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The Leaky Pipeline of Women in STEM

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INTRODUCTION

Women make up more than half of biology-related doctoral degrees yet are still underrepresented in the faculty and higher-level positions of this field (1). This disparity is referred to as the leaky pipeline problem and exists in the science, technology, engineering and mathematics (STEM) field. This issue was coined a "leaky pipeline" because women are more likely than men to leave their academic or professional careers, or "leak" out of the system. Their reasons for leaving could be related to family or personal issues or implicit biases regarding traditional male and female career paths. As of 2018, half of the college-educated workforce in the U.S. has been composed of women, yet women only make up 28% of the engineering and science workforce (2). This topic warrants further investigation since women make up such a small percentage of career positions in the STEM field.

In an article in the *Journal of Animal Science* (3), Pell describes four critical periods that influence female retention in science: early childhood, adolescence, college and graduate school and the job entry period. During these periods, females are strongly impacted by their self-esteem and performance, classroom interactions, and the quality of mentors and advisors (3). The goal of the research paper is to bring the leaky pipeline problem to the forefront and analyze solutions that can address it. This thesis will address the impacts of gender biases that people experience through childhood, adolescence, and high school into college and contribute to the lower retention of women in science. It will also investigate challenges women face while in academia that may cause them to leave and will conclude with a proposed solution to this leaky pipeline problem.

SOCIETAL INFLUENCES

Stereotypes

Stereotypes are a major obstacle women face that can greatly influence their decisions to pursue science careers. Girls are more likely than boys to conform to societal norms regarding their gender (4). Experiencing the stereotypes during adolescence may not raise attention to the issue but may hinder a girl's desire to pursue science-based courses. This is due to the backlash that they might endure when they reject the traditional values ascribed to women and pursue those associated with men (4). Career selection begins in childhood and continues through adulthood and is deeply rooted in societal stereotypes. Men are traditionally raised to value power, money, and achievement while females are raised to value altruism, family and knowledge development. These differences eventually lead women in another direction rather than leadership positions in the STEM field, which is in part due to the false idea that STEM careers cannot satisfy these traditional female values (5).

Influences of gender stereotypes are introduced in childhood and have the potential to shape a child's future. Children begin to encounter and absorb stereotypes from the environment they are raised in as well as when they begin to socialize. This occurs while in school, as early as kindergarten, and can begin to influence their preferences in various fields of study. For example, the subjects of mathematics and engineering are primarily thought of and are predominantly composed of males. According to the Census from 2019, in engineering specifically, women only make up 15% of engineering occupations (6). In the U.S., young female children experience this stereotype in grammar school and by the age of 10, prefer reading over math despite the fact that data shows that girls have proficiency in math scoring (5). A study conducted in 2008 that looked at gender differences of NAEP (US National Assessment of Educational Progress) test

scores showed that in the mid-2000s, boys had higher standardized math scores in second and third grade, while girls had higher scores in fourth through ninth grade. In this study, none of the differences had statistical significance, meaning the scores were relatively similar throughout elementary and middle school (7). These data shows that boys do not begin schooling with an advantage in mathematics, but due to various stereotypes and beliefs about ability, they develop an advantage over girls later on in development.

Though stereotypes about gender and their role in STEM are introduced early on in development, studies show that girls are taking the same number of math and science classes in high school and are earning better grades than boys. According to the U.S. Department of Education, from 1990 to 2005, in high school, girls scored higher combined GPAs in math and science than boys. The studied range was a GPA from 2.0 to 3.0 and girl's grades increased from a 2.42 to a 2.76 over this time period, while boys went from a 2.30 to a 2.56 (8). Conversely, girls performed worse on standardized testing in these same subjects and took fewer AP courses in STEM topics. This difference is likely due to the stereotypes girls encounter that lead them to believe they are not "fit" or "supposed to" do well in these subjects since boys typically pursue STEM fields. Additionally, girls are more concerned with their grades in these subjects and if they do poorly, they are less likely to proceed with that field of study. In a study conducted in 2017 (9), researchers found that girls who scored better grades in STEM related courses were more likely to feel as though they could succeed in that field and therefore were motivated to pursue it. They also found that males cited good grades as motivating factors in pursuing the field. This study was conducted by survey, which included questions regarding participants' sources of early STEM interest, factors in middle school to college that affected their retention in the STEM field, any informal experiences they had with STEM, reasons they might have

considered leaving the field, and the amount of support from parents or others in this field. They surveyed almost 8,000 individuals with about 70% in colleges and universities and the remaining percentage from a survey link on the *Scientific American* website. The correlation in their results exists because those who attained good grades in the courses had more confidence in their knowledge and felt as though it was valuable to them to pursue that field (9). These data show that females need more external motivation than males in order to pursue and be successful in the STEM field.

One hypothesis is that the leaky pipeline is likely related to gender differences in aspirations. A crucial difference between genders lies in the emphasis on family life and parenting. In most cases, women are more likely to leave their successful careers to pursue alternate career paths or to leave entirely to satisfy their life-work balance. Additionally, men are more likely than women to expect their partners to make career sacrifices for the benefit of their family (1). The societal stereotype that women are the caretaker of their families influences women to value this role more than their personal careers and is one of the leaks within this pipeline of women in science.

While these issues may seem pervasive and extensive, there are practical solutions to many of them that can be implemented, especially early in development. Implementing these early on would most likely have a greater effect, since children are malleable, and it is the time period where most societal stereotypes are learned. One important way to increase females in science is to praise and cultivate their growth toward goals and achievements. Actively engaging with and countering the stereotype that boys are good at math or should be dominating in STEM can lead to a changed mindset in society as a whole, as well as an increase in females in math and sciences. In college, many different steps can be taken to support and boost female

participation in STEM majors. Some possibilities could be to actively recruit girls to major in STEM fields, inform professors about the stereotypes and ways to combat them along with the growth mindset idea, and relate the courses to real-life (8).

Parental Influences

Along with stereotypes, parental influences play a major role in a child's academic path. If parents value their child's education and encourage them to participate in after-school STEM related activities, it could increase their interest in STEM subjects. This is not a predictor for females pursuing STEM fields, but it can likely increase their interest in the field since the science or math activities are done outside of schooling and grading. Additionally, when parents believe in their children and their abilities, especially in a class such as math, the child is more likely to perform better in school (5). This can be measured by surveying the parents on their beliefs about their child's achievement and comparing it to how well the child performs. A study was done by Frome and Eccles (10) on this topic where researchers looked specifically at parent's beliefs about their child's ability in math and English. For the subject of math, they found that although girls scored higher grades in the subject, mothers of daughters underestimated their child's abilities compared to mothers of sons. They found that fathers were relatively accurate in estimating their child's abilities for both sexes (10). Specifically in middle and high school, a girl's mother has a very significant role in her academic interests (5). Girls who have mothers in the STEM field are 7% more likely to follow in their mother's footsteps and go into the natural sciences such as biology, chemistry or physics. In general, having a parent in the STEM field can also increase a female child's probability of pursuing a STEM 10-17% (7).

Although some of these parental influences described are positive, they can also be negative and actually deter children from pursuing courses in the STEM field. Mothers, specifically, are more likely to employ gender stereotypes onto their children that cause the differences we see in student's attitudes toward mathematics, for example (7). Parents typically have lower math expectations for girls than they do for boys. In a study done in 2003 on this topic, researchers found that family expectations caused a statistically significant difference in the female to male high math achievement ratio. This significance value was found by comparing two variables found among the top 5% 12th grade math achievements. One variable included only individual characteristics and the other included the controls for the expectations of parents. The expectations of parents were based on educational attainment, family income, the education of parents, and if the family owned a computer. The characteristics of the families were similar on average, with the only difference being in the expectations for girls and boys. Any changes seen in gender were therefore traced back to the differences in gender expectations. Researchers also found that family influences do not cause the gender differences in potential STEM college majors (7). While this study found that parents do not directly influence the decision of a child to choose a STEM-based major, the fact that they do influence performance in math can relate to the topic of self-confidence and ability.

In a study where parents were interviewed about informal STEM education, parents reported positive attitudes toward providing their children with this type of education. When prompted possible ways to do so, they responded by activities such as taking their child to science museums, enrolling them in science-based summer camps, encouraging them to join math clubs, as well as supporting them with STEM related homework assignments (11). All of

these modes of support can be implemented in families, which would in turn provide more encouragement and potentially interest in these young students.

Teacher Influences

In addition to parental influences, a child's teacher has a major impact on their academic pursuits. This influence can be thought of in terms of a teacher's method of instruction as well as their praise and critiques. One method that is shown to improve learning is a growth mindset, which looks at knowledge and intelligence as changeable rather than fixed in a certain way. Teaching children using a growth mindset has shown to improve the performance of girls on tests, specifically math, and gives them the confidence to continue learning and improving in that subject. Hill et al. (8) investigated a growth mindset versus a fixed mindset and how it played a role in academic achievement in math. The study involved two control groups of adolescents; one who was taught using a fixed-mindset message and the other who was taught with a growth-mindset message. A subsequent math test was given where girls who were taught the fixed-mindset message did significantly worse than the males in the group and there were no gender differences among the students who received the growth-mindset message (8). Applying this model early in development will help children overcome academic challenges they might face, particularly when struggling with a certain subject. For example, say a young girl encounters a troubling math class in school. With a fixed mindset and previous knowledge about the stereotype that girls are not good at math, she will simply take the easy way out and settle with the idea of never being good at math. With a growth mindset however, she will try harder to understand the subject and gain confidence in the process, resulting in more knowledge and success. Overcoming this obstacle might even make her interested in math and potentially more inclined to pursue that subject in the future. This principle would apply to boys as well, but girls

could benefit more from this type of mindset as they are at a disadvantage for academic growth when compared to boys, based on published research (8).

One way teachers can begin to encourage female STEM development is to emphasize spatial skills early on in schooling. Spatial skills are the abilities an individual has to remember spatial relations of objects, like the ability to be able to rotate or transform an object in the mind without actually seeing it physically. These skills are thought to have an importance in STEM fields such as engineering and in science courses such as organic chemistry and physics. If teachers are encouraging girls to play with different toys that incorporate spatial skill development, it could translate to more girls being interested in pursuing careers in the STEM field later on. Some ways teachers can implement this spatial skill development is to teach their students gestures, having them build structures, teaching visualization strategies, and playing matching games (8). In a study done on building blocks and the development of spatial skills, researchers found that spatial play and Block Design scores were related. The data they analyzed were from a sample for the fourth edition of the Wechsler Preschool and Primary Scale of Intelligence, focusing on the Block Design test scores and questionnaires about children's play, called the Home Environment Questionnaire (HEQ). The researchers found that children who play with 3D toys would score higher on spatial performance tasks compared to nonspatial play such as drawing (12). In this study, they found more spatial play reported for boys compared to girls, which is likely why girls need more spatial skill development since they are less likely to play with those sorts of toys. Other suggestions for early childhood would be to expose the students to science museums, focus on hands-on learning in classrooms, and enroll more females in after school activities related to STEM. Science museums can allow for these students to have

first-hand encounters with science itself. These could spark interest in these young students and inspire them to pursue and thrive in courses related to STEM (5).

In middle and high school, teachers continue to impact their students. A way in which teachers in general could promote females to pursue STEM in college could be through a mentoring program. This could incorporate female college students or female professors from STEM fields at a university who mentor young female students in middle or high school. These relationships could show young girls the potential they have in science based on real-world applications. While in high school, females should be encouraged by teachers and parents to enroll in the more difficult STEM courses such as advanced math, physics and chemistry (8). Taking these in high school will better prepare females for college and future studies in the field, since they will have faced the initial challenge earlier on. Additionally, vocational programs such as Certified Nurse Assistant (CNA) can also help females begin their career in STEM if taken in high school.

Some suggestions for helping female adolescents would be to create better relationships between schools and universities or colleges so that young girls can have networks for future endeavors, and so they can see a female in a role that they might possibly want to pursue (5). An example of this mentorship that exists today is called the Distributed Lecture Series, which is sponsored by an organization called the Computing Research Association. This series involves female professors or researchers within a certain industry visiting universities and serving as female role models and mentors (5). This allows female students to ask questions and learn about other females in the field and gives them hope that they too can pursue the same career or path.

Mentorship

An additional factor that plays a role in females pursuing STEM related majors, specifically in college, is the number of female mentors or role models at their particular university. Female college students have fewer faculty of their same gender to look up to and serve as mentors while they navigate through their undergraduate studies. In the physical sciences and engineering departments, the professors are four times more likely to be male than female (5). This is problematic because female undergraduates can benefit from having a female professor to help them through their personal struggles and give them a sense of hope and confidence in the path that they are pursuing. A study done on women in engineering showed that having female mentors promoted aspirations to pursue engineering and gave the female students a sense of belonging and confidence. This was associated with greater retention in the engineering field. They compared female mentor relationships with female students that had a male mentor or no mentor and found that overall, the male mentored students' outcomes tended to be weaker or almost the same as the control group (13). Having mentors of the same gender in one's field of study makes it easier to relate to them and is therefore more encouraging for those female students. In the specific field of biological sciences where women have shown to outnumber men in bachelor degrees earned, women faculty remain underrepresented. In a book published in 2012, women faculty in biological science only made up a third of the overall faculty (8).

While in college, professors play an important role in impacting their students. If professors can actively try to reduce any implicit biases in the classroom, it might allow for more females to thrive and gain confidence. Acknowledging these biases and discussing the issues can bring forward comfortability with the issue and possibly steps in the right direction that could

lead to overcoming them. Also, a continuation of a growth mindset while in academia can further provide females with the confidence that by working hard, they can succeed in the STEM field. Finally, by relating STEM courses to real-world scenarios it correlates to a better understanding of the subject matter which will likely lead to an increase in women's desire to pursue and remain in a career in this field (8).

Women of color in STEM are at a further disadvantage due to social, systemic, and individual factors that lead to an experience of not belonging in the field. Based on data from 2014 from the National Science Foundation, women of color represent 13.3% of science and engineering bachelor's level degrees while women overall represent 21.9%. At the doctoral level, women of color represent only 10.0% of science and engineering degrees while women overall represent 18.8%. In order to retain women of color in STEM, there needs to be safe social spaces where these women feel supported. Regarding mentorship, it is often difficult for students of color to find mentors who share their same racial identity, which causes them to feel isolated and separate from other women in their field of study (14). Ong et al. (14) explains that students of color would benefit from any supportive mentor, no matter whether or not they shared the same racial and ethnic identities as the student. As long as a mentor can form a meaningful and supportive relationship with a female student, the student will feel more confident pursuing that field.

Peer Influences

While in adolescence, females encounter more biases and experience personal thoughts about their ability that impact their future academic path. One major influence on adolescents is their peers. For girls, same-sex peers are a major influence, since girls like to follow what their friends are doing or the popular trend at the time (5). This is true for females more so than males

and is seen with gender differences in relationship development late in adolescence. Researchers concluded that females are more attached to their partners in a relationship, such as a friendship, and that this dependency is most prominent around ages 18-19 (15). In both middle and high school, a girl's decision on whether or not to take a math or science course depends on if her girl friends had previously taken it and how well they did in the course. It is not based on their male friends (5). Peer influences are also evident in the culture of the classroom, especially when in collaboration between students of both genders, whether it be a female to female or female to male working together. This collaboration provides students, particularly girls, to listen and hear other ways of working through problems, which can help them gain more confidence in STEM subjects (5).

Just as the influence of peers is critical in early adolescence, it continues to play a role through high school and college. High school is very much a social competition where adolescents are constantly comparing themselves to others. Girls often avoid the negative stereotypes of females in science by just avoiding advanced math and science courses. Keeping away from these classes reduces the chance that these girls get judged, which is very important for their social status in high school (8). Whether or not a female friend has taken an advanced science or math course influences whether a girl takes the class too or does not take it at all. In the same scenario for boys, their friends are less likely to influence their decision to take that course (5). In addition to peers influencing course selection, they can also impact student learning. This is evident through collaboration with others in high school and in college. Specifically in college, the peer culture within a department has a major effect on the student experience and if they choose to continue with that field of study. In a study conducted in 2020 on a number of college students enrolled in undergraduate STEM courses, the students were

asked to provide their perceptions of classroom experiences, one of which was the perceptions of other students. Researchers found that although men were outperformed by women in the physical and life science courses, men were still perceived to be better or equal students. In addition, men were the ones who both genders said they would seek out for help in these STEM courses (16). This shows that gender bias can have a major impact in how females view their abilities and could ultimately decrease their interest in STEM. It seems to imply that gender biases have a greater influence in pursuing a certain field than grades and interest. Having a balanced number of both males and females in every department is important for students to feel welcomed and supported.

Peers have a major impact on females in high school and college, so the main strategy to face the disparity of women in the sciences is to create more exposure to other women in the field. This could be through peer networking with classmates who are female or through role models and mentorships with female professors (5). One example of a type of peer networking is seen in organizations such as the Society of Women in Engineering, which hosts meetings and conferences where females in the field can come together. Another organization, called the Anita Borg Institution, hosts annual conferences, specifically for women in computing. This provides an arena where females in this field can meet each other and present relevant work, as well as receive advice from expert mentors in the field (5). These types of workshops are beneficial to females in various STEM careers or fields because they are able to discuss their work or other related ideas with other females who share interests. They serve as platforms where females in STEM should feel empowered and encouraged.

Self Perception

A further influence that occurs in academic development is the idea of an individual's beliefs about their abilities. Hill et al. (8) found that girls are more likely to underestimate their abilities in math than boys, even though they actually perform at the same level. As explained previously, the math scores of both girls and boys throughout elementary and middle school remained relatively similar (7). Girls also hold themselves to a higher standard than boys in regard to their academic achievement. They believe they have to perform exceedingly well since the STEM field has always been dominated by men. Due to this standard that girls hold themselves to, it deters them from believing they will succeed in the STEM field and decreases the likelihood that they pursue a career in the field, since they have the idea that men are traditionally in these roles. This lack of confidence also causes girls to engage in fewer situations where these skills and knowledge are required, further isolating them from the STEM field as a whole. Relating this idea back to a growth mindset, if girls believe they can learn and overcome an obstacle in a tough class, they will become more engaged in the subject and are more likely to succeed (8).

Another area where self perception influences women in STEM is in career or major choice. Women are less likely to pursue careers in engineering and physics compared to biology, and even less likely to go on to graduate school in those fields (1). These academic interests begin in childhood and adolescence and are heavily influenced by societal norms and gender biases. Prior to entering college, more males than females are prepared to major in STEM related fields. In 2006 it was found that out of all races and ethnicities, 29.3% of male first year students intended on majoring in STEM fields compared to 15.1% of females (8). This being said, if colleges and universities reach out to girls before, it might motivate them to select a STEM major and take more related coursework. This could persuade females if they are undecided

about a certain career or major choice, as well as provide some external confidence that a university values their participation on the STEM path (8). Since females require more external motivation than males, this method of encouragement could be influential. Additionally, a non-profit organization called Pretty Brainy was established to empower females in STEM as well as create learning that respects women as thinkers, innovators and problem-solvers (17). According to surveys, 100% of females report that the organization has increased their interest in innovation and design, and 92% report that the organization has increased their interest in science and tech (17). Encouraging young girls to participate in organizations like Pretty Brainy could potentially help boost their interests and motivation in the STEM field.

Institutional Discrimination

Women did not have the right to vote in the United States until 1920. Around 35 years later, Rosa Parks was one of the many men and women that sparked the Civil Rights Movement, which initiated many future changes for women. In 1963 the Equal Pay Act was signed and prohibited sex-based wage discrimination between genders performing the same exact job. In the following year, a law against employment discrimination based on race, religion, national origin or sex was also passed. In 1972, Title IX was passed, which prohibits sex-based discrimination in schools or any educational program accepting federal funding (18). While there has been progress made in the past 100 years, there are still gaps that are negatively affecting females in particular, for example salary differences between males and females. A study that compared the wage of men and women in the sciences found that white women in the STEM field earn around 82 cents compared to the male's dollar (19). Even further, Latina women only earn 54% of a white man's earnings (20). This is problematic because it shows how even in recent years, there

is still discrimination present between genders regarding how much they are paid for performing the same job.

While there are many factors influencing a female's pursuit of STEM careers, an individual's background plays a major role. This is due to the fact that STEM careers require such a rigorous, time intensive, and costly commitment. African American women makeup 6.4% of the total population, yet only account for 2.4% of the careers in STEM. These women experience the intersectionality of being female and being part of a minoritized group, which means they experience discrimination based on both their gender and racial identities. This intersectionality is conceptualized as the "double blind" because they are simultaneously experiencing sexism and racism while trying to pursue careers in this field. Since the historically dominated gender and race of this field is white or Asian males, this double blind concept presents a major challenge to women of color (21).

The socioeconomic status of an individual can also impact their decision to pursue biological or physical sciences. Those who come from a poor socioeconomic background are beginning their educational experience at a disadvantage right from the start. This disparity can translate into a lower achievement and attainment levels in their education which can lead to financial instability when they become adults. This financial instability is evident since people living in poverty lack the education and resources to further their education leading to a success rate lower than children who come from a more privileged background (22).

To even the playing field and begin to try to solve this barrier, institutional policies that support quality education for all students regardless of socioeconomic status need to be created and implemented in order to support these students. Focusing more on the students, there are some ways to try to counter these barriers when their institutions fail them. One possible way to

help students from low socioeconomic backgrounds could be to help them regulate their emotions and response to adverse situations. A study used this method on a large number of ninth grade students in a science course by giving students in an experimental group an opportunity to perform an exercise that helped regulate anxious and worried feelings before a test. The control group was not given this exercise opportunity. They found that 39% of lower-income students failed the course from the control group, while only 18% failed in the experimental group. The researchers explained how negative emotions can impact a student's success in a course and since science courses require big exams to test knowledge, many students feel anxious before taking them. They also explained how these tests are even more stressful for lower-income students, so intervening with their emotions could help them perform better on the exams and might provide them the confidence they need to pursue more science-related courses in the future (23).

WORKPLACE INFLUENCES

Hiring Biases

For those women who do eventually make it to careers in the STEM field, there are still additional obstacles that ultimately cause some to leave their career. These barriers often come in stages, with the first being hiring. Hill et al. (8) found that even though a male and female might have the same exact qualifications, the male is more likely to be hired over the female, implying the decision was based on gender. This gender preference is common among many different disciplines, but especially in math-related STEM fields. A study investigating biases in hiring and peer review showed that females who are applying for post doctorates had to be more productive than males applying for the same position in order to get the same peer review score

(8). This productivity can be gained through publishing more scholarly papers and shows that female applicants are underrated simply because of their gender. This can also be why there is a lower number of high achieving females in the field (8). In biological sciences, men are still dominating the field in higher level positions, although women have made tremendous progress over the years in terms of bachelor degrees earned. As of 2014, out of all the workers with doctorates in the biological, agricultural, and environmental life science workforce, 62% were males full time compared to 29% females full time (8). The authors also found that women outnumbered men 48,001 to 31,347 in the number of individuals who earned a bachelor's degree in biological sciences (8). This difference in the number of females with degrees in biological science compared to the number of females who have a full time job in the field directly shows the leaky pipeline.

Unwelcoming Environment

Women also face an unwelcoming workplace environment or social climate when they reach their STEM career. Women often feel isolated and unsupported in different STEM fields due to the idea that these jobs are predominantly thought of as a man's job. In a study conducted in 2011 that included 3700 women participants who graduated with an engineering degree, around half left their job because of a lack of promotion or low salary and a third left because of the poor work environment (24). In a field that is primarily thought of as male dominated, women feel as though they do not have a place. Additionally, many women report that their work is not taken seriously compared to male counterparts (24). This is problematic because it causes these females to lack power and influence in a role that is so critical to society today. It also limits females from moving up in their career to make institutional changes necessary to change work culture. Feeling this sense of unwelcomeness and not being taken seriously in such a role

leads to so many of these women leaving, because no one wants to pursue a career in which they will not be valued for their contributions.

Lack of Promotions

In addition to a poor workplace environment, women also often leave the workforce due to family pressures and lack of promotions. Since women invest the most in having a child, and the demand to raise a family is often put on the female, women in the STEM force who have several children are more prone to leave (7). Even further, married women with children are less likely to complete their STEM degree, pursue a career in the field, and be promoted to higher level STEM jobs (7). With each female's child, her overall wage decreases by about 5% and for each male's child, his salary increases about 4%. This highlights the stereotype that children boost a man's commitment to his work yet limits a female's (20). Women with no children make more than women with children, with a pay gap penalty of about 10-15% for women with children (25). This decrease in pay is likely due to the lack of adequate, paid maternity leave in the United States, coupled with false beliefs that children prevent women from providing to the labor market (25). In regards to academic publications, males are more likely to have their publications and fellowship applications accepted and rated as higher quality compared to females (20). The combination of these barriers are likely why females fail to be promoted as commonly as men. They are often overseen and thought of as less important or intelligent than men, and are seen as less competent when they have several children.

Another challenge women face is the idea that gender plays a role in tenure positions. In 2009 one research study compared the number of married men and women with doctorates and found that women are 35% less likely to secure a tenure-track position. One reason is due to the obligations women have to their families. Since childcare responsibilities often fall upon the

mother of the family, women are less likely to stay in their career, especially when they have young children. This is due to the lack of childcare support from many institutions, and this issue of hiring females with children can relate back to hiring biases. Men do still have a role in parenting, but when both parents face demanding work schedules and need time to care for children, women are more likely to leave their career and prioritize their husband's job over their own (8). For those who are on tenure, junior female faculty are more likely to report feelings of insufficient support of a family while at that institution (5).

Pay Gap

Like in many professions, women in STEM face wage disparity which impacts job satisfaction. This correlates to the struggle of keeping women in the STEM field since women are not making the same as males in the same position, especially in the computer and math sciences. Some of the reasons why this is true are because women entering the field are primed to expect less pay since they have preconceived ideas that men should be in this field. Another factor is that women have a lower sense of self-efficacy or belief in themselves, leading them to accept a lower pay (26). This relates back to gender stereotypes children learn while growing up, and often deters young girls from aspiring to be chemists or physicists. Delving further into the pay gap, Caucasion women in the STEM field make 84 cents to the dollar compared to their Caucasion counterpart in the exact same position. This is a smaller pay gap than the overall difference between genders of 77 cents to the dollar in similar positions in business in general. In the biological sciences specifically, women only earn 82 cents to the dollar (19).

Iceland has made a change within their economy to combat this issue of the gender pay gap. In 2018, they passed a law that requires businesses with 25 or more employees to prove that they are paying men and women equally for a job of the same value. This proof of equal pay

ensures that the company receives a special certificate. In 2020, this certificate became required for businesses to have and without it, they are subject to daily fines. This new law has shown to change women's trust in their employer (27). Implementing laws like this in other countries could also provide a more positive female job satisfaction report, and could help reduce the wage gap overall. This in turn might encourage women to pursue fields that they might have been hesitant to in the past based on certain wage differences.

Women in Medical School

Narrowing in on females in medical school specifically, women have made drastic improvements over the years. In the 1960's, women only made up 26% of the students entering medical school and in recent years have stabilized at around 53% (28). According to the Association of American Medical Colleges (AAMC), in 2019 female medical students outnumbered males 50.5% to 49.4%. While this is true, practicing male doctors still outnumber female doctors 64% to 36% (29). Comparing men and women who work full-time as physicians, both progress at the same rate to consultant positions. Consultants provide expert opinions, analysis, and recommendations based on their knowledge and skills. On the contrary, women are more likely than men to work part-time due to other obligations such as families. Also, more women are found in specialties such as pediatrics, obstetrics and gynecology, and allergy and immunology while men dominate the specialities of orthopedic surgery, neurosurgery and radiology (29). This variability of specialites shows that men are more often seen in surgical professions compared to females. A study conducted on this topic of low representation of females in surgery, and found that the reasons women either do not pursue surgery or drop out is due to an unfavorable work environment, the male-dominated culture, and societal pressures (30). According to the Economic Research Institute (ERI), orthopedic surgeons make an annual

salary ranging from $430,000 to $840,000 while pediatricians make an annual salary between $220,000 to $360,000. These differences in specialites could also likely be due to the differences in inherent personal bias about our gender role, since women tend to value family, fixed hours, and altruism while men value personal and professional success (28). This could explain why men are more often seen in surgery, since the salary is much higher than other more altruistic medical professions.

Suggestions for Improvement

There are several recommendations and programs that can be established to retain females' important roles once in a STEM related career. A major concern in this stage of STEM development is the implicit biases of colleagues, especially of males. To combat this issue, it is important for institutions to encourage employees to be aware of implicit biases and to ensure that they are welcoming to anyone, regardless of their gender or race. Creating a workplace environment that is inclusive will not only cause an increase in productivity of the institution, but also will allow for employees to have a higher feeling of job satisfaction. One study regarding job satisfaction and performance found a direct relationship between the two. Employees who reported higher job satisfaction were more likely to also perform better for the organization (31). This is important for companies to consider because if they want to be successful, their employees need to be happy. In the hiring process, blind reviews of applications can be conducted to remove the potential that gender could play a role in the final decision. For females who do have children, more support for a family work-life balance can be implemented for STEM faculty such as paid time off, daycare facilities or subsidies, and flexibility. Policies can be generated that do not penalize a woman for having a child, adopting a child, or other forms of caregiving that they could possibly be involved with (5).

CONCLUSION

A highly developed and sustainable STEM field can increase a country's sense of power and advancement in the global market. Countries that have an advanced level of intellect in the science field are able to create new innovations that boost the economy. As our world is becoming more technologically advanced, the future jobs in the United States and the world abroad increasingly fall into this field (9). The demand for highly skilled STEM experts is high in today's society, which means that the best trained individuals in the field should be valued. While this is true, women are still very much undervalued in these positions and there are implicit and explicit ways that they are discouraged from pursuing this field. This type of undervaluing is evident in the lower number of females publishing articles and acquiring fewer citations (32). It is also seen in the lack of female faculty members in STEM fields in American universities. In a study conducted in 2020, which investigated the changes in U.S. medical school faculty over the last 20 years, researchers found that the percentage of women in these faculty positions increased from 24.5% to 35.3% (33). Though the number of females did increase, it remains true that the number of white males is significantly higher in these faculty positions. In order to sustain an innovative, inclusive, diverse economy that thrives off creativity, more emphasis needs to be put on attracting and retaining women in the sciences.

The specific field of biological and medical science has seen an increase in women participants over the past 40 years; however, there remains a gap in women pursuing the highest degrees in the field and taking on leadership positions in industry and academia. Though the number of women outnumber the number of men enrolled in undergraduate college, they are less likely to pursue a career in STEM (8). Increasing the number of women in STEM fields is

beneficial because it allows for more creativity, diversity of ideas, and competitiveness. It will also give women a seat at the table when decisions about their lives as females are being considered. Additionally, having more women in this field can reduce the overall wage gap between genders.

The leaky pipeline of women in STEM is multidimensional and is not caused by one specific factor and will not be solved by one specific change. The issue stems from a history of male dominance and a system that was designed by men for men to succeed. It will take time to counteract, but there are ways to slowly combat the stereotypes. Over time, changes can be made that could eventually lead to more equality of the genders and more representation of women in the higher-level jobs. Changing this reinforcement of gender stereotypes that society continues to show will require efforts on various fronts, including the education system and the local and federal government. Without this intervention and discussion, however, society will continue to support a male-dominated success in STEM careers.

Personal Reflections

As a female who is pursuing a career in the biological and medical sciences field, I chose to research this topic to bring more awareness to past inequities and how these still exist in different forms today. I hope that this awareness will spark change and inspire and encourage young females to pursue their passions, regardless of what the popular opinion is for females to pursue in society. I also wanted to learn more about my field of study and what barriers or obstacles I might face along the way of reaching my goals.

While conducting my literature review, I found a lot of information that seems promising for new generations to come. A lot of the potential solutions to some of these institutional barriers showed me that there can be progress made in increasing the amount of women across

all STEM fields. Some of these solutions seem minor but can still make a big impact, such as early education teachers slightly modifying their class framework and methodology to implement more of an emphasis on spatial skills. Additionally, parents have a huge impact on their children, and something as simple as having a more positive attitude can change how their child performs in a STEM subject. I think that in order to start making these changes, more education and awareness about the barriers women face need to be taught first so that people can understand the challenges and therefore be more inclined to support the changes.

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