Surprises along the Path toward Equity in Engineering and Computer Science Education

Rebecca A Atadero (Assistant Professor)

Becki Atadero is an Associate Professor in the Department of Civil and Environmental Engineering at Colorado State University. She earned her B.S. in Civil Engineering from CSU in 2002, and her Ph.D. in Structural Engineering from the University of California, San Diego in 2006. Dr. Atadero conducts collaborative research in the field of engineering education with particular emphasis on diversity, equity and inclusion in engineering. She has served as PI on three education related grants funded by the National Science Foundation, and a prior paper by the P4E research team was awarded Best Diversity Paper at the ASEE Annual Conference in 2015. She also conducts technical research with civil engineering and construction management graduate students. She and her students study ways to extend the safe and useful life of existing structures, particularly concrete bridges, through enhanced inspection, management and repair techniques. This research has been funded by the Mountain Plains Consortium, a USDOT University Transportation Center, and the Colorado Department of Transportation. She teaches courses in structural engineering such as reinforced and prestressed concrete design and civil engineering materials to upper division undergraduates and graduate students. She is a registered Professional Engineer in the state of Colorado.

Jody Paul (Professor)

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Dr. Karen E. Rambo-Hernandez is an associate professor at Texas A&M University in the College of Education and Human Development. Her research focuses on the assessment of educational interventions to improve STEM education, and access for all students— particularly high achieving and underrepresented students— to high quality education. Along with her research teams, she has published over 30 peer-reviewed articles and received over $3.4 million in grant funding from organizations such as the National Science Foundation and the U.S. Department of Education Javits Grants. Dr. Rambo-Hernandez was the District Teacher of the Year in Coppell, Texas, in 2006 and received the National Association of Gifted Children's Early Scholar Award in 2019.

Melissa Lynn Morris (Associate Professor In Residence)

Robin A.M. Hensel (Assistant Dean for Freshman Experience)

Robin A.M. Hensel, Assistant Dean for Freshman Experience in the Benjamin M. Statler College of Engineering and Mineral Resources at West Virginia University, leads a team of passionate faculty in the Fundamentals of Engineering Program who provide first-year students with high-quality, challenging, and engaging educational experiences to facilitate the transition to university life and prepare for success in their engineering majors and future careers. Hensel holds a doctorate in Curriculum and Instruction, focusing on STEM teaching in higher education, and B.S. and M.A. degrees in Mathematics. Prior to joining academia, she worked with engineering teams and in project management and administration as a Mathematician and Computer Systems Analyst for the U. S. Department of Energy. She has over 30 years of experience teaching mathematics, statistics, computer science, and fundamental engineering courses as well as serving in several administrative roles within higher education. Throughout her career, Hensel has created a childcare facility at a federal research lab, coached middle school MATHCOUNTS students, facilitated STEM K-12 teacher training, built an undergraduate first-year engineering program at a large R1 research institution and a Molecular

Biology/Biotechnology masters' degree program at a small internationally-focused teaching institution, lived on-campus as a Resident Faculty Leader for an engineering-focused residence hall, and secured over $5 million in funding and support for STEM education research, focusing on student success, inclusion, and retention, and including funds for summer bridge programs and scholarships for underrepresented students. She has been recognized for her excellence in teaching, advising, and service, and as an Exemplary Faculty Member for Excellence in Diversity, Equity, and Inclusion. An active ASEE member since 2005, Hensel has reviewed and presented papers, moderated sessions, planned division social events and regional conferences, and served for 10 years on the First-year Programs Division Executive Board, including as program and division chair.

Christopher Griffin (Dr.)

Dr. Griffin has over 10 years of experimental and computational aerodynamics research experience. His primary area of expertise is unsteady aerodynamics, with a focus on active flow control techniques and UAS aerodynamics. Dr. Griffin has experience in both supersonic and subsonic wind tunnel testing using a variety of measurement techniques, including strain gage based force and moment quantification and Particle Image Velocimetry (PIV). He is also well versed in the use of computational fluid dynamics for aerodynamic analysis. While at West Virginia University Dr. Griffin has taught a variety of classes, including Fluid Mechanics, Aerodynamics, and Computational Fluid Dynamics.

Scott Leutenegger

Ronald R. Delyser (Associate Professor Emeritus)

A. M. Aramati Casper

Aramati Casper is a Research Scientist II in the Department of Civil and Environmental Engineering at Colorado State University. Their research focuses on social justice, equity, diversity, and inclusion in STEM.

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Abstract

The Partnership for Equity: STEM (P4E) is a collaborative project funded by the NSF IUSE program. Four partner institutions have been working together for the past five years to develop, implement, and assess curriculum activities to enlighten students attending required undergraduate engineering and computer science courses about the relevance and importance of diversity, equity, and inclusion to the fields of engineering and computer science. As the P4E project nears completion, we use this poster session and accompanying paper to reflect on what we have learned during the past five years. We focus on the surprises we encountered during the course of the project in the hopes that the pleasant surprises can be replicated with intention and the unpleasant surprises avoided by others who travel a similar path.

"Surprise" is a personal emotion in response to something unexpected, thus this reaction varies with *a priori* held beliefs. For this paper we decided to present verbatim reflections from project team members. This unique format allows us to enact some of the diversity and inclusion lessons we have tried to teach students over the past five years. The format also acknowledges that while none of the surprises documented here were in fact surprising to all the authors, individually we each had experiences that violated our expectations.

Introduction

The Partnership for Equity (P4E) is a collaborative project funded by the NSF IUSE program. Four partner institutions have been working together for the past five years to develop, implement, and assess curriculum activities to enlighten students attending required undergraduate engineering and computer science courses about the relevance and importance of diversity, equity, and inclusion to the fields of engineering and computer science. As the P4E project nears completion, the project team has used this poster presentation and accompanying paper as a prompt to reflect on what we have learned during the past five years.

One of the lessons we have tried to teach students during this project is the value that diverse perspectives bring to the engineering and computing fields. Our project has taken a broad view of diversity, encompassing the varied social identities people hold such as race, ethnicity, and gender, as well as differences in prior experiences, upbringing, and interests. Teams composed of cognitively diverse individuals outperform teams with less diversity in their knowledge even when those less diverse teams are composed of high achievers [1]. The challenge of integrating lessons about diversity, equity, and inclusion into undergraduate engineering and computer science courses is substantial and complex and the diversity of perspectives on our project team has been essential to the progress we have made. In light of this fact, we have chosen a unique format for this paper. We have asked project team members to reflect on the project and we are sharing those reflections verbatim in this paper.

To collect the team reflections, we asked each individual who wanted to contribute to the poster/paper presentation to consider three things in their reflection:

1. Share what you are comfortable sharing about your context/positionality (your role on the grant, your role at your institution, your relationship to engineering and computer science, personal identities that impacted your participation in the project)
2. Something you learned/ encountered/ were surprised by that was a pleasing or positive outcome for you
3. Something you learned/ encountered/ were surprised by that was a challenge/barrier in your project efforts

We wanted to focus on the surprises and learning points we encountered during the project in the hopes that the pleasant surprises can be replicated with intention and the unpleasant surprises avoided by others who travel a similar path. "Surprise" is a personal emotion in response to something unexpected, thus this reaction varies with *a priori* held beliefs. Although no one of the surprises documented here was in fact surprising to all of the authors, we highlight the experiences that most engendered the sense of a violation of expectations.

After the reflections were collected, we read each other's contributions and added comments or questions to the authors in an effort to appreciate all the things we have taught each other and to suggest areas where a little more detail might strengthen the value of the reflection for readers outside the project. Authors then had the chance to respond to the comments (or not) before we finalized the paper.

Personal Reflections from our Team

Melissa Morris, Ph.D.
Associate Professor in Residence, Mechanical Engineering UNLV
While a faculty member at West Virginia University (WVU) I enjoyed working with faculty to develop several activities and reflection questions that have been used in courses from the first-year to senior level. I actively recruited new faculty to join in our efforts and incorporated several activities into my first-year courses when I taught at WVU. Prior to the start of fall 2019 I left WVU and am now at the University of Nevada, Las Vegas. Since joining the faculty in the Mechanical Engineering department at UNLV I have continued to implement many of the grant-related activities into my courses. As a result of working with this team I have become more confident in my abilities to address issues of Diversity, Equity, and Inclusion (DEI), and have volunteered to participate in related professional development opportunities.

Throughout the implementation of the DEI related curriculum I have been pleasantly surprised by the insightful responses from students related to the activities. Many of the topics were initially uncomfortable or foreign to students, but the vast majority of them were open to learning and exploring the topics. The majority of faculty I worked with saw the value in the efforts of this project and contributed ideas and recommendations that have been used to shape our activities.

A few faculty were resistant to the idea that DEI related content belonged in their engineering curricula, were unaware of the DEI issues their students face, and were at times difficult to work with. It was important for me to put these voices into perspective, and not let the negative thoughts of a few tarnish the growth, understanding, and efforts of many.

I went into this project with a goal to help change the climates of engineering classrooms and teach students to value diversity. I came out of this project with a greater empathy, appreciation, and respect for my students.

Christina H. Paguyo, Ph.D.
Former Director of Assessment, University of Denver
I originally joined this research initiative as a postdoctoral research fellow in 2014 when our project focused on first-year engineering students at one institution. After we received NSF funding to expand our research across disciplines and institutions in 2017, I was excited to serve as principal investigator for the University of Denver team. Over the course of this project, I often identified myself in terms of what I was not: not an engineer, not a computer scientist, not a professor, and not white.

A pleasant surprise is how this project has planted seeds of sustainability that will hopefully live beyond the cycle of this grant. Thanks to the leadership of Scott Leutenegger and Chris GauthierDickey, the computer science curriculum at DU is in the process of being redesigned with an increased focus on ethics and equity. Additionally, the college that houses engineering and computer science is redesigning the process of hiring faculty and conducting yearly evaluations so diversity, equity, and inclusion count in more substantive ways.

A growing edge I've learned is how any research project related to diversity, equity, and inclusion would benefit from team members taking time to intentionally nourish a psychologically safe environment. This will help people build trusting relationships, practice humility, and create entry points for team members to learn from and with each other. This practice carries great potential for transformation at multiple scales, from the individual to the institution, so we can truly move the needle on equity.

Karen Rambo-Hernandez, Ph.D.
Associate Professor, Texas A&M University
I have served on P4E as the principal investigator for West Virginia University (WVU), facilitated the quantitative data collection efforts at all four campuses, and led the quantitative data analysis. My background is as an educational psychologist/statistician, and I am largely interested in quantifying the psycho-social processes that influence student responses and behavior related to diversity, equity, and inclusion. Although I am not an engineer or computer scientist because I have a background in mathematics, I am very comfortable around both. I started this grant as a faculty member at WVU and transitioned to Texas A&M in year three of the grant.

One of the pleasant surprises was how willing and interested many faculty were in wanting to integrate the content into their courses. Those who had primarily teaching responsibilities were generally the most receptive, but I underestimated how much they would want to be involved in the activity creation. I assumed that even though they were interested in including DEI content that they would want the activities created for them—I wrongly thought they would not want additional work added to their proverbial plate. On the contrary, many faculty wanted to

participate in the activity creation. I found it much more effective for sustainability and long-term change to co-create new materials with the faculty members. It was important to create space for them to do the work. Similarly, it was important for their time and talents to be appropriately compensated.

Also, I originally thought I would target activities for the largest classes for the maximum impact for the largest number of students. However, a more effective route was to engage with faculty who were warm to DEI efforts and let them identify where the activities would best fit in their classes, and often those classes were ones that had a strong teamwork component already integrated into their course.

Another surprise was just how difficult it was to make long-term change due to the logistics of university life. Many faculty did not teach the same courses consistently or would find out their teaching assignments close to the beginning of the semester, which made integrating activities difficult. We were constantly building new connections with faculty. Many, like me, moved institutions. In some ways, moving institutions helped to spread our efforts organically, but it also meant creating new relationships with other faculty, which takes time.

We started with three PIs and grew to a robust team with wide-ranging expertise. As we wrap up this project, I leave with a greater appreciation for the work required to engage in DEI efforts. The rewards seemed to be far apart. To make progress we needed a multi-disciplinary approach, celebration over our small wins, and transparency and support when things didn't go as planned.

Becki Atadero, Ph.D., PE
Associate Professor, Department of Civil and Environmental Engineering, Colorado State University
I have served as the project PI at CSU working with faculty to develop and implement course activities and then to collect and analyze data about the student response to the activities and assignments. I am a straight and cis white woman who took the often masculine culture of engineering in stride as an undergraduate, but found the gender bias harder to ignore in graduate school and as a faculty member. Before we started this project I thought I knew a lot about being underrepresented because I was a woman in engineering, but the privileges that came with my dominant identities were largely invisible to me. The pilot to the P4E project came from my frustration that the many support structures for students from historically excluded identities in engineering didn't seem to be impacting engineering culture or interactions between students. As a woman and professor it made me angry that my bright women students were being overlooked and marginalized by their men peers, especially when many of the men seemed to be well-intentioned but oblivious. Teaching all students about the importance of diversity to engineering and how to be inclusive in teams seemed an obvious solution to me, although the approach was fairly novel when we started this project.

I was trained as a structural engineer and serving as the PI on engineering education research projects, especially projects to teach students about topics such as diversity, equity, and inclusion originally seemed to be taking a step away from "real" engineering. I was deeply conflicted because I had a real passion for DEI work but I struggled to reconcile the activities I was participating in with the work that "real engineering faculty" do. We do not have a department of

engineering education at CSU, so finding like-minded engineering colleagues took a bit of work when I moved into this space. After years of questioning whether or not I belong in engineering, as we near the end of this project, a powerful surprise for me is how the journey this project started has completely changed the way I understand engineering. I thought I was moving away from engineering, but I have come full circle and now deeply identify as a "problem-solver" who wants to make sure the problems I identify and the solutions I develop are contributing to a more equitable and just world. Engineering IS NOT a purely technical field divorced from society and social concerns. I am so grateful for the things this project has taught me and the way they will shape my future career.

A challenging realization for me is the complexity of social science! The situation regarding DEI and engineering has changed a lot over the past 5 years at CSU. I believe the work of this project has contributed to those changes, but there are so many other factors at play, I cannot say for sure. I wish we had understood the amount of change that would happen over the five-year period and engaged a separate research team to study change processes in academic units to better understand how our project contributed to change, and how we could have done more.

Ronald R. DeLyser, BSEE, MSEE, PhD in Electrical Engineering
Associate Professor Emeritus, Department of Electrical and Computer Engineering, University of Denver
I have served as project Co-PI at the University of Denver (DU), working with faculty to implement curriculum changes that foster DEI. I began the project while a tenured member of the faculty and then retired July 31, 2019. My role in the project continued unchanged. I guess you could call me the "very senior" member of the research team being born in the very first year of those considered to be "baby boomers". My background includes what I deem to be a double dose of the strongly white male dominated cultures: the military and the engineering professions, having served in the United States Air Force for 21 years, and as a practicing electrical engineer for 47 years (40 of those years in the teaching profession.) I have also been a family man for 56 years of my life, raising two daughters and being fortunate to have three granddaughters. As such, I have always been sensitive to the stereotyping of girls and women in attempts to exclude them from those "privileges" that boys and men enjoy.

Being "the old white guy" of the team, I tend to listen a lot to my younger colleagues, take every opportunity to learn about DEI issues, and learn from others with perspectives that differ widely from my own. During the past 5 years, I have gained insight from many workshops, two graduate classes, and many interactions with my colleagues on this grant; I see those experiences as a very important aspect of this project. Another equally important aspect is what can be learned from students in light of all of the turmoil that has surrounded their daily lives (as well as ours) for the past 5 years. I believe that there is probably more influence on the reception of the project interventions due to the external realities of recent social movements than the interventions themselves.

A challenge in the past few years is that my "influence" on faculty members has subsided because of my retirement, addition of new faculty members, and the retirement and relocation of other faculty members. There are only a few faculty members in the engineering departments who continue with the interventions. Luckily, they are young and will probably be staying at DU

for quite some time. The School of Engineering and Computer Science has also made some substantial changes that go to sustainability of DEI initiatives as noted by my colleague, Christina Paguyo above. I feel that our efforts have led to positive lasting changes for the school and its students.

Christopher D. Griffin, Ph.D.
Teaching Assistant Professor, Department of Mechanical and Aerospace Engineering, West Virginia University
Participating in this project has been a rewarding experience and one in which I have learned a great deal. As a Teaching Assistant Professor at West Virginia University, my first involvement with this project was when I was asked to have my Introduction to Aerospace Engineering class participate. This included assigning activities dealing with DEI aspects related to engineering and soliciting feedback through surveys. It was at this time that I first learned about the research project and its objectives. I was happy to incorporate topics of diversity and inclusivity in my classroom and relished the opportunity to have discussions about these topics with my students. I had not done anything like that up to this point while teaching engineering courses. In my experience, student response to incorporating DEI within the engineering curriculum was positive. Although some students expressed skepticism about why such topics were being discussed in engineering courses, most appreciated the impact that perceived differences could have on engineering education and career opportunities.

After being a faculty participant for a little over a year, I was asked to become a Co-I for my institution. To be honest, I had to take time to consider evolving into that role. A question kept coming to mind when I was considering joining the project as a Co-I, "who am I to provide critical perspectives on diversity, equity, and inclusivity?" As a cis white male, what can I add to the discussion that is noteworthy or worthwhile? Although I struggled with this, and still do to some extent, I am happy I said yes. Even if I have learned much more than I have contributed, my fellow researchers made me feel like my contributions were always respected and considered. I have learned that my perspective and my acknowledgment of bias can aid others in the same respect. Although struggling with this question of my role in DEI still occurs and can be a challenge to overcome, I have been surprised by many of the faculty eager to incorporate activities into their classes. Qualitatively, I feel many more faculty support such initiatives and value the work DEI research projects are conducting.

I have sought out other avenues to learn more about DEI in engineering by participating in this project. I joined a community that met once a month to discuss what we do at our institutions, what challenges we face, and support one another. Participating in this project, and the other communities I have since joined, shows me that many engineering faculty worldwide consider DEI to be a crucial part of educating engineering and science students. I feel fortunate to be part of this increase in exposure to DEI in engineering education and am thankful for being asked to participate in this grant. I hope my colleagues know my appreciation for allowing me to learn from them and grow as an engineering faculty member.

Jody Paul, Ph.D.
Professor, Department of Computer Sciences, College of Health and Applied Sciences,
Metropolitan State University of Denver

I joined the P4E:STEM project in its second year, perceiving the invitation as part of the project's expansion to include a non-engineering discipline (Computer Science) and a non-research-centric institution (MSU Denver). My career integrates academia, industry, and nonprofits to address education and pedagogy alongside applications of computing and basic research in the computer and cognitive sciences. I care about increasing the accessibility of computer science to all people, demystifying the field, correcting misunderstandings and inappropriate stereotypes, and reducing stigmas associated with those who participate in the computer sciences. My choice to join MSU Denver was primarily influenced by the demographics of its student body. MSU Denver is public, urban, and open-enrollment (admits all students with a high school diploma or GED). It offers 4-year bachelor's degrees along with a small number of certificates and master's degrees. Located in downtown Denver, MSU Denver serves the Front Range metropolitan region, is the top transfer destination for Colorado students, and is a Hispanic Serving Institution (HSI).

I was pleasantly surprised at the explicit recognition of the P4E:STEM project "scale up" investigation as lacking diversity in participating institutions. MSU Denver Computer Science being invited with the intent of expanding the diversity of participants was unexpected and very welcome. Educational resources for "higher education," created with the best intentions at R1/R2 institutions, often do not match with the environments and needs of institutions that are not research-centric. That P4E:STEM chose to include another *type of institution* was a happy surprise.

The acknowledgement of *computing* as relevant to the "scale up" of P4E:STEM was another welcome surprise. The inclusion of computing within STEM is relatively recent. (The STEM Education Act expanded the definition of STEM to include computer science in 2015. The NSF introduced the term STEM+C to indicate that computing was part of all STEM fields.) The broad label of "STEM" often obscures significant differences between constituent fields, with educational resources often so discipline-specific as to defy transfer to other disciplines.

Unanticipated challenges arose in trying to explain to existing project participants key differences between research-focused and other academic institutions as well as between the engineering and computing disciplines. The difficulty in articulating the former proved detrimental to the effectiveness of addressing the lack of institutional partner diversity. I was surprised at the extent to which a less equitable role for MSU Denver in the collaboration created impediments to participation by faculty and students at the institution. I have greater appreciation for the importance of *inclusive planning* when there's a desire for research activity and results to be shared and transferable across a broader scope than originally intended. A requisite early step in such redesign is learning about the environments and experiences of those outside the original scope. In P4E:STEM, this manifested as difficulties in transferring what appeared to be successful at research-centric institutions to a partner institution outside the research-centric-institution bubble and as difficulties in transferring concepts built around the profession of engineering to professions in the computing domains.

Scott T Leutenegger, Ph.D
Professor of Computer Science, JEDI (Justice, Equity, Diversity, and Inclusion) Director,
Ritchie School of Engineering and Computer Science, University of Denver
I have served as a project CO-I at the University of Denver (DU) and am now taking over as DU
PI given the departure from DU of PI Dr. Paguyo. I had worked previously in DEI focused
mostly on K12 outreach, K12 summer residential programs, and K12 teacher computing /games
professional development. I had also served as our school inclusive excellence director, now
called JEDI director, with a focus on K12 outreach and undergraduate student support. In a
previous NSF ITEST project we indirectly infused DEI into computing education in K12 through
teaching the creation of "Humane Games", i.e. games for change, games for education, and
games for health. We directly interacted with students both in and outside formal school settings
as well as providing teacher professional development. Thus, I had some experience with DEI
work before joining this project. That said, as a computer scientist and a (older) white male I still
to this day feel a level of ignorance, unease, and self doubt that I am the right person to occupy
this space.Prior to this project I had not attempted to infuse DEI into the undergraduate computer
science curriculum. At the beginning of the project we focused mostly on gender
inclusion. After the murder of George Floyd in 2020 we shifted to more of a focus on
race. Discussions with fellow faculty, including a seminar in late 2020 followed by a faculty
survey, revealed that many engineering and computer science faculty question whether these
issues belong in the technical classroom. At the same time many other faculty expressed it was
imperative that we do so. Listening to the latter, and hoping to convince the former, we went
ahead and devised interventions dealing with race in the technical computer science classroom.
So far, we have piloted 3 gender related and 3 race related interventions in our curriculum. I was
mildly surprised to see how supportive many of my fellow faculty and administrators have
been.

Being part of the project prompted me to think more broadly about how to win over more faculty
hearts and minds to embrace DEI within their teaching and research. Arguably, nothing is more
important to faculty than faculty hiring and tenure and promotion. We surmised one way to get
more faculty involved was to focus faculty hiring policy on DEI. This has the twin benefits of
(hopefully) hiring DEI minded faculty, and of opening a rich dialogue about DEI within the
context of both teaching and research. We are currently in the midst of our annual hiring cycle
and we have created and used rubrics that meaningfully incorporate DEI criteria. As JEDI
Director I am serving ex-officio on all search committees. The resultant committee discussions
have meaningfully included DEI in ways that I have never experienced before. I truly believe
we are beginning to win over hearts and minds.

I find it unlikely that any of this work would have happened without the impetus of the P4E
project and the local leadership of DU P4E project PI Christina Paguyo. I was surprised how
motivating it was to be part of a community of researchers and practitioners focused on
promoting inclusion and equity within engineering and computing. I was both surprised and
delighted at the amount I have learned from all of the co-Is and PIs on this project, both those
here at DU and at the other partner institutions. I believe the results from this project are having a
significant impact at my institution and hopefully others through our publications.

Robin A. M. Hensel, Ed.D.
Assistant Dean for Freshman Experience, Fundamentals of Engineering Program, West Virginia
University

I lead a team of teaching faculty dedicated to helping first-year engineering students transition and acclimate to college life, discover their engineering passion, and succeed academically. I was excited to join the expansion of this research initiative to West Virginia University, serve as a Co-PI on this project at WVU, and teach developing engineers and computer scientists to value diversity and behave inclusively as they learn to solve challenging problems within a broader societal context.

I was pleasantly surprised by the openness, curiosity and honesty of our students as they thoughtfully participated in the DEI-related activities. One specific activity, the Interactive Theatre Sketch, originally developed before the project was expanded to WVU, used professional actors to depict a dysfunctional team. Following one performance of the scene, the scene is repeated, and students are invited to join the cast, sit in a previously empty chair at the table, and try to intervene to correct, defuse, or improve the situation in some way. At WVU, we worked with our Theatre Department to use student actors to portray a similar scene. This activity was performed outside of class time and, while I made it a mandatory "out of class experience" for one of our first-year engineering courses, I was nervous about how engineering students would react to this type of presentation and curious if they would participate on-stage. I was very pleasantly surprised by the student response. Several students in each performance volunteered to intervene and the following discussions were sincere, thoughtful, and respectful. When the COVID-19 pandemic disrupted our in-person performances, an equally effective online sketch was created in which actors are interviewed, in character, about their emotions and their ability to continue working with the team to accomplish the objective following the incident. The result was a different, but equally powerful, experience than the original in-person event and received positive student feedback.

While I expected logistical challenges and pushback from some faculty and students, I was surprised that these issues were relatively minor. In some instances, listening to the specific complaint allowed me to identify potential revisions and improvements for specific activities to increase their relevance to students and the course. When ABET updated its student outcomes to include "an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives" [2] my faculty were appreciative that we had examples and data to demonstrate how we were teaching students to create collaborative and inclusive team environments to show the ABET evaluation team.

Finally, this project team, comprised of researchers who demonstrate passion, energy, and a desire to learn with humility, has truly embodied the ABET teamwork goals as it sought to make positive societal changes. Team members have succeeded in creating a welcoming, truly collaborative, inclusive and encouraging environment for its members. In turn, the members work together to establish goals, plan tasks and meet objectives well! When I joined this team, I felt included immediately in a way that is different from all other teams in which I have participated. Rarely do teams work so well together. I know I have learned and continue to learn more from the many and diverse members of this effective team than they have learned from me, and I am grateful.

A.M. Aramati Casper, Ph.D.
Research Scientist II, Department of Civil and Environmental Engineering, Department of
Biology, and Graduate Degree Program in Ecology, Colorado State University
I was first involved with the predecessor to this project in 2012- 2014 as a STEM education
graduate student and joined the current P4E project in 2018 as a Research Scientist. I am a white
queer person – specifically a genderqueer demisexual lesbian. My background is in both forest
ecology and education research, so I bring an inside STEM but outside engineering and
computer science perspective to the project.

My pleasant surprises and growing edges are numerous and intertwined. I knew my queer
identities were salient to this work when I joined the project, as the way gender is often
conceptualized and problematized within engineering and computer science is usually from a
binary perspective. Thus surveys, including the survey initially used by this project, usually ask
for gender or sex with the options of man/woman or male/female. What seemed like a simple
task in the first months of my joining the team in 2018 - to update the social identity
demographic questions we asked – became a long, involved, and ongoing process. My search led
to much time devoted to grappling with identity questions, how 'out' I felt comfortable being
with my collaborators, and, eventually, multiple conference presentations [3, 4, 5]), a PLOS One
Publication [6], a new direction for my research beyond the P4E project that includes
collaborations with other queer scientists on multiple papers and grant proposals, and becoming
part of the representation I never experienced as student when I spoke about my experiences of
navigating academia and science to over 500 people as part of a discussion panel for the 2020
Ecological Society of America conference [7]. This list of successes, however, doesn't represent
the challenges involved in each of these things. It was quite challenging at times when personal
reflection about identity, privilege, and related topics was an optional process for everyone else
but me; since our work has largely focused on (binary) gender in engineering, my queer
identities were always at least implicitly salient to our work, and often simultaneously
superficially irrelevant because they were not our focus, but highly relevant because they existed
beyond the conceptual framework of gender and identity that our work was focused on. Thus, a
key growing edge for me from this project is the importance of taking time to nourish a
psychologically safe environment that facilitates the building of trusting relationships, which has
the potential to lead to transformation from individual to institutional levels.

Discussion and Conclusion
As the reflections demonstrate, the project team members brought a wide range of prior
experience to the project and occupied many unique roles on the project. We have formed a team
that has accomplished a lot and learned a great deal from each other. At the same time, we have
experienced first-hand some of the difficulties that diverse teams can expose, and several team
members reflected on the need to work on process and communication within the team. Inclusion
is not automatic, even for well-intentioned folks interested in DEI, and this reinforces the need to
work intentionally with our students so they can become inclusive professionals.

The P4E project has benefitted from several pleasant surprises that have advanced the project
itself as well as the broader cause of social justice and equity in computer science and

engineering education. One surprise was the amount of personnel movement in some of the academic departments that occurred over the course of the grant. The project started with PIs and collaborators at 3 and then 4 institutions. While those four institutions are still represented today, people who were directly associated with the project at some point are now associated with four additional institutions. This was an unexpected mode of project dissemination. Looking back on the project, another pleasant surprise was how the series of seemingly small steps taken by individuals has combined to form an overall impressive body of change. For example, some institutions are creating sustainable practices beyond the life of the grant by creating new policies and practices to engage DEI, such as exploring new faculty hiring practices that focus on DEI and teaching, as well as examining the criteria for annual reviews, promotion, and tenure that index the value of DEI.

Other surprises to the research team manifested significant barriers during the project. One surprise was the sheer amount of administrative work necessary to coordinate activities in numerous classes across the campuses. Related to this surprise was the amount of fluctuation in department teaching assignments. We were not expecting instructor courses to change as much as they did. When instructors changed courses or left the institution, new classes were brought in or new instructors were recruited. Thus, integrating activities required a lot of time both upfront to get them initially incorporated and to maintain in the courses as new instructors took over. Future projects of this nature must budget for a project administrator who is not tasked with research tasks and can focus solely on the logistics and scheduling pieces.

We gained new insights into, and appreciation for, the different ways in which DEI is addressed at the various participating institutions. For example, local cultural practices and institutional contexts shape the ease of starting and scaling up DEI activities. Factors such as the degree to which teaching and DEI are valued and how much bandwidth faculty have to engage in different kinds of activities play a significant role.

Another surprise was the profound difference between research-oriented institutions and comprehensive education focused institutions with respect to the allocation of time for conducting research and for educational practice. Better *a priori* awareness would have allowed us to better plan and accommodate those differences.

Finally, we were also surprised by the extent of the differences between engineering and computer science. We note that some institutions house both engineering and computer science in the same department while other institutions house those in entirely different colleges. Although both currently fall under the umbrella of STEM, only the most generic activities could be easily modified for use in both disciplines. We had anticipated many more activities could be easily adapted, but addressing the differences in disciplines required heavy adaptation or completely new activities.

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