM fields as well as current initiatives to endorse equality and equity in STEM fields and what more needs to be done to achieve this.

I must acknowledge that, as a White woman, I am in a place of privilege and cannot speak to the experiences of people of color from personal experience. For discussions of race and racism, I rely on literature where appropriate as well as the input of the people of color I have collaborated with on this project.

Women in STEM

Information on women in STEM in ancient times is greatly limited. When we think of the ancient minds that shaped our world, we think of Socrates, Hippocrates, Plato - men, not women. This could be due to one of two reasons: lack of female figures or lack of records on female figures. It was commonplace in most ancient societies for women to be barred from participating in “men’s” fields such as medicine, mathematics, and philosophy. Some women were able to seek out education in these fields, such as Hypatia of Alexandria, who was a mathematician and philosopher who was educated by her father (Mark, 2009). However, this story is the exception and not the rule - thus, there was a great lack of women in STEM fields during this period. Additionally, women who were educated in STEM fields during ancient times were poorly documented. Hypatia of Alexandria was a gifted academic at Alexandria's University in ancient Greece. However, little is known of this and her death is the most well-known aspect of her life (Mark, 2009), providing evidence that her story, and likely others, were poorly documented. There are many reasons why this could be, but one of the most likely reasons was that these patriarchal societies focused primarily on men and their studies, pushing women aside in the process.

Unfortunately, what we do know of the history of ancient women in STEM fields can be foggy and riddled with misinterpretations. For example, Kate Campbell Hurd-Mead spoke of the ancient Egyptian physician, Merit Ptah, who was claimed to be the first woman to practice medicine. Her name was used to forward the feminist movement as she quickly became well-known. Many sources, such as Britannica (Ferry, 2010) cite her story as true - however, research has shown that Merit Ptah never actually existed. In fact, the story of Merit Ptah was the result of Hurd-Mead misinterpreting records about a healer (Kwiecinski, 2020). This story demonstrates how history is not always all it seems, or any of what it seems. This is especially true when our history books often leave out women’s accomplishments and achievements,

meaning that women's history can be based not on facts, but on historians' interpretations with a rather large margin for human error.

Change was slowly yet steadily made over time, leading to women eventually taking positions in STEM. By 1970, about 7% of jobs in STEM fields were filled by women - this is still a very low percentage, but was an improvement nevertheless at the time ("Women in STEM: A Guide to Bridging the Gender Gap"). However, discrimination against women in these fields was rampant. One example of this concerning issue was the discrimination faced by Sally Ride, who is now well-known as the first female astronaut for NASA. It was an uphill battle for women to even participate in NASA's programs, as NASA's requirements included military pilot experience that women were barred from. A brief experiment that lifted this barrier was attempted in the 1960s, but was cut short due to the idea that women were not fit for space travel and that this was part of our "social order." However, this was not the only barrier: once women were admitted into NASA's program in 1978, the discrimination against them persisted. Much of it consisted of being ill-prepared for the supplies they would need - they famously attempted to send Ride on a one-week trip to space with 100 tampons and suggested that she help develop a makeup kit for female astronauts - which was part of a larger issue that Ride's male colleagues were dumbfounded by the idea of working with a woman. This was during a time when women were just entering the workforce in larger numbers, meaning that men were well-accustomed to women being homemakers rather than astronauts and generally being subservient to men rather than being equals in the workplace. NASA was not the only place where this problem appeared - it also made itself known in Ride's interactions with the public, where it was apparent that interviewers did not take her seriously as a professional. Instead of asking about her achievements, interviewers asked her if her space travel would have any impact on her reproductive system and even what kind of makeup she was wearing. This

demonstrates that being unsure of how to go about working with a woman in a professional setting was not only an issue for NASA, but for society as a whole (Blakemore, 2019).

When society could not wrap its head around how women could work in STEM fields, it often chose to disregard women's achievements in STEM and focus more on other aspects of their careers. This was because women's work in STEM could be swept under the rug and focus on the aspects of a woman's identity that were considered to be more socially acceptable, ie. more traditionally feminine. An example of this is found in Hedy Lamarr, who is widely known for her Hollywood acting career and her beauty - however, few know that she was also a gifted inventor and engineer. Lamarr was partially responsible for inventing a novel system of communication to guide torpedoes during the second World War using frequency hopping (Cheslak, 2018) - despite what a breakthrough this invention was, Lamarr did not receive recognition for this until 1997 when she and co-inventor George Antheil were awarded the Electronic Frontier Foundation Pioneer Award, and Lamarr was awarded the BULBIE Gnass Spirit of Achievement Award (Ricard, 2018). Later on, Lamarr was inducted into the National Inventors Hall of Fame (Cheslak, 2018). While she was eventually given credit for her brilliance, how society disregarded and discredited Lamarr's work still shows how society's disregard for women's achievements throughout history had a lasting impact on their legacies, resulting in stories like Lamarr's being too little-known for the great impact they had. On the other hand, this story shows how some strides have been made over time regarding recognition of women in STEM, as Lamarr was awarded for her work in the 1990s-2000s after decades without credit (Ricard, 2018; Cheslak, 2018).

Today, discrimination against women in STEM looks quite different than it did in history. Instead of near-complete alienation from STEM fields, women make up a much larger group, albeit still a significant minority. In 2017, women made up 29% of workers in STEM fields ("Women in STEM: A Guide to Bridging the Gender Gap") - this is a significant increase from

1970, when only 8% of workers in STEM fields were women (Christnacht and Martinez, 2021). Although this is a sign of progress, this comes with its own set of problems. Now that more women work in STEM fields, discrimination is faced on a daily basis by women. A study of women in their first or second year of undergraduate education pursuing STEM careers found that women experienced sexism at an average rate of one to two occurrences per week (Baker, 2020). One of the most notorious forms of discrimination we see today is sexual harassment, which is defined as harassment in the form of unwelcome sexual attention ("Sexual Harassment").

Contrary to popular belief, this sexual attention is not actually about the perpetrator having any sexual attraction towards the victim - rather, sexual harassment is about exerting dominance and control as a means of creating and maintaining a position of power over the victim. This is why this occurs primarily in male-dominated fields such as STEM, as men socially hold a position of power over women due to women being a minority in those fields, allowing them to express that power dynamic in the form of sexual harassment. Sexual harassment is often downplayed as joking, compliments, or a situation in which "boys will be boys," but it has significant negative effects on women in STEM, including prospective female STEM students and workers. Women in STEM being seen as sexual creatures rather than highly educated professionals results in women not being taken seriously in their careers, greatly limiting what they can achieve. The fear alone of sexual harassment discourages women from seeking out education and careers in STEM, exacerbating the issue by making women even more of a minority in these fields (Barrios et al, 2022).

Discrimination against women in STEM also comes in the form of bias. These are strong beliefs and assumptions against women in STEM without significant data to back them up, resulting in careers in STEM proving to be a much steeper uphill climb for women than for men. Biases in STEM result in women having to work harder than men to receive the same

respect as their male coworkers while still being discredited and criticized. However, women cannot work too hard in STEM careers, as this can hurt them as well - women are expected in STEM to adopt more masculine traits while simultaneously maintaining their femininity to be both liked and respected by their peers. These concerns are especially true for mothers, who struggle to be taken seriously in the workplace. While discrimination in the workplace results in rifts between male and female coworkers, it also divides women, as studies have shown that some women in STEM have to compete with their female coworkers for respect. This demonstrates the wide variety of ways that bias affects women in STEM. There is no one effect - instead, it causes different problems across different aspects of women's careers (Williams, 2015).

A result of gender bias that directly impacts women in STEM is disparities in finances. This includes salary and research funding. In a study examining grant applications, it was found that men were considered more competitive for funding on the grounds that they had higher "quality of researcher" but not "quality of proposal." In turn, men were more likely to receive research funding than women. This study also looked into the language used in policies and communications for this grant, and found that the gender policy of selecting a number of female applicants proportional to the amount of women who submit a proposal is mentioned in nearly half of their communications (van der Lee and Ellemers, 2015). At first glance, this could explain the higher number of men than women receiving funding and that more men are considered to be higher quality researchers if more men than women submit proposals - however, this is not the case. If this were true, then men would be ranked higher than women in all categories. This is not the case, as men did not rank higher than women in "quality of proposal" (van der Lee and Ellemers, 2015). The fact that men ranked higher than women in only some areas and were still more likely to receive funding suggests that bias is to blame for the disparity.

Many laws are in place to prevent discrimination in our society. However, the law is not always there to protect us - it can occasionally even cause harm. The term “bona fide occupational qualification (BFOQ)” is rarely heard in the workplace, yet has huge effects on what women experience in their careers. BFOQ means that, under certain circumstances, discrimination can be considered a natural aspect of a career. For example, women working in entertainment are often not protected from scanty uniforms and sexual harassment from clients or customers as it can be considered part of the career (Hoerner, 2014). While this example does not necessarily apply to all women in STEM, it is the idea that the law can permit discrimination that affects all women. If discrimination can be accepted under some circumstances, then it would be all too easy to allow it under other circumstances as well.

One of the most notable ways sexism affects STEM fields is by producing the gender gap. The gender gap is used to describe the significant difference in numbers of men and women in STEM. As of 2017, only 29% of people in STEM careers were women - this unfortunately was an increase of only 6% since 1993 (“Women in STEM: A Guide to Bridging the Gender Gap”) and higher than the rate of women in STEM in 2019, which was 27% (Martinez and Christnacht, 2021). The percentage of female STEM workers varies depending on several factors, including the field of study and level of education. Only 21% of people who earned bachelor’s degrees in STEM were women - in comparison, 49% of people who earned chemistry degrees were women. The gap broadens as the level of education increases. (“Women in STEM: A Guide to Bridging the Gender Gap”).

While these statistics primarily represent women in undergraduate studies and beyond, the gender gap becomes prevalent much earlier on. Studies have found that the gender gap begins in school children as young as 5 years old in the form of stereotypes. These stereotypes lead children to believe that men are better at skills used commonly in STEM careers, leading to the conclusion that women are not as suitable for STEM. This carries on throughout childhood,

also being observed in older children from ages 9-12 (Law et al, 2021). This suggests that the gender gap is something that begins to form in youth and continues throughout childhood and into adulthood, deepening the rift between men and women over time until the result is a drastically larger number of men than women in STEM due to these biases. This issue does not affect everyone the same way: for instance, the gender gap in children varies significantly by region as well as socioeconomic status (Alam, 2020). This indicates that the cause of the gender gap in children is linked to these differences. This could be due to cultural differences leading to higher or lower levels of discrimination against women or socioeconomic status affecting the quality of education in some areas.

Despite overwhelming evidence that discrimination is harmful to women in STEM, some researchers do not accept this and argue against the prevalence and importance of this issue. For example, Ceci and Williams found that there is no longer evidence for the existence of sexism in STEM and that disparities between women and men in these fields are the result of differences between the sexes in choices. Their study found that sex discrimination in STEM is rare and in insignificant amounts when it is present. However, the support they use for their argument does not support their claim at all, but actually discredits it. They claim that historical data is the focus of those who argue for the prevalence of sex discrimination in STEM - while historical data is important, there is a multitude of studies and sources showing clear disparities in STEM today. The United States Census Bureau indicates that there were significantly fewer women than men in STEM in 2019, thus disproving Ceci and Williams' claim. Ceci and Williams use orchestra auditions as an example of how differences between men and women are not the result of discrimination, as more men were hired as professional musicians than women until blind auditions were used in which the gender of the musician was unknown, thus equalizing the number of men and women hired. However, this clearly demonstrates sex discrimination, as men were chosen over women when gender was known. Blind auditions did not prove that

discrimination does not exist, but merely showed an effective solution to the problem. When Ceci and Williams claim that women's low representation in STEM is by free or constrained choice, thet do not examine why these choices are made - a more in-depth analysis would find that these choices are made based on bias and stereotype threat, which are products of discrimination (Ceci and Williams, 2011). In short, Ceci and Williams' argument is invalid as they do not sufficiently analyze their data and base their conclusions on their claims, not data, as well as using weak supporting evidence that actually tears down their argument as they make it.

Disbelief of discrimination in STEM is not only a concern with researchers, but with the general public as well. Studies have shown that 61% of US adults surveyed believe that there are fewer women than men in STEM because of reasons aside from discrimination. They claim reasons such as women having less interest in STEM, not having sufficient female role models, or not having encouragement to pursue STEM in childhood (Funk and Parker, 2018). It is worth noting that all of these reasons are technically correct - however, they are not the root cause of the issue. All of these reasons are a direct result of sexism in STEM, as was previously discussed. Regardless, this statistic shows that, while cited reasons for fewer women in STEM are based on discrimination, the blame is being placed on discrimination by less than half of the population. This is significant, as the first step to solving any problem is being aware of it - if awareness is so low, then it makes it much more difficult to advocate for equality in STEM. One cannot advocate to someone who does not believe a problem exists. Furthermore, people who are unaware of discrimination in STEM and what it entails are more likely to be perpetrators of discrimination. If people do not know or do not believe that discrimination is a problem, it will make it more difficult to recognize it in their workplace and in their own behavior, resulting in male coworkers who believe sexual harassment is a "joke" or bosses that give their male

employees more raises than their female counterparts because they believe men are more capable.

People of Color in STEM

The history of people of color in STEM is short and not very well documented. This can be attributed to the relatively short history since the time of slavery in the United States and even shorter time that people of color have been able to access quality education. Education was often used as a tool during slavery for White slave owners to maintain control of their slaves by limiting their access to education, and education was poor even after emancipation due to heavy segregation lowering the quality of education in segregated schools. University educations for Black students focused primarily on preparation for roles in society that served Whites and were lower quality than White universities - this served as another method of control over minoritized groups. Finally, in the 1960s during the civil rights movement, Black students began to attend White universities in significant numbers, providing opportunities for people of color to earn the education needed for careers in STEM (“History of Black Education”).

One significant person of color in STEM was George Washington Carver, who was the first Black student and faculty member at Simpson College in Iowa, where he earned Bachelor’s and Master’s degrees in bacterial botany and agriculture before he was brought on as the head of Tuskegee Normal and Industrial Institute’s agriculture department (“George Washington Carver”). However, this was no easy task - Carver had been born into slavery, limiting his access to education early on. The schools he attended were all-Black schools, which, as discussed, were of lower quality than all-White schools, further limiting his access to resources that would aid in his success. When he applied to an all-White college, he was at first accepted - however, this acceptance was revoked shortly after when his identity as a Black man was revealed (History.com Editors, 2022). This is a blatant example of discrimination against Carver, as his race proved to be a limiting factor in his college acceptance.

While we have made great strides since the days of slavery and segregated universities, racism is still prevalent in STEM today. People of color are still significantly underrepresented in STEM fields, as Black workers make up a meager 9% of people in STEM while they represent 11% of workers in all fields. This is true across other marginalized groups, including Hispanic workers, who make up only 7% of workers in STEM fields but 16% of workers in all fields (Funk and Parker, 2018).

A concerning aspect of racism in STEM is that it is structural, meaning that the practices perpetrating discrimination go beyond choices and behaviors of those in power and lie in the system itself and how it is designed. Many aspects of higher education are based on eugenics - the idea that some races are biologically inferior, which results in stereotypes perpetrating exclusion of people of color from STEM curricula and reinforces harmful ideas of White superiority. Another result is the insistence that STEM is unbiased, which eliminates any accountability. This is often called “color blindness,” a term used to describe the mindset that ignoring racial differences and how discrimination negatively affects people of color will eliminate the problem on the grounds that it is treating everyone equally - in essence, the idea that ignorance is bliss. This means that instead of issues being addressed, they are ignored and the resulting effect of those in power wearing metaphorical blinders is called equality. This is detrimental to people of color in STEM because ignoring problems will not make them go away - thus, problems stemming from racism are pinned on other sources that become scapegoats, such as student’s intelligence, that fall through once examined (McGee, 2020).

One concern that is easy to overlook are microaggressions. This is defined as a form of discrimination that the aggressor can be unaware of, characterized by subtlety rather than more blatant forms of racism (“Microaggression”). While the name suggests something small, microaggressions can pose a large problem. This is because their inconspicuous nature makes them difficult to detect, making it all too easy for aggressors to participate in and ignore this

behavior, sometimes without realizing what they are doing and that it is harmful. 22% - more than 1 in 5 - Black workers in STEM report experiencing microaggressions in the workplace, meaning that this is an issue with a broad impact (Funk et al, 2018). These microaggressions manifest in many ways, such as exclusion. This can result in feelings of rejection and social isolation/informal segregation for POC students - these are referred to as environmental aggressions, as they create an environment in which people of color are treated as though they do not belong in STEM. These can be characterized as the use of derogatory language, assumptions that people of color are incompetent in their field of study, or exclusion from activities, group work in courses, etc (Lee et al, 2020).

Microaggressions largely stem from stereotypes coming from decades of discrimination against people of color. This is not a recent occurrence - in the 19th century, pseudo-scientists unsuccessfully sought to prove that people of color were of a different species that were inherently inferior to Whites. This was fortunately proven false due to complete lack of evidence for this claim (“Scientific Racism”), as the claim was based largely on the researchers’ prejudice rather than actual science - however, the harmful rhetoric remains to this day, resulting in the stereotypes we see today. Some of these can seem innocuous, such as the stereotype that people of color demonstrate better athletic performance than their White counterparts. Despite this claim being proven false numerous times, it is still perpetrated to this day and debunking the myth is often met with backlash instead of understanding. However, stereotypes can become a slippery slope when they are excused in our society. This results in some people holding beliefs that some groups are smarter than others or better fit for certain fields than others, leading to discrimination.

Another result of discrimination against people of color in STEM is segregation. While many believe that segregation was no longer a concern after Jim Crow laws were abolished, this is not the case. Segregation still occurs today, and although it looks quite different than it

did historically, it is still detrimental to people of color in STEM. In 2018, only 19% of Black students attended schools that were predominantly White - this is a sharp decrease from 1988 by almost half. However, this does not only occur in high schools - this also occurs in colleges that have significantly more diversity (Arcidiacono et al, 2013). This can be attributed to segregation in schools early on. Schools with predominantly Black populations tend to provide poorer-quality education than predominantly White schools (McDonald, 2021), leading to gaps in educational backgrounds that lead to White students often choosing to form friendships and professional relationships with other White students instead of Black students (Arcidiacono et al, 2013). This could also be due to stereotypes leading White students to prefer White students over Black students, which would make this a complex social issue rather than one of just education.

These issues may not seem severe to those who have not experienced them, but they nevertheless have drastic consequences. For example, people of color are some of the most likely STEM workers to leave their field despite holding a PhD - 21% on average leave their fields, more than any other race. Black workers in STEM also earn thousands of dollars less per year than Hispanics, Asians, and Whites in their fields and simultaneously are over 20% more likely to go into debt for their degrees than Whites - this makes it abundantly clear that racism in STEM affects people of color financially. Discrimination also affects mental health - it has been found that Black students earning their PhD in STEM fields suffer from increased stress levels during their education and frequently value their careers over their health. Elevated stress can be attributed to oppressive environments as well as financial stressors previously mentioned (McGee, 2020).

Despite evidence showing that racism in STEM is a prevalent issue and is detrimental to people of color in these fields, some critics do not acknowledge these issues. Some argue that there simply is no evidence of discrimination in STEM. Given the extensive evidence that has

been previously discussed, this is not the case. This idea could come from the fact that racism in STEM can be difficult to recognize due to microaggressions often being unconscious and unintentional, resulting in those not experiencing them being unaware of the harm. The harm is still present - it is just unnoticed by the aggressor. Others argue that they are not racist, so they do not need to worry about racism in STEM. While it is a step in the right direction for people to not participate in racist practices - this is likely the source of this argument - simply not being a part of the problem is not enough, for one must also be part of the solution for any progress to be made. This means that racism in STEM still must be a concern even for those who do not partake in discriminatory practices, thus nulling this argument. Another argument against racism in STEM is that education eliminates equalities. This argument is ironic, for education has been proven to create inequalities instead of mitigate them (Gosztyla et al, 2021). This is because, as previously discussed, schools predominantly attended by people of color tend to be of lower quality than predominantly White schools, meaning that people of color are more likely to receive poor-quality education than White students and thus be afforded fewer opportunities for success (McDonald, 2021). Additionally, it has been found that education access is largely dependent on race - Black, Hispanic, and Native American students have drastically lower access to math and science courses in high school than White students, meaning that White students are given more opportunities to develop skills in STEM and gain the education needed for careers in these fields than people of color.

Intersectionality Between Race and Gender in STEM

Racism and sexism do not exist in two separate spheres, but can occur at the same time and cause different effects. This idea is known as intersectionality, as it describes the discrimination that occurs at the intersection of two or more identities (race, gender, class, etc), creating multiple dimensions to discrimination (Crenshaw, 1989).

Women of color have a relatively short history in STEM beyond ancient history. In 2300 BCE, women of color served as priestesses and astronomers, performing what was considered men's work. In the past several hundred years, limitations on education due to slavery and segregated schools greatly limited the opportunities afforded to people of color, and women of color more so due to intersectional discrimination ("Women of Color in STEM"). When women of color were able to succeed in STEM fields, their work was often overshadowed and even stolen by men. Alice Ball, the first Black female professor of University of Hawaii's Chemistry department, tragically died in the middle of her research on curing leprosy - instead of crediting her for her work and continuing it, another scientist took credit for her achievements. Some scientists even won awards for the work of women of color - two scientists won Nobel Peace Prizes in 1957 for experiments disproving one of the laws of physics, but the Asian-American woman Chien-Shiung Wu who performed the experiments was not awarded for her work (Noushin, 2020).

A prominent woman of color in STEM was Katherine Johnson, who was the first female mathematician to work for NASA. Johnson was accepted to West Virginia University for the purpose of integrating the school as a Black graduate student - despite her intelligence, the primary focus of her acceptance proved to be her race and gender ("Life Story: Katherine Johnson (1918-2020)"). Integration led to social isolation and exclusion towards Black students, leading to the formation of Black social groups - this means that segregation still persisted even

during integration, resulting from racism from White students (Sanders, 2020). During the Cold War, Johnson was hired as a computer (mathematician) for NASA. Here, she faced severe segregation. Despite claims that NASA did not discriminate between races, this proved to be false - Black computers were required to have more education than Whites, needing to have a degree and higher grades than Whites. This is an example of bias against people of color. NASA also had segregated restrooms and cafeterias, which Johnson refused to adhere to. Eventually, her advocacy was somewhat successful and she was permitted to attend upper-level meetings. Later, Johnson was successful in performing the necessary calculations to send a man to the moon - however, few even at NASA knew about Johnson's contributions. This is an example of women of color not receiving proper credit for their work ("Life Story: Katherine Johnson (1918-2020)").

Today, women of color are severely disadvantaged compared to other demographics in STEM. Currently, women of color make up only 5% of STEM workers ("Women of Color in STEM"), of which 2% are Black women (McGee and Bentley, 2017). Low rates of women of color in STEM can be caused by a combination of the discrimination faced by women and people of color, resulting in a cumulative effect. Race and gender can be discriminated against separately with bias and stereotypes, leading to discrimination on two fronts rather than one. For example, women of color are often encouraged to pursue "soft sciences" such as sociology and social work rather than other STEM fields. This results in women of color being pushed out of many STEM fields due to stereotypes (McGee and Bentley, 2017). When women of color do enter STEM fields despite this bias, they face high rates of discrimination, higher than those faced by White women. For instance, 18% of women of color report missing work events due to safety concerns, compared to 12% of white women (Greene, 2017). Additionally, women of color are 77% more likely than White women to claim to have to prove their capability repeatedly in their fields (Chia, 2018). This difference indicates that the problem here is not only

sexism, but racism and the intersectionality between race and sex causing increased rates of discrimination towards women of color.

Discrimination against women of color in STEM leads to similar results as sexism and racism separately, such as leaving their careers at a high rate. However, just as women of color face higher levels of discrimination than White women, women of color also face more severe consequences for discrimination. This leads to even lower numbers of women of color in STEM than White women and a high rate of women leaving STEM (“Women of Color in STEM”). This underrepresentation leads to their work being undervalued and disregarded (Noushin, 2020), further perpetuating stereotypes by giving the appearance that women of color do not make significant contributions to STEM - this cannot be further from the truth, but is a result of bias that can skew our perception.

Moving Forward

We have made significant progress as a society in promoting equality and equity in STEM. Title IX provides some legal protections for women in education, allowing women better educational opportunities (U.S Department of Education, 2021). Initiatives are not only at the government level, but also in universities and schools. For example, universities have focused on training their staff as well as students in promoting gender equality. The NAVIGATE project aims to train university staff in dealing with gender discrimination. This initiative also educates women in how to approach discrimination in their careers, including recognizing that the blame falls not on them, but on their universities and institutions, and using objective, analytical problem-solving techniques (University Communications, 2021). As stereotypes leading to discriminatory practices and beliefs often begin young, so do solutions. After-school programs have been shown to be successful in encouraging school-age girls to participate in STEM (Allen et al, 2016), which will aid in mitigating stereotypes that can cause girls to not seek out education in STEM.

Similar initiatives have been taken to promote equality and equity for people of color in STEM. Eliminating racism in STEM is often found in disrupting how we teach and work on a systemic level by changing how we go about these parts of our lives. This means changing school curriculums so that White experiences no longer take precedence over those of Black students and actively resisting racism instead of simply not participating in it by explicitly teaching about bias and countering it (Braaten et al). The fight against discrimination has also moved beyond academia and into the general public in the form of mass protests such as the Strike For Black Lives movement and #ShutDownSTEM (Chen, 2020). These initiatives disrupt the status quo by holding mass protests that draw attention to the issues at hand.

Currently, there are barriers being put in place to prevent education on discrimination. There have been recent proposals and bills passed to ban discussions of “divisive” and “harmful” topics in schools, including critical race theory and many books that discuss discrimination and the experiences of women and people of color. These bills have gone as far as to ban certain words and phrases, including “patriarchy,” “white privilege,” and even “diversity, equity, and inclusion” (Wichgers, 2021). This is framed as protecting young minds and preserving their innocence, when it actually only protects those who are in power who benefit from the current disparity between Whites and people of color, between men and women. The politicians proposing these radical bills see the power of education and what it can do to our society as a threat, and their fear of loss of power causes them to stifle anything that threatens it, even children’s education. Education can be a powerful tool, powerful enough to either maintain or dismantle the structures that support the status quo of discrimination.

Despite the progress that has been made, there is still more work to be done. While the problem of discrimination lies primarily in institutions and universities - and those in power in these systems - this is unlikely to be the source of change. This is because those in power directly or indirectly benefit from power imbalances, meaning that they are likely to be unwilling to change. This means that change will likely have to be forced by the general population. It is crucial to understand that it is simply not enough to understand and not participate in discriminatory practices - it is necessary to actively push for change, or interrupt the bias in our society (Williams, 2014). These actions must occur on many levels, not only universities - education on bias and discrimination must begin early to create widespread social change. This must begin for children in the home and be carried on through their schooling in order to be effective in their careers (“Women in STEM: A Guide to Bridging the Gender Gap”).

In schools, educators need to not only avoid curricula that perpetuate stereotypes, but include lessons on inclusion and tolerance. This can look like lessons on the contributions of

women and people of color in STEM, discussions on myths versus facts, and having educators educate themselves on racism and sexism to work through their own biases (Nichols, 2020). Studies have shown that implementing a growth mindset - one focused on learning and developing one's strengths - has been shown to dramatically decrease the levels of bias seen in children (Law et al, 2021). To create an equal and equitable society, our children truly are our future. Unfortunately, this approach will take some time to result in change, as it relies on raising our youth to advocate for women and people of color in STEM, so discrimination will not show significant improvements until they are old enough to take on careers in STEM. This means that change must also happen at the institutional level. Universities can offer financial assistance to women and people of color studying STEM to encourage them to seek out education in these fields.

Employers can ensure that hiring processes and wages are fair to mitigate disparities in hiring and the wage gap ("Women in STEM: A Guide to Bridging the Gender Gap"). They can also provide programs such as maternity leave and flexible scheduling to help prevent women from having to leave their careers to raise a family. Solutions to discrimination in the workplace are not only in policies, but in social values as well. This means that employers and employees must promote diversity in the workplace and work together to assess barriers affecting women and people of color (Noushin, 2020). It is crucial to ensure that some underrepresented groups are not falling through the cracks when these methods are implemented. Some studies indicate that women of color are actually advantaged compared to Black men regarding representation in STEM fields (McDaniel et al, 2011). This is supported by statistical data, as Black individuals make up 9% of STEM workers ("The STEM Labor Force of Today: Scientists, Engineers, and Skilled Technical Workers"), showing that the 5% of STEM workers that are Black women have a slight majority over Black men ("Women of Color in STEM"). This could be attributed to programs encouraging minoritized groups to participate in STEM fields being geared more

towards women of color rather than men. This means that it is imperative to provide resources for all groups facing discrimination in STEM to ensure that steady progress is made to benefit everyone.

In conclusion, women and people of color have faced discrimination throughout history and to the present day. This causes decreased numbers of women and people of color in STEM and leads to stereotypes and bias as well as harassment, financial disparities, and erasure of their contributions. Current initiatives seek to promote equality and equity in STEM, such as protests against discriminatory practices and after-school programs to encourage youth from minoritized groups to participate in STEM, but these are not enough. Mass change is necessary to achieve equality and equity, including broad changes in social thinking and changes to institutions at the structural level - there is always more work to be done until everyone is treated equally and equitably with respect and dignity in academia and in the workplace in STEM.

Bibliography

Alam, Andaleeb. "Mapping gender equality in STEM from school to work." *Unicef,* 20 Nov 2020, https://www.unicef.org/globalinsight/stories/mapping-gender-equality-stem-school-work. Accessed 15 Sept 2022.

Allen, P., Noam, G., Little, T., Fukuda, E., Chang, R., Gorrall, B., Waggenspack, L. Afterschool & STEM System-Building Evaluation. 2016.

Arcdidiacono, P., Aucejo, E., Hussey, A., Spenner, K. Racial Segregation Patterns in Selective Universities. The Journal of Law & Economics. 2013. Volume 56, pages 1039-1060.

Baker, M. Daily Sexism Experiences by Women in STEM Majors: Incidence and Relations to Belonging, Interest, and Intentions. University of Minnesota. 2020.

Barrios, Nayeli, Becker, Jessica, Murphy, Elise, Sanches, Larissa. "The challenge of gender bias: experiences of women pursuing careers in STEM." *Nevada Today,* 8 Apr 2022, https://www.unr.edu/nevada-today/blogs/2022/the-challenge-of-gender-bias-in-pursuing-stem-careers. Accessed 28 Sept 2022

Blakemore, Erin. "When Sally Ride Took Her First Space Flight, Sexism Was The Norm." *History.com,* 6. Mar 2019, https://www.history.com/news/sally-ride-first-astronaut-sexism. Accessed 3 Mar 2022.

Braaten, Melissa, Foster, Danelle, Foster, Jason, Han, Rae Jing, Scipio, Déana, Suárez, Enrique. "How can we confront and dismantle systemic racism through science learning?" STEM Teaching Tools, https://stemteachingtools.org/brief/79. Accessed 15 Sept 2022.

Ceci, S.J., Williams, W.M. Understanding current causes of women's underrepresentation in science. Proceedings of the National Academy of Sciences. 2011. Volume 108, pages 3157-3162.

Chen, Sophia. "Researchers around the world prepare to #ShutDownSTEM and 'Strike For Black Lives.'" Science, 9 Jun 2020, https://www.science.org/content/article/researchers-around-world-prepare-shutdownstem-and-strike-black-lives. Accessed 30 Mar 2022.

Cheslak, Colleen. "Hedy Lamarr." *National Women's History Museum,* 30 Aug 2018, https://www.womenshistory.org/education-resources/biographies/hedy-lamarr. Accessed 29 Sept 2022.

Chia, Gabby. "Influential Women of Colour in STEM." Westcoast Women in Engineering, Science and Technology, 14 Dec 2018, https://www.sfu.ca/wwest/WWEST_blog/women-in-colour-in-stem.html. Accessed 29 Sept 2022.

Christnacht, Cheridan and Martinez, Anthony. "Women Making Gains in STEM Occupations but Still Underrepresented." *United States Census Bureau,* 26 Jan 2021, https://www.census.gov/library/stories/2021/01/women-making-gains-in-stem-occupations-but-still-underrepresented.html. Accessed 29 Sept 2022.

Crenshaw, K. Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscrimination Doctrine, Feminist Theory and Antiracist Politics. University of Chicago Legal Forum. 1989. Volume 1989.

Ferry, Georgina. "Women in Science." *Encyclopedia Britannica,* 22 Dec 2010, https://www.britannica.com/topic/Women-in-Science-2100321. Accessed 31 Mar 2022.

Funk, Cary and Parker, Kim. "Women and Men in STEM Often at Odds Over Workplace Equity." *Pew Research Center,* 9 Jan 2018, https://www.pewresearch.org/social-trends/2018/01/09/women-and-men-in-stem-often-at-odds-over-workplace-equity/. Accessed 30 Mar 2022.

"George Washington Carver." Missouri Dept. of Agriculture, https://agriculture.mo.gov/gwc.php. Accessed 15 Sept 2022.

Gosztyla, M., Kwong, L., Murray, N., Williams, C., Behnke, N., Curry, P., Corbett, K., DSouza, K., Gala de Pablo, J., Gicobi, J., Javidnia, M., Lotay, N., Prescott, S., Quinn, J., Rivera, Z., Smith, M., Tang, K., Venkat, A., Yamoah, M. Responses to 10 common criticisms of anti-racism action in STEMM. PLOS Computational Biology. 2021. Volume 17.

Greene, Sydney C. "Women of color in STEM face greater risks of gender, racial harassment at work." USA Today, 14 Jul 2017, https://www.usatoday.com/story/news/nation-now/2017/07/14/women-color-stem-face-greater-risks-gender-racial-harassment-work/467501001/. Accessed 29 Sept 2022.

History.com Editors. "George Washington Carver." *History.com*, 29 Aug 2022, https://www.history.com/topics/black-history/george-washington-carver. Accessed 15 Sept 2022.

"History of Black Education." *Kenyon.edu,* https://www2.kenyon.edu/Depts/Amerstud/blackhistoryatkenyon/Individual%20Pages/History%20of%20Black%20Education.htm. Accessed 3 Mar 2022.

Hoerner, B. The Role-Modeling BFOQ: Court Confusion and Educational Promise. University of Pennsylvania Journal of Business Law. 2014. Volume 19, pages 1211-1256.

Kwiecinski, J. Merit Ptah, "The First Woman Physician": Crafting of a Feminist History with an Ancient Egyptian Setting. Journal of the History of Medicine and Allied Sciences. 2020. Volume 75, pages 83-106.

Law, F., McGuire, L., Winterbottom, M., Rutland, A. Children's Gender Stereotypes in STEM Following a One-Shot Growth Mindset Intervention in a Science Museum. Frontiers in Psychology. 2021.

Lee, M., Collins, J., Harwood, S., Mendenhall, R., Huntt, M. "If you aren't White, Asian, or Indian, you aren't an engineer": racial microaggressions in STEM education. International Journal of STEM Education. 2020. Volume 7, pages 1-16.

"Life Story: Katherine Johnson (1918-2020)." WAMS New-York Historical Society, https://wams.nyhistory.org/growth-and-turmoil/cold-war-beginnings/katherine-johnson/. Accessed 28 Sept 2022.

Mark, Joshua J. "Hypatia of Alexandria." *World History Encyclopedia,* World History Publishing, 2 Sept 2009, https://www.worldhistory.org/Hypatia_of_Alexandria/. Accessed 18 Jun 2022.

McDaniel, A., DiPrete, T.A., Buchmann, C., Shwed, U. The Black Gender Gap in Educational Attainment: Historical Trends and Racial Comparisons. Demography. 2011. Volume 48, pages 889-914.

McDonald, John. "Confronting pervasive segregation." University of California, 7 Jan 2021, https://www.universityofcalifornia.edu/news/confronting-pervasive-segregation. Accessed 3 Mar 2022.

McGee, E., Bentley, L. The Troubled Success of Black Women in STEM. Cognition and Instruction. 2017. Volume 35, pages 265-289.

McGee, E. Interrogating Structural Racism in STEM Higher Education. Educational Researcher. 2020. Volume 49, pages 633-644.

"Microaggression." *Merriam-Webster.com Dictionary,* Oct 21 2022, https://owl.purdue.edu/owl/research_and_citation/mla_style/mla_formatting_and_style_guide/mla_works_cited_electronic_sources.html. Accessed 24 Nov 2022.

Nichols, Hedreich. "A Guide to Equity and Antiracism for Educators." Edutopia, 5 Jun 2020, https://www.edutopia.org/article/guide-equity-and-antiracism-educators?mkt_tok=eyJpIjoiTURCa05ETmpPVGhtWW1VMSIsInQiOiJyN2puaXJtcGQrQVZDeVpCaVVyejR4dHZIbGtUN3MyYW9rRGx4dEhTb2VabFVYN1h6dW1ZN0JoS1BNWG1oQjdDN1VwR3FUK3NXb2JyUXRBaEhcL01cLzcwTWVNRTErT1hWdTlaVERmaUpvQnNFeENXOUJzRG5YSkg2d3B4K3VJVEp3In0%3D. Accessed 29 Sept 2022.

Noushin, R. "Women of Color within STEM: Underrepresentation and its Impacts." Dupuis Editing, 3 Dec 2020, https://www.dupuisediting.com/woc-in-stem. Accessed 29 Sept 2022.

Ricard, Alicen. "Hedy Lamarr: a mind that mixed arts and sciences." *Westcoast Women in Engineering, Science and Technology,* 8 Aug 2018, https://www.sfu.ca/wwest/WWEST_blog/hedy-lamarr--a-mind-that-mixed-arts-and-science.html. Accessed 3 Mar 2022.

Sanders, Crystal R. "Katherine Johnson should also be remembered for desegregating higher education." *The Washington Post*, 25 Feb 2020,

https://www.washingtonpost.com/outlook/2020/02/25/katherine-johnson-should-also-be-remembered-desegregating-higher-education/. Accessed 3 Mar 2022.

"Scientific Racism." *Harvard Library,* https://library.harvard.edu/confronting-anti-black-racism/scientific-racism. Accessed 28 Sept 2022.

"Sexual Harassment." *U.S. Equal Employment Opportunity Commission,* https://www.eeoc.gov/sexual-harassment. Accessed 3 Nov 2022.

"The STEM Labor Force of Today: Scientists, Engineers, and Skilled Technical Workers." *National Science Board Science and Engineering Indicators,* https://ncses.nsf.gov/pubs/nsb20212/participation-of-demographic-groups-in-stem. Accessed 6 Dec 2022.

U.S. Department of Education. "Title IX and Sex Discrimination." *Office for Civil Rights,* Aug 2021, https://www2.ed.gov/about/offices/list/ocr/docs/tix_dis.html. Accessed 29 Nov 2022.

University Communications. "Helping Women Overcome Discrimination in STEM." The University of Arizona, 8 Nov 2021, https://news.arizona.edu/story/helping-women-overcome-discrimination-stem. Accessed 29 Sept 2022.

van der Lee, R., Ellemers, N. Gender contributes to personal research funding success in The Netherlands. PNAS. 2015. Volume 112, pages 12349-12353.

Wichgers, Chuck. "Joint Hearing on Education." *Wisconsin Legislative Documents,* 11 Aug 2021,

https://docs.legis.wisconsin.gov/misc/lc/hearing_testimony_and_materials/2021/ab411/ab0411_2021_08_11.pdf. Accessed 5 Mar 2023.

Williams, Joan C. "Hacking Tech's Diversity Problem." Harvard Business Review, Oct 2014, https://hbr.org/2014/10/hacking-techs-diversity-problem. 30 Nov 2022.

Williams, Joan C. "The 5 Biases Pushing Women Out of STEM." *Harvard Business Review,* 24 Mar 2015, https://hbr.org/2015/03/the-5-biases-pushing-women-out-of-stem. Accessed 29 Sept 2022.

"Women in STEM: A Guide to Bridging the Gender Gap." Maryville University, https://online.maryville.edu/blog/women-in-stem-a-guide-to-bridging-the-gender-gap/. Accessed 29 Sept 2022.

"Women of Color in STEM." Maryville University, https://online.maryville.edu/blog/women-of-color-in-stem/. Accessed 3 Mar 2022.