Racism in Technology: An Analysis of the History and Consequences of Racism in Tech

By Mellany Andrea Quiroz Almendarez

Summary—I will be explaining the history behind racism, analyze how it developed in the tech industry, the consequences that have followed, and in the end explain the various ways we can use to address the problem. From products failing to recognize different skin tones to blatant disregard of representation, racism is rampant in the tech industry. If we want to keep innovating, then the tech innovators that create these products must reflect all communities.

Intended Audience—Teenagers, College students, professionals in the tech industry, STEM professors and teachers, and anyone else interested in this subject.

Chosen Style Guide—IEEE Format

Racism in Technology: An Analysis of the History and Consequences of Racism in Tech (December 2020)

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Abstract— **I will be analyzing why there is a lack of diversity in the tech industry. I will begin by researching the origins of this problem by analyzing at the U.S. educational system and its "pipeline" problem, looking at the current diversity in tech, and the instances in which the technology produced has reflected this problem. I will be looking at data from diversity reports from five prominent tech companies to see their progress with diversity. Then, I discuss potential solutions from previous research and others in academia that are working to solve this problem.**

Index Terms— **Diversity, Racism, STEM, Technology.**

I. INTRODUCTION

IN this course, Technical Writing for Computer Science and Engineering, we have learned of various ways of writing, reviewing, editing, and presenting technical information. I want to explore the process that has led to a lack of diversity in the tech industry. I want to explore why it has been such a big problem for black and brown people to get into tech, hold positions of power, and ultimately have a seat at the table. Specifically, I want to examine how the lack of diversity has then produced racist, whether intentional or not, products in the tech industry. Racism might be a social construct, but it has real life consequences. From products failing to recognize different skin tones to blatant disregard of representation, racism is very much alive in the tech industry. If we want to keep moving forward, keep innovating, then the tech innovators that create these products must reflect the general population, not just white or Asian men. In order to understand this issue in its entirety, I will be exploring the history behind this problem. My research for history focuses on the educational system, which is where I believe is where the inequality begins. Then, I will be analyzing the trends and data of how diversity has either succeeded, or failed, in increasing in the tech industry. Moreover, I will be analyzing tech products that have produced racist results. Most of these incidents have been accidental, but they are results of a very real problem: racism and a lack of diversity. Also, I will be briefly going over any recent data to see if there have been improvements in diversity in the last decade. Finally, I will be discussing possible solutions that companies and individuals have created to try and tackle this problem.

With this project, I hope to bring together years of research done by other professionals who have studied this problem, especially because I have not found enough scholarly sources that specifically address the racism within tech products that have been launched in recent years. Finally, I hope the reader themselves walk away with new insights, new knowledge, and the drive to be more aware of this problem and help bring an end to this inequality. Anyone is welcomed to read this project, although I do urge my fellow Computer Scientists to take time out of their day to read this and think about their place in all of this. We all have a duty in making this world a better place.

Although I do not have a professional background in history, I am an avid fan. In high school, I got a 5, the highest score, on the Advanced Placement U.S. History Exam. I also received a certificate in Latin American and Latinx Studies from the City College of San Francisco. Currently, I am completing a minor in Latino American and Latino Studies. Thus, unless explicitly stated, I will be providing most of the historical context in this paper.

The rest of my research will be cited accordingly. The bulk of my sources are scholarly articles, but occasionally I will present personal accounts or news articles. Testimonials are great first-hand accounts to use sometimes, but as said before, the majority of my research has used academic papers, as the purpose of this paper is to analyze diversity and racism in the tech industry, as well as analyze work that has been done in this area before me.

For my research, I will be focusing on Black, Latinx, and Indigenous people. I am choosing to exclude Asian people, which prevents me from then just saying Black, Indigenous, and People of Color (BIPOC). The reason behind this is because Asian people are not underrepresented in the tech industry, Asian and white people have presented themselves to be the major faces of tech. I will also try to look at data that pertains to technical roles, the focus of my study is Black, Latinx, and indigenous engineers, scientists, IT, designers, etc.

II. A History Behind the Lack of Diversity: The Educational System

The issue of racism is deeply embedded in the United States. This country was founded on the genocide and labor from Native Americans and African slaves. In America, slavery was abolished in 1865, freeing millions of slaves across the country. However, despite their newfound liberty, former slaves were still oppressed by systemic racism that runs deep in this country. When slavery ended, segregation and Jim Crow laws followed. Jim Crow laws enforced segregation between white people and black people. Furthermore, these laws kept black people as a subordinate group since they were not given equal rights. For example, black people were not allowed to vote until the Civil Rights Act of 1964 gave them that right. Segregation was enforced in all aspects of life, and the educational system was no different. White-only schools were better funded, were given the appropriate resources, and given the best for their white students. On the other hand, "colored"-only schools were given the most minimum amount of support. In fact, History.com's page for the Jim Crow laws state that schools would give white and black kids different textbooks to learn from [1]. This problem was only worsened by racism in housing. Terry Gross explains that, in 1933, the U.S. government began segregating housing by prioritizing white families when it came to purchasing homes [2]. The Federal Housing Administration (FHA) would refuse to insure mortgages for African American neighborhoods, this policy was known as "redlining", and is the reason why even today there are neighborhoods that are segregated by racial grouping. The FHA made it illegal for African Americans to buy homes in suburban areas, claiming that the property value would go down. The FHA's *Underwriting Manual* declares, "incompatible racial groups should not be permitted to live in the same communities" [2]. This is why we see heavier policing in minority communities, less opportunities, and more impoverished conditions. And although the Fair Housing Act of 1968 aimed to dismantling this racism, by declaring that it was "OK" for African Americans to buy homes in suburban areas, the damage had been done. While white people could send their children to college with their home equities, and essentially create intergenerational wealth, minority communities were struggling to get by.

Unfortunately, we are seeing this legacy of segregation continue in the present. According to an article written by Reporter Emma Brown, students in US private schools are overwhelmingly white [3]. Private schools give more individualized attention to their students and better educational resources, as their parents are paying for top notch education. Kids living in low-income communities barely get by as they face a myriad of problems: housing insecurity, food insecurity, job insecurity, poor public-school education, police brutality, child abuse, and the list can go on and on. They are born into this word with disadvantages already, and these are all systemic problems that are literally rooted in racist policies. This is also known as the pipeline problem, in which pre-determined factors such as their living conditions contributes to a student's success, or failure. In his article, *Bias in Technology*, by Gregory Mone, he explains that the talent is there, but underrepresented students do not receive the same resources their more privilege counterparts receive [4]. Gregory Mone also reached out to several academics to ask them about their experienced in the educational system. One of them was Ann Quiroz Gates, chair of the Department of Computer Science at the University at El Paso. Gates says that many skills companies look for in students can usually be acquired outside of school, however finding the time to catch up to their more privileged peers can be exhausting, especially if student's have other commitments [4]. Personally, I have spent college not only trying to stay on top of school, but also be a mother figure for my little sister and work part-time jobs whenever I can. Furthermore, Kinnis Gosha, an assistant professor of computer science at Morehouse College, notices that those students who were attended high schools with Advanced Placement courses have a "tremendous" head start. He goes on to say, "A student able to take that class and do well is a year or more ahead of the others. But Gosha notes, "In the Atlanta public school system there are only two high schools that offer the A.P. Computer Science course" [4]. Unfortunately, this is a problem that has been persisting for decades, and is happening in impoverished communities across the country.

III. The Consequences of Racism in the Tech Industry

We will be discussing and analyzing different racist incidents that have happened with tech products in the last fifteen years. I will be going in reverse-chronological order, with the most recent incidents first and the older ones later in this discussion. This past year, we have seen, and perhaps been involved in, the fight against white supremacy and anti-blackness. Following the brutal death of George Floyd, many have taken to the streets demanding justice as well as examining our race relations in this country. In, *Amazon "Stands in Solidarity" Against Police Racism While Selling Racist Tech for Police*, Sam Biddle writes for The Intercept on Amazon's hypocrisy regarding this year's civil unrest over racism [5]. During the protests that began in mid-May, Amazon tweeted a vague message of support:

Amazon's tweet in support of the Black Community [5]

However, Biddle reports that Amazon is expanding its public/private video surveillance dragnet across the country with an "anti-crime" mission [5]. In 2018, the ACLU published a report that Amazon's "Rekognition" facial recognition software had racial bias ingrained it. Furthermore, Biddle reports that in ACLU's test, Amazon's facial recognition software would misidentify black members of

Congress as people who were arrested and had a mugshot in police databases [5]. The report reads, "The false matches were disproportionately of people of color, including six members of the Congressional Black Caucus, among them civil rights legend Rep. John Lewis (D-Ga)" [6]. The report goes on to say, "Nearly 40 percent of Rekognition's false matches in our test were of people of color, even though they make up only 20 percent of Congress." One can quickly see how this software is life-threatening, innocent people of color can be caught up in violent interactions with police who might believe them to be who the software says they are. This is only made worse by the rampant police brutality that people of color are already subjected to, Rekognition will only worsen things with its racist flaw. Computerized misidentification is not only an academic error but a fatal error too if it inappropriately influences a police officer's actions with false criminal backgrounds.

If Amazon is truly in solidarity with the Black community, it needs to remove Rekognition from law enforcement use until this type of technology is biasproof. In situations where someone's life can be on the line, a person's life should not be in the hands of flawed artificial intelligence. Amazon must stop selling facial recognition software technology that worsens police brutality. These horrific findings only paint a darker picture. This type of software could possibly lead to it being used to suppress and identify protesters. When Sam Biddle reached out to Amazon and asked to what extent do the police use Rekognition for, he received no response from them [5]. The lack of transparency only makes this an even more dangerous product.

In 2015, Mone states that Google's facial recognition software for Google Photos "sorted images of one user and her African-American friend into an album labeled "Gorillas" [4]. He also discusses an incident in where a white man and his African American friend recorded a video of themselves testing electronic soap dispensers at an Atlanta Hotel. They did this because this because the device wouldn't dispense soap to the African American friend, it essentially would not register the presence of his black skin.

This problem doesn't stop at racist technology, it affects people as well. In November 2017, a group of twenty low-income, mostly Latinx students, were kicked out of the Dreamforce conference in San Francisco, report Joe Rodriguez for the San Francisco Examiner [7]. These students were members of a non-profit, dev/Mission, which teaches coding and hardware skills to underrepresented youth. Although they were invited by Salesforce, a pair of security guards singled them out from the conference for not looking like the usual participants who attend these events. The security guards accused them of having "fake badges" and allegedly told some of the youth, "You don't belong here." Although this isn't a tech product, this was an instance of racism at a high-profile technology conference held by Salesforce, a prominent tech company in San Francisco. Salesforce is hard to miss, especially with their new 1,070-foot Salesforce Tower.

IV. THE CURRENT STATE OF DIVERSITY IN TECH

For this portion of my research, I wanted to use the San Francisco Bay Area as the focus of the current state of diversity in the tech industry. Born and raised in San Francisco, I have seen first-hand the rise of gentrification with the tech boom from the nineties. Ironically, the Bay Area is known to be one of the most diverse and progressive areas in the U.S., but also it is argued to be the Tech capital (San Francisco) of the nation. Back in 2014, Global Head of Diversity at Facebook, Maxine Williams, wrote, *Building a More Diverse Facebook*, making Facebook the first big tech company to publish a diversity report [8]. Other companies have followed suit and have produced their own diversity reports as well. For my research I selected five companies that have consistently published diversity report and those being Facebook, Microsoft, Apple, Twitter, and Amazon. I took into account the number of employees as well as their influence among the general public. I wanted to have two extreme cases, those being Amazon and Twitter, and then three companies with relatively similar figures, those being Apple, Microsoft, and Facebook.
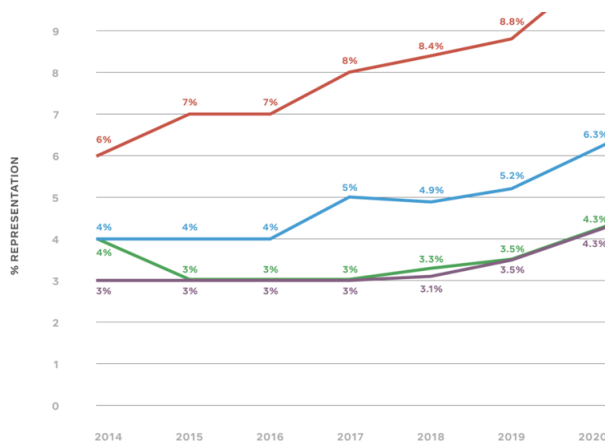

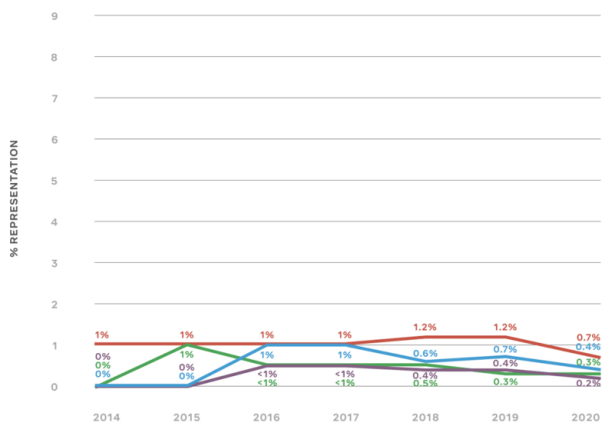Number of Employees at each company.
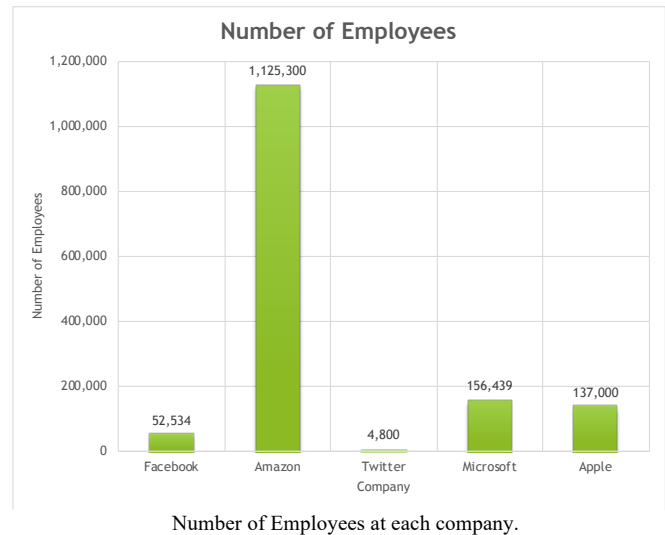
A. Facebook

Facebook's diversity report shows underwhelming progress. Below are the statistics of Black, Latinx, and Indigenous workers in technical roles:
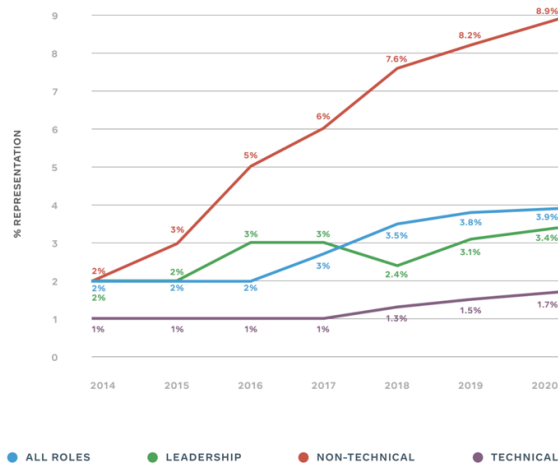
Black technical employees at Facebook [9]

Hispanic technical employees at Facebook [9]

"Additional Groups" employees at Facebook [9]

For my research, I am focused on looking at the diversity in Technical roles, as those are roles such as engineers and IT. Facebook's 2020 Diversity Report paints a bleak picture. In six years, Black technical employees have only increased by

0.7%, while Hispanic technical employees have only seen an increased 1.3% [9]. Unfortunately, Facebook lumped indigenous people with other minority groups in an "Additional Groups" label. However, this doesn't look good for Facebook either way since these "additional groups" have only seen a decrease in technical roles, and this is as multiple groups lumped together.

B. Microsoft

Microsoft's diversity report offered a more detailed picture:
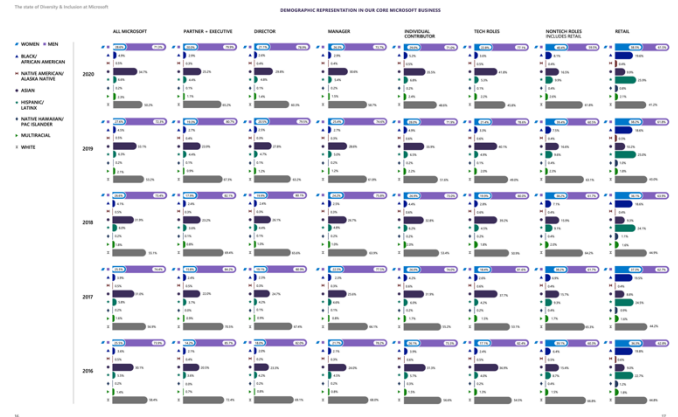
Demographic Representation at Microsoft [10]

Their data begins in 2016, which is when they released their first diversity report. Again, I will be looking specifically at the Technical roles. Since 2016, Black people in technical roles increased from 2.4% to 3.6%, an 1.2% increase. Hispanic people in technical roles increased from 4% to 5.3%, an 1.3% increase [10]. Native Americans in technical roles remained unchanged at 0.5%, however it had increased by 0.1% before going back to 0.5% in 2020.
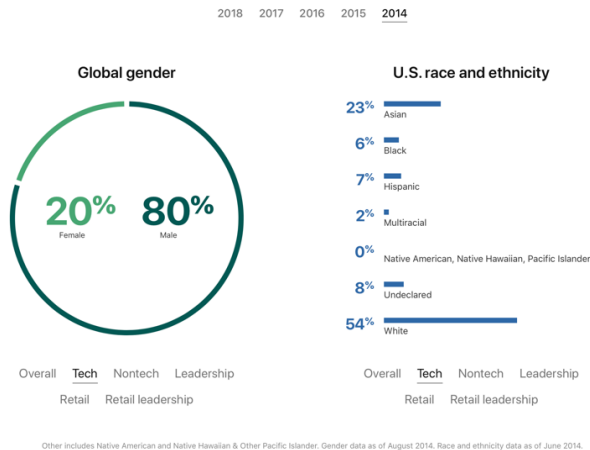
C. Apple

Apple's diversity report that is available to the public is somewhat outdate. However, on their website Apple claims:

"Our most recently filed Federal Employer Information Report EEO-1, representing employees as of December 2018, is available for download below. We make the document publicly available, but it's not how we measure our progress. The EEO-1 has not kept pace with changes in industry. We believe the information we report elsewhere on this site is a more accurate reflection of our progress toward diversity." [11]
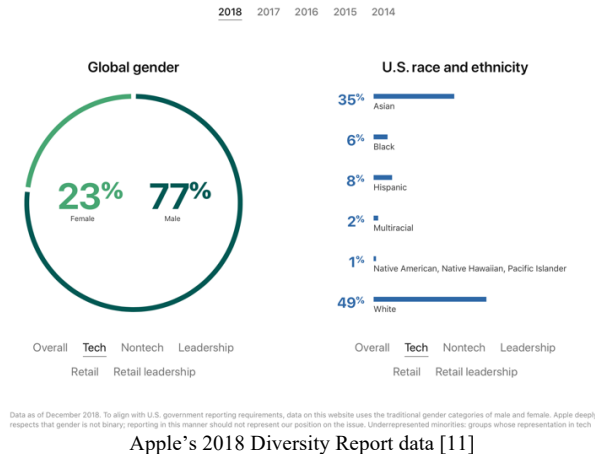
Below are the comparisons between their first diversity report, and their 2018 diversity report:

A look at the last five years.

2018 2017 2016 2015 **2014**

Global gender

20% Female 80% Male

Overall Tech Nontech Leadership
Retail Retail leadership

U.S. race and ethnicity

23% Asian
6% Black
7% Hispanic
2% Multiracial
0% Native American, Native Hawaiian, Pacific Islander
8% Undeclared
54% White

Overall Tech Nontech Leadership
Retail Retail leadership

Other includes Native American and Native Hawaiian & Other Pacific Islander. Gender data as of August 2014. Race and ethnicity data as of June 2014.

Apple's 2014 Diversity Report data [11]

A look at the last five years.

2018 2017 2016 2015 2014

Global gender

23% Female 77% Male

Overall Tech Nontech Leadership
Retail Retail leadership

U.S. race and ethnicity

35% Asian
6% Black
8% Hispanic
2% Multiracial
1% Native American, Native Hawaiian, Pacific Islander
49% White

Overall Tech Nontech Leadership
Retail Retail leadership

Data as of December 2018. To align with U.S. government reporting requirements, data on this website uses the traditional gender categories of male and female. Apple deeply respects that gender is not binary; reporting in this manner should not represent our position on the issue. Underrepresented minorities: groups whose representation in tech

Apple's 2018 Diversity Report data [11]

Based on the data above, there has been no apparent increase in the amount of Black people in technical roles. For Hispanic workers in technical roles, there was an increase of 1% in the span of four years. The same goes for Native Americans, who only increased by 1% and that isn't mentioning the fact that they are grouped in with Native Hawaiians and Pacific Islanders [11].

D. Twitter

Twitter's diversity reports were harder to find, but the following data offers a similar pattern to the previous data from the other companies:

US ethnicity

All roles Technical roles Leadership

34.4% White
35.8% Asian
5.4% Black

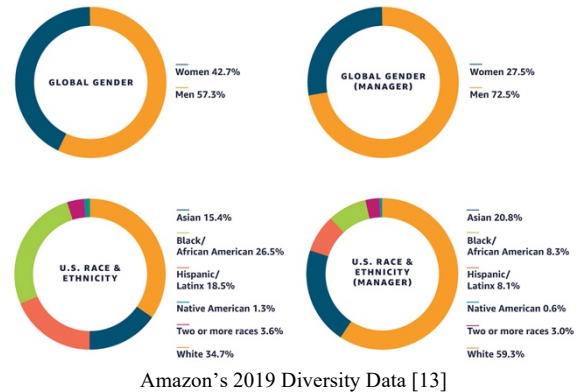4.5% Latinx
3.4% Multiracial
<1.0% Indigenous

Twitter's 2020 Diversity Report data [12]

Twitter's data is consistent with the data from the other companies. Once again, Twitter explains their Indigenous label as follows: '"Indigenous" includes Native American, Native Alaskan, and Native Hawaiian/Pacific Islander populations.' [12]

E. Amazon

Amazon's case is slightly different. Only recently did Amazon agree to start releasing EEO-1 reports. The following is the data they have on their website:

GLOBAL GENDER
Women 42.7%
Men 57.3%

GLOBAL GENDER (MANAGER)
Women 27.5%
Men 72.5%

U.S. RACE & ETHNICITY
Asian 15.4%
Black/African American 26.5%
Hispanic/Latinx 18.5%
Native American 1.3%
Two or more races 3.6%
White 34.7%

U.S. RACE & ETHNICITY (MANAGER)
Asian 20.8%
Black/African American 8.3%
Hispanic/Latinx 8.1%
Native American 0.6%
Two or more races 3.0%
White 59.3%

Amazon's 2019 Diversity Data [13]

There are problems with Amazon's data. First, there is no data specifically looking into the diversity within technical roles in the company. Managers can be from every sector of their workforce, so I will not be looking to closely at this. However, their overall diversity is actually close to the previous data we have seen, and overwhelmingly white. Amazon's poorly written data report only shows just how behind we are on progress, this should have been the standard decades ago, not just now.

In general, these numbers are troubling. Even though it was the largest company I looked at, it had the vaguest data and did not fare better than the others. On the other hand, Twitter was the smallest company, and its data was consistent with everyone else's numbers. Despite the differences in employee numbers, their diversity data paints a similar picture across the board: There is a lack of Black, Latinx, and Indigenous people in technical roles. Furthermore, this is troublesome because is are these numbers consistent across most tech companies? If so, the tech industry has a lot of work to do if they truly want to make their companies more diverse and tackle racism.

V. DISCUSSION ON FIGHTING BACK

In recent years, many in academia have sought to research the lack in diversity, find out why it's happening, and point out the flaws in our institutions as well as propose different solutions. From the data we have just reviewed previously, the conclusion I have come up with is that change is not happening enough. It is actually very worrisome that it is taking so long to see any change. From the data, there have been increases no larger than 2% in the span of years. My discussion will be separated in subsections regarding different solutions from different sources I have read and reviewed. I will also provide my own proposed solutions that I have researched outside of academic articles.

A. The Diversity–Innovation Paradox in Science by Hofstra et al.

Hofstra et al's study is based upon previous work done on the subject. Hofstra et al focuses on the diversity paradox, which they define as, "Diversity breeds innovation, yet underrepresented groups that diversify organizations have less successful careers within them." [14]. Similar to Bernard and Cooperdock's research, they want to see if this holds true in their area of interest: scientists. The way they conducted their research was by collecting data of US doctoral recipients from 1977 to 2015 and seeing if this translated into them attaining faculty positions and publishing work. Again, this is similar to the approach taken by Bernard and Cooperdock, however their methods of attaining this data was different. Hofstra et al use text analysis and machine learning to answer the following questions: How can they detect scientific innovations? Are underrepresented groups more likely to generate scientific innovations? And are the innovations of underrepresented groups adopted and rewarded? Their study shows that indeed, diversity does breed innovation. Simply put, scholars from underrepresented groups have experiences that differ from "groups traditionally represented." Hofstra et al go on to add that because of this, "historically underrepresented groups often draw relations between ideas and concepts that have been traditionally missed or ignored [14]. Then the goal of their research becomes answering the question as to why this paradox arises. When collecting data, they used ProQuest dissertations, which Hofstra, et al say "includes records of nearly all US PhD theses and their metadata from 1977 to 2015: student names, advisors, institutions, thesis titles, abstracts, disciplines, etc. They then cross-reference the dissertations with the US Census data and Social Security Administration data in order to form the demographic on students' gender and race. To measure scientific innovation, they identify the set of scientific concepts being used in their theses. Hofstra, et al. does this by using natural language processing techniques of phrase extraction and structural topic modeling to identify meaningful concepts through millions of documents. Ultimately, when this process is done, they have links between these scientific concepts. The following figure is of their findings, and how they present it to their reader:


Hofstra, et al. [14]
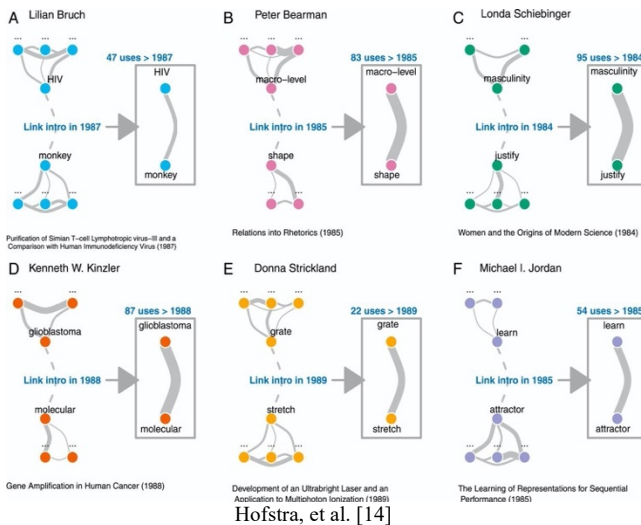
Above, the nodes represent concepts, and the link thickness represent the frequency of its usage by multiple PhD students. Furthermore, the dotted lines represent when students have introduced new links with their work. Overall, these show the introduction of innovations and the uptake that follows. This is a unique way of displaying their data, and in general show that their study took a different direction. The audience they have written up their research for are fellow scholars who are knowledgeable in these fields. For my project, this wasn't an article that should be worth following its format for. My project will be an accessible one, one that everyone and anyone should be able to read and learn from. Hofstra, et al. do however show us the various ways scholars can use technology to their advantage. There has hardly been any research done like this before, and one can hope that others take note and creatively figure out different ways to research this issue. After their discussion, Hofstra, et al. go into detail about their methods of concept extraction from the dissertations they reviewed. They acknowledge that not all terms would be meaningful so they "set out to define the latent themes in our corpus of dissertations and the most meaningful concepts in every theme." They then go into further detail of the technologies used. To summarize, they are checking what concepts are introduced by students and which are then linked to work done after it was first introduced. Their research effectively goes through documentation to then produce links between concepts as well as marking which PhD students then go on to become faculty at universities or do not continue their career in research after attaining their PhD. In other words, careers are their outcome variables. Hofstra, et al. show us that there isn't just one way of getting results, and that we can apply technology to almost any problem at hand.

B. Inside the Double Bind: A synthesis of Empirical Research on Undergraduate and Graduate Women of Color in Science, Technology, Engineering, and Mathematics, Maria Ong, Carol Wright, Lorelle Espinosa, and Gary Orfield

Maria Ong, Carol Wright, Lorelle Espinosa, and Gary Orfield analyze nearly forty years of data on the postsecondary academic experiences of women of color (WOC) in science, technology, engineering, and mathematics (STEM). They call the recruitment and retention of WOC "a critical challenge facing the nation." Similar to my research, they begin their introduction by starting at what they believe is the root of the problem: the failure to properly fund K-12 STEM education. Their main goal is "to fill the gap in the knowledge base by synthesizing disparate research about the individuals who traverse the double bind and the programs and institutions with which they interact..." They believe that by filling this gap of knowledge, they will give those in the field with the knowledge of which factors are more successful in helping WOC get into and stay in STEM. Not only did they compile nearly forty years of information in order to publish their research, but they also note that they offer their research as a "comprehensive agenda" that will help expand this field of literature in the future. Furthermore, Ong, et al. take a national approach, stressing that diversity and closing the gender gap is important because "failure to advance the education of women of color and move

them into productive STEM careers represents a failure of the United States to maximize our own talent pool at a moment when we can ill afford it-socially, technologically, or economically." Additionally, they also note that in recent years, more women than men are going to college. However, even though this might seem like progress, their research aims to answer why we are not seeing faster changes. In their own words, "America's scientific community should reflect its population at large", but unfortunately this problem just gets worse at the doctoral level. I have attached below the data figure they use to display this disparity:

FIGURE 2   *2006 female U.S. population (ages 25–44) and STEM PhD recipients for selected racial/ethnic groups*
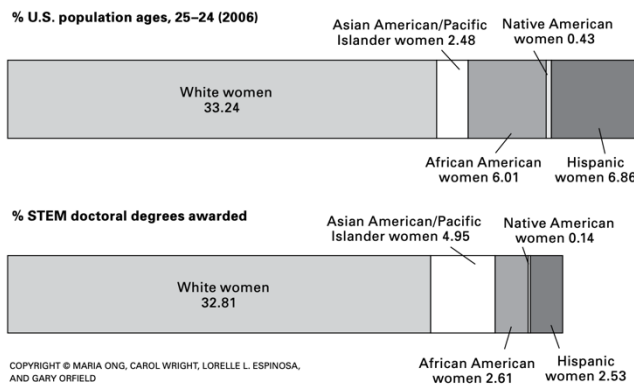
Ong, et al. [15]

For the most part, they use graphs and tables to show the data they are using, which is readable and what most people are familiar with when looking at data. In their study, Ong, et al. make it clear that the reason for the lack of women of color in STEM is due to its direct link to "important historical and contemporary issues of social justice in the U.S. education and employment systems" [15]. The first time this problem was acknowledged was in the Advancement of Science (AAAS) 1976 publication *The Double Bind: The Problem of Being a Minority Woman in Science*. This previous research serves as the basis and inspiration for Ong, et al.'s work since they are not the first ones to define the "double bind." The "double bind" refers to the "unique challenges minority women faced as the simultaneously experienced sexism and racism in their STEM careers" [15]. As they explain the research that came before them, they do well in linking it to historical events of the time, for example noting that it wasn't a coincidence that this publication was published amid the second wave of feminism in the 1970s. Just like Hofstra, et al., they also believe that minority's women's backgrounds and experiences can bring new approaches and ways of innovating in STEM. This will only benefit everyone, not just those in academia but all Americans that will benefit from technological advancements. Ong, et al.'s work is divided into two main sections: undergraduate v. graduate school experiences. To them, analyzing their research by separating it this way "most closely reflected the categorizations commonly found in a majority of the empirical research documents" [15]. This approach is safe and easy for the reader to understand, as it tries to keep the data it has found in its original form. For the

undergraduate section, they want to disprove the argument that there is a lack of women of color in STEM due to a lack of interest in these field. Ong, et al. present the factors that contribute to the retention of women of color in STEM as follows: STEM enrichment programs, personal relationships and influences, a sense of academic self, individual agency and drive, and finally the overall climate in STEM learning environments for women of color. Then, their graduate section highlights how the first years of graduate school are critical points in which women of color might drop out of pursuing higher degrees in STEM. For this section, important factors are funding issues, mentorship and role models, faculty influences, graduate training and networking, family support, outreach, and once again STEM climate. Their method for data collection was to find relevant reports and papers across multiple levels of STEM education and careers: undergraduate. Graduate, postdoctoral, early entry, midcareer, and leadership positions. Ong, et al. used forty-eight electronic databases, clearinghouses, dissertation indexes, and Internet search engines. Additionally, they sent more than 125 calls to national conferences and special interest groups working in areas of gender, sex, culture, race, and STEM. They also sent direct inquiries to STEM organizations, journal editors, and researchers who study the topic of women of color in STEM. Although Ong, et al. researched extensively, they did find some limitations in their study, such as not including materials in K-12 education and not taking immigration as a factor for their research. The rest of the body of their study focuses on the different factors of the two sections that were detailed earlier. They show concrete evidence that refute the claim that women of color are not as interested as other groups in pursuing an education in STEM. For example, Ong, et al. present evidence that women of color are just as interested in pursuing STEM as other groups. Another finding of their study is that the STEM climate is crucial in encouraging women of color to stay in STEM. Lastly, they also did not find it surprising when they concluded that STEM Enrichment Programs usually always benefit women of color. Research also suggests that women of color seek out academic and personal support constantly, so support from loved ones and mentors is crucial in their retention in the field. Another interesting find, one that many aren't aware of, is that the top five highest producers of Latinx female STEM bachelor's degree recipients are all Hispanic Serving Institutions (HSIs). Ong, et al. also found out that between 1980 and 1990, the majority of the top fifty undergraduate institutions that produced African American female doctoral recipients in STEM where Historically Black Colleges (HBCUs). After analyzing all of the factors they listed under the two categories, Ong, et al. proceed to their conclusion and recommendations. Their conclusion summarizes the different findings that came out of their research. They also acknowledge the cross-cutting research gaps that their synthesis revealed, however it would have been easier to have just said "intersectionality." They discuss about the future of this area of research and what other areas need further research, such as current discriminatory practices. Like many other articles in this area of research, their study began out of the want to advocate, to actually do something. Ong, et al. say it best themselves, "We must utilize our collective knowledge

1. Deliberate practice that emphasizes highly focused efforts in improving performance, feedback, exercises, and repetition
2. A culture of inclusion in which students are treated with dignity and respect, communicating confidence in students' ability to meet high standards, and showing a genuine interest in students' learning and personal growth.

These two key elements aim to answer most of what hinders underrepresented students. They provide solutions to improve the gap while also bolstering students' confidence. Their emphasis on the roles of instructors is extremely important, not just as the teaching figure but as the one to give them the confidence they need. Both of these elements are the basis of the heads-and-hearts hypothesis, although Theobald, et al. recognizes that extensive research should be done on this hypothesis as it would greatly benefit discipline-based education research. It was helpful to see the mathematical formulas and procedures they used when measuring their data, and their explanations of their processes was helpful in further understanding their calculations. Their study highlights something unique that the other ones didn't take into account as much: the power of love and human connection. Humans are social beings, and especially during times of hardship, we must remember to support each other and our communities.

C. Active Learning Narrows Achievement Gaps for Underrepresented Students in Undergraduate Science, Technology, Engineering, and Math by Theobald, et al.

Theobald, et al. study the effects of actually implementing solutions to combat the diversity problem in STEM. Prior research shows that achievement gaps increase income inequality and decrease diversity in the workplace. The data they collected were exam scored and failure rates in a wide array of STEM courses taught by the same instructor. Also, they collected data from both traditional lecturing and active learning and analyzed how different teaching methods affected underrepresented minority and low-income students. Like the research done by Ong, et al., Theobald, et al., found that underrepresented minority students start college with the same level of interest in STEM as their overrepresented peers. However, over time their completion rates drop, and this is also reflected when studying low-income versus higher-income students. For their study, Theobald, et al. tested their hypothesis by conducting a comprehensive search for both published and unpublished studies that compared the performance of underrepresented students to their overrepresented classmates. They collected data on student examination from fifteen studies, which collectively studied 9,238 students. Also, data on student failure rates was collected from twenty-six studies, which collectively studied 44,606 students. Theobald, et al. used Bayesian regression analysis to find out that on average, active learning reduced achievement gaps in testing scores by 33% and narrowed gaps in passing rates by 45%. They found it important to note that classes that implemented high-intensity active learning narrowed achievement gaps. This supports the call to replace traditional lecturing with evidence-based, active-learning course designs across STEM and suggest that innovations in instructional strategies can increase equitable teaching across the board. Their results indicated that active learning's beneficial impact on the probability of passing a STEM course is greater than its impact on exam scores. Grades in most STEM courses are largely driven by exam scores, even in active-learning classrooms. However, Theobald, et al. recognize that active learning is not the one and only solution, but just one of many that one can use. They acknowledge that in some studies that they analyzed; active learning actually hindered some students instead of helping them. This is a reminder to scholars everywhere that absolutes are nearly impossible, there could be results that contradict what we might be looking for. Furthermore, they add that the support of faculty and the educational administrations is crucial in ensuring underrepresented students feel capable of succeeding in STEM. Based on their research, they have proposed two elements they believe are key to helping underrepresented students succeed:

D. Other solutions

I came across interesting solutions that can be used by companies looking to increase diversity. Stanford University emerita in organizational behavior, Margaret Neale, proposed that we should be looking at both hiring and retention [17]. She believes that finding a mentor within the company can help black and brown tech workers remain at companies. Representation can be a powerful thing; we have seen it when Black Panther released in theatres or when Barack Obama became president. I was part of a software engineering fellowship at Uber from April 2019 to December 2019. They supported us by pairing us with a mentor of color, taking us to talks with engineers of color, and networking events with their inclusion initiatives. This tremendously helped me, my mentor was a woman of color who was a software engineer. It definitely made me think, "I feel safe with her, I see myself in her, I can be her!" Margaret Neale goes on to say:

"We see the same kind of diversity reports from a variety of different tech companies, what you see very clearly is that there's very little change," she said. "There continues to be hiring, but there's not stickiness to those hires. There's a substantial shedding of folks of color at much higher proportions given the total numbers that exist." (remember to cite)

This can become another viable solution, should tech companies choose to implement similar mentorship programs and practices at their companies. This solution closely resembles Theobald, et al's suggestions to help underrepresented students get into and stay in STEM [16]. We

must not only make a commitment to getting black and brown people in these companies, but to keeping them there.

Many companies are beginning try and speed up their commitment to diversity by creating campaigns and other opportunities for underrepresented people. For example, Microsoft CEO Satya Nadella pledged to donate $1.5 million to different social justice organizations as well as using the company's platform to give to its Black workers [17]. Microsoft is just one of the many companies that are starting to financially invest and implement diverse solutions to battle this problem. However, it is vital that these solutions then reflect real changes to the diversity in the tech industry.

VI. CONCLUSION

Technology is our new obsession. Rightfully so, technology has paved the way to new innovations that benefit people all over the globe. However, this can't be done when those making these products do not reflect the general population. We are seeing very slow progress in tech at the moment. Yet, more and more of these companies are trying to reach out to underrepresented workers in different forms, from mentor programs to diversity initiatives for their hiring processes. This work is important to me because I have been struggling with this for some time. I am a queer Latina studying Computer Science. I am the first in my family to attend college and will be the first to graduate, and yet I am feeling scared. I have endured the whiteness of my major for four years, and I know I will have to endure it in the workplace soon as well. I want to feel safe and have a voice at the table at whatever tech company I end up. I also want to feel supported by others who look like me, who have shared similar experiences as me, who understand me and my culture. I know I am not the only one that feels this way. I know that I won't be the last one to feel like this, so this is where my research stems from, it stems from a love for my community and the potential it has to do amazing things in technology. I know that there still needs to be aggressive change in this industry. I hope that this research makes the reader think about racism, bias, and how it is manifesting in the tech industry. I hope that the reader feels motivated to help combat this problem. Educate yourself, educate others, and be the change you want to see in this turbulent world. Academia and corporations need to continually deliver efforts necessary to see change. As Dartmouth student Kaya Thomas puts it, "If you never see anyone who looks like you in a space, it's a challenge for you to be in that space. But if you can see it, you can be it."

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