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RESEARCH

Evidence-based Strategies for Attracting and Retaining Girls and Women in STEM

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Addressing Gender Representation Disparities in STEM

Recent data show that women constitute 51% of the U.S. population (NSF, 2019) and 56% of total undergraduate enrollment (National Center for Education Statistics, 2020). Yet women remain underrepresented in most science, technology, engineering, and mathematics (STEM) fields at all levels of education and occupations (García-Holgado et al., 2019).

The disparity in representation is even greater for women of color (National Science Board, 2020; NSF, 2019). Enhancing gender representation from different racial and ethnic backgrounds in STEM is imperative: girls and women deserve equitable access to all education and career opportunities. In addition, diverse ideas and perspectives are necessary to promote progress in STEM that can support our entire diverse society (Peckham, et al. 2007; Committee on Equal Opportunities in Science and Engineering, 2016).

This research brief includes evidence-based strategies for attracting and retaining girls and women in STEM. It incorporates intersectional approaches to addressing inequalities specific to the experiences of girls and women of color (see Box 1). We feature the perspective of the National Girls Collaborative Project (NGCP), an organization with strong on-the-ground experience implementing some of these strategies. The brief also contains a list of 19 NSF INCLUDES awards (10 active, 9 expired) and related publications focused on girls and women in STEM.

Box 1. Defining Intersectionality

When it was first coined in a 1989 legal brief by legal scholar Kimberlé Crenshaw, intersectionality was defined as the double oppression that Black women faced because of the marginalization of both race and gender. She argued that discussions of feminist theory and antiracism excluded Black women because the "intersectional experience is greater than the sum of racism and sexism." (Crenshaw, 1989, p. 140). Today intersectionality has become a versatile term describing many overlapping systems of oppression including class, sexuality, ability, nationality, and religion in addition to race and gender.

Background: Gender Diversity in STEM Pathways

Exploring the many gender disparities along the educational pathways from early elementary school to ultimate career choice helps identify barriers to girls' and women's participation in STEM. In addition, intersecting identity categories of gender and race/ethnicity create unique experiences for women of color. Race and gender identity in these cases cannot be adequately studied apart from one another (Collins & Bilge, 2016). For example, only 2% of practicing scientists and engineers are Black women, a result of compounding racist and sexist barriers along the STEM career pipeline (McGee & Bentley, 2017). To improve representation of all women in STEM education and careers, an intersectional framework is necessary when analyzing gender disparities in STEM.

In early years, girls and boys engage in science-related activities equally but the content of these activities is often divided along traditional gender-stereotypic lines (Diekman et al., 2015). For girls, the opportunities to experience science learning activities are most often provided after they have expressed interest, whereas the same opportunities are available for boys regardless of individual differences in interest (Alexander et al., 2012; Jirout & Newcombe, 2015).

Gendered discrepancies in early exposure to STEM learning environments contribute to differences in boys' and girls' future levels of engagement and interests. For instance, "boys engaged more with activities that involve batteries, fuses, microscopes while girls are engaged more with planting seeds" (Diekman et al., 2015, p. 54). The divergence in experiences tends to be along traditional gender stereotypes and such divergence may contribute to gender gaps in self-efficacy that later influence their progress in the STEM pipeline (Cheryan et al., 2017).

When disaggregating by race and ethnicity, it is clear that girls' experiences with STEM differs. One study of 1,800 middle school girls found that Latinx girls' in-school participation in STEM was significantly lower than their white counterparts and that Black girls' self-perception in relation to science was the lowest among all races/ethnicities (Kang et al., 2019). Early exposure to STEM learning environments is critical for building girls' interest and self-efficacy for later participation (King & Pringle, 2019; NSF, 2010; Maltese & Tai, 2010).

High school is another critical time to "encourage exposure, build skills and confidence, and initiate identification with STEM fields" in girls (Diekman et al., 2015, p. 55). High school presents many opportunities for girls to engage in STEM activities and career preparation through exposure to Advanced Placement classes, STEM electives, and STEM-related extracurricular activities.

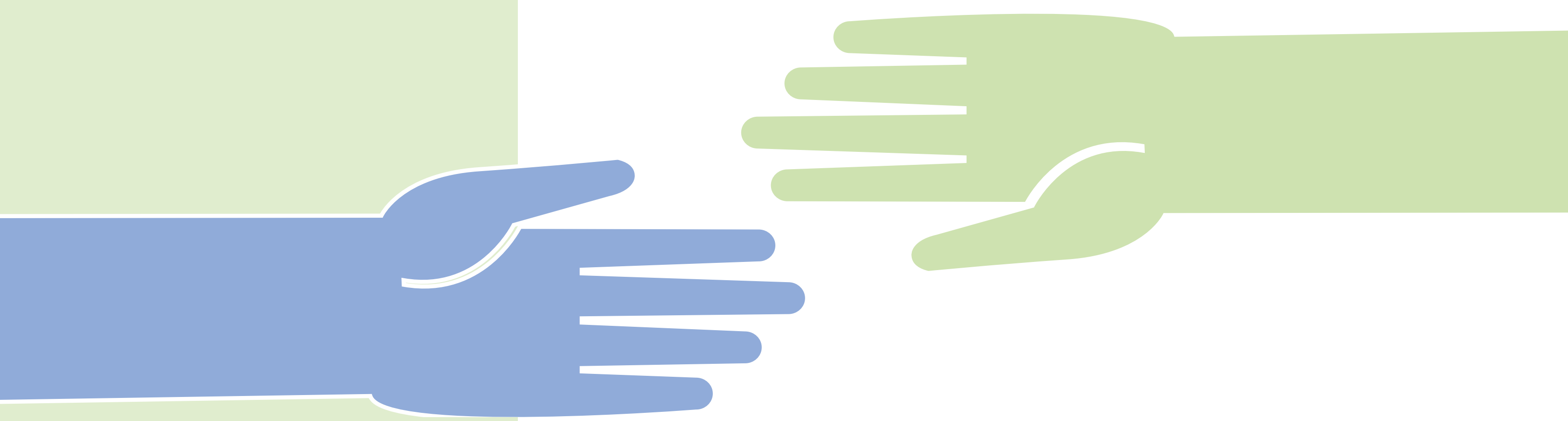
Background: Gender Diversity in STEM Pathways (Continued)

In high school, gender differences in attitudes and interest in STEM are heightened (Sadler et al., 2012). Negative stereotypes about science not being "for" girls, particularly for adolescent girls of color, lower their self-perceptions of their STEM-related abilities and affect their STEM educational aspirations (Falco et al., 2019). The evidence indicates involving girls in STEM activities in high school helps build their STEM interests and identities and can potentially mitigate gender differences in attitudes towards and interest in STEM.

In postsecondary education, gender differentiation of STEM pursuits is even greater (Diekman et al., 2015). While the proportion of women earning bachelor's degrees in STEM fields such as biological sciences and social sciences is promising (55%) women still represent smaller proportions in physical sciences (39%), engineering (21%), and computer science (19%) (NSF, 2019).

The gender disparity in postsecondary education becomes even greater when analyzed by race. In 2016, less than 8% of engineering undergraduate degrees were awarded to women of color while about 13% were awarded to white women and 79% awarded to men of any race/ethnicity (Ong et al., 2020).

Gender differentiation in STEM persists beyond degree attainment and into career paths. In 2015, while Black workers made up about 11% of the total U.S. labor force they held only 5% of all science and engineering (S&E) jobs and Black women held only 1.6% of those jobs. Hispanic workers represented 16% of the U.S. labor force and held 6% of S&E jobs but Hispanic women only held 2% of S&E occupations (NCSES, 2017). The data indicates intersectional strategies must be incorporated to meet the specific needs of girls and women of color when addressing gender diversity in STEM.



Strategies for Attracting and Retaining Girls and Women in STEM

Gender disparities along the STEM pipeline suggest the need to implement interventions early on in academic trajectories, to tailor those interventions to girls and women, and to apply an intersectional framework to address gender inequities by race and ethnicity when developing and implementing strategies for broadening participation in STEM.

Below are eight evidence-based strategies along the STEM pathway that work to attract and retain girls and women in STEM-related academic fields and careers. The list of strategies featured in this brief is not exhaustive; we identified 81 articles on broadening participation focused on girls and women and reference 49 articles that provide strong examples of strategies for attracting and retaining girls and women in STEM.

In addition to the strategies discussed in this brief, relying on evidence-based practices, creating a shift in institutional culture, and sustaining those changes are key to achieving systemic change in the participation of girls and women in STEM. Any effort aimed at bringing systemic change to women's participation in STEM fields must also consider the sexist and racist policies and practices inherent to the institution where the strategies are being implemented. Understanding institutions' weaknesses and their opportunities for improvement through advancing system level changes is imperative.

Eight Strategies for Attracting and Retaining Girls & Women in STEM

- **Emphasize Communal Goals and Opportunities for Practice**
- **Foster Engagement Among Key Entities and Stakeholders**
- **Provide More Informal STEM Learning Environments**
- **Enhance Professional Development for Educators: Content, Context, and Connection**
- **Confront Gender-Based Biases and Provide Supportive Spaces**
- **Use Targeted Messaging and Conversations to Build Interest and Confidence**
- **Encourage Mentoring and Role Modeling from Female Faculty**
- **Embrace Work-life Balance and Family-friendly Policies**

Emphasize Communal Goals and Opportunities for Practice

In comparison to men, women tend to show greater interest in STEM professions that apply scientific innovations to offer societal solutions and make a difference in people's lives (Diekman et al., 2017; Shealy et al. 2016; Silbey, 2016). Demonstrating the connection between STEM concepts and skills and showing how scientific knowledge can solve important societal problems and improve quality of lives was associated with enhanced interest and retention of women in STEM (Freeman et al., 2014; Shealy et al., 2016). Promoting communal opportunities and goals in STEM can enhance interest, participation, and success of students (Boucher et al., 2017; Fuesting et al., 2019). According to one study, women of color in STEM often engaged in STEM-related volunteer work by participating in or founding programs in their communities and institutions to provide opportunities for others like them. Incorporating these volunteer opportunities into programs of study in ways that do not impede women's education and careers can strengthen the STEM pipeline for women of color (Ko et al., 2013).

Foster Engagement Among Key Entities and Stakeholders

Collaborative efforts between K–12 schools and STEM departments in colleges and universities play an important role in building relationships and inspiring girls by bringing them face-to-face with scientists, engineers, and technology creators (Dasgupta & Stout, 2014). For instance, collaboration between schools and science museums or libraries creates an opportunity to link concepts from the classroom to real-world applications by highlighting how STEM fields help people and presenting communal goals and values. To be most effective, visits to museums and libraries should align with students' curricula. Such initiatives can increase the relevance of STEM in society and disrupt the stereotypical expectations about preparation or talent in STEM.

Higher education institutions successful in recruiting women of color made consistent efforts to engage women in events and programs designed explicitly for women of color, "recognizing that they may have needs distinct from those of White women and men of color" (Ong et al., 2020).

For girls of color, the cultural stereotypes of STEM disciplines as male dominated and white prevent them from seeing their current or possible future selves within these communities (Kang et al., 2019). For example, computer scientists are assumed to be male and socially awkward and the discipline is framed as an isolating profession, the career path is perceived as being in tension with collaboration and helping others (Brown, et al., 2010; Cheryan, et al., 2015). One study emphasized the importance of providing opportunities for students to understand the societal application of research and integrating communal opportunities such as collaboration and service learning (Diekman et al., 2017).

Partnerships between programs and parents are essential, as caregivers are often the first role models for girls, influencing their STEM interests as they progress in the pipeline. Dasgupta and Stout (2014) indicated that parents are critical early socializers of children's academic interest through building their persistence in STEM. Partnerships between caregivers and programs working with girls and underrepresented racial and ethnic groups at a young age are important for disrupting the gendered socialization processes that often shape the interests, development of skills, and confidence of children.

NSF INCLUDES Network Highlight: Collaboration in Action

The National Girls Collaborative Project (NGCP) has developed, tested, and revised a comprehensive theory of change that uses collaboration to expand and strengthen STEM-related opportunities and impact for girls and women. In a review of NSF-funded projects focused on equity in STEM authors Sevo and Chubin state that NGCP participants benefit from the model's "effective use of resources and funds, integration, and alignment with others and with national agenda, synergy, sharing promising practices, mutual moral support, [and] increased opportunity for access to resources" (2010).

The NGCP model creates a network of practitioners and organizations, community-based organizations, K-12 and higher education, researchers, and government, facilitating collaboration, delivering high-quality professional development and disseminating robust, research-based resources and curriculum. These mechanisms empower educators to better engage and more effectively serve girls to increase their interest, confidence, and agency in STEM. Girls, women, and their organizations gain confidence and power to break down stereotypes about what STEM is and who does it, continuing to dismantle structural oppression historically present in STEM occupations.

Programs consistently report increased levels of collaboration and capacity because of participation in NGCP, with greater levels of participation correlated with greater outcomes (Britsch et al., 2014). Programs report being more effective and efficient because of increased collaboration and access to research-based resources and professional development. An overwhelming majority of programs participating in NGCP report being able to better serve girls (82%), resulting in girls' increased interest (78%) and confidence (77%) in STEM (Education Development Center, 2016).

Provide More Informal STEM Learning Environments

Informal STEM learning opportunities are considered an important vehicle to increase STEM interest among underrepresented groups. Informal STEM education programs play an important role in fostering interest, a sense of belonging, and participation in STEM for girls of color (Kang et al., 2019; King & Pringle, 2019; Riedinger & Taylor, 2016; Tan et al., 2013; National Research Council, 2009).

According to a study facilitated by the American Museum of Natural History, three design principles led to STEM persistence: (1) creating opportunities to become practitioners of science, (2) providing exposure and repeated experience with STEM professionals, and (3) providing opportunities for the development of shared science identities in preparing for STEM majors and careers (Habig et al., 2020). Similarly, informal STEM education provides opportunities for girls to engage in hands-on, authentic science experiences, interact with diverse female role models, problem-solve, and understand the real-world application of STEM (Barton et al., 2013; King & Pringle, 2019; Riedinger & Taylor, 2016; Robinson et al., 2016).

Studies have also shown the important role of summer outreach programs in inspiring female students to pursue science and engineering courses (Veenstra, 2012; Puck & Stary, 2012). Such principles can enable girls to build their problem-solving and creativity skills, converse and learn collaboratively with role models, and help strengthen girls' self-esteem and confidence in relation to STEM concepts.

For example, Grand Valley State University's STEM preview summer camp—a camp for girls entering seventh grade—demonstrated the impact of a four-day camp in increasing participants' interest in science-related careers. To retain female students, Grand Valley State University sponsored a Society of Women Engineers student chapter, allowing female engineering students to network with other engineers and fostering engagement with role models (Corneal & Maas, 2014). Further, inequitable access to education results in gifted girls of color often losing interest in school because of being under-challenged. Culturally responsive STEM out-of-school-time activities, like afterschool programs and summer programs, can be effective in enriching STEM skills for gifted girls of color (Young et al., 2019).

Enhance Professional Development for Educators: Content, Context, and Connection

When students have teachers with high expectations, students' performance rises. However, girls must manage negative gender stereotypes from education staff about their intellectual abilities in STEM. Girls of color experience compounding forms of discrimination, managing negative gender and racial/ethnic stereotypes about their capabilities (McPherson, 2017). In this regard, training teachers to address their bias toward women—alongside an emphasis on the importance of appreciating the cultural nuances of their students of color—can help them better support and empower girls of color to pursue their STEM interests.

Targeted professional development programs for teachers are essential to increase their effectiveness of teaching in STEM-related fields. For example, the Western Wisconsin STEM Consortia's integrated professional development approach combines STEM content over the course of K–12 schooling, context-setting where participants discuss and share effective teaching strategies, and process-connecting teaching to context-specific scenarios.

Using a STEM-integrated approach the Western Wisconsin STEM Consortia provided professional development for teachers and the program improved teachers' content and pedagogical knowledge in mathematics and science as well as their teaching practices (Mason et al., 2012; Veenstra, 2012). Similar professional development opportunities that take into consideration the practice of teaching and how it may affect students may improve teachers' perceptions and expectations of girls' academic achievement.

Confront Gender-based Biases and Provide Supportive Spaces

Studies suggest that affirming social inclusion and female student ability in STEM is positively related to strengthened resilience and motivation to persist in STEM domains (Estrada et al., 2018; Leaper & Starr, 2018). Negative remarks and attitudes toward women in STEM send the message that women do not belong in STEM (Moss-Racusin et al., 2018; Simon et al., 2017). Gender stereotypes are shaped and projected onto individuals at an early age, affecting self-perception, self-esteem, and decision-making about the future (Lane, et al., 2012; Ramsey, 2017).

Programming focused on gender which aims to confront stereotypes and foster supportive and safe spaces for girls to learn STEM concepts with female STEM roles models can help girls gain confidence and build a foundation for decisions about their futures (King & Pringle, 2019). For women of color campus resources like support groups and learning communities where they have a safe space to share experiences can help students manage stereotypes, develop healthy responses to adversity, and complete their degrees (Charleston, 2014; Johnson, 2011).

Use Targeted Messaging and Conversations to Build Interest and Confidence

Research indicates that girls and women of color struggle to overcome their perceptions of STEM as a white male career path (Young et al., 2019). Strategic messaging can help deconstruct stereotypes and misconceptions that perpetuate discriminatory myths.

Evidence shows the importance of messaging and conversation in building STEM interest; the effectiveness of such conversations depends on how people describe their experiences, engage with girls and women of color, and the importance of college degrees in increasing performance and persistence of women in STEM fields. For instance, one study found using dissemination techniques such as posters, flyers, and brochures featuring photographs of female role models was essential in increasing women's interest in a STEM program (Milgram, 2011).

Other studies emphasize that messaging is effective if a connection is made between how STEM fields help people and foster collaboration (Colvin et al., 2013, Milgram 2011). For instance, Techbridge Girls uses personal stories of role models to make a connection between roles models' lives outside the professional sphere and how that relates to girls' own experiences, with the purpose of improving effectiveness of messaging around STEM fields and careers (Sammet & Kekelis, 2016). Research also reveals that messages of vision such as "engineers are creative problem solvers," "engineers make a world of a difference," and "engineering is essential to our health, happiness, and safety" were effective in attracting girls to STEM fields (Veenstra, 2012, p.3).

Encourage Mentoring and Role Modeling from Female Faculty

Female students in STEM are inspired by successful female professionals; having female role models increases women's academic performance and persistence in STEM (Herrmann et al., 2016; Milgram, 2011). By sharing their experiences on the path to a STEM career, female role models influence students' academic engagement (Herrmann et al., 2016). Lin-Siegler et al., (2016) purport that having female role models discussing how they overcame challenges, normalizing and overcoming feelings of not belonging in STEM, and accentuating the significance of a college degree was associated with increased performance and persistence of female students.

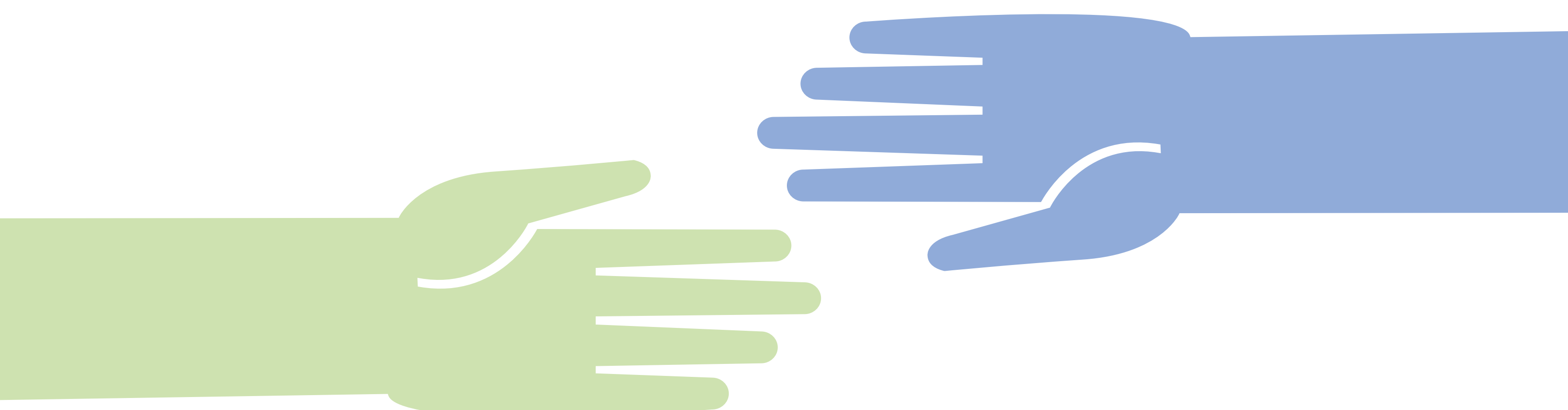
Diverse faculty who can provide culturally specific mentoring is especially important for female students of color who are often ignored by faculty, are less likely to be recommended for fellowship opportunities, and receive little support as they complete their research (Charleston, 2014; Johnson, 2011).

Embrace Work-life Balance and Family-friendly Policies

Women place higher value on balancing their work demands with family obligations (Guo et al., 2018; Milgram, 2011). Women of color often have financial and childcare obligations that can make a lengthy, advanced STEM education difficult to prioritize (Ko et al., 2013; Ong et al., 2011).

Asking women of color what they need to lead successful personal and school/work lives can help illuminate their concerns (Ko, 2013). Creating more flexible work environments by reducing barriers to family commitments is essential to recruiting and retaining women in STEM fields (Ko et al., 2013; Weisgram & Diekman, 2016).

Conveying the message that STEM professionals can achieve their career requirements while also attending to their personal and family duties was found to elevate aspiring female students' positivity toward STEM careers (Milgram, 2011; Weisgram & Diekman, 2017). According to Tan-Wilson and Stamp (2015), having STEM professionals describe how they raised families while progressing in their STEM careers led to a significant shift in female students' perceptions of scientific careers as no more difficult than non-scientific occupations. Family friendly policies (e.g., a favorable back-to-work transition structure after a break) are essential in recruiting, retaining, and advancing women in the STEM workforce (Amon, 2017; Guo et al., 2018).



Key Takeaways

Apply Intersectional Approaches: Girls and women of color face unique challenges and opportunities in STEM fields. Interventions that solely address gender discrepancies do not fully encompass the needs of women of color. Intersectional strategies to attract and retain girls and women in STEM are necessary to address social disparities for students from marginalized racial and ethnic backgrounds.

Build Collaborations with Diverse Stakeholders: Collaborations enable programs and professionals to design strategies that equip girls with access to mentors, resources, and tools to inform their decision making and improve access to STEM opportunities.

Build Connections between Programs and Caregivers: Often, caregivers are the first role models to advise and shape girls' interest in STEM fields. It is important to acknowledge their role in influencing girls' interest in STEM and engaging caregivers early in the process can increase the success of the program.

Design Targeted Outreach: It is important to design and employ outreach strategies targeted towards girls and women. Intentional outreach and targeted programs are more likely to appeal to this group and provide increased exposure to STEM settings where they are not overshadowed by their male peers.

Foster Interest across STEM Pathways: To ensure full participation of women in STEM professions it is necessary to expand opportunities for STEM education and careers at all points of the educational pathway and into professional careers. Early exposure to STEM-related learning opportunities is linked to later participation, increased interest, self-efficacy, and performance in STEM.

Train Role Models: To better connect role models' experience with girls and women it is important to train role models in sharing their experiences outside of their professional sphere and in emphasizing how role models' careers contribute to communal goals. Sharing role models' challenges in their career pathways will help girls and women make connection between their own experiences and the experience of role models.

Next Steps

Drawing from the content in this Research Brief, we will offer opportunities for further discussion on www.includesnetwork.org. In these discussions, we will highlight examples from NSF INCLUDES National Network members who have used these strategies and others to attract and retain girls and women in their projects. As part of this next step, we would like to offer several questions to help drive the conversation:

- What are some of the strategies you use to attract and retain girls and women in your project? Can you share your experiences, lessons learned, and opportunities? Is there data you can share that demonstrate the influence or impact of these strategies?

- What strategies is your project using to specifically address the needs of girls and women of color in their STEM pursuits?

INCLUDES Awards Focused on Girls and Women

Based on our review of the NSF award database (as of September 14, 2020) there were 19 INCLUDES-funded projects focused on this topic (see Table 1 below). Related publications are included after the table.

Award #	Title	Leadership Team
165442	Enhancing the Success of Women in Vision Science: Females of Vision, et al. (FoVea)	PI: Mary Peterson Co-PIs: Diane Beck, Karen Schloss
1649082*	NSF INCLUDES: Indigenous Women Working Within the Sciences (IWWS)	PI: April Lindala Co-PIs: Jessica Cruz, Martin Reinhardt
1649289*	NSF INCLUDES: A Program Designed to Recruit, Retain, and Train Hispanic Women in STEM Disciplines	PI: April Marchetti Co-PIs: Rachele Dominguez, Laurie Massery, Rebecca Michelsen, Charles English
1649312	NSF INCLUDES: Mississippi Alliance for Women in Computing (MAWC)	PI: Sarah Lee Co-PIs: Vemitra White, Andy Perkins
1649346*	Creating a Diverse STEM Pathway with Community Water Research	PI: Mohamad Musavi Co-PIs: Venkat Bhethanabotla, Shakila Merchant, Cary James, Vemitra White
1649355	NSF INCLUDES: Increasing Degrees Awarded to African American, Hispanic, Native American and Women Students in Engineering (50K Coalition)	PI: Karl Reid Co-PIs: Karen Horting, Sarah Echohawk, Barry Cordero, Raquel Tamez
1649361*	Design & Development Launch Pilots: UTAH PREP	PI: Daniel Horns Co-PIs: Carlos Cortez,Violeta vasilevska,Liz Andrus
1649365*	NSF INCLUDES: WATCH US (Women Achieving Through Community Hubs) in the United States	PI: Judy Walker Co-PIs: Ami Radunskaya, Ruth Haas, Deanna Haunsperger

***Note: award has expired**

Award #	Title	Leadership Team
1649377*	NSF INCLUDES: Supporting Women Advancing Through Technology	PI: Linda Christopher Co-PI: Christine Olmstead
1649381*	STEM Core Initiative	PI: Jim Zoval Co-PIs: Frank Gonzalez, Courtney Brown, Mark Eagan, Michael Venn, Jim Zoval
1733679	Forum on Inclusive STEMM Entrepreneurship	PI: Gilda Barabino
1744440*	Southeastern Compact for Inclusive Student Transitions in Engineering and Physical Sciences (SCI-STEPS)	PI: Keivan Stassun Co-PIs: Kelly Holley-Bockelmann, William Robinson, Rena Robinson, Roger Chalkley
1744472	Intermountain STEM (IM STEM)	PI: Benjamin Williams Co-PIs: Mimi Lufkin, Susan Thackeray, Anne Jakle, Alexander Carter, Angela Hemingway
1744490*	NSF INCLUDES DDLP: Leadership and iSTEAM for Females in Elementary school (LiFE): An Integrated Approach to Increase the Number of Women Pursuing Careers in STEM	PI: Bruce Bukiet Co-PIs: James Lipuma, Nancy Steffen-Fluhr
1813017	NSF INCLUDES Symposium for ADVANCING STEM Latinas in Academic Careers	PI: Ala Qubbaj Co-PI: Marie Mora
1834897	DCL: NSF INCLUDES: EAGER: Examining Collective Impact in a Community-University Partnership to Broaden Girls' Participation in Science from Middle School to High School Graduation	PI: Ezekiel Kimball Co-PIs: Mark Pachucki, Nilanjana Dasgupta, Ryan Wells, Chrystal George Mwangi
1835063	DCL NSF INCLUDES: Increasing the Number of Women in Mechanical Engineering	PI: Aisha Lawrey Co-PI: Ashley Huderson
1840644	NCWIT Participation in BPCNet (Broadening Participation in Computing Network)	PI: Lucinda Sanders
1841271	EAGER: CRA-W Programs for Partnerships in the BPCnet Pilot	PI: Sandhya Dwarkadas Co-PI: Erik Russell

***Note: award has expired**

Related Publications & References

A review of the NSF INCLUDES abstracts with a focus on girls and women revealed a number of publications linked to specific projects. The first ten publications are associated with INCLUDES award #1649312, while the last is linked to award #1649346 (these were among the first cohort of awards hence make sense to have published work):

Conference Proceedings:

1. Das, Meenakshi and Lee, Sarah and Lineberry, Litany and Barr, Chase. “Meenakshi Das, Sarah Lee, Litany Lineberry, Chase Barr (2018). Why inclusion programs are beneficial to students with disabilities and how universities can help: perspectives of students with disabilities. 1st Annual Conference of CoNECD-Collaborative Net,” 1st Annual Conference of CoNECD-Collaborative Network for Engineering and Computing Diversity, 2018.

2. Jessica Ivy, Dana Franz. “Exploring Pathways to Developing Self-Efficacy in New Computer Science Teachers,” 2017 ASEE Zone 2 Conference Proceedings, 2017.

3. Lee, Sarah and Ivy, Jessica and Stamps, Andrew. “Providing Equitable Access to Computing Education in Mississippi,” 4th international conference on Research in Equity and Sustained Participation in Engineering, Computing, and Technology, 2019.

4. Lee, Sarah and Sun, Richard and Lynn, Randy. “Mississippi Coding Academies: A non-traditional approach to computing education,” ASEE annual conference & exposition proceedings, 2019.

5. Lineberry, Litany and Lee, Sarah and Ivy, Jessica and Bostick, Heather. “Bulldog Bytes: Engaging Elementary Girls with Computer Science and Cybersecurity,” ASEE SE Section Annual Conference, 2018.

6. Lineberry, Litany and Lee, Sarah and Ivy, Jessica and Bostick, Heather. “Bulldog Bytes: Engaging Elementary Girls with Computer Science and Cybersecurity. Journal of Transactions on Techniques in STEM Education. 2018 (January-September); 3(2):76–81. ISSN: 2381–649X,” Transactions on techniques in STEM education, v.3, 2018.

7. White, Vemitra and Lee, Sarah and Lineberry, Litany and Grimes, Danielle and Ivy, Jessica. “Illuminating the Computing Pathway for Girls in Mississippi,” ASEE Annual Conference and Exposition, 2018.

8. White, Vemitra and Alexander, Jamel and Prince, Debra. “Mississippi BEST Robotics: An analysis of impact and outcomes on student performance and perceptions towards earning STEM degrees,” ASEE Annual Conference, 2017.

Journal Articles:

9. Ivy, Jessica and Lee, Sarah B. and Franz, Dana and Crumpton, Joseph. "Seeding Cybersecurity Workforce Pathways With Secondary Education," Computer, v.52, 2019. doi:10.1109/MC.2018.2884671

10. White, Vemitra and Alexander, Jamel and Prince, Debra and Verdell, Angela. "The Impact of Student Engagement, Institutional Environment, College Preparation, and Financial Support on the Persistence of Underrepresented Minority Students in Engineering at a Predominately White Institution: A Perspective from Students," Journal of Higher Education Theory and Practice, v.18, 2018.

11. Musavi, Mohamad and Friess, Wilhelm A. and James, Cary and Isherwood, Jennifer C. "Changing the face of STEM with stormwater research," International Journal of STEM Education, v.5, 2018. doi:10.1186/s40594-018-0099-2.

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Boucher, K. L., Fuesting, M. A., Diekman, A. B., & Murphy, M. C. (2017). Can I work with and help others in this field? How communal goals influence interest and participation in STEM fields. Frontiers in Psychology, 8, 1–12.

Britsch, B., Peterson, K., Liston, C., & Ragan Coulon, V. (2014). Collaboration as a catalyst for building capacity of afterschool programs to integrate STEM learning. Paper presented at the Annual Meeting of the American Education Research Association, Philadelphia, PA.

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