Women in STEM: A Lesson in Perseverance

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Abstract

Inder Verma was a notable biologist at the Salk Institute who made significant contributions in the field of cancer biology during his time there. What is perhaps even more notable is that it took nearly four decades for his numerous accounts of sexual misconduct against his female colleagues and students to come to public light, and as a result, consequences to be decreed.

He is but one example out of hundreds of men in STEM academia who have used their status and privilege to exploit women under their guidance and/or influence. Though the #MeToo movement has finally exposed the magnitude, breadth, and uniformity of the female experience of sexual misconduct globally, and ushered in a certain perspective shift in the way perpetrators of sexual misconduct are viewed, the playing field is still woefully uneven--women still must cope with the daily hazards of unearned male dominance. Women suffer financially, psychologically, and physically, especially in environments where men still dominate the field. The National Academy of Sciences reported in 2018 that the rate of sexual harassment in STEM is second only to that of the military.

“Women in STEM: A Lesson in Perseverance” explores different facets of sexual misconduct, harassment, and discrimination in STEM academia through data to highlight how the environment has protected perpetrators of sexual misconduct, and therefore facilitated a self-perpetuating gender gap to this day. By combining insights from a database of publicly reported academic misconduct cases, reports from investigative journalism, and gender metadata pulled from scientific journal databases, it provides a comprehensive view of the harsh environment for women in STEM. I hope that insights from the visualizations resulting from this project will buoy and increase efforts in advocacy for women’s rights both in and out the STEM field, as well as recognize the resilience and significance of women who have pursued and are pursuing careers in STEM.

Introduction

"He held the dreams of many people in his hand," Joan Iluzzi, prosecutor for the Harvey Weinstein trial in New York, stated. "He saw no limit to what he could take, no desire he could not grant himself. The young struggling dreamers were not even people to him."[1] Since the New York Times first published investigative reports of some of his sexual assault allegations in late 2017, more than 90 women came forward to accuse him of sexual misconduct. After decades of using his power in the film industry to sexually manipulate women, Harvey Weinstein was sentenced to 23 years in prison on March 11, 2020.

Sexual harassment, misconduct, and discrimination carry strong consequences beyond the already significant physical and mental damage it causes to the receiver of those actions. More often than not, these actions signify a power imbalance—"sexual harassment makes all forms of women's work into a form of prostitution: forced trading of sexual access for economic survival," writes Catharine MacKinnon, Professor of Law at Michigan Law and pioneer of the legal claim of sexual harassment. [2] They deprive women of what has been granted to men without question: equal opportunity, representation, and control over their own bodies and careers. This is precisely what made Weinstein's treatment of women from his position of power so damaging.

The beginning of the #MeToo movement in 2017 significantly jumpstarted activism calling for accountability from perpetrators of sexual harassment and assault, and a more just and receptive system to deal with these matters. Weinstein's trial is a resounding success that resulted from this movement. Progress has been made in improving the environment for women in all sectors of society, or at least visibility of the efforts to do so--many other prominent figures have been exposed, and institutions are being forced to address how to better respond to these incidents.

Even in the STEM sector, where the National Academy of Sciences reported in 2018 that the rate of sexual harassment in STEM is second only to that of the military, small steps are being taken to right these wrongs.[3] In the momentum of the #MeToo movement, several high profile academic professors have been ousted due to very public investigative reports. For example, Inder Verma, a renowned cancer biologist, resigned from the Salk Institute and as editor in chief of *Proceedings of the National Academy of Sciences* (PNAS) after four decades of sexual harassment incidents implicated to his name. However, the field is still far from equal: In the course of this thesis, I will go over different facets of sexual misconduct, harassment, and discrimination first in the broadest scope of society, then focus on the impact in STEM fields, and finally in STEM academia. Our historical track records overwhelmingly indicate that the environment has largely protected perpetrators of sexual

[1] Jan Ransom, "Harvey Weinstein's Stunning Downfall: 23 Years in Prison ...," The New York Times, accessed March 18, 2020, https://www.nytimes.com/2020/03/11/nyregion/harvey-weinstein-sentencing.html.
[2] Catharine A. MacKinnon, "Where #MeToo Came From, and Where It's Going," The Atlantic (Atlantic Media Company, March 24, 2019), https://www.theatlantic.com/ideas/archive/2019/03/catharine-mackinnon-what-metoo-has-changed/585313/.
[3] "Sexual Harassment of Women: Climate, Culture, and ...," 2018, https://www.nap.edu/catalog/24994/sexual-harassment-of-women-climate-culture-and-consequences-in-academic.

misconduct, and facilitated a self-perpetuating gender gap to this day. It is imperative that we bring to light the magnitude and prevalence of this problem, repeatedly, until sufficient action has been taken, and equally important to recognize, empower, and promote the women who have persevered through these harsh environments to be the successful women in STEM that they are today. It is only through persistent education, reflection, and action that we can hope to equalize the STEM field, and society in general, for women of the future.

Background

Exposing the sexual misconduct, harassment, and discrimination ingrained in today's society

It is now almost three years since the #MeToo movement sparked a global phenomenon that changed the cultural landscape of how we perceive sexual misconduct. A term originally coined in 2006 by civil rights activist Tarana Burke, #MeToo reemerged on Twitter in October 2017, where actress Alyssa Milano used it as a hashtag to highlight sexual abuse by the Hollywood titan Harvey Weinstein. With this, she called out for fellow survivors of sexual violation to step forward and join in highlighting similar experiences. What ensued was nothing short of extraordinary--by sheer number and persistence, the voices of women were finally being legitimized in the public lense. Bill Cosby was sentenced to three to ten years in prison in April 2018, after being found guilty for drugging and sexually assaulting former Temple University employee Andrea Constand in 2004.[4] Harvey Weinstein was sentenced to 23 years in prison on March of 2020, for first-degree criminal sexual act and third-degree rape.[5] For each of these cases, dozens of women raised their voices to accuse the men of sexual misconduct (more than 60 for Cosby, more than 90 for Weinstein). There was incredible media coverage on sexual misconduct, not only in a conciliatory tone of defending the perpetrators, but in at least neutral and oftentimes accusatory perspectives. In the New York Times, the number of articles that mention sexual harassment spiked in the wake of the #MeToo movement: the number has tripled from 2016 to 2017, and quadrupled from 2016 to 2018.[6] We are at last in an era where sexual harassment is at last being portrayed by mainstream media as less epidemic than endemic, less isolated than pervasive.

[4] Graham Bowley, "Bill Cosby Assault Case: A Timeline From Accusation to Sentencing," The New York Times (The New York Times, April 25, 2018), https://www.nytimes.com/2018/04/25/arts/television/bill-cosby-sexual-assault-allegations-timeline.html.

[5] Jan Ransom, "Harvey Weinstein's Stunning Downfall: 23 Years in Prison ...," The New York Times, accessed March 18, 2020, https://www.nytimes.com/2020/03/11/nyregion/harvey-weinstein-sentencing.html.

[6] New York Times API.

Fig 1. Alyssa Milano's text that ignited the #MeToo movement in 2017 (Twitter)

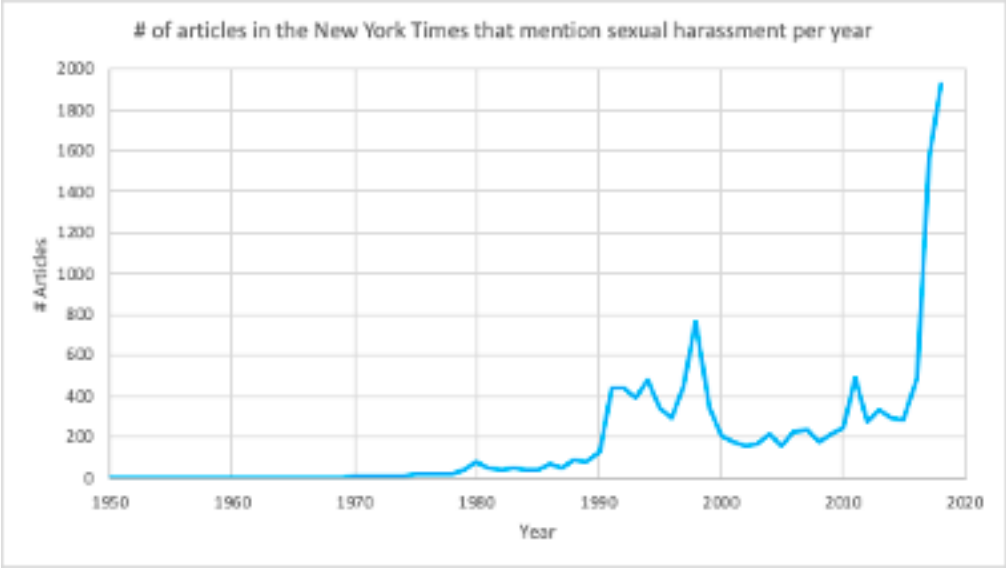

Fig 2. The number of articles in the New York times that mention sexual harassment per year. Interestingly, there is a slight increase in mentions between 1990 and 2000, but nothing comparable to what the numbers are in 2017 and 2018. At more than 300 articles already mentioning sexual harassment in 2019, this year is projected to have similar numbers as the last. (adapted from NYT API)

The influence of the #MeToo movement has been felt not only in Hollywood, but in all industrial sectors. HR Acuity, an employee relations technology company, conducted a survey of companies representing 4.4 million employees in the Fortune 100, 500, and 1000 lists, and found that since the movement started, 54% of companies state the number of harassment claims have gone up.[7] The number jumps to 84% when looking at large scale companies of more than 20,000 employees. Women are increasingly comfortable coming forward with incidents they have experienced in the workplace.

[7] Liz Elting, "A Hard Look At The Hard Numbers Of #MeToo," Forbes, October 15, 2018, , accessed March 26, 2019, https://www.forbes.com/sites/lizelting/2018/10/15/a-hard-look-at-the-hard-numbers-of-metoo/#20f14fde79f9.

> "Radiating out from sexual harassment to sex inequality as a whole, the movement has stimulated a wider public discussion of equal hiring, equal numbers of women on boards, equal pay, and more women in politics, as well as brought further focus to the role of white supremacy in misogyny. Anyone who doubts that sexual abuse is central to the second-class status of women might consider what taking it seriously on a systemic basis has set off. **Sexual harassment encompasses, parallels, evokes, or echoes many other abuses of women and children, from simple discrimination to other abuses of authority or trust or power.** Sexual harassment is like sexual abuse in childhood, in that the trust of victims is manipulated, dependency exploited, and institutions betray those who report. Sexual harassment often includes rape, and it raises similar issues of sex that is acquiesced to under conditions of unequal power. **Sexual harassment makes all forms of women's work into a form of prostitution: forced trading of sexual access for economic survival.** Sexual harassment turns real work into an arm of the sex trade. The imperative to exchange sex for survival, or the dangled possibility of survival whether real or not, governs women's inequality, hence women's lives, worldwide."

Writes Catharine MacKinnon, Professor of Law at Michigan Law and pioneer of the legal claim of sexual harassment, in an essay commenting on the global effects the #MeToo movement.[8] She makes several points that exemplify exactly why sexual misconduct is such a serious transgression of human rights (women's rights, in this case). She states 1) that sexual harassment, in its premise and outcome, parallels other forms of abuse, such as abuses of power, and 2) that sexual harassment inevitably make women's work into a form of prostitution. This can be applied to the female experience in STEM academia perfectly. Academic investigators are in a position of power, where they control the successes of their students, employees, and colleagues on multiple levels. At the undergraduate level, professors are in charge of students' coursework, and often act as mentors for independent research opportunities. At the graduate and postdoctorate level, they are advisors of research who greatly influence the course of their lab members' academic career trajectories. In terms of colleagues in the same department or field, investigators can have power over who gets tenure, who gets elected to be members of scientific organizations, and who gets access to funding--all aspects that can make or break a scientist. When they propose sexual favors as exchange for academic and career advancement, or exhibit inappropriate behavior towards their female colleagues, it creates a power dynamic in which women can do nothing but endure in order to ensure their own survival in the field.

The mental, physical, and social impact of sexual misconduct in any situation, whether in the workplace, academia, or in personal life, should not be undermined. We must lift up those who have stepped forward to speak up for themselves and others, and make sure their efforts are not in vain. We must continue to point out prevailing issues and demand that institutions and people are held accountable. We must educate those who have yet to understand the implications of sexual misconduct and its prevalence in society. Most effective is to start from the ground up--teach people from a young age about how to navigate and respect each other's boundaries through consent.

[8] Catharine A. MacKinnon, "Where #MeToo Came From, and Where It's Going," The Atlantic (Atlantic Media Company, March 24, 2019), https://www.theatlantic.com/ideas/archive/2019/03/catharine-mackinnon-what-metoo-has-changed/585313/.

Varying perspectives of consent and sexual misconduct

The act of sexual misconduct is inexcusable in any circumstance--it lacks respect for other humans on the most basic level. However, there has been a severe lack in understanding of boundaries, consent, and what comprises sexual misconduct across all demographics in society. In a Planned Parenthood survey conducted in 2015, a nationally representative group of adults age 18-95 across the US were asked questions about their views on consent and sexual assault. There were varying perspectives on what actions constituted sexual assault, as well as what the term consent actually meant. Overall, women showed a better understanding of the definition of consent, regardless of age, marital status, race, and ethnicity.[9] The survey also brought to light how most students did not get educated about consent and sexual assault in middle or high school. Most people reported that their parents did not talk with them about consent and sexual assault when they were growing up. Particularly concerning in the context of this project is how people had different opinions on what behaviors do or do not communicate consent. Between 19 and 37% of people strongly agreed that taking off their own clothes (35%), getting a condom (37%), nodding in agreement (24%), engaging in foreplay (22%), or not saying 'no' (19%) indicates consent for more sexual activity. However, 12 to 13% of people strongly disagreed that these behaviors mean consent. 20% of people strongly disagreed that not saying 'no' is giving consent.

When people formulate differing views on matters of consent and sexual misconduct, it causes significant problems on the societal level on how people treat each other. For better understanding of these concepts, we will now define these terms for clarity within this project.

Consent in the context of physical relationships is the affirmative, conscious, and voluntary agreement to engage in sexual activity, but can be applied to non-physical sexual advances as well. **Affirmative consent**, as defined by New York's "Enough is Enough" law, which protects students against sexual assault on college campuses, is "a knowing, voluntary, and mutual decision among all participants to engage in sexual activity. Consent can be given by words or actions, as long as those words or actions create clear permission regarding willingness to engage in the sexual activity. Silence or lack of resistance, in and of itself, does not demonstrate consent. The definition of consent does not vary based upon a participant's sex, sexual orientation, gender identity, or gender expression."[10]

[9] "New National Survey from Planned Parenthood Shows Need to Educate Young People on Consent and Sexual Assault," Planned Parenthood, April 21, 2016, https://www.plannedparenthood.org/about-us/newsroom/press-releases/new-national-survey-from-planned-parenthood-shows-need-to-educate-young-people-on-consent-and-sexual-assault.

[10] Suny, "Definition of Affirmative Consent," SUNY, accessed March 13, 2020, https://system.suny.edu/sexual-violence-prevention-workgroup/policies/affirmative-consent/.

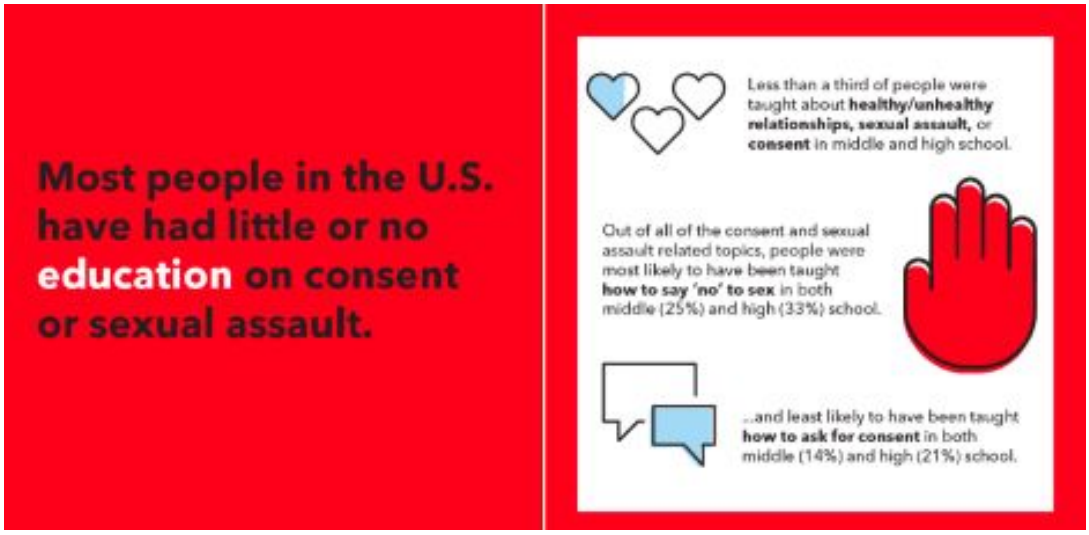

Fig 3. Planned Parenthood conducted a survey on perspectives of consent and sexual assault, and found that most people in the US have had little or no education on consent or sexual assault (Planned Parenthood).

Psychologists who study gender-related behavior have developed a three-part classification system, which divides sexual harassment into: sexual coercion, unwanted sexual attention, and gender harassment.[11] **Sexual coercion** consists of sexual advances, in which the conditions of employment or academic standing depend upon sexual cooperation. **Unwanted sexual attention** also consists of sexual advances but does not include threats or rewards contingent upon cooperation. Examples of this are unwelcome touching, hugging, stroking, persistent requests for dates despite expressed decline, and can include assault. **Gender harassment** includes ‘‘a broad range of verbal and nonverbal behaviors not aimed at sexual cooperation but that convey insulting, hostile, and degrading attitudes about members of one gender”.[12] It can be further separated into two subcategories: **sexist hostility**, which includes demeaning jokes about women, indicating women are not suited for leadership positions, etc, and **crude harassment**, which entails the use of crude terms to reduce women to their gender (i.e. “pussy”, “slut”).

[11] Louise F. Fitzgerald, Suzanne Swan, and Karla Fischer, “Why Didn't She Just Report Him? The Psychological and Legal Implications of Women's Responses to Sexual Harassment,” *Journal of Social Issues* 51, no. 1 (1995): pp. 117-138, https://doi.org/10.1111/j.1540-4560.1995.tb01312.x.
[12] Louise F. Fitzgerald, Suzanne Swan, and Karla Fischer, “Why Didn't She Just Report Him? The Psychological and Legal Implications of Women's Responses to Sexual Harassment,” *Journal of Social Issues* 51, no. 1 (1995): pp. 117-138, https://doi.org/10.1111/j.1540-4560.1995.tb01312.x.

Fig 4. The public consciousness of sexual harassment and specific sexual harassment behaviors, some of which are mentioned above in the text. Much of what we perceive as sexual harassment, namely acts in the realm of sexual coercion and unwanted sexual attention, is only a small portion of what encompasses sexual harassment. (adapted from National Academies Report, 2018)

Sexual misconduct is observed wherever one chooses to look for it, but it is perhaps most prevalent and damaging to women who find themselves in sectors that are male dominated. For example, the harsh environment that women must endure in the STEM sector is apparent just by looking at the numbers--I will break this down in the following section.

Sexism in STEM fields: a problem reflected in numbers

STEM fields (fields pertaining to science, technology, engineering, or mathematics) have historically been male dominated. Women make up half of the college-educated workforce in the US, but only 28% of the science and engineering workforce. Though there is a relatively high share of women in the social sciences (60%), and biological, agriculture, and environmental life sciences (48%), only 15% of engineers and 26% of computer scientists and mathematicians are women.[13] Minority representation remains low, although significantly better than a decade ago. As of 2015, 63% of women in science and engineering occupations were white, compared to 14% Asian, 8% black, and 10% Hispanic (0.2% for American Indian/Alaska Native, and Native Hawaiian/Pacific Islander respectively).[14] In STEM, there exists a unique condition where there is a staggering lack of female presence, let alone female empowerment. In the absence of such oversight, support network, and/or mentorship, sexism becomes normalized, and toxic environments are left to bloom. Consequently, women in STEM experience the highest rate of sexual harassment of any profession outside of the military.[15]

This toxic environment can be reflected in numbers, for example, like in the wage gap between genders. In 2015, there was found to be a $29,000 gap between the median annual salary among science and engineering full time workers with PhDs—with men earning $86,000/year and women earning $57,000/year.[16] Tracy Chou, a former software engineer at Pinterest, now CEO at Block Party, an app that tackles sexual harassment on Twitter, notably brought to light the abysmal number of female engineers at major tech companies back in 2013, with a crowdsourced spreadsheet. In her medium article she states, “every company has some way of hiding or muddling the data on women actually in engineering roles...the actual number I’ve seen and experienced in industry are far lower than anybody is willing to admit.”[17] Indeed, looking at the crowdsourced data, the average percentage of female engineers at all companies listed in the spreadsheet clocks in at around 20% (last updated in May 2019, with individual company statistics updated anywhere between 2013 and 2019). Since then, Silicon Valley and its tech giants have implemented diversity measures, but these problems are those that must be addressed continuously and ceaselessly. Ellen Pao, former Reddit CEO and another leader in advocacy for diversity and inclusion in tech, has mentioned in a 2018 TechCrunch Disrupt conference that the industry has come to realize that “45-minute unconscious bias training isn’t as effective as having conversations and sharing stories about people’s experiences.” She said, “This idea that you can change somebody’s values easily through short interactions, that’s really hard. Everybody’s realized that actually does not work at all. You need these ongoing trainings, you need ongoing interaction and you need to measure and hold people accountable.”[18]

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[13] “National Science & Engineering Indicators 2018” (National Science Board, January 2018), https://nsf.gov/statistics/2018/nsb20181/report/sections/science-and-engineering-labor-force/highlights.
[14] “National Science & Engineering Indicators 2018” (National Science Board, January 2018), https://nsf.gov/statistics/2018/nsb20181/report/sections/science-and-engineering-labor-force/highlights.
[15] “Sexual Harassment of Women: Climate, Culture, and ...,” 2018, https://www.nap.edu/catalog/24994/sexual-harassment-of-women-climate-culture-and-consequences-in-academic.
[16] “National Science & Engineering Indicators 2018” (National Science Board, January 2018), https://nsf.gov/statistics/2018/nsb20181/report/sections/science-and-engineering-labor-force/highlights.
[17] Chou, Tracy. “Where Are the Numbers?” Medium. Medium, October 21, 2013. https://medium.com/@triketora/where-are-the-numbers-cb997a57252.
[18] Abrar Al-Heeti, “Ellen Pao, Tracy Chou Say They Worry about Tech's Negative Impact, Lack of Values,” CNET (CNET, October 4, 2019), https://www.cnet.com/news/ellen-pao-tracy-chou-say-they-worry-about-negative-impact-lack-of-values-in-tech/.

The environment for women in STEM academia

In STEM academia, there has been a spike in activism since the advent of the #MeToo movement. Four years ago, Julie Libarkin, a professor at Michigan State University, started compiling a database of publicly available cases of sexual misconduct in academia. Now, this report includes over a thousand cases of misconduct throughout US institutions. Several high-profile investigators have left their positions after their conduct was uncovered by journalists in light of their sexual harassment investigations, including geneticist Francisco Ayala, cancer biologist Inder Verma, and physicist Lawrence Krauss.

When taking a look at Libarkin's database previously, I found that around 45% of publicly reported cases of sexual misconduct end with little to no action by the institution, and/or with a voluntary resignation or retirement from the perpetrator. Frequently, even when the institutions did suspend the perpetrators, it was under paid leave. Some lawsuits were settled by the institution on behalf of the perpetrator.

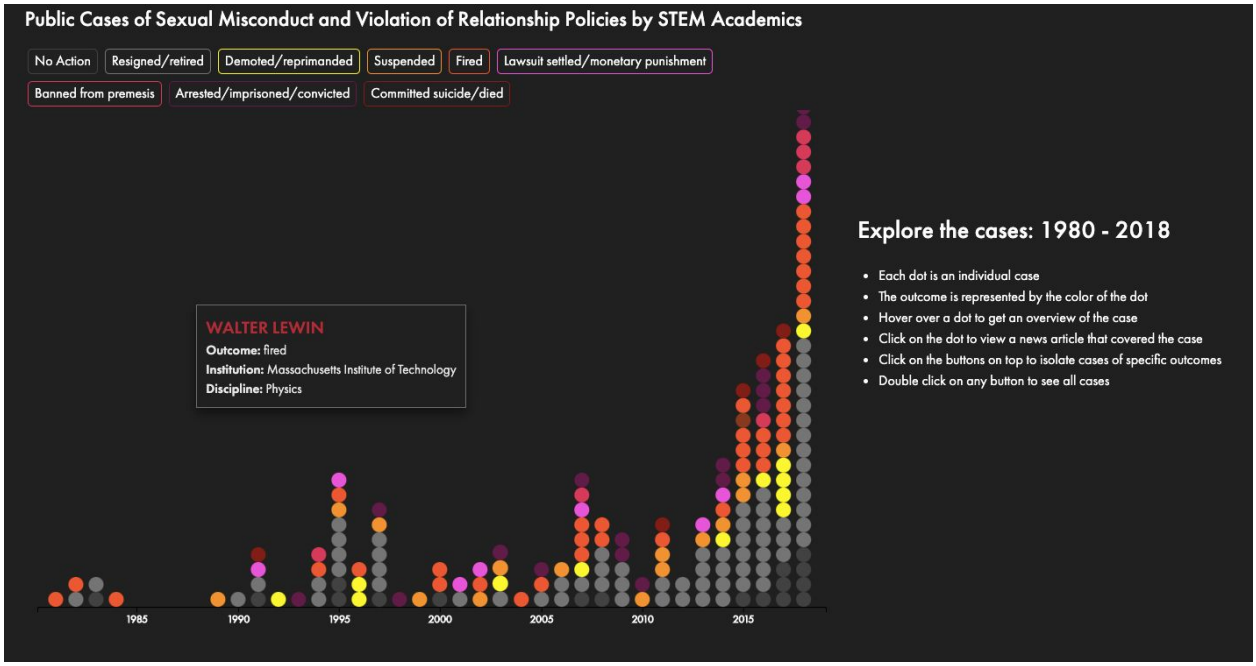


Fig 5. Dot plot histogram depicting individual cases of sexual misconduct from STEM academics from the Academic Sexual Misconduct Database.

The nature of how perpetrators are protected by their host institutions becomes clear when examining the stories of each individual perpetrator.

Inder Verma was a renowned cancer biologist who resided at the prestigious Salk Institute in San Diego. In 2017, several sexual discrimination lawsuits were filed against the institute, citing his name. Subsequently, *Science*, a distinguished journal of scientific discoveries published by the American Association for the Advancement of Science (AAAS) conducted a four month investigation into

allegations of sexual misconduct by Verma that spanned from 1976 to 2016. Five women agreed to be named in the resulting story, as well as three who requested to remain anonymous.[19] Francisco Ayala was a famous evolutionary biologist who was on the faculty at the University of California, Irvine. In the official investigation report by the Office of Equal Opportunity and Diversity of UC Irvine, four complainants made statements about his behavior towards them during his tenure there.[20] Both Verma and Ayala were titans in their fields, whose inappropriate behaviors were noted by many, well before formal investigations took place. Their careers soared and their achievements exalted, while women continued to be targets of their harassment. In Verma's case, women who turned to Salk after being harassed were told to keep quiet of their experiences. Both men failed to right their behaviors even after initial complaints were filed with human resources. Lawrence Krauss was a celebrity physicist, prominent atheist, and leader of the skeptical movement. Buzzfeed News published a comprehensive report of the allegations and complaints against him in February 2018.[21] His career is littered with cases of sexual harassment, and of outright sexual assault. He has denied all allegations against him, and attributes them to his fame. "It is common knowledge that celebrity attracts all forms of negative attention from many different angles...There is no pattern of discontent revealed here that suggests any other explanation," Krauss has stated.

These case studies show that institutions take a long time to act on complaints, and that they are, in many instances, unsympathetic to the women who come forward with their experiences. In some cases, they tell the women to drop their complaint or discourage them from doing so. These men have such powerful influences on the institution, and on the careers of faculty within these institutions--even when they have resigned, they continue to hold power as members of distinguished national STEM organizations and have a say in funding allocation and promotion of scientists all over the US.

[19] Meredith Wadman, "A Hidden History.", Science, May 04, 2018, Accessed March 07, 2019, http://science.sciencemag.org/content/360/6388/480.full.

[20] Erik Pelowitz and Karen Bell, Findings of the Office of Equal Opportunity and Diversity (OEOD), Report, Office of Equal Opportunity and Diversity, University of California Irvine, May 16, 2018.

[21] Peter Aldous, "Celebrity Atheist Lawrence Krauss Accused Of Sexual Misconduct For Over A Decade," BuzzFeed News, October 13, 2018, Accessed March 07,, 2019, https://www.buzzfeednews.com/article/peteraldhous/lawrence-krauss-sexual-harassment-allegations.


Inder Verma
Renowned cancer biologist at the Salk Institute
1974
Hired by Salk Institute
1988
Wins "Outstanding Investigator" award from NIH, giving him and Salk $12.8 million for cancer research over next 13 years
1997
Elected to the National Academy of Sciences
2011
Elevated to become editor-in-chief of PNAS
2018
Verma resigns from Salk
1970
2019
1987
Verma asked Jean Wang, assistant professor at UC
come to his hotel room
asked her to sit in his lap
started asking her about ex-boyfriend and sex life
1992
Zoppe files complaint with Salk HR; is told to stay home from work because Verma will be angry, and to say nothing of the incident if anyone asks
2001
a grabbed Beverly
son, full professor at the
Institute, and kissed her
e mouth while she was
ing in the library stacks
2017
Gender discrimination lawsuits filed by two senior female scientists accusing Verma of denying lab space and personnel, career advancement, and funding opportunities because they were women
Explore the timelines
Each colored line represents an incident during the academic's career
White: Career achievement | Red: Incident of sexual harassment | Yellow: Related to complaint or result of complaint
Hover over the lines to view details about the specified incident


Francisco Ayala
Acclaimed evolutionary biologist at University of California, Irvine
1989
Named Donald Bren Professor of Biological Sciences, Director of the Bren Fellowship Program, and professor of philosophy at UC Irvine
2001
Awarded the National Medal of Science
2014
UCI names its School of Biological Sciences after Ayala
2018
Ayala resigns from UCI
1970
2019
2003
Ayala repeatedly made unwelcome comments about Kathleen Tresedor's (professor and chair of UCI Biological Sciences) appearance, told her she looked huge when pregnant
2012
Ayala told Treseder that she was so enthusiastic in talking about her research during a lecture that he thought she would "have an orgasm" in fron tof everyone
Inder Verma and Francisco Ayala were both titans in their field--cancer biology and evolutionary biology, respectively. Their inappropriate behavior were noted by many, well before formal investigations took place. Their careers continued to soar and their achievements exalted, while women continued to be targets of their harassment. In Verma's case, women who turned to Salk after being harassed were told to keep quiet of their experiences. Both men failed to right their behaviors even after initial complaints were filed with human resources.

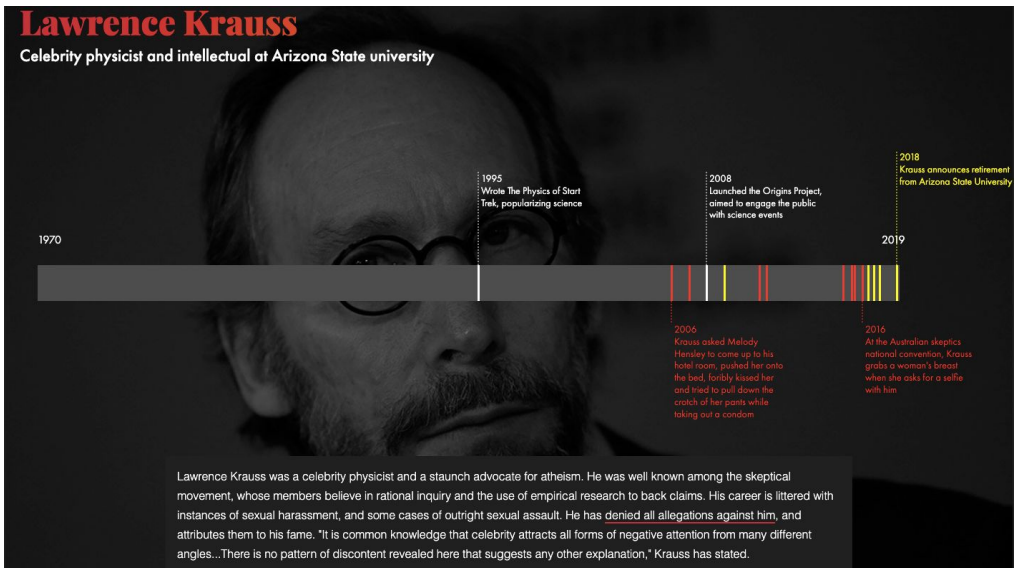

Lawrence Krauss
Celebrity physicist and intellectual at Arizona State university
1995
Wrote The Physics of Start Trek, popularizing science
2008
Launched the Origins Project, aimed to engage the public with science events
2018
Krauss announces retirement from Arizona State University
1970
2019
2006
Krauss asked Melody Hensley to come up to his hotel room, pushed her onto the bed, forcibly kissed her and tried to pull down the crotch of her pants while taking out a condom
2016
At the Australian skeptics national convention, Krauss grabs a woman's breast when she asks for a selfie with him
Lawrence Krauss was a celebrity physicist and a staunch advocate for atheism. He was well known among the skeptical movement, whose members believe in rational inquiry and the use of empirical research to back claims. His career is littered with instances of sexual harassment, and some cases of outright sexual assault. He has denied all allegations against him, and attributes them to his fame. "It is common knowledge that celebrity attracts all forms of negative attention from many different angles...There is no pattern of discontent revealed here that suggests any other explanation," Krauss has stated.

Fig 6. Timelines that correspond to three renowned scientists who were indicted for sexual misconduct. Note that in each of these cases, many harassment incidents had happened before institutions took any reasonable action. In Verma's case, it took four decades for Verma to resign from the Salk.

It is possible to get a glimpse of how such an environment rampant with sexual misconduct affects the number of women who pursue STEM careers by looking at faculty equity reports of institutions. When referencing the faculty equity reports from Columbia and NYU, it is apparent that female faculty in the sciences have been consistently lower than that of social sciences or humanities. The percentage of female tenured/tenure-track professors in the sciences never went above 22% in NYU or Columbia as of .[22]

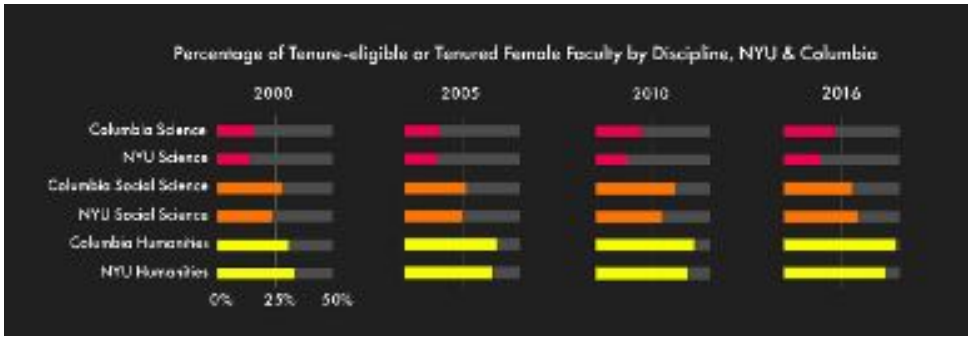


Fig 7. Percentages of tenure-eligible or tenured female faculty by discipline for NYU and Columbia

When looking at the percentages of women in each step up the academic career ladder in the sciences, there is an obvious drop off of women on the faculty level--especially women on the tenured faculty level. The percentage of women majoring in the sciences on the undergraduate level is consistently around 50%, in some years going above that. It is shocking that the retention rate for women in STEM academia is so low, even with so many women choosing to delve into the sciences.

[22] Advancement of Women Through the Academic Ranks of the Columbia University Graduate School of Arts and Sciences: Where Are the Leaks in the Pipeline? Report, The Commission on the Status of Women, Columbia University, November 2001.

Maya Tolstoy,. 2004-2013 Update: Advancement of Women Through the Academic Ranks of the Columbia University Graduate School of Arts and Sciences: Where Are the Leaks in the Pipeline? Report, Commission on the Status of Women, Professor Daniel Rabinowitz (Dept of Statistics), Columbia University Senate, Columbia University, April 20, 2015.

Policy and Planning Committee Equity Reports.Report. Policy and Planning Committee, Columbia University. October 2018.
Carol Shoshkes Reiss and Andre Fenton, Faculty of Arts and Sciences Equity Committee Executive Summary of Data to End of 17/18 Academic Year and Recommendations, Report, Faculty of Arts and Sciences Equity Committee, New York University.

Fig 8. Percentage of women in the sciences in each level of the academic ladder at Columbia

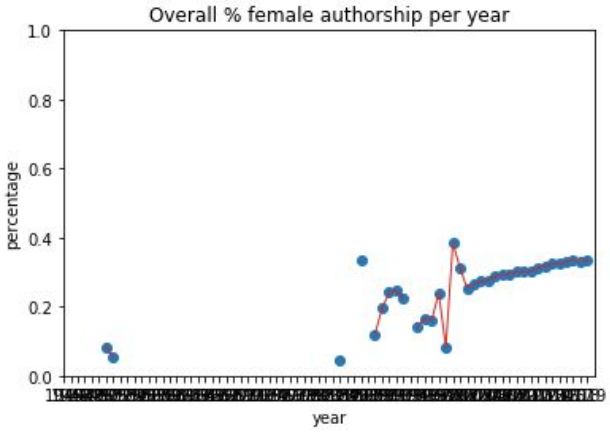
Gender gap in STEM academia reflected in publishing

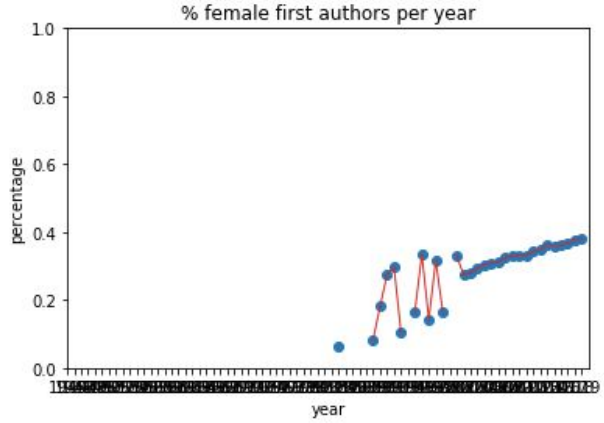
The unequal playing ground for women in STEM academia is also reflected in the number of women whose names are in published journals. In 2018, Luke Holman published a very comprehensive paper on the gender gap in STEM academia, noting that the gender gap in journal publishing will likely persist for generations.[23] He obtained the metadata of 36 million articles on Pubmed and Arxiv, both databases of biomedical journals. With statistical methods, he projected when the gender gap will close in various different biomedical fields. He found that in most fields, it will take decades, even centuries, to reach gender parity given the current rates of authorship.

I also pursued my own analysis of the rates of female authorship in STEM academia using a more limited dataset of journal metadata specifically in the neuroscience field, both for the sake of simplification and personal interest as a neuroscientist. I pulled metadata from MEDLINE, a U.S. National Library of Medicine bibliographic database that contains more than 25 million references to journal articles in life sciences with a concentration on biomedicine.[24] From this, I took all of the author's names, and ran them through the Genderize API, which gave probabilities of whether a name was female or male.[25] I used this data to analyze gender ratios of the authors of neuroscience journal publications for each year, spanning from 1945 to 2019. It should be noted that because publications in earlier years did not require full first names to be printed, and because many names are ambiguous, there are several holes within the dataset.

[23] Luke Holman, Devi Stuart-Fox, and Cindy E. Hauser, "The Gender Gap in Science: How Long until Women Are Equally Represented?," PLOS Biology 16, no. 4 (2018), https://doi.org/10.1371/journal.pbio.2004956.
[24] "About MEDLINE® and PubMed®: The Resources Guide." 2019. Nih.Gov. U.S. National Library of Medicine. 2019. https://www.nlm.nih.gov/bsd/pmresources.html.
[25] Genderize.io. 2019. "Genderize.Io | Determine the Gender of a Name." Genderize.Io. 2019. https://genderize.io/.

Based on this analysis, unsurprisingly, the gender gap in publishing still exists in academic neuroscience. However, both overall and within each authorship category, the percentages of women contributors are going up. The overall gender ratio of papers written by women is around 33% in 2019 compared to 10-20% in the 90s. The percentage of female first authors has risen steadily and is at 38% in 2019. First authors are almost always the researcher who conducted most of the research involved in the paper. The percentage of female last authors are lower, as expected, peaking at 25%. Last authors are primarily the principal investigators who mentored the first author, or in other words, researchers who have been able to secure a position as head of a lab. Papers with single female authors have steadily increased in percentage and is at 24% in 2019. Papers with both first and last female authors peak at around 13% in 2019. The first identifiable papers with both first and last female authors came out in 1990 from France in The European Journal of Neuroscience (all five of them). A caveat that should be mentioned is that many names have uncertain gender assignments, especially for the earlier years, which have resulted in some inaccurate percentages that display as outliers. And though the numbers of female authors are increasing overall, when will be the day that percentages will be 50-50? Holman's paper predicts that at the current rate, even in 2045, we will not have reached gender parity in neurology, nor neurosurgery fields (he did not have a neuroscience field).





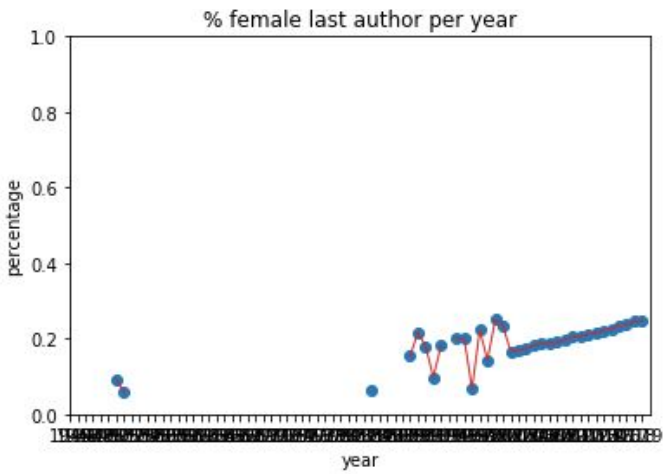


Fig 9. Percentage outputs of female authorship overall, as first author and as last author, from top to bottom.

My work in the past two years has overwhelmingly been focused on bringing to light the difficulties that women have had to face in STEM academia on the individual, departmental, and institutional levels, and the numbers that reflect this reality. I have given examples of these numbers above, including the wage gap, authorship gap, and more. My aim for this project is to provide a visual conduit that encapsulates the findings of my work and recognize the women who have persevered in this environment.

Methods

Data Collection and Processing

Many of the data sources mentioned have been used in this project. I list all of them below:

I. Public perception of sexual consent and sexual assault

I pulled in data from Planned Parenthood's 2015 survey on sexual consent and assault to illustrate that a big part of what creates issues surrounding sexual misconduct is the varying perspectives of what consent and assault entails.[26] Because the raw survey data was unavailable, I had to make do with what their report stated, which were of percentages of people who strongly disagreed with a given statement. I chose some of the statements most relevant to illustrate my point.

Statements pertaining to consent	Consent for sex one time is consent for future sex
	Engaging in foreplay such as kissing or touching means someone is giving consent for more sexual activity

[26] "New National Survey from Planned Parenthood Shows Need to Educate Young People on Consent and Sexual Assault," Planned Parenthood, April 21, 2016, https://www.plannedparenthood.org/about-us/newsroom/press-releases/new-national-survey-from-planned-parenthood-shows-need-to-educate-young-people-on-consent-and-sexual-assault.

	Mixed signals can sometimes mean consent
	Someone not saying no means they are giving consent for more sexual activity
Statements pertaining to sexual assault	If a woman is sexually assaulted while she is drunk, she is at least somewhat responsible for what happened
	When women go to parties wearing revealing clothes, they are asking for trouble
	Sexual assault accusations are often used by women as a way of getting back at men

II. Academic Sexual Misconduct Database

Details of sexual misconduct in academia were obtained by a database compiled by the Geocognition Research Laboratory at Michigan State University, helmed by Julie Libarkin, a professor of Earth and Environmental Sciences. This database, titled "The Academic Sexual Misconduct and Violations of Relationship Policies Database", lists all publicly available cases of sexual misconduct and violation of relationship policies at US institutions, starting as early as 1980.[27] For each case mentioned, the database lists the name, institution, discipline, outcome, and links to media sources outlining details of the case. From this, only cases pertaining to perpetrators in STEM disciplines were extracted for use in the visualization.

As of March 30th, there are 1030 cases total in the database, 332 of which are in STEM fields. I used the National Science Foundation's definition of what fields count towards STEM. Initial quantification of the data was done in Python. Cleaning of fields and categories for use in the web platform was done in Javascript within the app. I focused mainly on the outcome year, discipline, and outcome of these cases.

III. Publicly available journal articles of investigations into perpetrators

For the 58 STEM perpetrators with initial outcomes of cases in 2018, I researched the details of each case, finding news coverage of their investigations. For each case, I looked for the date in which they were first known to commit sexual misconduct, and the date of the first complaint filed. After compiling a spreadsheet of those cases, I picked 15 of the cases that were the most "high profile" and had concrete dates for at least one of the two variables (coverage by more mainstream news sources rather than local news, had multiple news sources), and researched their stories more in depth. For the chosen 15, I calculated the time between first incident and first complaint, and first complaint and initial outcome. Using multiple sources, I constructed a general summary of their story arcs. I have included the three I previously researched, since their cases were all well documented with outcomes

[27] Academic Sexual Misconduct Database. Accessed March 17, 2020. https://academic-sexual-misconduct-database.org/.

in 2018. Here are the 15 that were chosen and their summaries, obtained from the news or investigative reports :

1. **Lawrence Krauss, Arizona State University**
   Lawrence Krauss was a celebrity physicist and a staunch advocate for atheism. He was well known among the skeptical movement, whose members believe in rational inquiry and the use of empirical research to back claims. His career is littered with instances of sexual harassment, and some cases of outright sexual assault. He has denied all allegations against him, and attributes them to his fame. "It is common knowledge that celebrity attracts all forms of negative attention from many different angles...There is no pattern of discontent revealed here that suggests any other explanation," Krauss has stated.[28]

2. **Thomas Jessel, Columbia University**
   Thomas Jessel was a prominent neuroscientist who was a key contributor to the founding of Columbia's Zuckerman Mind Brain Behavior Institute. He was engaged in a relationship with a lab member under his supervision for years, violating university policies on consensual romantic and sexual relationships. Though a formal investigation started in December 2017, at least five years after the relationship began, faculty members have confirmed that a complaint was filed to a mandated reporter in 2012, with no disciplinary actions taken. In March 2018, he was removed from all administrative positions and was stripped of all titles and grants. He has since passed away.[29]

3. **Todd Heatherton, Dartmouth College**
   Todd Heatherton is one of three tenured professors in Dartmouth College's Department of Psychological and Brain Sciences accused of sexual misconduct in a $70 million class-action lawsuit against the trustees of the college. Heatherton has been accused of groping multiple graduate students. Dartmouth allowed him to retire after an internal investigation.[30]

4. **Paul Whalen, Dartmouth College**
   Paul Whalen is the second of three Dartmouth professors accused of sexual misconduct in the lawsuit. Whalen allegedly a raped a neuroscience graduate student and refused to wear a condom after cajoling her into a night of drinking. He then asked her to meet him at a bar to "celebrate" the results of medical testing she'd pursued following the rape. He has also

[28] Peter Aldhous, “Celebrity Atheist Lawrence Krauss Accused Of Sexual Misconduct For Over A Decade,” BuzzFeed News (BuzzFeed News, October 13, 2018), https://www.buzzfeednews.com/article/peteraldhous/lawrence-krauss-sexual-harassment-allegations.
[29] Gavrielle Jakobovitz and Karen Xia, “Before Removal, MBBI Director Thomas Jessell Engaged in Years-Long Relationship That Violated Columbia Policy,” Columbia Daily Spectator, April 12, 2018, https://www.columbiaspectator.com/news/2018/04/12/before-removal-mbbi-director-thomas-jessell-engaged-in-years-long-relationship-that-violated-columbia-policy/.
[30] Mitra, Mili. “Opinion | The Most Horrifying Part of the Dartmouth Sexual Harassment Case.” The Washington Post. WP Company, November 20, 2018. https://www.washingtonpost.com/blogs/post-partisan/wp/2018/11/20/the-most-horrifying-part-of-the-dartmouth-sexual-harassment-case/.

harassed multiple other students, allegedly telling them that Dartmouth "protects its male professors", and that complaining has historically backfired. Whalen was allowed to resign after an internal investigation recommended that he be terminated.[31]

5. **William Kelley, Dartmouth College**
   William Kelley is the third Dartmouth professor accused of sexual misconduct in the class action lawsuit. Kelley is alleged to have manipulated hotel room arrangements so a graduate student would need to stay in his hotel room during a conference, and proceeded to assault her. He has been accused of hosting hot tub parties at his house, playing inappropriate versions of Charades with them while drinking, sending photos of himself having sex with various people to students, and more. He resigned after internal investigations. The lawsuit was settled in August of 2019, which included $14 million for the class of plaintiffs.[32]

6. **Harvey J. Makadon, Harvard University**
   Harvey Makadon held multiple medical positions, including a faculty position at Harvard Medical school, Fenway Community Health Center, and Beth Israel Deaconess Medical Center. He has been alleged to sexually harass and bully coworkers, and accused of sexually assaulting a coworker in an elevator. Multiple investigations were conducted throughout the years with recommendations that he be fired, but action was not taken. He was forced to resign from his positions after multiple allegations arose from colleagues at both Fenway Health and Harvard Medical School.[33]

7. **Richard Vogt, Joint Meeting of Ichthyologists and Herpetologists**
   Richard Vogt is a prominent herpetologist (turtle researcher) who was briefly given an award for distinguishment before it was rescinded due to his plenary lecture featuring photos of scantily clad former female students. Previous to this, he has had a reputation for his sexually inappropriate behavior in the herpetology field. Scientists had been warned to avoid him, and many have exited the field due to its toxic culture.[34]

8. **Karl Kjer, University of California, Davis**
   Karl Kjer is an entomologist who was a tenured professor at UC Davis. Two researchers in his lab accidentally discovered a hard drive full of pornography and videos of women unknowingly being filmed undressing in his bathroom at home. He was charged in 2017 for one count of invasion of privacy in New Jersey, as these were filmed before his time at UC Davis. The university allowed him to resign confidentially in 2016, but news of his charge broke

[31] Daniel Engber, “The Dartmouth Sexual Harassment Allegations Are So Much Worse Than I Thought,” Slate Magazine (Slate, November 16, 2018), https://slate.com/technology/2018/11/dartmouth-sexual-assault-harassment-lawsuit-psychology.html.
[32] “Newspapers of New England - Valley News - Dartmouth Lawsuit - Page 54-55 - Created with Publitas.com,” Publitas, accessed April 8, 2020, https://view.publitas.com/newspapers-of-new-england/valley-news-dartmouth-lawsuit/page/54-55.
[33] Beth Healy and Sacha Pfeiffer, “For Years, Fenway Health Center Kept Prominent Doctor Accused of Harassment, Bullying - The Boston Globe,” BostonGlobe.com (The Boston Globe, December 8, 2017), https://www.bostonglobe.com/metro/2017/12/08/for-years-fenway-health-center-kept-prominent-doctor-accused-harassment-bullying/djZugTTaxy1upIJfThMQZK/story.html.
[34] Zoë Schlanger, “A Turtle Scientist's Crude Behavior Has Sparked a #Metoo Moment in Herpetology,” Quartz (Quartz, July 17, 2018), https://qz.com/1330066/turtle-scientist-richard-vogt-is-accused-of-sexually-inappropriate-behavior/.

in 2017, upsetting students and faculty that they were not told the circumstances of his resignation.[35]

9. **Inder Verma, Salk Institute**
   Inder Verma is a famed cancer biologist who resided at the Salk Institute. He was also notorious for sexually harassing colleagues. His misconduct spanned decades, with multiple complaints being raised against him for inappropriate touching, kissing, and attempts at sexual engagement. In the past, when women raised issues with human resources, they were told to keep quiet of the incidents. He resigned from the institute after an investigation was opened regarding his misconduct. The Salk Institute has since faced and settled gender discirmination lawsuits filed by senior female professors who claimed that the institute systematically undermined and marginalized its female professors.[36]

10. **Terry Speed, University of California, Berkeley**
    Terry Speed was a statistics professor at UC Berkeley who was accused of sexually harassing a postdoctoral researcher for multiple years. A UC Berkeley mathematics professor and Caltech computational biology professor Lior Pachter filed a Title IX complaint against him in 2016 for creating a hostile environment for him and the researcher. He frequently sent the researcher explicit emails and declarations of love, and emailed Pachter about his infatuation. The investigation took more than a year with no proper outcome, prompting Pachter to go public with the investigation in a podcast. In 2018, Speed resigned from UC Berkeley.[37]

11. **Stanton Glantz, University of California, Berkeley**
    Stanton Glantz is the director of UCSF's Center for Tobacco Control Research and Education, who was involved in a lawsuit filed in 2017 by his former postdoc. She claimed that he sexually harassed her by making lurid remarks, ogling her breasts, and forcing her to hug him. She also claimed that he refused to include her name on a research paper. She left UCSF after filing a complaint with the university. UCSF settled the lawsuit with $150,000.[38]

12. **Francisco Ayala, University of California, Irvine**
    Francisco Ayala is a famed geneticist who was at UC Irvine who allegedly had a track record for sexual harassment. His colleagues and students who were harassed details accounts of inappropriate comments on their appearances and unwanted touching. He was cautioned

[35] Hannah Holzer, "Former UC Davis Professor Filmed Individuals Showering without Their Consent, Stored Footage on University-Owned Hard Drives," The Aggie, June 8, 2018, https://theaggie.org/2018/06/07/former-uc-davis-professor-filmed-individuals-showering-without-their-consent-stored-footage-on-university-owned-hard-drives/.
[36] Meredith Wadman, "A Hidden History," Science (American Association for the Advancement of Science, May 4, 2018), http://science.sciencemag.org/content/360/6388/480.full.
[37] Rachael Cornejo, "UC Berkeley Statistics Professor Allegedly Sexually Harassed Researcher," The Daily Californian, April 2, 2018, https://www.dailycal.org/2018/03/25/uc-berkeley-statistics-professor-allegedly-sexually-harassed-postdoctoral-researcher/.
[38] Oransky, Ivan, and Adam Marcus. "UCSF Settles Sexual Harassment Suit Involving Star Researcher." STAT, October 16, 2018. https://www.statnews.com/2018/10/16/stanton-glantz-ucsf-sexual-harrassment/.

about his behavior many years before the last investigation led to his resignation, but he did nothing to right it.[39]

13. Robert Kurzban, University of Pennsylvania

Robert Kurzban is a former professor of psychology at the University of Pennsylvania. He resigned after being accused of having multiple inappropriate relationships with students. Details from multiple students reveal that he was a repeat offender in terms of engaging in romantic relationships with students.[40]

14. George Tyndall, University of Southern California

George Tyndall is a former gynecologist at the University of Southern California accused of sexually assaulting hundreds of women as the university's only full time gynecologist for 30 years. More than 350 women stepped forward to detail their acounts of sexual assault with them. After a year long investigation, the LA police arrested him, and was charged with 18 counts of sexually penetrating a person while she was unconscious, and 11 counts of sexual battery by fraud. The college admitted that it had received complaints of his behavior dating back to the 90s. A $215 million federal class action settlement was approved by the court in 2019.[41]

15. Eugene Redmond, Yale University

Eugene Redmond was a Yale School of Medicine professor who retired after an investigation into sexual assault allegations from five students affiliated with his university research, and at least eight other undergraduates. Most incidents occurred at his research facility on St. Kitts, a Caribbean Island where he ran a summer internship program for Yale undergraduates. Yale first investigated his conduct in 1994, though did not properly implement disciplinary action. An investigation was finally conducted after three separate complaints, and Redmond's resignation. In 2019, additional allegations surfaced of Redmond sexually assaulting a 12 year old boy during a ski trip in Vermont.[42]

IV. Female authorship in scientific journals

Though my main focus was to build a comprehensive view of the harsh environment for women in STEM, I wanted to in some way give recognition to women in STEM who have persevered in the field. I used the neuroscience journal metadata dataset that I previously pulled from MEDLINE in order to

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[39] Wadman, Meredith. “Report Gives Details of Sexual Harassment Allegations That Felled a Famed Geneticist.” Science, August 18, 2018. https://www.sciencemag.org/news/2018/07/report-gives-details-sexual-harassment-allegations-felled-famed-geneticist.

[40] Vibha Kannan, “Penn Graduate Says Robert Kurzban Had Relationship with Her While He Was Her Minor Advisor,” The Daily Pennsylvanian (The Daily Pennsylvanian, April 27, 2018), https://www.thedp.com/article/2018/04/kurzban-philadelphia-evolutionary-psychology-upenn-ivy-league-pennsylvania-misconduct-higher-ed.

[41] Medina, Jennifer. “'Just the Grossest Thing': Women Recall Interactions With U.S.C. Doctor.” The New York Times. The New York Times, May 17, 2018. https://www.nytimes.com/2018/05/17/us/USC-gynecologist-young-women.html.

[42] Mariwala, Jever, Alice Park, and Marisa Peryer. “I SAW WHAT I SAW: On This Island, a Yale Professor Sexually Harassed a Yale Student. Did the University Do Enough?” Yale Daily News, 2019. http://features.yaledailynews.com/blog/2019/03/05/i-saw-what-i-saw/.

create a list of names of women who have published in neuroscience journals. The data was originally pulled using an R package called RISmed, which was then run through the Genderize API to obtain probability of gender of each name within the data.

Main Data Sources	
Public perception of sexual consent and sexual assault	
Planned Parenthood Consent Survey	https://www.plannedparenthood.org/files/1414/6117/4323/Consent_Survey.pdf
Academic sexual misconduct cases	
Geocognitive Research Laboratory, Michigan State University	https://academic-sexual-misconduct-database.org/download-data
Sexual misconduct case studies (listing only primary source but have used more to vet)	
Lawrence Krauss	https://www.buzzfeednews.com/article/peteraldhous/lawrence-krauss-sexual-harassment-allegations
Thomas Jessell	https://www.columbiaspectator.com/news/2018/04/12/before-removal-mbbi-director-thomas-jessell-engaged-in-years-long-relationship-that-violated-columbia-policy/
Todd Heatherton	https://www.washingtonpost.com/blogs/post-partisan/wp/2018/11/20/the-most-horrifying-part-of-the-dartmouth-sexual-harassment-case/
Paul Whalen	https://slate.com/technology/2018/11/dartmouth-sexual-assault-harassment-lawsuit-psychology.html
William Kelley	https://view.publitas.com/newspapers-of-new-england/valley-news-dartmouth-lawsuit/page/54-55
Harvey J. Makadon	https://www.bostonglobe.com/metro/2017/12/08/for-years-fenway-health-center-kept-prominent-doctor-accused-harassment-bullying/djZugTTaxy1upIJfThMQZK/story.html
Richard Vogt	https://qz.com/1330066/turtle-scientist-richard-vogt-is-accused-of-sexually-inappropriate-behavior/

Karl Kjer	https://theaggie.org/2018/06/07/former-uc-davis-professor-filmed-individuals-showering-without-their-consent-stored-footage-on-university-owned-hard-drives/
Inder Verma	https://sci-hub.tw/http://science.sciencemag.org/content/360/6388/480/tab-pdf
Terry Speed	https://www.dailycal.org/2018/03/25/uc-berkeley-statistics-professor-allegedly-sexually-harassed-postdoctoral-researcher/
Stanton Glantz	https://www.thearmstronglawfirm.com/NEELEY-COMPLAINT-FINAL.pdf
Francisco Ayala	http://ulum.es/wp-content/uploads/2018/07/Informe-Ayala.pdf
Robert Kurzban	https://www.thedp.com/article/2018/04/kurzban-philadelphia-evolutionary-psychology-upenn-ivy-league-pennsylvania-misconduct-higher-ed
George Tyndall	https://www.nytimes.com/2018/05/17/us/USC-gynecologist-young-women.html
Eugene Redmond	http://features.yaledailynews.com/blog/2019/03/05/i-saw-what-i-saw/
Female Authorship in Scientific Journals	
MEDLINE database	https://www.nlm.nih.gov/bsd/pmresources.html

Narrative and Design Thinking

My intended focus for this project was to expose the realities within STEM academia that have hindered women's advances in the field, but I thought it necessary to start more broadly. The most fundamental, underlying issues that cause these problems in STEM academia are also those that cause problems elsewhere in society. I decided to work with a structure that would start off with an introduction, which would lead to multiple visualizations that were all equally important. I considered both a visual essay format in which scrollytelling would be the main driver of the story, and a more platform-based approach where the user would be able to scroll through the intro, then navigate through multi-page visualizations that captured the main points of the project. Ultimately, I pursued a platform-based approach for simplicity, and a desire to make each individual visualization a standalone product.

After several different iterations and considering time constraints, I decided to create four main visualizations:

I. Introduction: Illustration of people's perception of sexual consent and assault

The introduction should get the user familiar to the problem of sexual misconduct in the context of society. What I want users to take away from it is that the lack of education around sex, consent, and sexual harassment has created a situation in which people do not understand how to navigate with consent, or how to recognize sexual assault. I decided to use simple bars with colors indicating percentage to visualize survey answers. Pink signifies women, and purple signifies men.

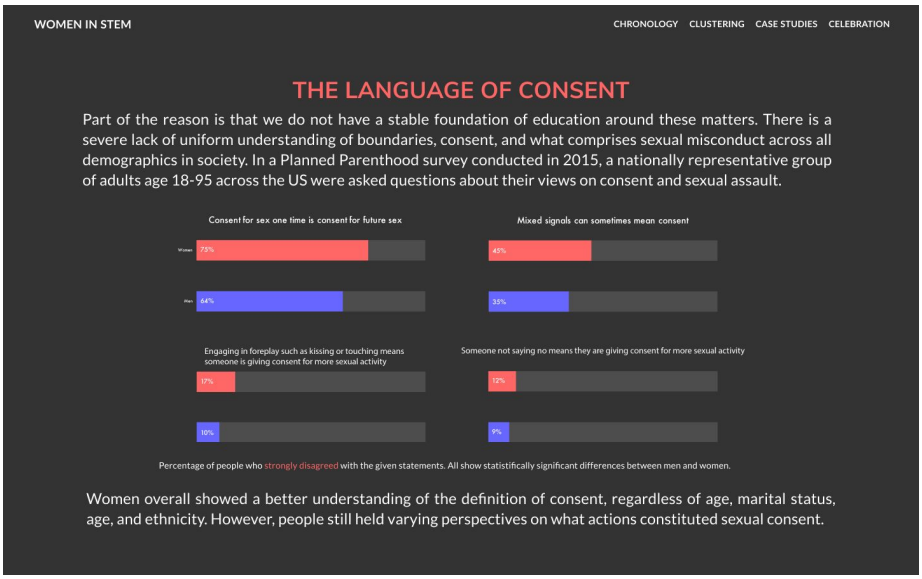

Fig 10. Wireframe for survey answers of questions related to consent.

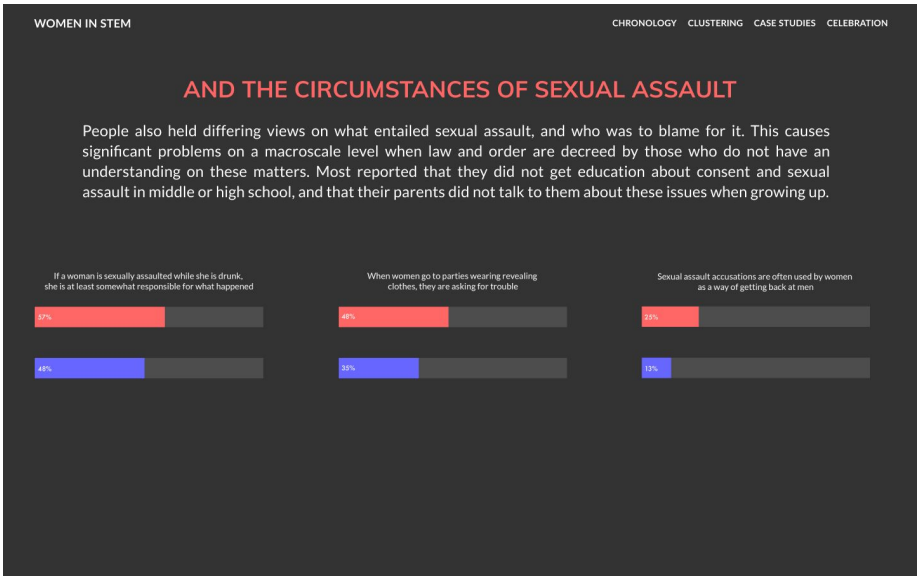

Fig 11. Wireframe for survey answers of questions related to sexual assault.

II. Main visualization #1: Timeline of academic sexual misconduct cases

I wanted the first main visualization to be timeline oriented, in order to visualize the frequency of cases over time, and how reported cases have significantly increased in recent years. I designed a rectangle histogram plot in which each rectangle represented an individual case, and the x axis represented years. The functionalities I wanted were a toggle effect, in which the user could see the proportion of STEM cases vs all academic cases, and two hover effects, in which the user could both see the overview of each individual case and hover over a year to get the stats for each year.

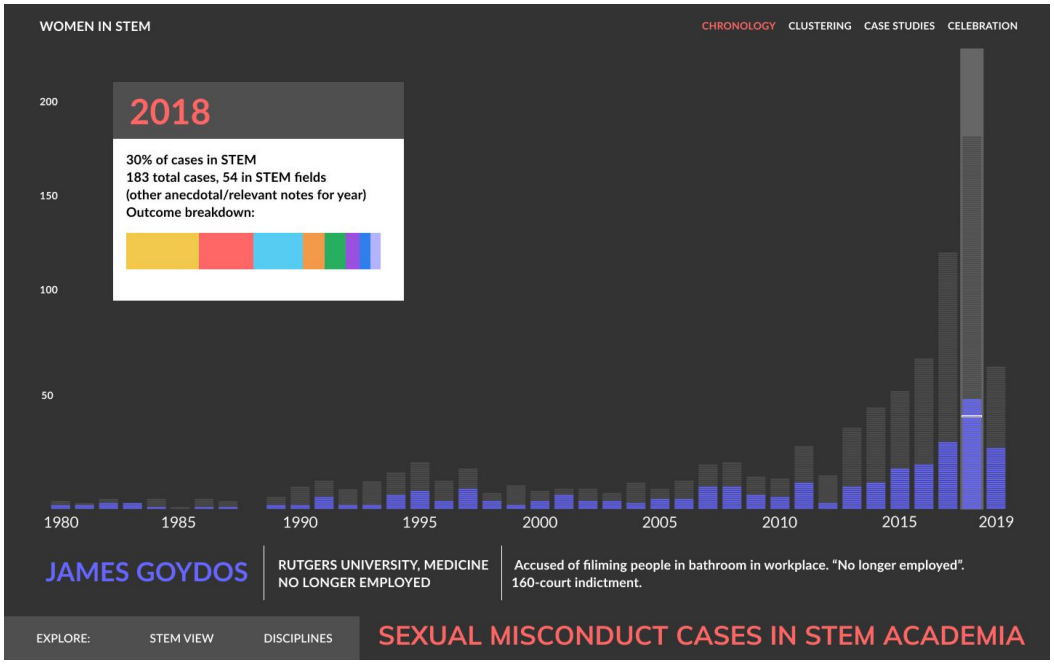

Fig 12. Wireframe of timeline of sexual misconduct cases in STEM academia

III. Main visualization #2: Outcomes of academic sexual misconduct cases

For the second main visualization, I wanted to switch the focus from frequency of cases over time, to the various outcomes of cases. I envisioned a cluster diagram in which each cluster would represent a specific outcome of a case. Each individual circle represented a case. With a cluster visualization, the user would be able to see the relative ratio of each outcome relative to the others.

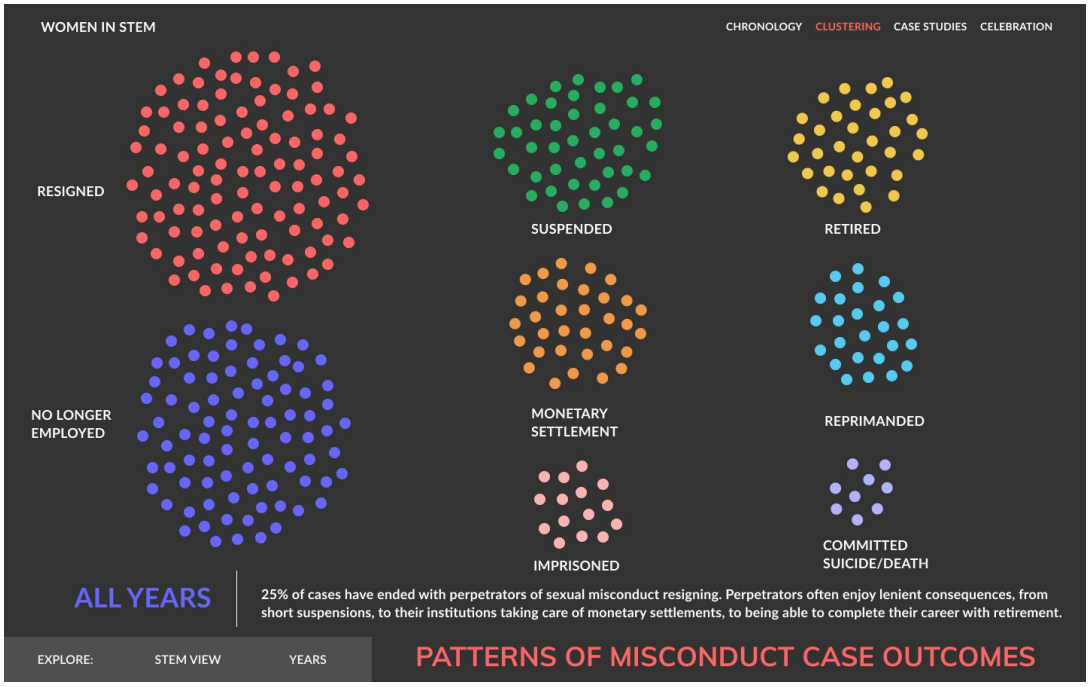

Fig 13. Wireframe of outcomes of sexual misconduct cases in STEM academia

IV. Main visualization #3: Case studies of misconduct cases with outcomes in 2018

The final main visualization will create the transition from a macroscopic view to a more detailed view of the problem. Here we will take a closer look at the fifteen chosen perpetrators with outcomes in 2018. The visualization will be a diverging bar plot of sorts that maps the story arc of the perpetrators, from when they "first" began inappropriate action to when their cases resulted in a recommended outcome. The midpoint is the "zero point" in years, which signifies the year in which the first complaint was officially filed against the perpetrator. The left side of the plot shows the number of years that passed between the first known incident by the perpetrator and the first complaint. The right side of the plot shows the number of years that passed between the first complaint and initial outcome. This would give a general understanding of how long these perpetrators have been active, and how mobile the host institution was after receiving a complaint. A hover interaction would give a detailed account of each perpetrator's "story".

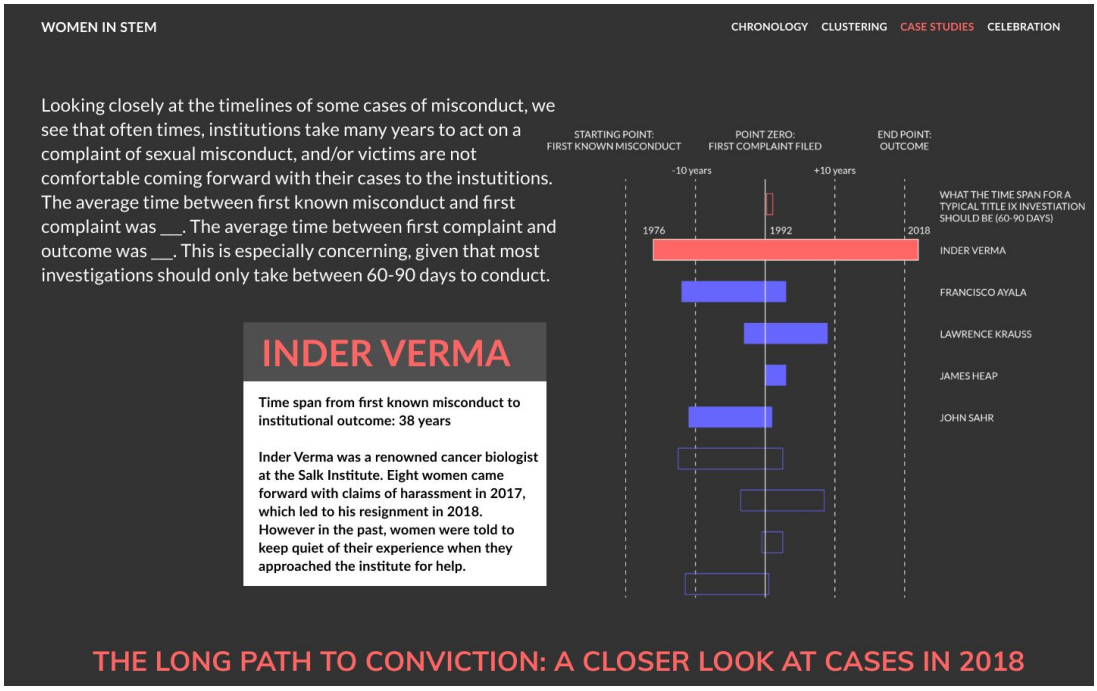

Fig 14. Wireframe of timelines of case studies with outcomes in 2018

V. Concluding animation: Names of female authors of published neuroscience papers

Though I wanted to do a standout visualization that portrayed the stats of women who have published papers in STEM and perhaps pointed out some notable women and their contributions, I unfortunately did not have the time to do so. However, I felt an important part of the project was to end with recognizing the women who have succeeded in STEM regardless of the setbacks that blocked their way. I decided to make an animated string of all of the names of women from my MEDLINE dataset.

Results

The implementation of these wireframes were made with Illustrator, D3, and P5, within a Vue.js framework.

The Planned Parenthood consent survey visualization is made with Illustrator and thus is static. All of the questions used are those in which the difference in percentages of men and women strongly disagreeing to the question is statistically significant. It indicates that across all demographics, women have a better understanding of what consent and sexual assault entails.

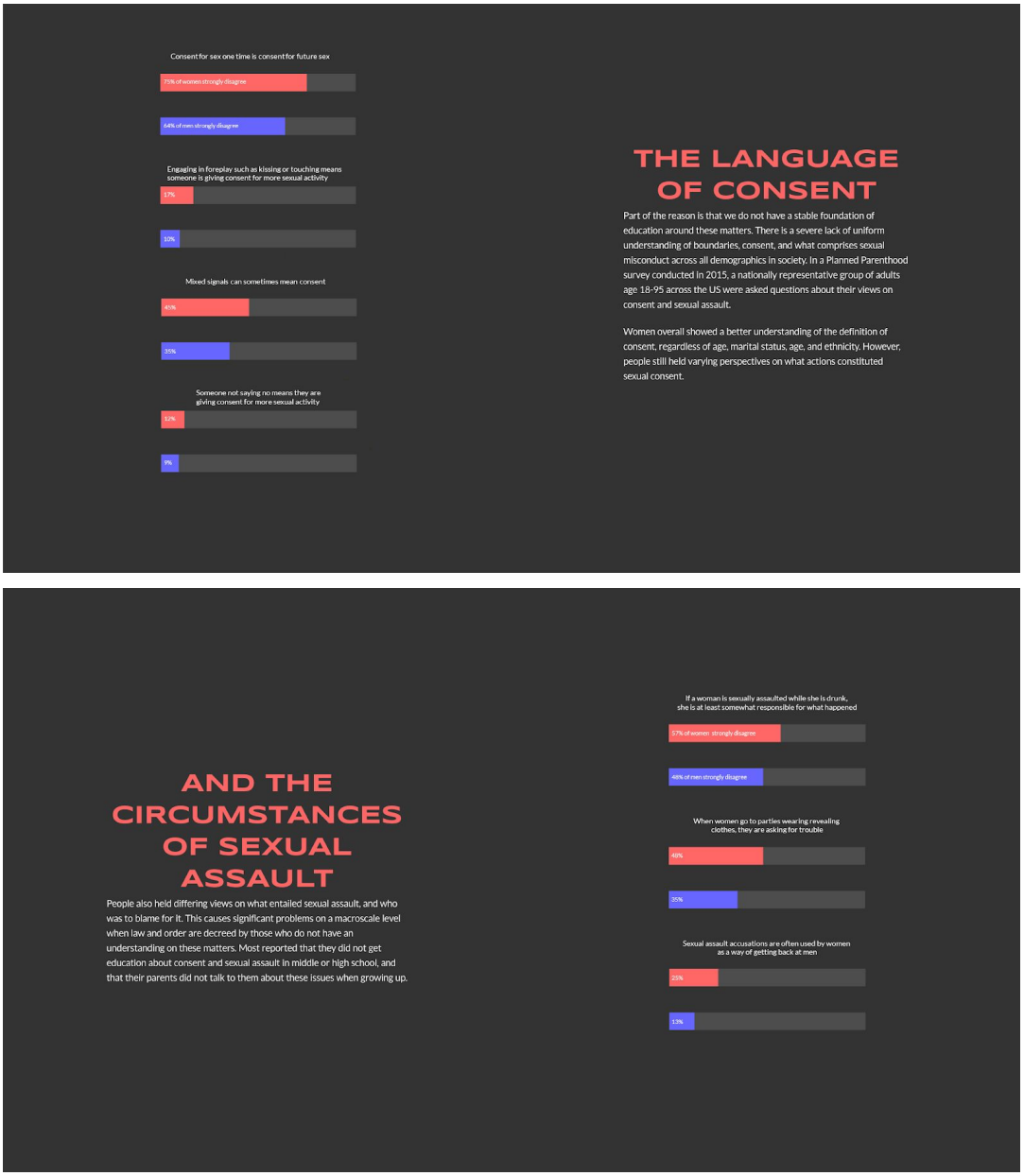

Fig 15. Introductory sequence with survey results from Planned Parenthood consent survey

I created a separate page for each of the main visualizations, which are created with D3 . In order to effectively tell a narrative story without scrollytelling, I had to think of a way to add a sequence to each visualization. I came up with the arrow buttons at the bottom of the page, which the user can click through to follow a story through each visualization, then explore it on their own.

The timeline visualization first shows the total number of cases in the academic sexual misconduct database (1030). The user is then prompted to learn about the major events from 1980 to 2020 that have increased the frequency of reporting--I decided this was necessary to input, in order to give context to the change in the number of reports over the years. This is also where the concept of Title IX is introduced, which is extremely relevant for reporting sexual misconduct cases within academic

institutions (Title IX will also come up in other visualizations). Under the Educational Amendments of 1972, the federal civil rights law Title IX was passed, which prohibited discrimination on the basis of sex in educational institutions receiving federal aid. Title IX becomes crucial for sexual harassment cases within educational institutions in 1980, when it was used for the first time in charges of sexual harassment against an educational institution in the landmark case *Alexander v Yale*.[43] While the plaintiffs did not win the case, they succeeded in having Yale set in place a grievance procedure for students in the event that they experienced sexual harassment. It also established that sexual harassment could be considered sex discrimination under Title IX, and was thus illegal. Another significant event that solidified sexual harassment as a concept that would stay in the public eye was Anita Hill's testimony against then Supreme Court nominee Clarence Thomas during his confirmation hearings in 1991. She testified that he had sexually harassed her while he was her supervisor at the Department of Education and the Equal Employment Opportunity Commission. In that year alone, the number of sexual harassment cases reported to the EEOC increased by more than 50% , and has steadily increased since.[44] The final event that is pointed out is the #MeToo movement--there was an unprecedented number of reported cases after its inception in 2017. Each significant year is highlighted in white. The STEM cases are highlighted at the end of this story sequence. The user can hover over each rectangle to get the details for each case, including name, outcome, institution, discipline, and short summary of the case.

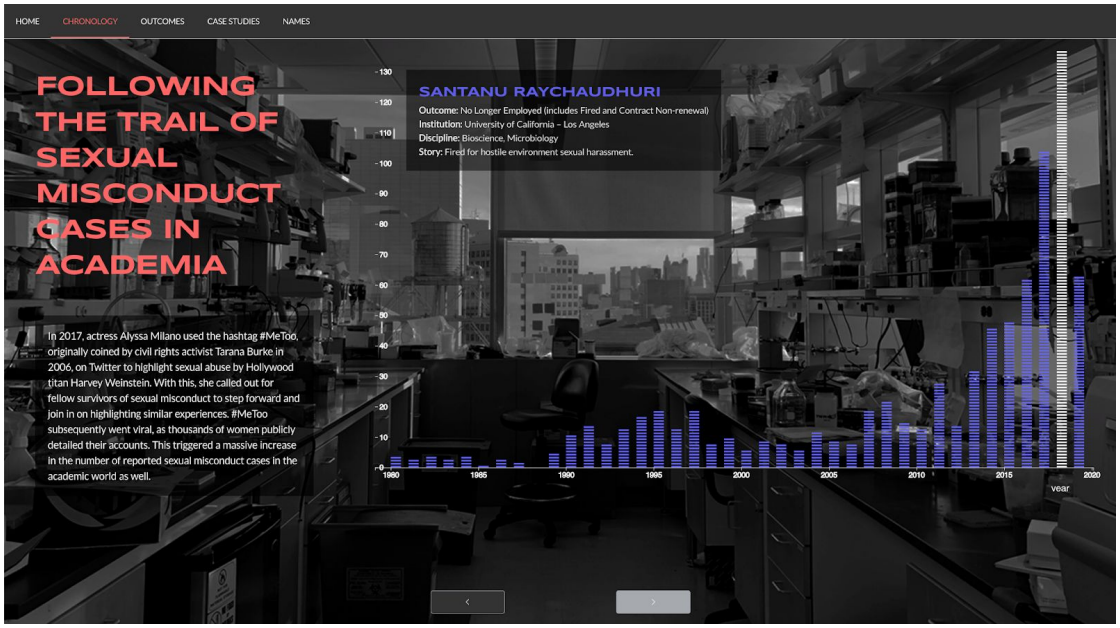

Fig 16. Timeline of academic sexual misconduct cases

The visualization of outcomes of STEM misconduct cases resulted as a circle packing chart rather than a cluster diagram. The hierarchy of circle packing is as follows: the parent circle (biggest circles)

[43] Michigan Law, "Alexander v. Yale: Civil Rights Litigation Clearinghouse," Alexander v. Yale | Civil Rights Litigation Clearinghouse, accessed May 1, 2020, https://www.clearinghouse.net/detail.php?id=12614.
[44] Carol Kleiman, "SEX HARASSMENT COMPLAINTS ON RISE," chicagotribune.com, September 2, 2018, https://www.chicagotribune.com/news/ct-xpm-1992-03-07-9201210842-story.html.

represent the outcomes of the cases. Then the circles are packed by discipline, then institution. Here, the story sequence visualizes how institutions are largely reluctant to impose harsh consequences on perpetrators. Only an estimated 20% of the cases result in perpetrators losing employment to the institutions, whether they get fired or their contracts get terminated. Another 20% of the perpetrators are given the opportunity to resign (these are the two biggest circles). Other outcomes include: suspended, retired, monetary settlement, official warning, training, fine, criminal plea, barred, honor revoked, demoted, committed suicide, jury, other, and no known outcome. Many of these outcomes are not severe at all. The 20% of perpetrators who resign are, in many circumstances, given this opportunity before an investigation is officially complete. Some are able to conclude their academic careers by retiring. Others are suspended from teaching classes for a few years, but then are invited to come back. Institutions often settle cases in court on behalf of the perpetrators. Particularly when the perpetrators in question are highly influential, academically accomplished, and well known, investigative action takes longer. The most common STEM disciplines in which misconduct cases have been reported are bioscience, psychology, and mathematics, with bioscience and psychology making up roughly 10% of STEM cases, and mathematics making up around 7% of STEM cases.

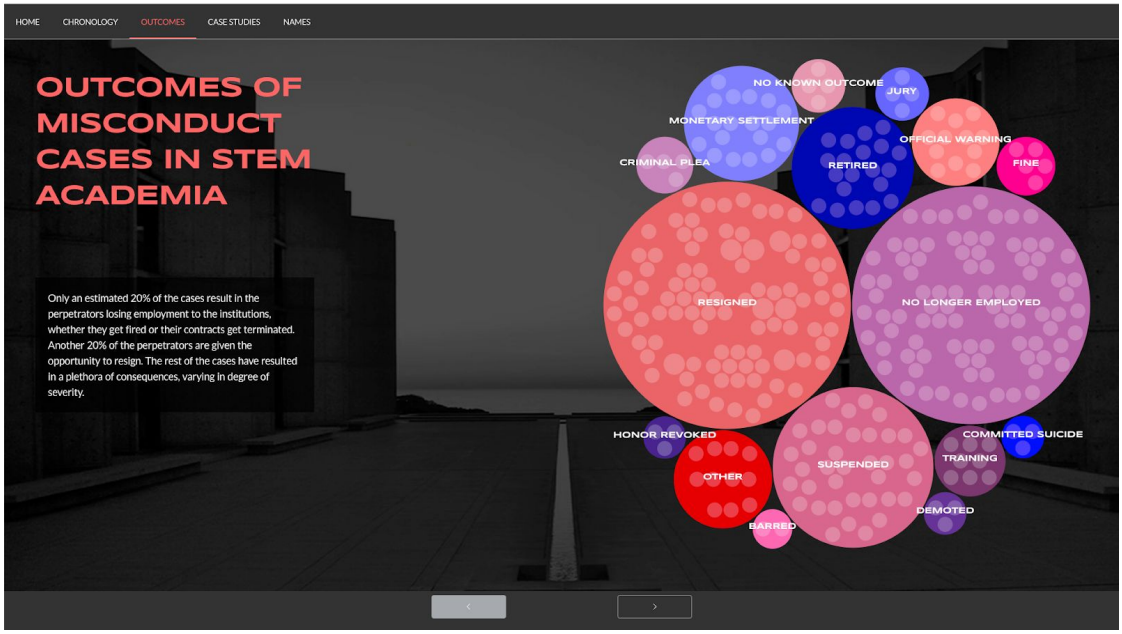

Fig 17. Outcomes of STEM misconduct cases visualized in circle packing diagram

Title IX makes another appearance in the visualization of select perpetrators' misconduct timelines, as a measurement for which to compare the length of time these perpetrators have been free to do as they please. The US Department of Education Office for Civil Rights previously indicated that a typical investigation should take 60-90 calendar days following receipt of the complaint. In 2017, it issued a guidance stating that there is no fixed time frame under which a school must complete a Title IX investigation, only indicating that it will "evaluate a school's good faith effort to conduct a fair, impartial investigation in a timely manner."[45] In the visualization, I have used a 90 day time span for

[45] "How Long Can a Title IX Investigation Take?," NESENOFF & MILTENBERG LLP, November 4, 2019, https://nmllplaw.com/blog/long-can-title-ix-investigation-take/.

the time between the first complaint and first outcome for the Title IX investigation bar, as well as immediate reporting between an incident and a complaint. The color gradient of the bars signify the length of the overall time span between first known incident and outcome. Red is the shortest, signifying any timeline shorter than 5 years. Pink signifies anything less than 10 years; magenta less than 20 years; purple less than 30 years; blue-purple for anything over 30 years. These cases highlight the fact that almost no investigations have resulted in outcomes within 90 days (only one). Many of these cases have spanned decades, some over 40 years. It is evidenced in most of these cases that more than one woman has had to come forward with a complaint (in one case over 300), and that institutions often will not take action on the first complaint. Hovering over the bars will show the user a detailed summary of each perpetrator's timeline.

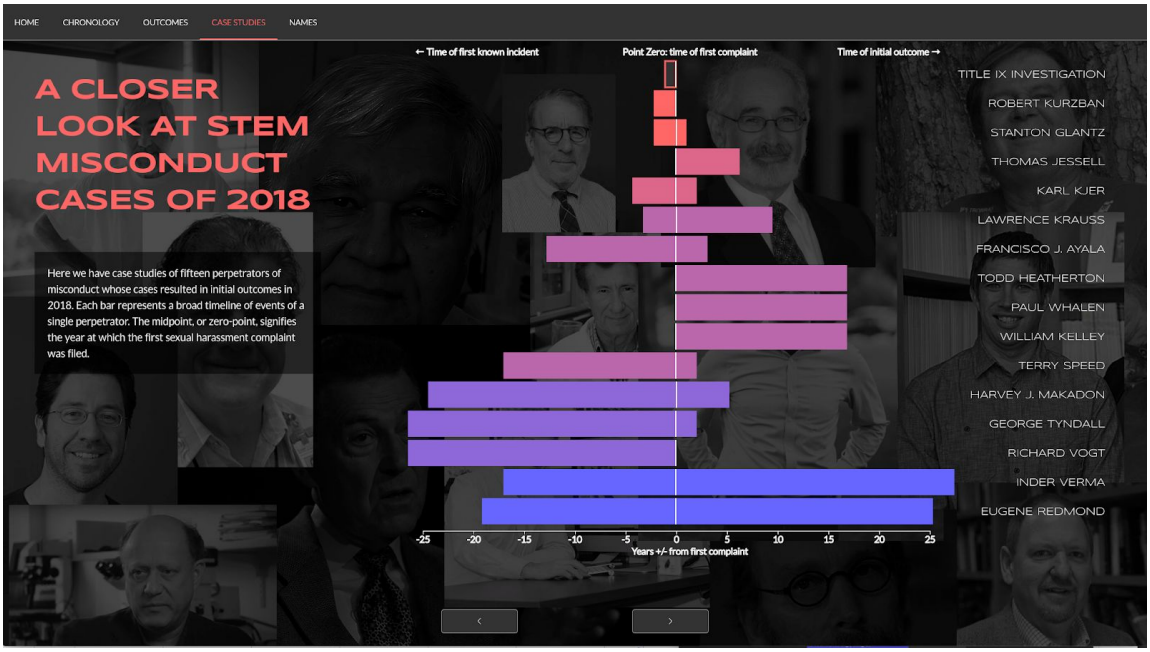

Fig 18. Fifteen case studies of perpetrators with outcomes in 2018

To conclude the project, I was able to put together an animation of the names of women who have published in scientific journals using P5.

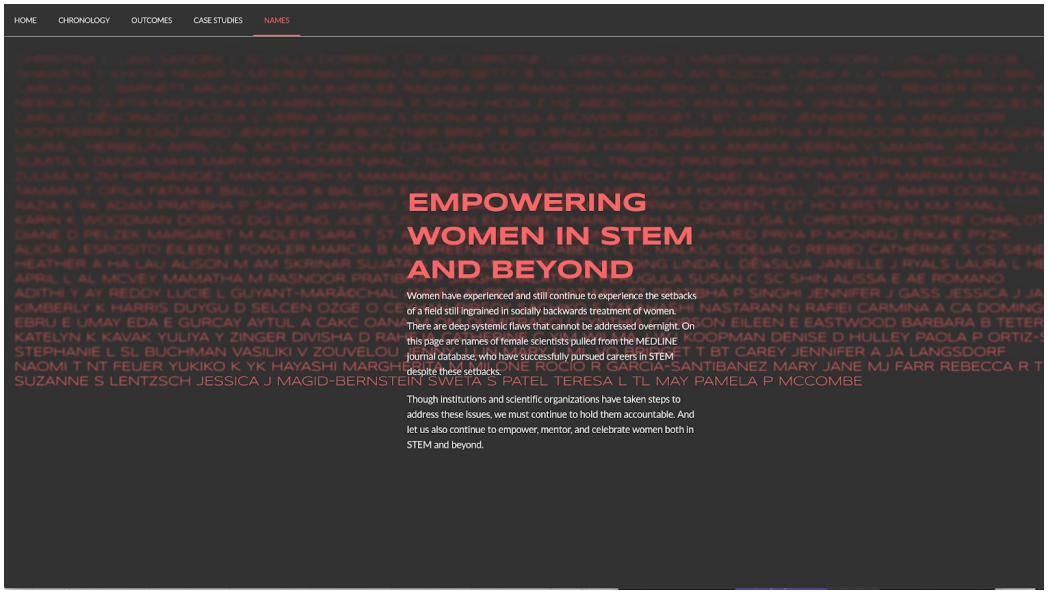

Fig 19. Still image of the animation of names of female authors of scientific papers running across screen

Discussion

The results of this project align with what has been brought up time and time again by personal anecdotes of female scientists, by the latest news article reporting another sexual harassment incident in an university, by reports highlighting the disparity in wage, numbers, and comfort in the workspace between men and women--that women are put at a disadvantage in every scenario (economically, psychologically, physically), and we must work towards abolishing this inequality.

In terms of the project design, there are many improvements that could be made to enhance the communication and visualization of these datasets. Both the timeline and outcome visualizations would benefit from capabilities that would allow the user to more easily explore the visualization on their own: buttons to highlight specific cases with variables of interest is one way to do this. The visualization of timelines of case studies would benefit most from more iterations--I have received several comments that it is the most confusing visualization, yet has the most striking information. The most basic of improvements would be a legend that describes the significance of the colors. It would also be interesting to play around with the order of the bars. Right now they are ordered just by shortest overall to longest overall, but perhaps better insight could be gained by the ability to order by year between first incident to first complaint, first complaint to outcome, or even the ratio of the two. I think the stories of these perpetrators deserve more spotlight than just during hover as well, since reading them will likely impact the user. I would also like to convert this to a scrollytelling visual essay to perhaps make the narrative transitions more elegant than pressing the arrow buttons.

Conclusion

The environment for women in STEM academia and the implications of it has been a focal point of my work for a few years now--I am both frustrated and pleasantly surprised at what I have gathered. My own personal experience as a woman in STEM has been quite the opposite of what I have been exposed to in my research. I have been fortunate enough to always have mentors who encourage my pursuit of a scientific career, and many of them have been women. The men who have mentored me have always been respectful and encouraging. The biotechnology company I work at currently is headed by three powerful women who have had long successful careers in STEM. And yet, the numbers and the stories indicate a different reality. I have approached this subject from multiple standpoints--from prevalence and outcomes of sexual misconduct cases, to detailed pursuit of individual stories of perpetrators, to gender ratios in scientific papers, to retention rates up the academic career ladder, to salaries--and it is clear on all fronts that the gender imbalance is ingrained into the fabric of the field. Women in STEM earn $29,000 less than men in STEM in the US. The retention rate for women up the academic ladder is shockingly low, from around 50% of undergraduates in science being women to only ~20% as tenured faculty (at Columbia University in 2015). The overall percentage of female authorship in neuroscience papers has yet to go above 40%, let alone 50%. Perpetrators of sexual misconduct in STEM academia are oftentimes protected by their institutions, and the number of reports keep increasing. Even in the current environment of increased advocacy for women's rights, it feels like not much progress has been made.

However, I have also been surprised that there actually exists an organized, vetted database of academic sexual misconduct cases that has been maintained for several years now. I have been grateful that so many journalists have written about the stories of sexual harassers, not just in general but focusing on those in STEM academia. I have also witnessed some positive changes in the landscape during the timespan I have been researching this topic--for example, the National Academy of Science voted to allow sexual harassers to be expelled from its membership.[46] I have been reassured that there are advocates out there who are continuously working to change the environment for the better.

Education can solve many of our problems in society, especially if we start at a young age. Beginning with education on consent, there must be a methodology by which we establish a good foundation for navigating physical and psychological boundaries. We must keep pointing out the difficulties that women in STEM face and keep advocating for change. Institutions, influential scientific organizations, and figureheads should be the first to implement better accountability on themselves and their members. I hope that this project contributes to this movement for change, and encourages women to keep empowering fellow women and themselves--both in STEM and beyond.

[46] Amanda Field, "NAS Votes for Final Approval on Expelling Harassers," AAMC, June 7, 2019, https://www.aamc.org/advocacy-policy/washington-highlights/nas-votes-final-approval-expelling-harassers.

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