Valuable Professional Learning and Development Activities for Black STEM Postdoctoral Scholars

Dr. Sylvia L. Mendez, University of Colorado at Colorado Springs

Dr. Sylvia Mendez is a Professor and Chair of the Department of Leadership, Research, and Foundations at the University of Colorado Colorado Springs. She earned a PhD in Educational Leadership and Policy Studies from the University of Kansas, a MS in Student Affairs in Higher Education from Colorado State University, and a BA in Economics from Washington State University. Dr. Mendez's research centers on effective faculty mentoring practices, broadening participation in higher education, and the educational attainment and schooling experiences of Mexican descent youth in the mid-20th century.

Dr. Valerie Martin Conley, University of Colorado at Colorado Springs

Valerie Martin Conley is dean of the College of Education and professor of Leadership, Research, and Foundations at the University of Colorado Colorado Springs. She previously served as director of the Center for Higher Education, professor, and department chair at Ohio University. She was the PI for the NSF funded research project: Academic Career Success in Science and Engineering-Related Fields for Female Faculty at Public Two-Year Institutions. She is co-author of The Faculty Factor: Reassessing the American Academy in a Turbulent Era.

Dr. Canek Moises Luna Phillips, Rice University

Dr. Canek Phillips is a Research Scientist at in the George R. Brown School of Engineering at Rice University where his research interests touch broadly on efforts to promote greater equity for underrepresented groups in engineering. Canek earned his PhD from the Purdue School of Engineering Education in 2016 and worked as a graduate research assistant in Dr. Alice Pawley's Feminist Research in Engineering Education Lab. Canek was brought on at Rice originally as a postdoctoral research fellow in 2017 on an NSF-funded study that investigates the efficacy of an audio-based method of learning mathematics where he now serves as Co-PI. In 2019, he began working as Co-PI on another NSF-funded study to reduce barriers in the hiring of underrepresented racial minority faculty in data science and data engineering fields.

Dr. Tammy Michelle McCoy, Georgia Institute of Technology

Tammy M. McCoy is the TA Development and Future Faculty Specialist for the Center for Teaching and Learning (CTL) at the Georgia Institute of Technology. In this capacity, she works closely with graduate students and postdoctoral scholars interested in pursuing careers in college teaching through teaching assistant (TA) training and support, academic career development programs, and training and certification in college teaching. Specifically, she teaches courses and facilitates workshops to support future faculty development; assists in the implementation of the orientation program for new TAs and the support of departments offering TA training courses; contributes to the Tech to Teaching certificate program for graduate students and postdoctoral scholars; provides individual consultation and teaching evaluation to graduate students and postdoctoral scholars seeking to enhance expertise in the classroom; and assists with the campus-wide awards program that recognizes excellence in teaching within the TA community at Georgia Tech. Tammy earned her Ph.D. and completed a postdoc in materials science and engineering at Georgia Tech. She also earned a M.S. in materials engineering from Auburn University and a B.S. in mechanical engineering from Mississippi State University. Prior to beginning her current position, Tammy taught science at a local high school, was an instructor in the Department of Chemistry and Biochemistry at Spelman College, and an adjunct instructor in the Department of Mathematics, Computer Science, and Engineering at Georgia Perimeter College.

Dr. Comas Lamar Haynes, Georgia Tech Research Institute

Comas Lamar Haynes is a Principal Research Engineer / faculty member of the Georgia Tech Research Institute and Joint Faculty Appointee at the Oak Ridge National Laboratory. His research includes modeling

steady state and transient behavior of advanced energy systems, inclusive of their thermal management, and the characterization and optimization of novel cycles. He has advised graduate and undergraduate research assistants and has received multi-agency funding for energy systems analysis and development. Sponsor examples include the National Science Foundation, Department of Energy and NASA. Dr. Haynes also develops fuel cells and alternative energy systems curricula for public and college courses and experimental laboratories. Additionally, he is the co-developer of the outreach initiative, Educators Leading Energy Conservation and Training Researchers of Diverse Ethnicities (ELECTRoDE). He received his Bachelor of Science degree from Florida A&M University and his graduate degrees (culminating in a Ph.D.) from Georgia Tech; and all of the degrees are in the discipline of Mechanical Engineering.

Ms. Kathryn Joan Watson, University of Colorado Colorado Springs

Kathryn is a doctoral student at University of Colorado Colorado Springs in Education Leadership, Research, and Policy. Her studies focus on supporting student mental health in secondary education. Kathryn's prior education includes a Master's from Marist College in Poughkeepsie, NY in Integrated Marketing, and her Bachelor's is from Michigan State University in Interdisciplinary Social Sciences: Secondary Education. Kathryn has taught high school Social Studies and is passionate about increasing equity in education.

Dr. Sarah Elizabeth Cooksey, University of Colorado Colorado Springs

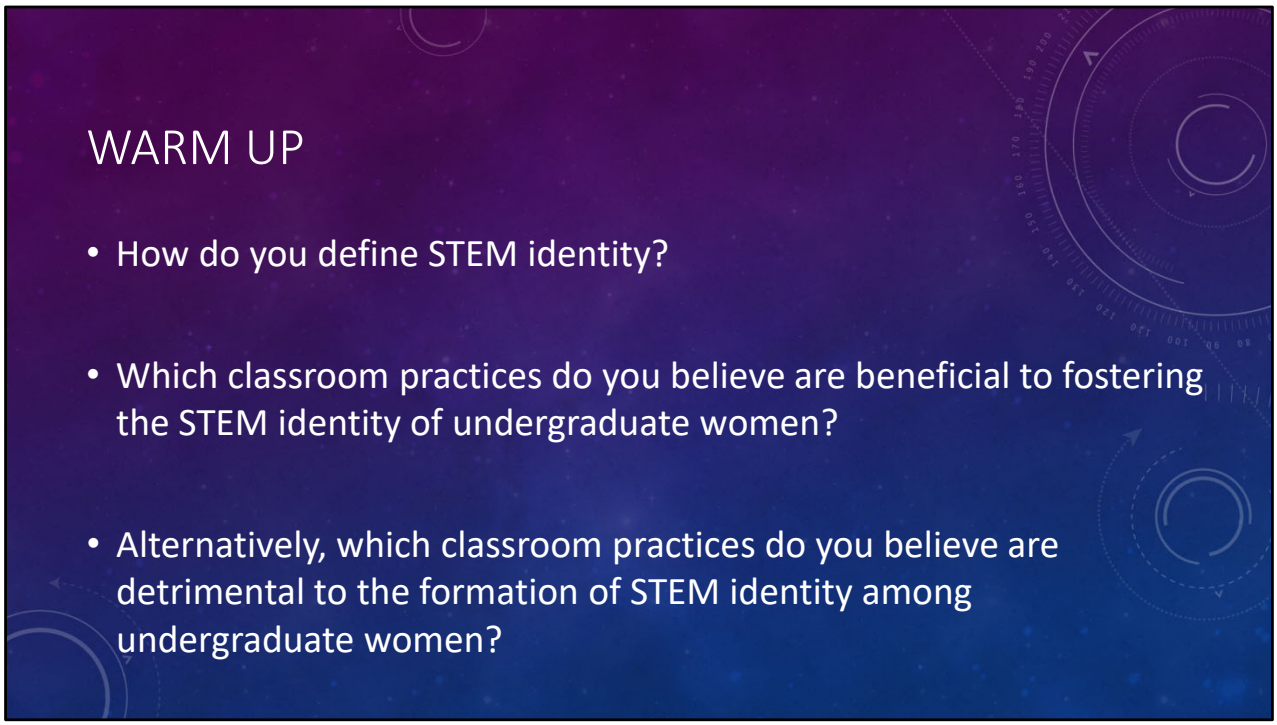
Sarah Cooksey is a Ph.D. graduate from the University of Colorado Colorado Springs. She currently works at UCCS as a Research Assistant and Lecturer in the department of Leadership, Research, and Foundations and on a grant with the National Science Foundation trying to understand the career decision making process of underrepresented minorities in STEM fields. Sarah is a special education teacher in the state of Colorado, whose specific research interests lie in the educational experiences of marginalized populations, special education best practices, and education in prison reform.

Ms. Kathryn Elizabeth Starkey, University of Colorado at Colorado Springs

Ms. Starkey is currently a thid year doctoral student in Leadership, Research, & Policy at the University of Colorado Colorado Springs. In addition to her doctoral studies, she is currently employed at the Adult Learning Lead Specialist at Colorado State University Pueblo. Her research interests include state education policy, adult learning, and policy analysis and evaluation, which allows her to pursue these interests both in her studies and in employment.

Thank you for joining us this morning as we share the results of our phenomenological study which examined the ways in which engineering faculty conceptualize science, technology, engineering, and mathematics (STEM) identity and promote the STEM identity of undergraduate women in the classroom.

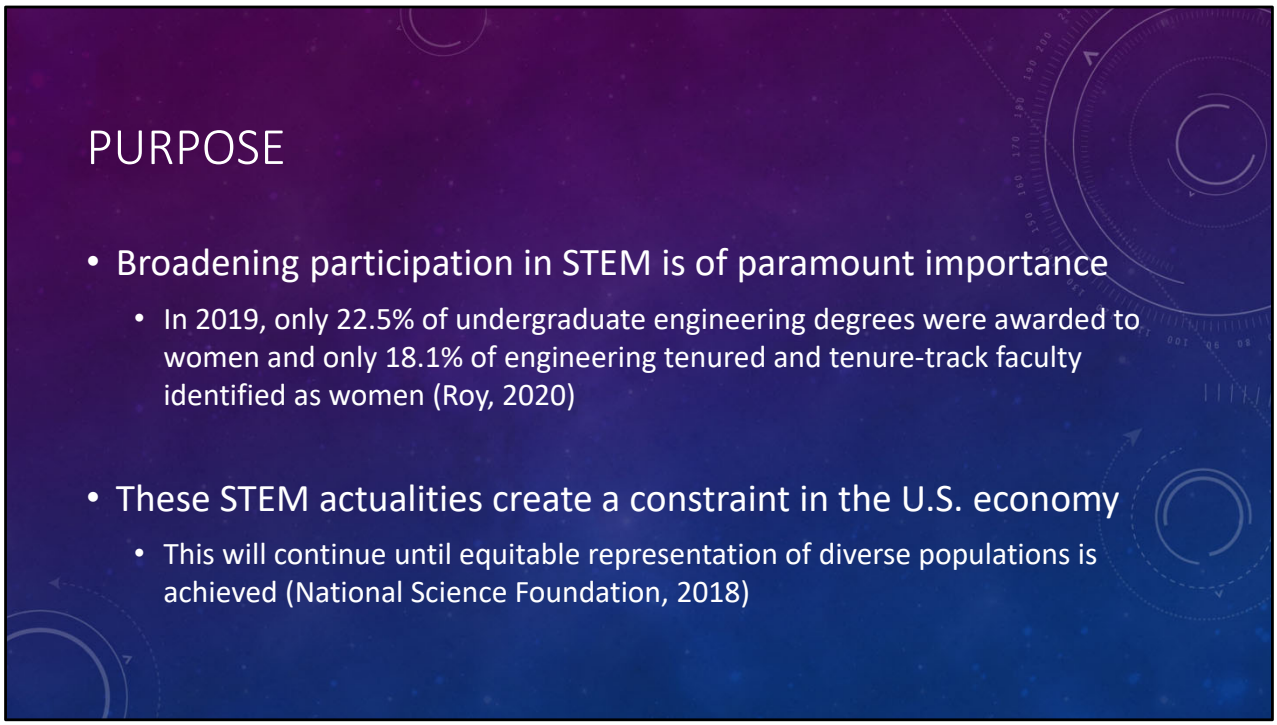
Our research team includes Sylvia Mendez, Emily Kulakowski, and Elizabeth Peterson from the University of Colorado Colorado Springs.



To begin, how do you define STEM identity?

Which classroom practices do you believe are beneficial to fostering the STEM identity of undergraduate women?

Alternatively, which classroom practices do you believe are detrimental to the formation of STEM identity among undergraduate women?



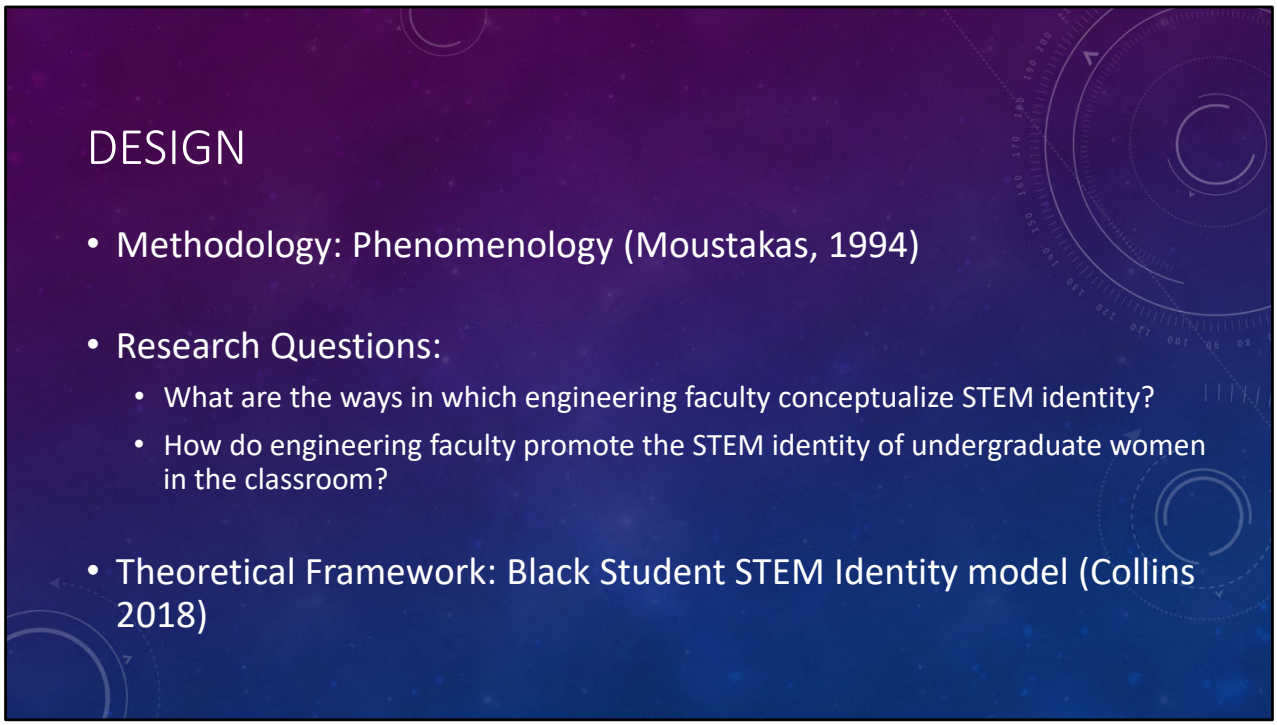
Broadening participation in STEM, particularly in the engineering discipline, is of paramount importance to the scientific and educational communities as it is imperative that all individuals contribute their diverse talents and creativity to the nation's technological base. Although engineering graduation numbers have increased over time, the disproportional rates among certain population groups continue to be cause for concern with a mere 22.5% of undergraduate engineering degrees awarded to women (Roy, 2020). Consequently, only 18.1% of engineering tenured and tenure-track faculty identify as women (Roy, 2020).

These STEM actualities create a constraint in the U.S. economy as our society is deficient in the human capital necessary to be competitive in the 21st century. This reality will continue until those underrepresented in STEM are more effectively engaged and equitable representation of diverse populations is achieved (National Science Foundation, 2018).

Thus, the focus of this study was to advance knowledge on practices that support the promotion of STEM identity among women undergraduates, which can be used to address challenges in expanding participation in STEM and to bolster faculty professional development efforts.

Despite rising levels of diversity, members of historically underrepresented groups such as women and women of color continue to experience difficulties with respect to their STEM success (Clark et al., 2016). Notably, research has demonstrated that full gendered participation in STEM is often hindered by cultural understandings of a woman's traditional gender role as well as gendered assumptions regarding academic abilities (Castro & Collins, 2021; Clark et al., 2016; Kricorian et al., 2020). As a result, women often report that their STEM identity is compromised, particularly from a recognition standpoint, due in part to lack of access to discipline-specific socialization and being subjected to implicit biases, microaggressions, stereotype threat, and overt discrimination at both the peer and faculty level (Carlone & Johnson, 2007; Castro & Collins, 2021; Clark et al., 2016; Diamond & Stebleton, 2019; Morton & Parsons, 2017; Robnett et al., 2018; Rodriguez et al., 2019; Seyranian et al., 2018).

Yet, researchers have found faculty who act as "institutional agents" mediate these damaging experiences by proactively supporting student STEM identity (Bensimon et al., 2019). Researchers have observed STEM faculty who offer disciplinary socialization experiences and provide both intellectual and personal/emotional support boost student STEM identity (Thiry & Laursen, 2011) . Additionally, faculty can strengthen student STEM identity by exposing their students to STEM professionals who mirror their identities (Kricorian et al., 2020) and developing encouraging classroom, research, and mentoring environments bolster student STEM identity and STEM career pathways (Rodriguez, et al., 2019; Singer et al., 2020).



This phenomenological study (Moustakas, 1994) explored the conceptual knowledge of engineering faculty regarding STEM identity as well as the ways in which they promote the STEM identity of undergraduate women in the classroom. Phenomenological designs allow researchers to capture *what* individuals have experienced and *how* they experienced it by collecting narratives and stories around particular, concrete interactions and events (Creswell & Poth, 2017). The goal of this method is to discover patterns in the data, to develop a rich description of the essence of the phenomenon under study, and to transfer the findings beyond the bounds of the study to individuals in similar situations (Moustakas, 1994).

The research was guided by the following two central research questions: (1) What are the ways in which engineering faculty conceptualize STEM identity?(2) How do engineering faculty promote the STEM identity of undergraduate women in the classroom?

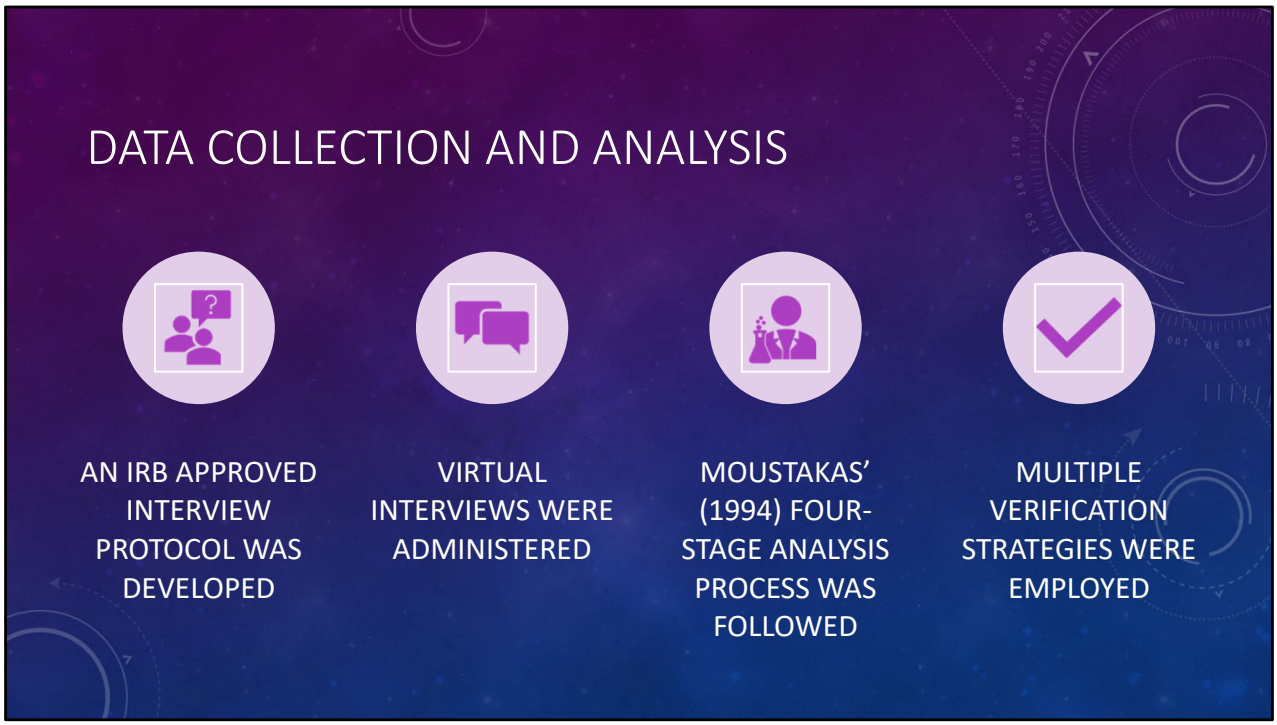
Collins' BSSI Model (2018) was used as the conceptual framework for this study. Four components comprise Collins' BSSI model: reflective identity, competence/ability, values/interest, and assimilation The model assumes an asset-based approach to STEM talent development for students and suggests that identity is intersectional, dynamic, developmental, and multidimensional. Thus, student STEM identity continues to be refined and influenced over the course of one's entire college experience. The model served as the foundation of the interview protocol as well as the deductive data analysis plan and was used to consider the implications of the study.

PARTICIPANTS

Pseudonym	Year of Birth	Gender	Race/Ethnicity	Engineering Discipline	Faculty Rank
Guara	1979	Woman	White, Latinx	Electrical, Computer, and Systems	Assistant
Rose	1983	Woman	White	Civil and Environmental	Assistant
Kelly	1983	Woman	Asian	Electrical, Computer, and Systems	Assistant
Michelle	1987	Woman	White	Mechanical	Assistant
Chris	1978	Man	Black	Mechanical	Assistant
Rosalee	1977	Woman	Black	Chemical and Biomedical	Associate
Natalie	1978	Woman	International	Electrical, Computer, and Systems	Associate
Eugene	1969	Man	White	Chemical and Biomedical	Associate
Janey	1955	Woman	Asian and White	Civil and Environmental	Full
Lisa	1960	Woman	White	Electrical, Computer, and Systems	Full
Cynthia	1966	Woman	White	Electrical, Computer, and Systems	Full
Jay	1971	Man	Black	Civil and Environmental	Full

This specific study included 12 engineering faculty, ages ranged between 34 and 66, nine identified as women and three as men, and there was a diversity in racial/ethnic background of the participants with one identifying as Asian, three as Black, two as multi-racial, one as international, and five as White. Engineering disciplines included chemical and biomedical, civil and environmental, electrical, computer, and systems engineering, and mechanical engineering. And finally, five were assistant professors, three were associate professors, and four were full professors.

Additionally, it is important to note that all participants teach in engineering bachelor degree programs at Doctoral Universities with High Research Activity, commonly known as R2 institutions. We chose to focus on R2 institutions as they tend to be more accessible to a demographically diverse student population. Tenured and tenure-track faculty at these institutions were randomly selected to participate in an interview from institutional website searches. Each faculty member received a $50 electronic gift card for participation.

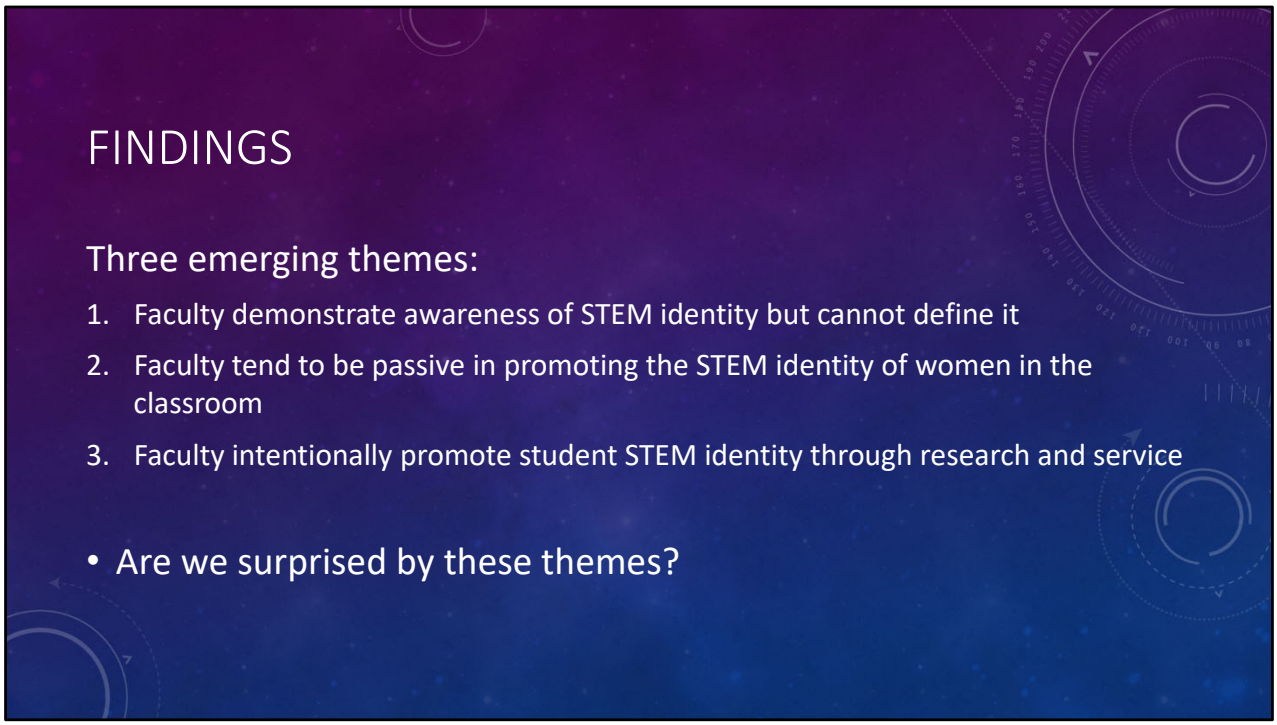


Upon obtaining Institutional Review Board approval, an interview protocol was developed from Collins' (2018) BSSI model by addressing ways in which faculty conceptualize STEM identity and seek to strengthen the STEM identity of their students, particularly their undergraduate women students in the classroom.

Virtual interviews were administered one-on-one. They averaged 60 minutes in length and were digitally recorded for transcription.

The four-stage process of phenomenological data analysis as outlined by Moustakas (1994) was then followed including epoche, horizonalization, imaginative variation, and synthesis.

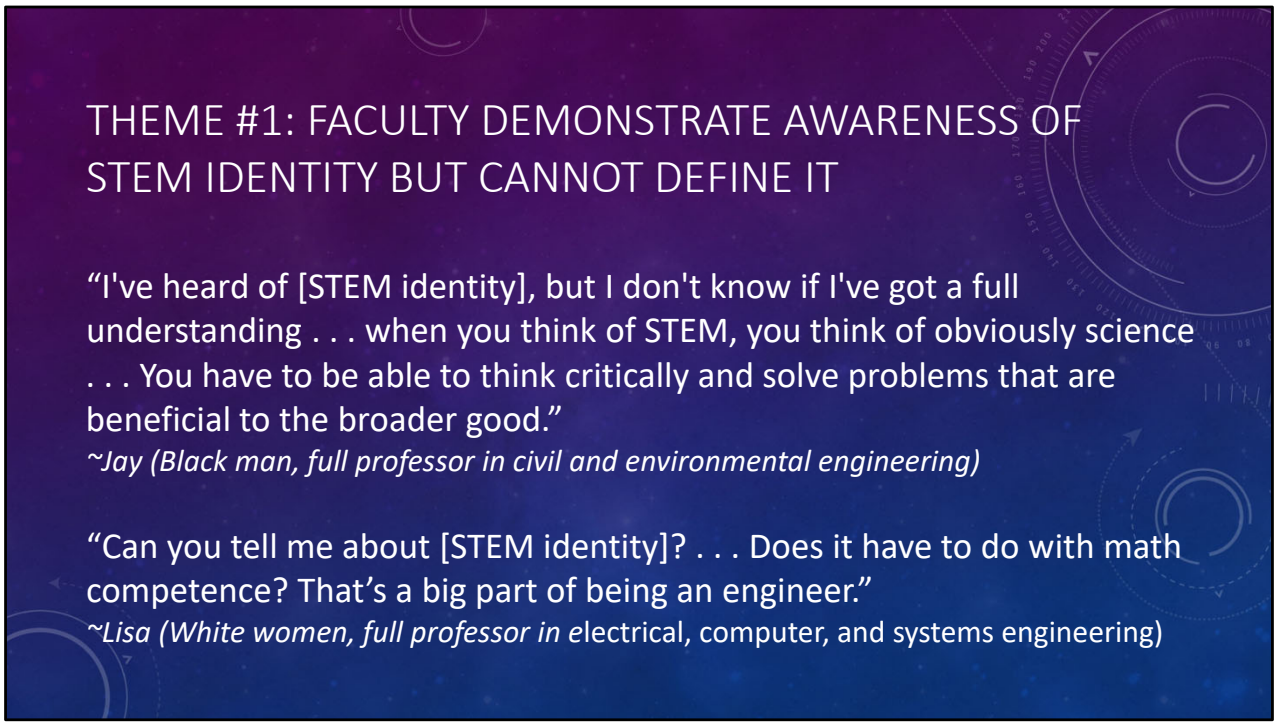
Multiple verification strategies were included to ensure the findings were trustworthy (Lincoln & Guba, 1985; Nowell et al., 2017). Strategies employed include thick, rich descriptions with faculty quotations, engagement in the epoche process through bracketing during data collection and analysis, validation of the themes and composite essence and assurance they represented the whole of the data, and through comparing several analytic feedback loops.



Three major themes emerged relative to the ways in which engineering faculty conceptualize STEM identity and the ways in which they promote the STEM identity of their women undergraduates in the classroom:

1. Faculty demonstrate awareness of the concept of STEM identity but cannot define it
2. Faculty tend to be passive in promoting the STEM identity of women in the classroom
3. While faculty attribute great value to broadening participation in engineering, they are inclined to accomplish it through research and service

Are we surprised by these themes?

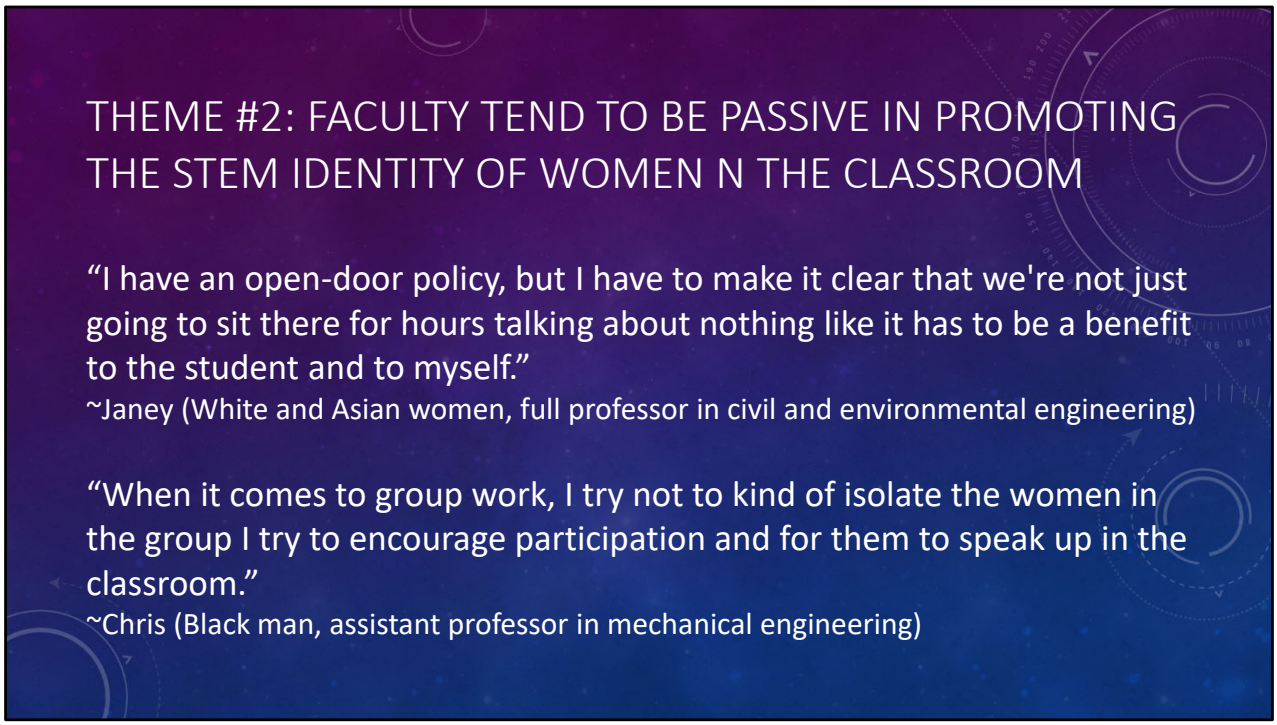


So let's dig into the themes, to begin, faculty demonstrate awareness of the concept of STEM identity but cannot define it.

Jay—a Black man, full professor in civil and environment engineering said, "I've heard of [STEM identity], but I don't know if I've got a full understanding . . . when you think of STEM, you think of obviously science . . . You have to be able to think critically and solve problems that are beneficial to the broader good."

And Lisa—a White woman, full professor in electrical, computer, and systems engineering questioned, "Can you tell me about [STEM identity]? Well does it have to do with math competence, that's a big part of being an engineer?"

Though some faculty shared an interest in learning more about STEM identity and the ways in which they can foster it, most made it very clear that the cultivation of any sort of identity was moot if basic competencies were not present, such as deep knowledge and understanding of calculus. A few intimidated that a student's math competencies will always be the foremost indicator of their place in STEM and that crossed all demographic lines.

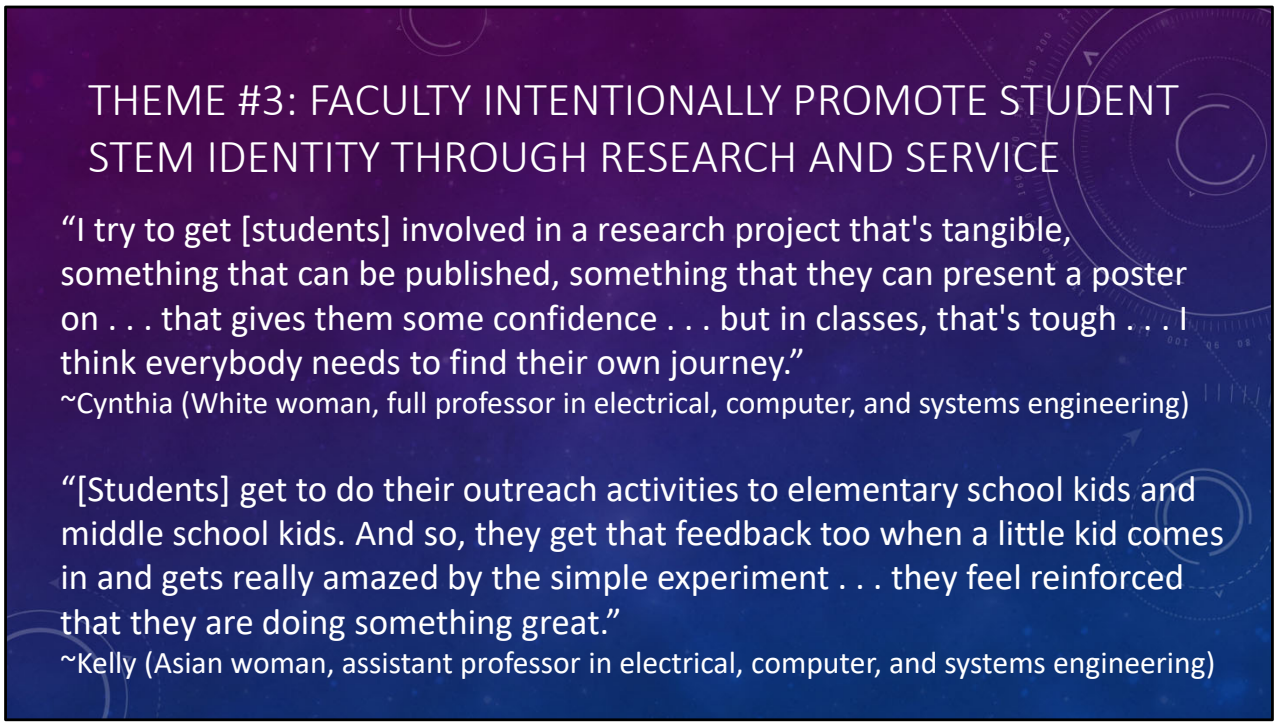


In the second theme, we found faculty tend to be passive in promoting the STEM identity of women in the classroom:

Janey—a White and Asian woman, full professor in civil and environmental engineering stated, "I have an open door policy but I have to make it clear that we're not just going to sit there for hours talking about nothing like it has to be a benefit to the student and to myself."

And Chris—a Black man, assistant professor in mechanical engineering shared, "When it comes to group work I try not to kind of isolate the women in the group I try to encourage participation and for them to speak up in the classroom."

Participants reported being aware of the lack of gender diversity across engineering and particularly in certain sub-disciplines of engineering but it did not translate into intentional action in the classroom environment. And yet, all participants appeared to be intrigued by the conversation in how faculty might do this and seemed genuinely interested in ways to foster the STEM identity of their students generally.

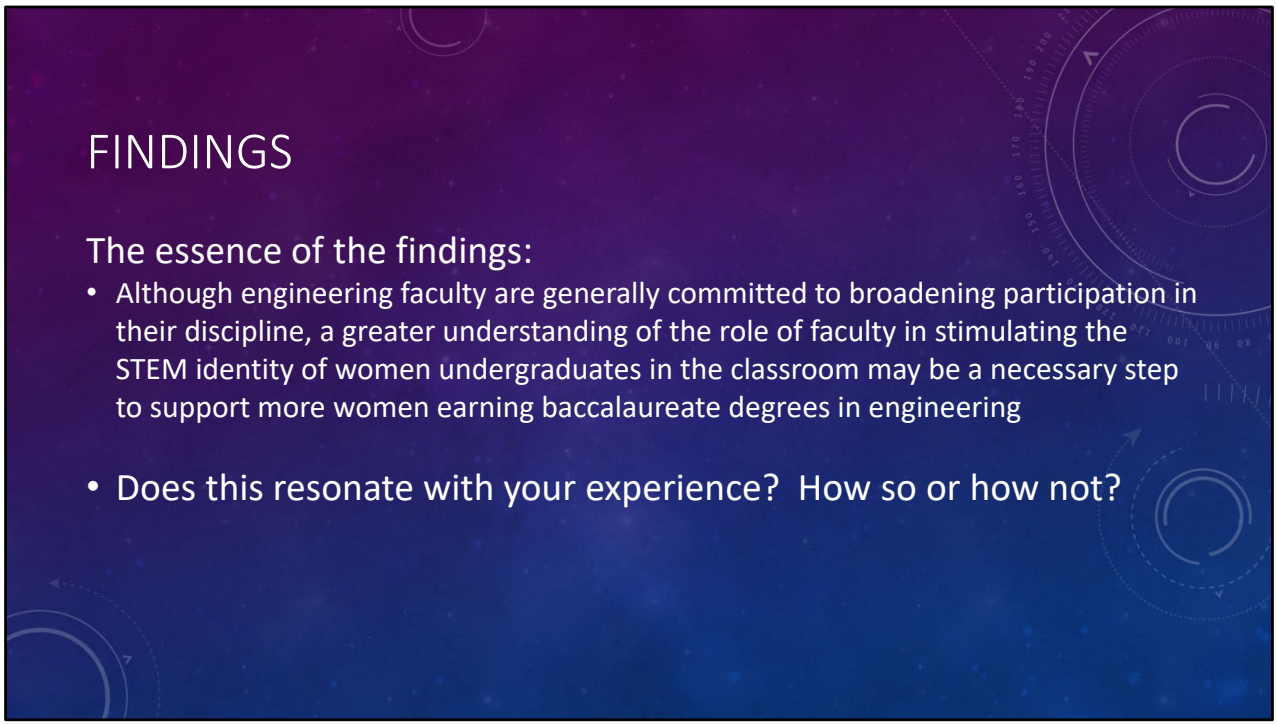


In the last theme, we found faculty intentionally promote student STEM identity in research and service but shy away from doing so in teaching:

Cynthia—a White woman, full professor in electrical, computer, and systems engineering said, "I try to get [students] involved in a research project that's tangible, that's something that can be published, that's something that they can present a poster on. And I think that gives them some confidence . . . but in classes, that's tough . . . I think everybody needs to find their own journey, so I don't want to push anything."

And Kelly—an Asian woman, assistant professor in electrical, computer, and systems engineering shared, "[Students] get to do their outreach activities to elementary school kids and middle school kids. And so, they get that feedback too when a little kid comes in and gets really amazed by the simple experiment . . . they feel reinforced that they are doing something great."

All the faculty engaged students in ways that promoted their STEM identity and increased their self-concept, sense of belonging, and cognitive ability in STEM but had not associated these outcomes with STEM identity. For most, it did not occur to them to do this in the classroom environment or were hesitant to do so. They spoke of these activities as broadly supporting students' interest in engineering but did not necessarily think of these efforts with purposefulness or intentionality for women undergraduate students.



In taking these three themes into account, the essence of the findings are: Although engineering faculty are generally committed to broadening participation in their discipline, a greater understanding of the role of faculty in stimulating the STEM identity of women undergraduates in the classroom may be a necessary step to support more women earning baccalaureate degrees in engineering.

Does this resonate with your experience? How so or how not?

DISCUSSION

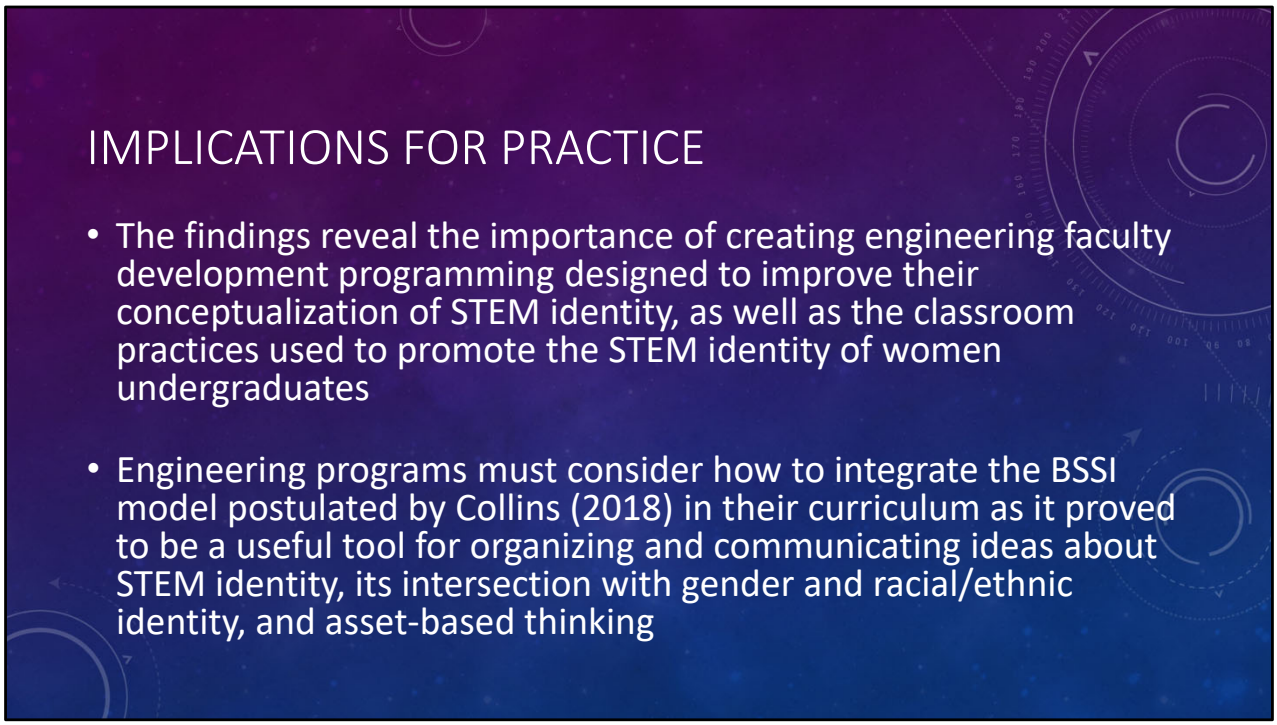
- Faculty cited the future of engineering innovation is dependent on broadening participation in academia and the larger workforce
- Many participants had never considered their own STEM identity nor that of their students
- Despite faculty struggling to connect with the concept of STEM identity they shared ways in which they promoted student STEM identity outside the classroom

Participants reported being aware of the lack of diversity in engineering and shared a commitment to broadening participation for the practical outcome of generating greater innovation in the US, but faculty of color also couched broadening participation as a matter of social justice.

Many participants had never considered their own STEM identity nor their students. The women faculty had not considered their gendered positionality of being an engineer and cited their education and experience as a measure of success in the field. In other words, their competence as engineers replaced their desire to define a sense of gendered STEM identity but paradoxically, they reported an obvious imbalance of representation, both by gender and race/ethnicity, and the ways in which this negatively impacted them personally and professionally in their careers.

Generally Associate and full professors were more apt to express a gender-blind attitude toward the concept of STEM identity with comments such as I treat all students the same or I provide the same opportunities to students regardless of gender, race, or its intersection. Whereas assistant professors displayed a stronger understanding that historical and contemporary disparities in educational access and opportunity have reverberating effects in STEM education and the STEM workforce today. For women specifically, all faculty saw that the lack of gender representation negatively affects the experiences of women undergraduate but there was discomfort in considering proactive measures needed to increase representation and attributed the lack of representation to the leaky pipeline and that with time representation would improve.

Despite faculty struggling to connect with the concept of STEM identity, many citated ways in which they promoted student STEM identity outside the classroom, be it in their research labs, through service experiences with K-12 students, through individual mentoring which nearly all participants spoke of with great pride as making a difference for the few women persisting through an engineering undergraduate major, and through advising their local chapter of the Society of Women Engineers. Faculty also reported encouraging students to attend office hours, form peer study groups, and participate in conferences and seminars—which is generally seen as good advising practices.



The findings reveal the importance of creating engineering faculty development programming designed to improve their conceptualization of STEM identity, as well as the classroom practices used to promote the STEM identity of women students—this study indicated there is a desire to learn about this concept, as well as effective practices which could be leveraged to support the advancement of women in STEM and all students.

Engineering programs and faculty must consider how to integrate the Black Student STEM identity model postulated by Collins (2018) in their curriculum as it proved to be a useful tool for organizing and communicating ideas about STEM identity, its intersection with gender and racial/ethnic identity, and asset-based thinking—we postulate that this will not only benefit those underrepresented in STEM but will also aid in retention and persistence rates of all students.

Our participants tended to apply a deficit-based approach thinking pattern to their students so transitioning to asset-based and focusing on strengths is imperative if diversity of thought, culture, and traits are to be considered positive rather than negative. We want to be sure that students are valued for what they bring to the classroom rather than being characterized by what they may need to work on or lack.

FUTURE RESEARCH CONSIDERATIONS

- Benefits of promoting the STEM identity of undergraduate women
- A survey could be used to gain a larger understanding of faculty perceptions
- How to integrate STEM identity concepts into the undergraduate engineering curriculum
- Ways in which to engage engineering faculty in STEM identity professional development opportunities
- Understanding if the promotion of STEM identity in undergraduate education is “too late” as postulated by many participants

Future exploration is warranted on the tangible and intangible benefits of promoting the STEM identity of undergraduate women.

Additionally, a survey could broaden the pool of potential participants to gain a larger understanding of faculty perceptions about this topic.

How to integrate STEM identity concepts into the undergraduate engineering curriculum. The best source of knowledge here would be to consider the robust and growing literature on what students say influenced their STEM identity in college.

The ways in which to engage engineering faculty in STEM identity professional development opportunities.

Last, understanding if the promotion of STEM identity in undergraduate education is in fact “too late” as postulated by many participants. The majority cited this as a rationale for not focusing on this with college students and felt that greater results would occur if the focus was on elementary and middle school students and indicating even high school may be too late. Yet, research is emphatic that identity development in general is always evolving so why would STEM identity development be any different.

CONCLUSIONS

- STEM identity is yet to be fully recognized in the engineering vernacular
- Fostering STEM identity, especially for women undergraduates, has much room for improvement
- Operating in more inclusive ways by attending to the STEM identity of women can potentially improve their sense of belonging in STEM, enhance their academic outcomes, and expand the engineering workforce

STEM identity is not yet recognized in the engineering vernacular, at least not as shared by faculty in this sample, but there is an interest to leverage as nearly all expressed a desire to learn more about this concept and how to foster student STEM identity broadly.

Fostering STEM identity, especially for women undergraduates, has much room for improvement, but can be accomplished through purpose and intent.

Operating in more inclusive ways by attending to the STEM identity of women can potentially improve their sense of belonging in STEM, enhance their academic outcomes, and expand the engineering workforce—which must be the goal for all students.

KEY REFERENCES

- Bensimon, E. M., Dowd, A. C., Stanton-Salazar, R., & Davila, B. A. (2019). The role of institutional agents in providing institutional support to Latinx students in STEM. *The Review of Higher Education, 42*(4), 1689–1721.
- Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching, 44*(8), 1187–1218.
- Cheryan, S., Master, A., & Meltzoff, A. N. (2015). Cultural stereotypes as gatekeepers: Increasing girls' interest in computer science and engineering by diversifying stereotypes. *Frontiers in Psychology, 6*(49), 1–8.
- Collins, K. H. (2018). Confronting color-blind STEM talent development: Toward a contextual model for Black student STEM identity. *Journal of Advanced Academics, 29*(2), 143–168.
- Kricorian, K., Seu, M., Lopez, D., Ureta, E., & Equils, O. (2020). Factors influencing participation of underrepresented students in STEM fields: Matched mentors and mindsets. *International Journal of STEM Education, 7*(16), 1–9.

Key references are included on this slide.

KEY REFERENCES

- Morton, T. R., & Parsons, E. C. (2017). #BlackGirlMagic: The identity conceptualization of Black women in undergraduate STEM education. *Science Education, 102*, 1363–1393.
- Moustakas, C. (1994). *Phenomenological research methods.* Sage.
- Rodriguez, S., Cunningham, K., & Jordan, A. (2019). STEM identity development for Latinas: The role of self- and outside recognition. *Journal of Hispanic Higher Education, 18*(3), 254–272.
- Roy, J. (2020). *Engineering and engineering technology by the numbers 2019*. American Society for Engineering Education. https://ira.asee.org/wp-content/uploads/2021/02/Engineering-by-the-Numbers-FINAL-2021.pdf
- Singer, A., Montgomery, G., & Schmoll, S. (2020). How to foster the formation of STEM identity: Studying diversity in an authentic learning environment. *International Journal of STEM Education, 7*(57), 1–12.
- Thiry, H., & Laursen, S. L. (2011). The role of student-advisor interactions in apprenticing undergraduate researchers into a scientific community of practice. *Journal of Science Education and Technology, 20*(6), 771–784.

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Thank you for your time. Are there any questions or comments?