

Overcome Gender Discrimination in STEM Using the Case Study Method

Coleen Carrigan

Coleen Carrigan is an Associate Professor of Anthropology and Science, Technology and Society (STS) at California Polytechnic State University, San Luis Obispo. Using ethnography, she investigates the cultural dimensions of science, technology, engineering and mathematics (STEM), with a particular emphasis on Computer Science and Engineering, and why these high-status fields appear impervious to desegregation. Professor Carrigan shares the findings from her research to foster welcoming environments in STEM and help strengthen alliances between liberal arts scholars, engineers and scientists to enhance civic engagement and combat social injustices. She is a recipient of a five-year Faculty Early Career Development (CAREER) Award for her research into the intersections of gender, race and social values in computing.

Liesl Folks (Senior Vice President for Academic Affairs and Provost)

Dr. Liesl Folks serves as Provost at the University of Arizona, as well as a professor in the Dept. of Electrical and Computer Engineering. She holds a PhD degree in Physics from the University of Western Australia and an MBA from Cornell University. Prior to joining UA, she served as dean of Engineering at the University at Buffalo for 6.5 years. During her time at UB, she was the architect of a strategic growth plan for engineering. Previously, she performed research and development on nanoscale magnetic materials and devices in support of the data storage industry for 16 years in Silicon Valley. Dr. Folks has co-authored more than 60 archival peer reviewed journal articles and 14 US patents, resulting in more than 12,400 citations. She served as President of the IEEE Magnetics Society from 2013-2014 - the first female president. She also served as chair of the congressionally-mandated National Academies panel which delivered the "2020 Quadrennial Review of the National Nanotechnology Initiative" report. Dr. Folks has long been a champion for women and underrepresented minorities in STEM degree programs.

LAURENE M TUMIEL BERHALTER (University at Buffalo, The State University of New York)

Laurene Tumiel Berhalter, PhD, is Associate Professor and Director of Community Translational Research in the Jacobs School of Medicine and Biomedical Sciences, Department of Family Medicine, at the University at Buffalo (UB). An epidemiologist by training, she has over 25 years' experience conducting community-based participatory research and health disparities research to improve the patient-provider interface among underserved communities in chronic disease self-management and cancer prevention. She has worked with a variety of partners from both urban and rural communities. For over 11 years, she has worked with the Patient Voices Network (PVN), a grassroots group of patients receiving care from safety-net practices, to design and implement programs to improve the delivery of health care using a Patient Ambassador model, a peer support model to empower patients in their own care and address social determinants of health. As Director of the Community Engagement Team at the UB Clinical and Translational Science Institute (CTSI) she is committed to building infrastructure to facilitate community engagement and community partnered research.

Nancy A Schiller (Engineering Librarian) (University at Buffalo, The State University of New York)

Nancy A. Schiller is Engineering Librarian Emeritus and former Co-Director of the National Center for Case Study Teaching in Science (NCCSTS) at the University at Buffalo (UB). She has served as Co-Principal Investigator on a number of educational reform grants funded by the National Science Foundation (NSF) and the Pew Charitable Trusts as well as PI on an Educational Technology Initiative grant awarded by the State University of New York's Office of Educational Technology. In 1997, she received the SUNY Chancellor's Award for Excellence in Librarianship. Currently,

she serves as Co-PI on an NSF NRT-IGE grant awarded to UB to develop case studies to help train women graduate students in STEM to navigate gender bias and discrimination in the workplace (NSF Award #1735143). She has published extensively on the use of case-based pedagogies in STEM education. Her Master's in Library Science is from Columbia University.

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Introduction

The NAVIGATE Project, funded by the National Science Foundation (NSF), is a collaboration between scholars at the University at Buffalo, University of Arizona and California Polytechnic State University, San Luis Obispo that aims to increase the number of women in science, technology, engineering and mathematics (STEM) who persist in their chosen disciplines and achieve leadership roles.

NAVIGATE uses the case study method to provide women STEM graduate students with educational materials on how to recognize and confront discrimination, both interpersonally and organizationally. Our skills-based program promotes the internalization of learning and the development of analytical and decision-making skills, as well as proficiency in oral communication and teamwork. The core of the training program is a set of ten peer-reviewed case studies, with detailed facilitation guides, which explore issues related to gender-based bias, harassment and discrimination in the STEM workplace. Each case study is coupled with discussion questions for individual and group reflection, for which the accompanying facilitation guides provides possible answers for those leading the training to promote meaningful engagement with the material. All of the cases are based on the real-life experiences of women at work.

There are a wide array of programs that work to broaden understanding of gender bias, harassment and discrimination in the STEM disciplines. While prior efforts have indeed created widespread awareness of these persistent inequities, more education is needed on how to acquire and implement skills to pro-actively navigate gender biases and inequitable relations of power in the STEM workplace. Even though 90% of early-career women agree that gender discrimination in the workplace is an issue today; 84% agree there are inherent biases in the workplace that hold women back; and 78% expect gender discrimination to negatively impact their careers, sexism in science continues to negatively impact women's persistence in STEM fields. [1] In other words, despite an understanding that they may be facing specific situational hurdles arising from bias, harassment and discrimination, many women in STEM disciplines continue to be dissuaded from career and leadership goals when targeted by such harms.

The NAVIGATE program encompasses a three-day retreat followed several months later by a one-day workshop as well as ongoing support through the use of social media tools such as Twitter, Facebook, and Instagram. To recruit participants, we made an open call to all STEM graduate students at the University at Buffalo (UB) who identify as women or non-binary. The program entails eight months of contact with each cohort of students, and has been offered three times over three years to different cohorts of students, with assessment tools deployed to collect data on all three cohorts. Thus far, NAVIGATE has reached 135 women graduate students in STEM (See Table 1 for list of disciplines represented at NAVIGATE), with a fourth workshop completed in March 2022.

Why Use Case Studies?

Case studies, often used as a method of instruction in the teaching of business or law principles, involve assigning realistic scenarios to stimulate students to actively engage in analysis related to specific topics. While case studies are widely used to teach technical material, in this project we specifically set out to develop cases to help women STEM graduate students recognize—and devise strategies for dealing with—gender-based inequity, bias and discrimination that they will almost certainly encounter in the workplace. Each of the cases is based on ethnographies collected from women working in STEM settings (with names, places, and, in some cases, certain details changed to maintain anonymity), and each involves a women protagonist who is pursuing a STEM career. The goal of the cases is to promote strategic thinking, problem solving and decision-making around issues related to workplace bias and discrimination that deter women from persisting in STEM career paths.

In our project, the design of the cases followed Bird & Erickson’s [2] constructive controversy approach in which a brief but contextually rich story-like scenario based on an actual experience is provided to students that entails a dilemma that needs to be resolved. To guide the work of the students, a set of Key Concepts and Terms (typically 1-2 pages of material) is provided for each case along with a series of guided activities and discussion question sets. The cases require that students first understand the situation (the who, what, where, when, how, and why of the story), then analyze it, and finally engage in active strategic problem solving to collectively, and collaboratively, develop a course of action to resolve the problem. This type of case is intended to explore the practical contingencies and consequences of personal decision making and to promote strategic problem solving, with the ultimate goal of helping students develop skills for navigating the power dynamics of the workplace.

NAVIGATE Case Studies

To date, ten cases (listed with titles and descriptions below) have been fully developed by The NAVIGATE Project team. They are available for free download to be used in trainings for senior undergraduate, graduate, or early-career women in STEM. Each case has a comprehensive

Field of Study - All Cohorts	Frequency
Anthropology	1
Biological Sciences	1
Biomedical Engineering	10
Biomedical Sciences	5
Biophysics	1
Biostatistics	1
Chemical & Biological Engineering	4
Chemical Engineering	2
Chemistry	7
Civil, Structural & Environmental Eng.	4
Cognitive Psychology	2
Community Health & Health Behavior	1
Computational & Data-Enabled Science	2
Computer Science	20
Econometric & Quantitative Economics	1
Economics	5
Electrical Engineering	8
Engineering and Applied Sciences	3
Evolution, Ecology & Behavior	2
Finance	1
Geography	1
Geology	5
Industrial & Systems Engineering	7
Materials Design & Innovation	4
Mechanical and Aerospace Engineering	2
Microbiology and Immunology	1
Neurology	1
Neuroscience	2
Operations Management and Strategy	1
Pathology and Anatomical Sciences	1
Sustainable Transportation and Logistics	1

Table 1

Teaching Guide, allowing any interested party to facilitate the training. Each case study training is designed to be completed in a 1 hour 45 minutes (105 minutes) session, with small groups of five or so students working together. The cases can be used individually, or in combinations, depending on the interests of the group and the time available.

CASES WITH STUDENT PROTAGONISTS

Pei Wu – Running Out of Time: A graduate student is assigned to work in the lab with a male PhD student from a different cultural background who seems to lack respect for her and her career path and may be actively working against her.

Anitta – Based on My Own Merit: Five female friends with diverse backgrounds - three engineering students, and two practicing electrical engineers - discuss intersectional challenges arising from biases they currently face in school and the workplace.

Nadia Spencer – A Confidence Challenge: A PhD civil engineering student contemplates quitting the degree program as her confidence is shaken while working as a TA for a male professor who has created a hostile work environment.

CASES WITH EARLY-CAREER PROTAGONISTS

Ayesha and the Trade Show: A junior engineer who has just returned from representing her company at her first trade show is excited to present her report, but she leaves the meeting confused by her senior director's muted reaction.

Kaira and the Big Pitch: An early-career engineer is passed over by the CEO of her firm for the lead role in delivering a pitch to a valuable external potential client.

Michelle and the Grant Proposal: An early-career faculty member tries to obtain a letter of support for a grant application from her department chair, but senses that he is reluctant to provide it.

Rachel Frank – Conflicted at Work: An early-career engineer is first befriended by, and then becomes romantically entangled with, a more senior and more powerful male colleague at work, leading to a number of conflicts of interest.

CASES WITH MID-CAREER PROTAGONISTS

April and the Promotion Committee: The only female member of a promotion committee struggles to prove that a fellow female faculty member in the department is worthy of promotion to a full professorship.

Brenna McGee – A Balancing Act: A mid-career academic researcher receives personal advice from an older female faculty member on how to better prepare herself for promotion to full professor that doesn't take into account her work-life balance choices.

Claire King – Overlooked for Promotion?: A mid-career engineer finds her path to promotion to partner at the small, private company where she has worked for ten years blocked by the existing partners, all of whom are male.

Evaluation Methods and Outcomes

Cohort participants completed an extensive evaluation to assess knowledge of discrimination and bias and the confidence to address these issues should they be faced with such situations. A pre-assessment was conducted at beginning of each three-day retreat and, at the end of the retreat, we administered a post-test. We also surveyed participants seven months after the end of each retreat (for more information on all the evaluation data collected for the NAVIGATE project, see Table 2). We employed the Knowledge of Gender Equity scale, which requires participants score 21 items on a 5-point likert scale (very much believe to be true to very much believe to be false) [3]. An average score was computed for all 21 items. Paired-samples t-tests were used to determine significant changes in mean scores between pre- and post-test.

Among all UB NAVIGATE Project participants who completed both the pre and post-test surveys (N=99), there was a significant difference in the scores between Pre-Survey Knowledge

of Gender Equity (KGE) Scale Scores (M=46.43, SD=10.25) and Post-Survey KGE Scale Scores (M=38.85, SD=11.39; $t(98)=8.218, p = .000$). Overall, when comparing the pre-test to the

INSTRUMENT NAME	TIMELINE
Pre-Assessment	Immediately prior to Retreat Participation
Case Study Evaluation	After each Case Study facilitation (During Retreat & Workshop)
Retreat Wrap-up Writing Prompt	Last day of Retreat
Post-Retreat Evaluation	Last day of Retreat before participants are released from the 3-dat retreat
Workshop Evaluation	Before participants are released from the 1-day workshop
Mid-term Assessment	Approximately three months after the Retreat
Post-Assessment	Approximately seven months after the Retreat

Table 2

post-test scores, the women graduate students who participated in the NAVIGATE project reported that their belief that there are gender inequality issues within the workplace increased. Specifically, the greatest increases in awareness occurred within the following topics: 1) the old-boys network; 2) cloning bias in evaluative settings; 3) communicating one’s impacts; and 4) successfully negotiating employment conditions.

Our pre- and post-retreat assessments also included a 19-item scale created by the NAVIGATE team to assess the confidence participants had in conducting various behaviors or activities. Confidence was measured by a 10-point likert scale, 0 being not confident at all and 10 being highly confident.

Statement of Behaviors	Pre Confidence	Post Confidence	p-value paired sampled t-test
Give myself "permission" to say "No" to things and focus more on my own development.	5.94	7.09	.001
Advocate for myself, by openly talking about all my hard work and highlighting the outcomes of my efforts with my peers and supervisors.	5.05	6.73	.000
Actively work on building relationships with a sponsor or someone higher up in the organization who will advocate for me.	5.86	6.90	.001
When gender conflicts arise, I work to understand the role that cultural differences may play in the workplace conflict.	6.27	7.38	.001

Table 3

Paired-samples t-tests were used to determine significant changes in mean scores between pre- and post-test. The largest increases in confidence can be found in Table 3.

Impacts

A total of 135 University at Buffalo (UB) graduate women participated in three cohorts of the NAVIGATE Project. Participants were from diverse racial and ethnic backgrounds and represented a variety of academic departments (see Table 1 above). Of the participants, 97.9% were very satisfied or satisfied with the overall program. 96% of NAVIGATE participants continue to persist in their STEM careers. Participants' belief that gender inequality exists within the STEM workplace increased. Participants showed a statistically significant increase in confidence in 11 out of 19 behaviors (see Table 3). Qualitative data collected at each three-day retreat (see Table 2 for more details) also show evidence that the two main outcomes we had anticipated at the start of this project have been achieved. Firstly, we hypothesized that the case facilitations would not only make students aware of interpersonal and systemic sexism in science but also empower participating graduate students with the confidence to navigate challenges related to gender bias and discrimination in STEM workplaces. For example, a NAVIGATE participant from the second cohort stated:

As someone who is young and inexperienced I always thought these things happen on the news and I did not realize the frequency at which this has affected my own peers. Nor did I know it had a toll on both their personal and professional life. I realize how important it is for me to be informed about the law regarding these topics. Not to mention the negotiation skills I have learned. I am very thankful to have had this opportunity and am leaving with more information and confidence.

Secondly, we anticipated NAVIGATE participants would learn new techniques and strategies for successfully mitigating circumstances in which they were targeted by bias and discrimination and thereby persisting in their STEM career trajectories. For example, one participant from the second NAVIGATE cohort shared that she had recently been targeted by racism. In the NAVIGATE program she said: "I learned to be confident and never take no for an answer. If I

ever face racism again, I will be able to tackle the situation with more self-assurance and deal with the situation rationally rather than emotionally stressing over it.” Another participant also gained new knowledge of how to mitigate sexism at work:

Men tend to interrupt me when I am talking during a meeting and repeat my ideas as if they are their ideas. From the retreat, I learned I can speak up for myself in a pleasant way or I can find an ally, a change agent to help me to speak up for me. And I will be a change agent for others too.

A participant from the third NAVIGATE cohort reflected:

In my previous job, women were often expected to take on auxiliary tasks in addition to their normal workload (lab manager, equipment manager, health and safety manager) leading for higher burnout rates among women than men. I realize now that this is a “raising the bar” example and protects the old boys network. If this happens again, I will compile data and present it to my office manager. I will use strategic alignment techniques to argue my point.

Finally, women who have participated in the NAVIGATE program report that it helped them to learn that the discrimination and harassment they have experienced in STEM workplaces, labs and classrooms are not their fault, and they are not alone. They reported feeling relieved to share in these moments of consciousness-raising about sexism and bias, which allow them to work collectively with other women to devise strategies to combat these discriminatory and unfair treatments.

2022 ASEE Case Facilitation: “Michelle and the Grant Proposal”

In this 2022 ASEE workshop, the NAVIGATE facilitators will lead workshop participants through this novel case study approach to supporting the career persistence of women in STEM. We will facilitate one of our ten cases titled “Michelle and the Grant Proposal.” In this scenario, a junior faculty member tries to obtain a letter of support for a grant application from her department chair, but senses that he is reluctant to provide it. The case aims to help early-career women in STEM develop skills that may be useful to achieving long-term success, such as building a professional support network for career resilience and communicating impacts. The structure of this 2022 ASEE workshop will be comprised of a short introduction to The NAVIGATE Project, followed by an active learning exercise during which the NAVIGATE team will lead the group through the case study facilitation, followed by wrap-up and a question-and-answer session.

Much like the students who have participated in NAVIGATE retreats, upon completion of this case facilitation, workshop participants will be able to:

- Recognize workplace gender biases related to career advancement;
- Identify strategies for building one’s professional support network for career advancement;

- Identify strategies for “managing up;”
- Identify strategies for communicating one’s impacts and accomplishments;
- Experience the impacts of collectively strategizing to end sexism in STEM using the case study method.

Overall, we have designed these cases to deepen the confidence of women graduate students in STEM and to provide them with practice in using various techniques and tools (e.g., decision trees and SWOT analyses) for developing a strategic plan of action so that they can "unpack" complex workplace issues and find solutions that don’t derail their careers.

Workshop participants will have the opportunity to work collectively on devising short-term and long-term strategies to solve the social problems manifested in this case study. They will experience first-hand how the NAVIGATE program works through the use of case studies and collaborative problem-solving to learn the skills necessary to (1) recognize gender bias, inequity and discrimination when encountered, and (2) act to overcome career adversity created by gender bias, inequity and discrimination to persist in their STEM careers and become transformational leaders in STEM fields.

NAVIGATE Resources

To learn more about the NAVIGATE project and use the suite of materials we have developed to help end structural gender violence in STEM, please refer to the following resources:

- The NAVIGATE Project website: <https://www.buffalo.edu/navigate-project.html>
- The NAVIGATE Project Case Studies Portal: <https://www.buffalo.edu/navigate-project/case-studies.html>
- The NAVIGATE Project training program description: <https://www.buffalo.edu/navigate-project/training-materials.html>
- The NAVIGATE Project reviewer bios: <https://www.buffalo.edu/navigate-project/people/reviewers.html>
- The NAVIGATE Project keynote speaker bios: <https://www.buffalo.edu/navigate-project/people/keynote-speakers.html>
- Public FACEBOOK Group Page: <https://www.facebook.com/UBNavigate/>
- Twitter Page: <https://twitter.com/UBNAVIGATE>
- Ten downloadable case studies that teach a variety of concepts, issues and strategies concerning women in STEM: <https://www.buffalo.edu/navigate-project/case-studies.html>

References

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[2] Bird, Sharon R., and Karla A. Erickson. 2010. A constructive controversy approach to case studies. *Teaching Sociology* 38(2): 119-131.)

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