

2023

State of STEM Education Stakeholder Report

Twenty-One Years of Measuring
Students and Teachers Perceptions
about STEM



CSTEM™

Reagan Flowers, PhD | June 9, 2023

✉ info@cstem.org

☎ 713-443-4521

🌐 CSTEM.org

Acknowledgments

C-STEM Teacher and Student Support Services surveys serve as the foundation upon which C-STEM's PreK-20 programs were established and informs programmatic updates year to year. C-STEM has been measuring perceptions of students and teachers for twenty-one years in urban, suburban, and rural communities across the U.S. and other countries. C-STEM programs would not be possible without the vision, guidance, and leadership of the founder, Dr. Reagan Flowers. These study's benefit from the generous information provided by C-STEM students and teachers who take the time to tell us about their opinions, attitudes, and experiences with STEM. This report is only possible because of their participation and support.

June 2023

Copyright © 2023 by C-STEM Teacher and Student Support Services. All rights reserved.

Contributors: Dr. Reagan Flowers, Azsa Snipes, and Jahlyn Sommerville

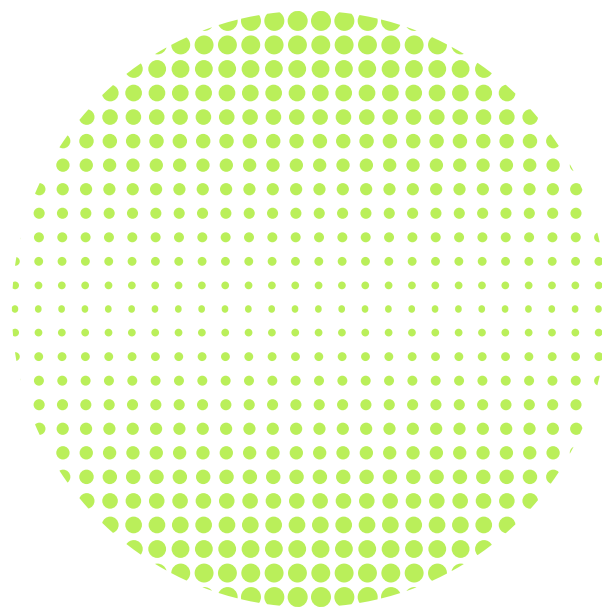
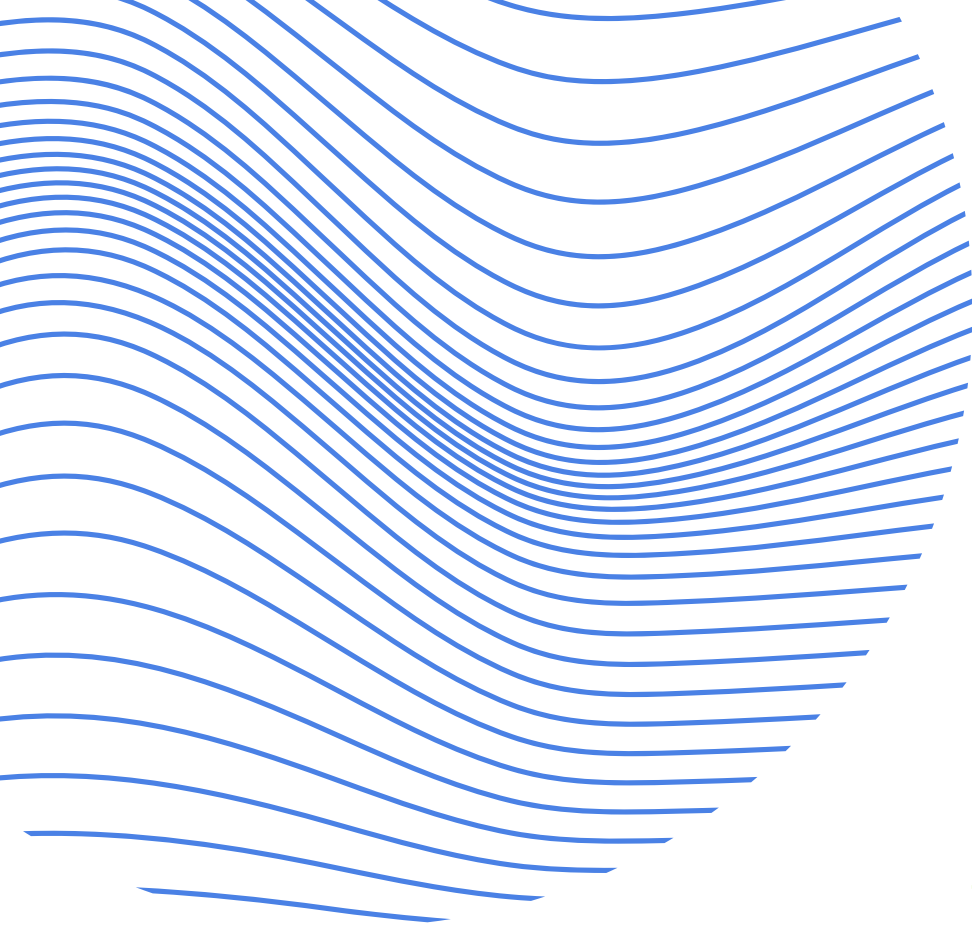
C-STEM Teacher and Student Support Services, Inc.

3226 Alabama St., Houston, TX 77004,

713-443-4521

www.cstem.org

For more information, contact info@cstem.org



Our mission is to support teachers in delivering project-based learning that ignites curiosity and teaches Communications + STEM (C-STEM) skills to students historically underrepresented in STEM fields.

We are working to create a world where minority and economically disadvantage students have high-quality communication and STEM experiences that catapult them into transformative spaces, creating opportunities for economic and social mobility.



713-443-4521



www.cstem.org



info@cstem.org



C-STEM

Table of Contents

02

Introduction

04

Girls and Women in STEM

07

School Building Leadership

11

Informal STEM

13

Attract and Retain in STEM

15

Conclusion



Introduction

Since 2002, C-STEM has collected data that capture, the experiences, perceptions, and demographics of participants in its PreK-12 programs to shed light on the existing disparities faced by underrepresented groups in STEM education and the broader STEM economy. The demographics of the majority of respondents surveyed are either Black or Hispanic indicating that the specific challenges faced by these communities regarding access to quality math and science education, technology resources, and opportunities for economic advancement continue to persist (see Figure 1).

The underrepresentation of Black and Hispanic individuals in STEM fields reflects systemic barriers and inequities that contribute to the widening gaps in knowledge, skills, and socioeconomic status. These disparities can be attributed to a range of factors, including limited access to educational resources, lack of role models, implicit biases, and unequal distribution of opportunities.

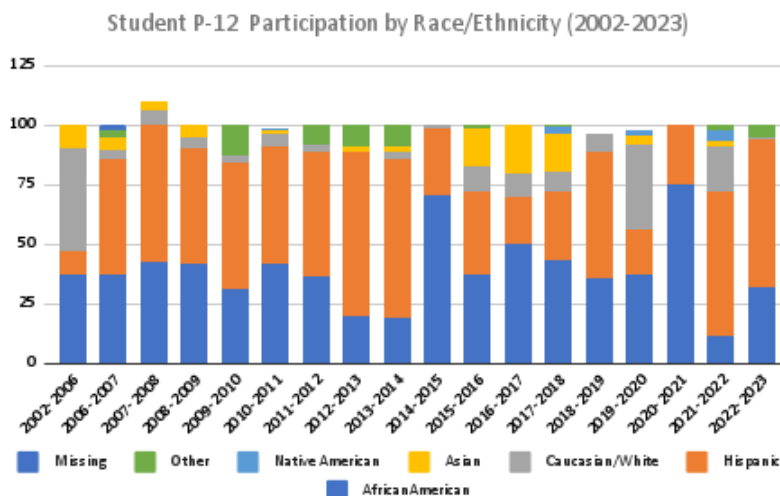
The valuable insights into the experiences of these communities from the data collected by C-STEM help to identify areas that require targeted interventions and support.

By understanding the specific challenges faced by underrepresented groups, organizations, educational institutions, policymakers, and community leaders can develop strategies to address the disparities and promote equity in STEM education and employment.

The professional development theme during the 2022-2023 academic year, "Climate Technology: Creating Innovative Solutions for a Sustainable Future," demonstrates a proactive approach to addressing global challenges like climate change and involving underrepresented groups in the process. C-STEM continues to expose students and teachers to STEM workforce opportunities where there is low participation of minorities and females to increase awareness, interest, and capacity to select pathways that lead to socio-economic mobility.

Climate technology presents a significant STEM economic opportunity (see Figure 2). As the world grapples with the challenges of climate change, there is a growing need for innovative solutions that can mitigate its impacts and transition toward a more sustainable future.

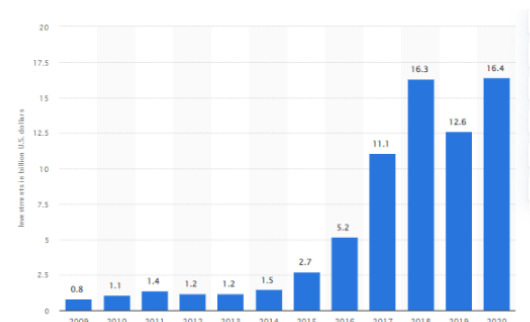
Figure 1



Source: (C-STEM Teacher & Student Services, 2023)

Figure 2

Value of venture capital investments in climate technology worldwide from 2009 to 2020
(in billion U.S. dollars)



Source: (Statista, 2023)



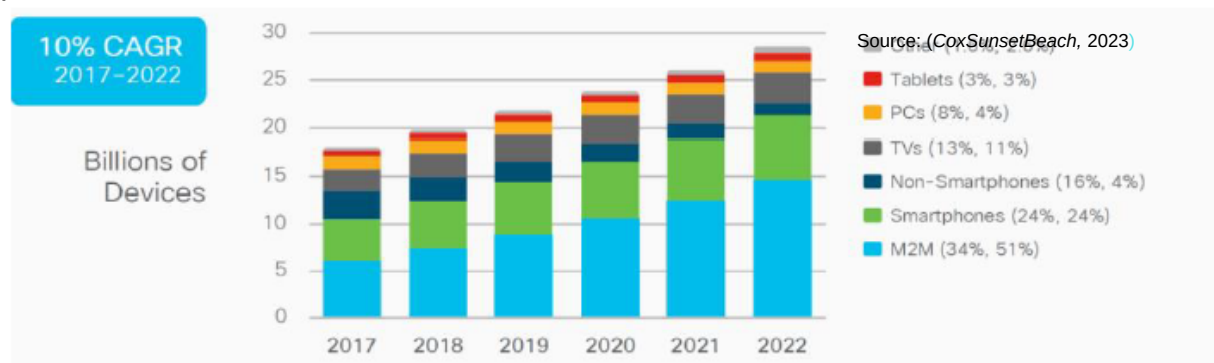


Introduction continued

This need opens up various avenues for economic growth and job creation in the field of climate technology and C-STEM students are being prepared. By focusing on the leading factors contributing to climate change and the role of technology in combating it, the program aims to equip students with the knowledge and skills to contribute to sustainable solutions. The emphasis on underrepresented groups in STEM fields is necessary to foster diverse perspectives and ensure that marginalized communities are not left out of conversations.

Targeted outreach programs can help raise awareness about STEM opportunities and provides resources and support to encourage participation from underrepresented populations. Mentorship opportunities can also play a vital role in providing guidance and inspiration for students from these backgrounds. Increased funding for schools and communities serving marginalized groups is essential for creating equitable access to quality STEM education. Increased funding for schools and access to a quality STEM education provides opportunities for families in marginalized communities to experience greater probability for socio-economic mobility. By providing adequate resources, technology, and infrastructure schools can better prepare students to engage in real-world learning experiences such as climate change-related problem-solving and innovation.

There are many problems being worked on by various STEM industries that impact our quality of life, issues around climate change is one. A collaborative approach with educating students involves various stakeholders including educators, community organizations, and industry partners. C-STEM is a community partner that aids schools in developing talent pipelines that could make a meaningful impact in building a more sustainable future. C-STEM's curriculum makes it a priority to emphasized sustainable living practices and in doing so acknowledges the importance of individual actions in mitigating environmental impacts. Encouraging students to make small changes in their daily lives to reduce their carbon footprint can have a significant collective impact and promote a culture of sustainability within their communities in the future (see Figure 3). This is also how students get the opportunity to experience how what they are learning in their classrooms applies to their life and the world around them.

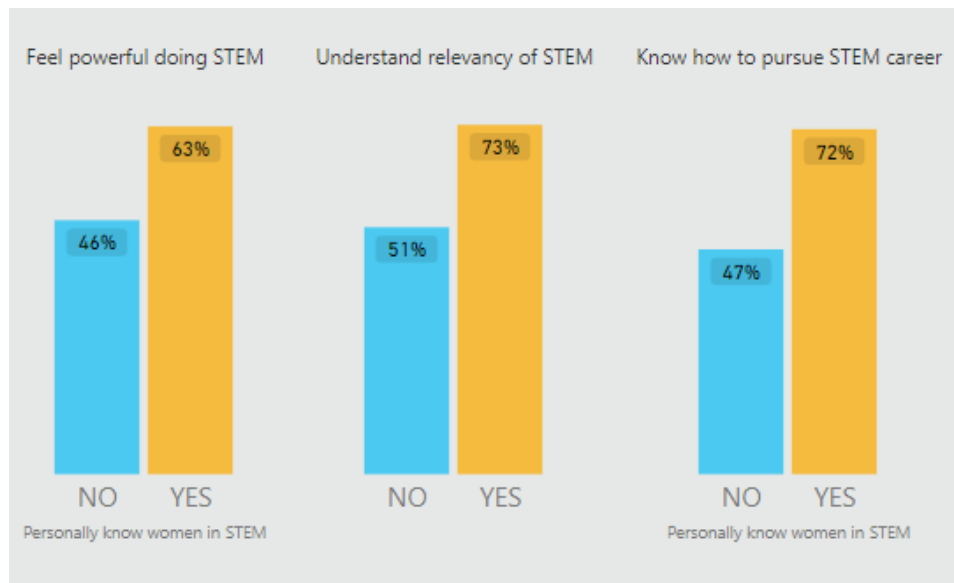




Girls and Women in STEM

Providing PreK-12 students exposure to STEM subjects and activities ignites interest and curiosity in underrepresented groups as demonstrated by C-STEM for more than two decades. The key has been providing high-quality hands-on experiences with STEM content during and after-school, organizing STEM-focused C-STEM Challenge competitions and showcases, and partnering with schools, community organizations, and the business community. Of the PreK-12 students surveyed, 63% of middle school girls who know women in STEM feel powerful doing STEM (see Figure 4).

Figure 4



Source: The State of STEM Education Told Through 26 Stats, 2023



Girls and Women in STEM continued

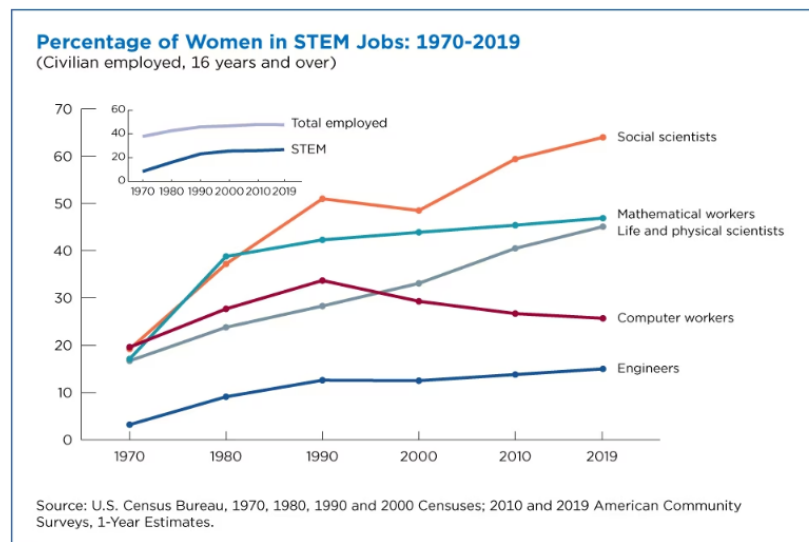


Figure 5

Source: (U.S. Census Bureau, 2021)

Addressing representation disparities in STEM is crucial for promoting belonging in these fields. It is important to implement a combination of strategies to create a lasting impact. By prioritizing diversity and inclusion in STEM fields, we can ensure that all individuals, regardless of their background, have equal opportunities to pursue and thrive in STEM fields.

In comparison, 46% of middle school girls who don't personally know women in STEM feel powerful doing STEM (*The State of STEM Education Told Through 26 Stats*, 2023). This highlights the importance of students having diverse role models in STEM. Encouraging professionals from diverse backgrounds to engage as mentors and offering opportunities for students to interact with successful individuals in STEM, such as what the C-STEM Challenges provides, can help broaden their horizons and build a sense of belonging.

Similarly, 73% of those girls who personally know women in STEM understand the relevance of STEM, and 72% know how to pursue a STEM career. This is compared to 51% and 47% of those who don't personally know women in STEM, respectively (*The State of STEM Education Told Through 26 Stats*, 2023). These figures demonstrate how crucial it is for young girls to have role models and mentors in STEM fields. They are more likely to feel confident and empowered to pursue their own passions in STEM if they interact with and observe successful female professionals in these fields.

Women made up 38% of all American workers in 1970 and 8% of STEM workers. In 2019, women made up 48% of all workers, and the STEM proportion rose to 27% (see Figure 5). All STEM occupations have seen an increase in the representation of women since 1970, and social science occupations have seen the largest increase, from 19% in 1970 to 64% in 2019 (U.S. Census Bureau, 2021).

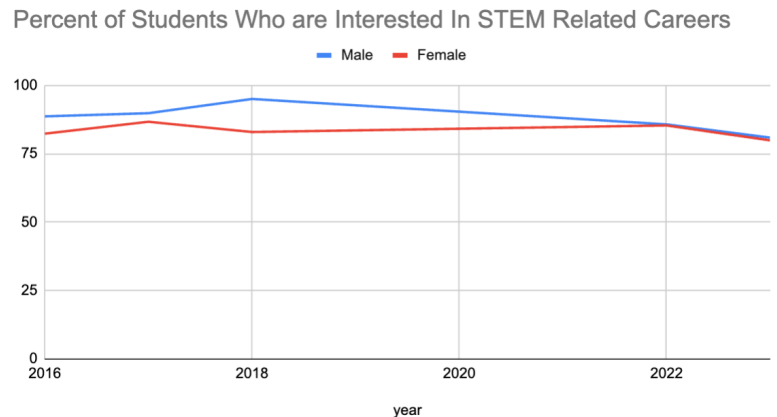
In 2019, women accounted for 47% of all math jobs and 45% of jobs in physical and life sciences. The majority (80%) of the STEM workforce was employed in computer and engineering-related fields, but women did not make as much progress in these fields. Only about 25% of computer workers and 15% of those in engineering occupations were women (U.S. Census Bureau, 2021). This gender disparity in computer and engineering-related fields is often attributed to societal stereotypes and biases that discourage girls and women from pursuing these careers. Efforts to increase diversity and inclusion in STEM fields have been ongoing, but progress has been slow.

Girls and Women in STEM continued

It is important to challenge societal stereotypes and biases that discourage girls and women from pursuing STEM careers. This involves assessing classrooms and making changes where needed to promote inclusive and equitable learning environments, creating opportunities that bring mentors into school buildings, and implementing policies that address biases and stereotypes that adversely impact the advancement of girls and women in STEM fields. Such efforts ensure that girls and women have equal opportunities to thrive and contribute in these fields.

While progress has been made in increasing the representation of girls and women in STEM, as evidenced by the data showing their sustained interest in STEM careers (see Figure 6), there is still work to be done to achieve full gender parity. The percentages of male and female students interested in STEM-related careers have shown some variations over the years, but recent data from 2022 and 2023 indicate a convergence as well as a decrease in their levels of interest. While the majority of C-STEM participants are female (see Figure 7), to foster a more diverse and inclusive STEM workforce, it is crucial for PreK-12 schools to leverage the power of role models, mentorship, and supportive policies so schools can further encourage talented girls to choose STEM pathways. These efforts will contribute to the development of robust pipelines that cultivate diverse and inclusive STEM talent, shaping a future where gender parity in STEM fields is fully realized.

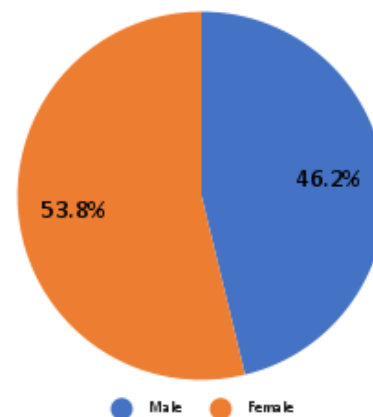
Figure 6



Source: (C-STEM Teacher & Student Services, 2023)

Figure 7

Student P-12 Participation by Gender
(2002-2023)



Source: (C-STEM Teacher & Student Services, 2023)



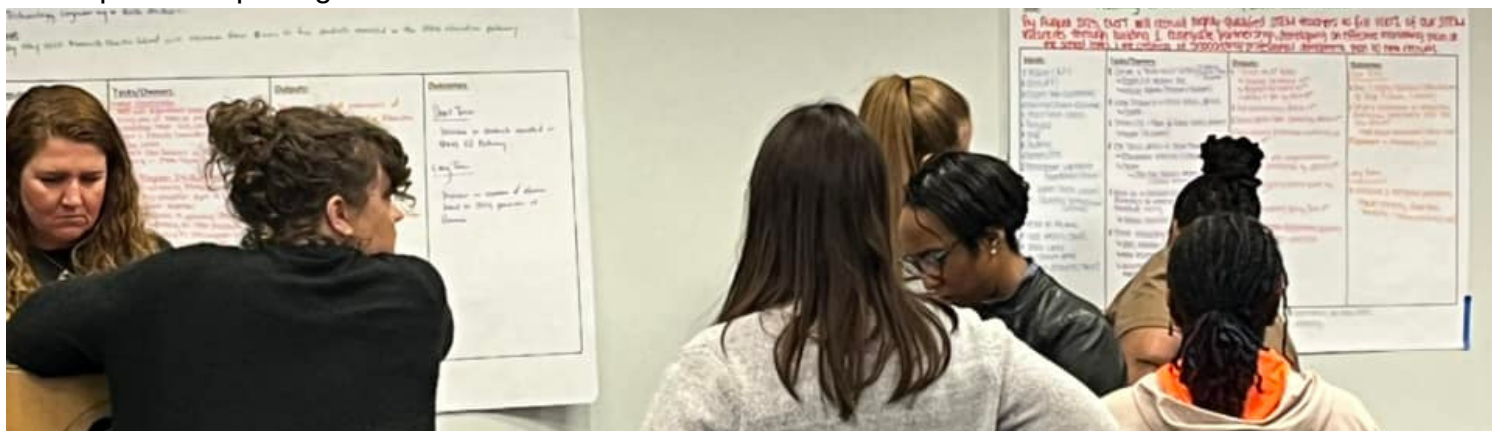
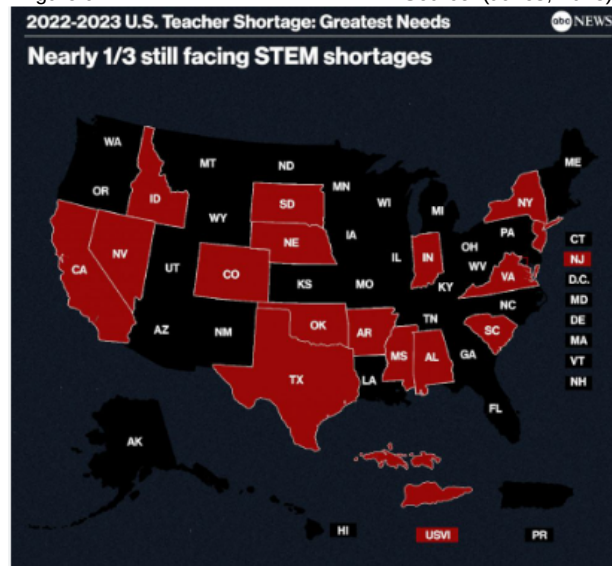
Source: (Jones, 2023)



On October 13, 2022, the American School District Panel (ASDP), a research partnership between the RAND Corporation and the Center on Reinventing Public Education, conducted a survey to examine educator turnover and staff shortages in the 2021-2022 and 2022-2023 school years. The survey involved a random sample of 300 district and charter network leaders who were surveyed between October 13, 2022, and December 12, 2022. To ensure national representation, their responses were weighted accordingly. The survey focused on voluntary staff turnover, such as retirements and resignations, as well as staff shortages defined as 'unfilled open positions.'

The findings from this survey provide valuable insights into the challenges faced by schools nationwide (see Figures 8 and 9). The general education departments in all 50 states, Washington, D.C., Puerto Rico, and the U.S. Virgin Islands were contacted by phone and email for an article between October and the end of January, asking each of the 53 to identify any severe staffing gaps or shortages, and, if so, what their top requirement for subject-matter position openings were.

Source: (Jones, 2023)



School Building Leadership continued

Many people claim that there aren't enough teachers in the field, but there are also not enough hopeful applicants. In the 2021-2022 school year, there was a notable increase in school principal turnover, with around 16 percent of principals choosing to retire or resign (see Figure 10). This significant increase equates to approximately 19,000 more school leaders leaving their positions compared to the previous year. These findings are in line with other studies that indicate a growing trend of principal attrition during the pandemic, following a period of relative stability or even decline in previous years (Diliberti & Schwartz 2023).

School building leadership turnover can have a significant impact on external partnerships and the sustainability of STEM programs. When administrators or teachers depart from a school or District, the relationships built with external partners may be disrupted, potentially affecting the support these partners provide to STEM initiatives. The departure of a leader can also bring changes in program priorities and goals under new leadership, which may lead to shifts in the importance or even abandonment of previously established STEM partnerships and/or programs.

Teachers must adapt to new directives that may be implemented by new leadership, which can potentially be overwhelming, particularly when implementing a project-based learning curriculum. The transition to a new instructional approach requires support and professional development to ensure that teachers feel equipped and confident in implementing project-based learning effectively.

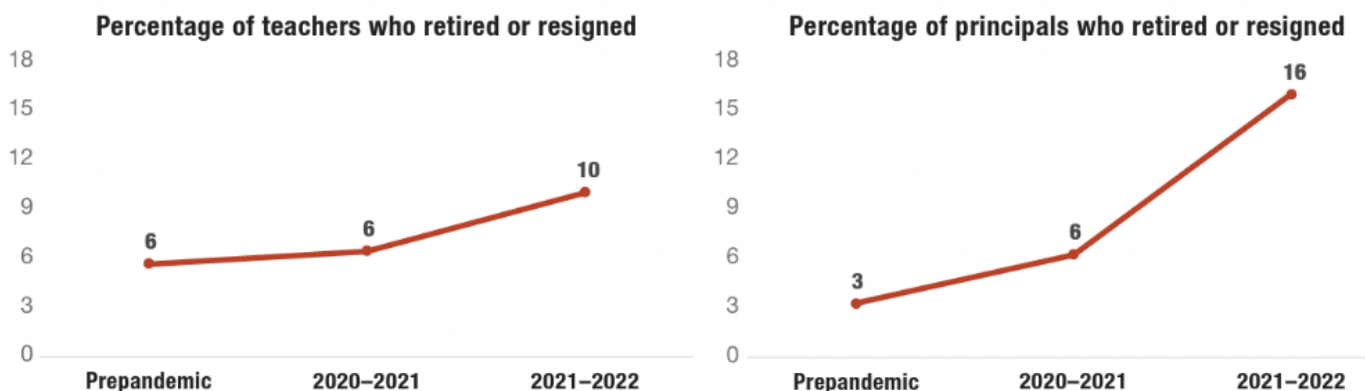
C-STEM's focus on providing ongoing support and professional development to teachers is crucial in addressing the challenges associated with building leadership turnover and sustaining STEM programs. By equipping educators with the necessary knowledge, skills, and resources, C-STEM empowers them to navigate transitions, implement project-based learning, and effectively integrate STEM concepts into their classrooms.

Furthermore, C-STEM's emphasis on collaboration and creating a network of educators, including those who may not traditionally consider themselves as STEM leaders, fosters a sense of community and enables teachers to connect with others who have successfully implemented project-based learning and STEM initiatives. This support system helps alleviate the challenges associated with new directives, providing a platform for knowledge-sharing, problem-solving, and inspiration.

Figure 10

Source:(Diliberti & Schwartz 2023)

District Leaders Reported Teacher and Principal Attrition Increased in the 2021–2022 School Year



School Building Leadership continued

By prioritizing teacher support and professional development, C-STEM recognizes the critical role that educators play in creating an inclusive and empowering STEM learning environment. Through these efforts, C-STEM contributes to building resilient and sustainable STEM programs that can thrive even in the face of administrative and teacher turnover. Overall, C-STEM's commitment to supporting teachers during transitions and providing ongoing professional development contributes to the success and continuity of STEM programs, ensuring that underrepresented students have access to high-quality STEM education and the opportunity to pursue their interests and aspirations in STEM fields.

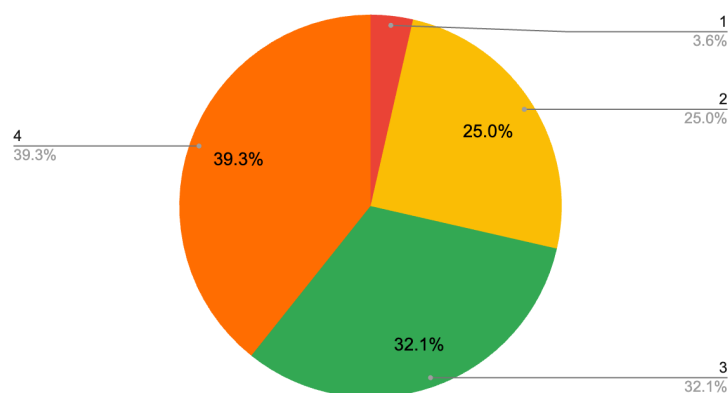
Teachers' perceptions of the school environment play a crucial role in their ability to effectively teach STEM subjects (see Figure 11 and Figure 12). The data obtained from teachers participants in the Integrated C-STEM Training Institute largely reflects that 71.4% feel they have the planning time they need to lead STEM learning and 78.6% feel they have adequate space to work on STEM projects. Some of the observed key factors that influence teachers' perceptions of their school environment for teaching STEM include:

- Supportive Leadership
- Access to Resources
- Collaborative and Professional Learning Communities
- Supportive Colleagues
- Professional Development
- Parent Engagement

By addressing these factors, schools, no matter the zip code or low socio-economic background of the families the schools serve, an environment can be created where teachers feel supported, empowered, and motivated to teach STEM subjects. This, in turn, positively impacts students' learning experiences and outcomes in STEM content areas.

Figure 11

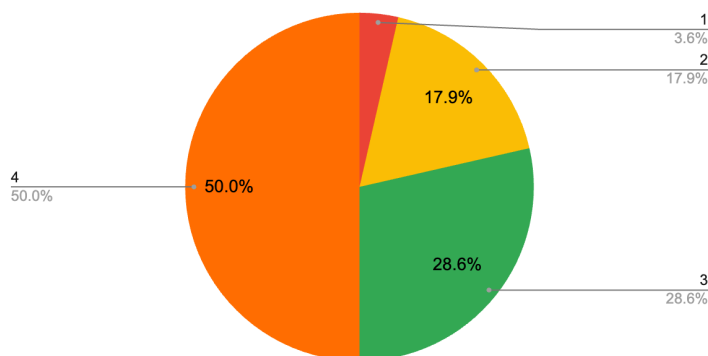
Teacher Perception of C-STEM Challenge Planning Time



Source: (C-STEM Teacher & Student Services, 2023)

Figure 12

Teacher Perception of Learning Work Space for C-STEM Activities



Source: (C-STEM Teacher & Student Services, 2023)



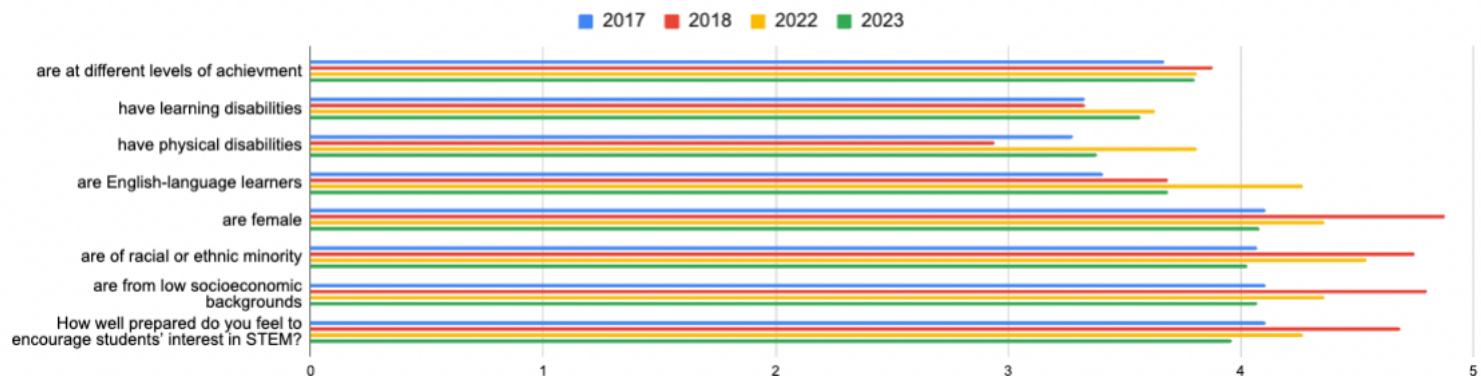
School Building Leadership continued

To maintain continuity in school buildings in the face of such high turnover, C-STEM provides professional development opportunities for educators, equipping them with the necessary knowledge and skills to effectively implement STEM activities. Through training workshops, ongoing support, and access to a network of fellow educators, C-STEM ensures that teachers are prepared to deliver high-quality STEM experiences. The average ratings from teachers who completed the Integrated C-STEM Training Institute (ICTI) indicate their perceived level of preparedness in encouraging students' interest in STEM, taking into account various factors such as achievement level, learning disabilities, physical disabilities, English-language learners, female students, racial or ethnic minority students, and students from low socioeconomic backgrounds. Across the years surveyed (2017, 2018, 2022, and 2023), teachers consistently reported feeling well-prepared. (see Figure 13)

Source: (C-STEM Teacher & Student Services, 2023)

How well prepared do you feel to teach STEM to students who-

Figure 13



Despite the challenges posed by leadership changes, the consistent positive ratings demonstrate the resilience of C-STEM's professional development initiatives. This indicates that C-STEM's efforts to equip educators with the necessary knowledge and skills have remained effective in navigating leadership transitions and ensuring that teachers are equipped to deliver high-quality STEM experiences to their students.

C-STEM facilitates partnerships with external organizations, including businesses, universities, and community groups. These partnerships provide access to valuable resources, expertise, and real-world experiences for both staff and students. By leveraging these partnerships, C-STEM creates opportunities for students to engage in authentic STEM projects and connect with professionals in STEM fields.

Building strong leadership and providing staff support is essential for the successful implementation of a STEM program outside of the traditional classroom. C-STEM recognizes the challenges that arise and offers professional development, partnerships, and effective communication strategies to overcome these obstacles. By empowering staff and fostering collaboration, C-STEM creates an environment where students can thrive and develop essential STEM skills for their future success.





Informal STEM

Providing students with opportunities to experience STEM outside of the classroom is incredibly valuable for their overall understanding and engagement in STEM disciplines. Informal STEM experiences offer a more hands-on and practical approach to learning, allowing students to see the real-world applications of the knowledge and skills they acquire in the classroom.

By incorporating informal STEM experiences into the curriculum, C-STEM enables students to explore STEM concepts in authentic and meaningful ways. Additionally, field trips to maker spaces, museums, zoos, and botanic gardens expose students to interactive exhibits, hands-on activities, and expert demonstrations, fostering a deeper understanding of STEM principles and sparking curiosity.

Everyday activities can be leveraged as informal STEM experiences. Encouraging students to explore the physics of hitting a ball and a bat, examining the properties of produce at the grocery store, or engaging in scientific observations during nature walks all contribute to their scientific literacy and critical thinking skills.

These informal STEM experiences provide students with opportunities to connect classroom knowledge to real-life scenarios, making STEM subjects more relatable and relevant. They help students develop a deeper appreciation for the practical applications of STEM disciplines and inspire them to pursue further studies or careers in STEM fields.

Additionally, informal STEM experiences can help address equity and access issues by reaching students who may not have equal access to traditional classroom resources or STEM-related extracurricular activities. By bringing STEM learning opportunities to different environments, C-STEM helps broaden participation and reaches students from diverse backgrounds.



Informal STEM continued

STEM educators can be found in various settings where learning takes place and are not limited to formal classroom teachers. Those who pose questions, provide guidance, and help students connect their everyday experiences to STEM concepts are also considered STEM educators.

Parents and caregivers, who may not readily identify themselves as STEM educators, contribute significantly to children's STEM learning in everyday settings. Through their own experiences and interactions with children, they create valuable opportunities for STEM exploration. They play a pivotal role in nurturing children's curiosity, encouraging them to ask questions, and helping them discover the STEM elements that are present in their daily lives.

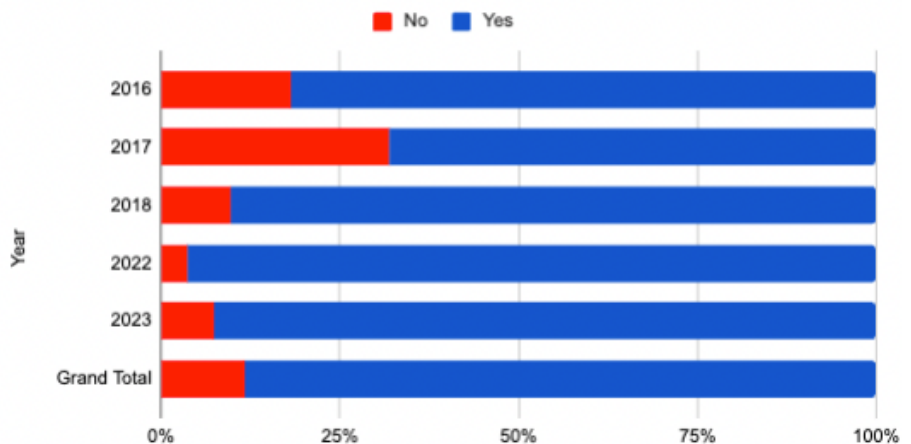
Our survey results reveal that 88% of students reported their parent(s) being involved in supporting their STEM engagement (see Figure 14). By recognizing their crucial role as STEM educators and providing them with the necessary tools and support, C-STEM creates an opportunity for families to explore STEM together and nurture their children's curiosity and interest in science, technology, engineering, and mathematics.

By recognizing the potential for STEM learning in everyday experiences and involving a diverse range of educators and caregivers, C-STEM promotes a lifelong engagement with STEM. We emphasize that STEM is not confined to the classroom but is present in all aspects of our lives. C-STEM comprehensive approach ensures that students develop a deeper understanding of STEM, see the relevance of STEM in the world around them, and continue to engage with STEM throughout their lives.

Overall, incorporating informal STEM experiences into the curriculum enhances students' understanding, increases their engagement level, and cultivates enthusiasm for STEM. By connecting classroom learning with real-world applications and providing access to a range of informal STEM activities, C-STEM empowers students to see the relevance and excitement of STEM disciplines in their everyday lives.

Figure 14

My parent(s) are involved with supporting my participation in STEM



Source: (C-STEM Teacher & Student Services, 2023)





Attract and Retain in STEM

To attract and retain students in STEM it is essential to start early and to implement STEM programming that is accessible as students matriculate from one grade level to the next. It is through hands-on activities, interactive experiments, and engaging demonstrations that attracts students to STEM and the quality of the experience that retains them. Offering STEM-related clubs, competitions, and events will spark students interest and curiosity (see Figure 15 and Figure 16).

Learning environments that emphasize the practical applications of STEM in solving real-world problems are attractive to students. When students connect STEM concepts to issues they care about, such as climate change, health, or technology advancements, it makes learning STEM more meaningful and relatable.

It is essential to offer comprehensive professional development programs for teachers to enhance their content knowledge, pedagogical skills, and familiarity with STEM teaching methodologies. C-STEM provides ongoing support and resources to ensure teachers feel confident and equipped to deliver quality STEM instruction.

The Integrated C-STEM Training Institute and C-STEM Challenge ensures teachers have access to relevant and up-to-date STEM content, resources, materials, technology, and equipment. Teachers require support with integrating technology tools and digital resources into their teaching practices.



Attract and Retain in STEM continued

Recognizing and celebrating the achievements of STEM teachers, both individually and as a school community goes a long way. Teachers appreciate incentives and opportunities for professional growth, such as grants, awards, or presenting at conferences.

When it comes to retaining students, it is important to keep top of mind that STEM is for all students no matter the learning level or abilities. Selecting programs such as C-STEM that encourages positive and supportive teacher-student relationships fosters engagement, trust, and heightens communication. Students should feel comfortable asking questions, taking risks, and exploring their interests in STEM within their classrooms and community. Creating such environments can keep students connected to STEM programs and builds their confidence and desire to do more.

Figure 15

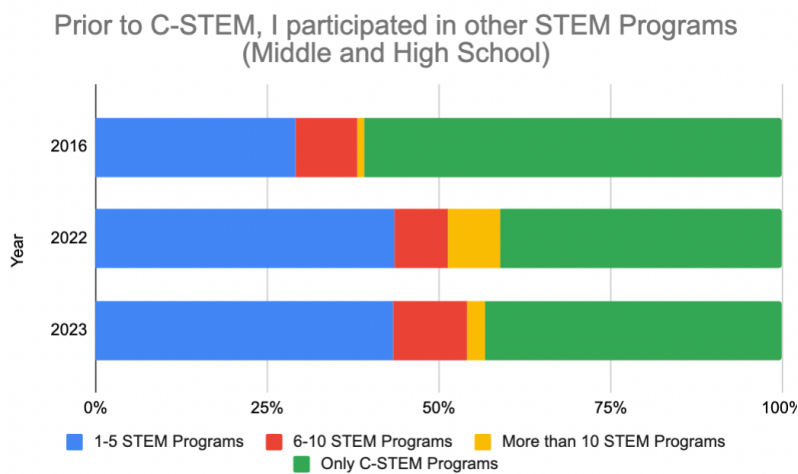
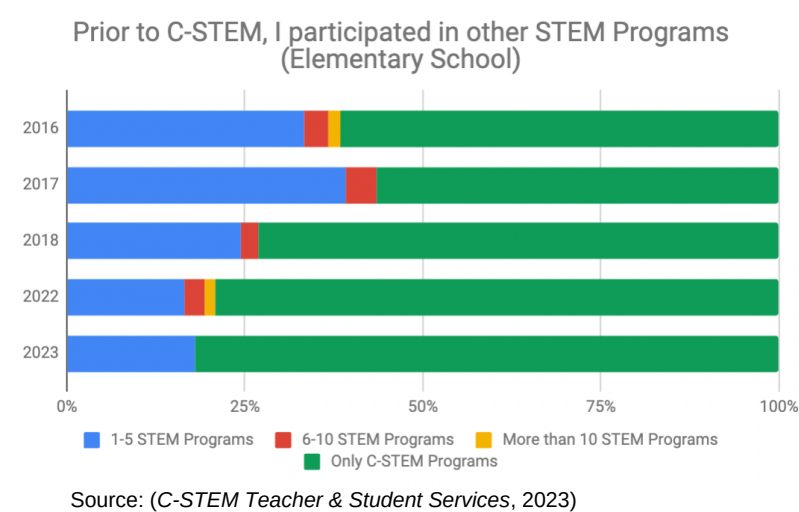


Figure 16



Conclusion

Some potential actions that can be taken to bridge the gaps and promote inclusivity in STEM include:

- Efforts should be made to improve access to high-quality math and science education, particularly in schools serving underprivileged communities. This can involve investing in resources, teacher training, curriculum development, and after-school programs that foster STEM learning.
- Bridging the digital divide is crucial to ensure that all students have access to broadband internet and modern technology tools. Initiatives focused on providing technology resources, such as computers, internet connectivity, and software, can empower underrepresented communities to engage in digital learning and exploration.
- Creating inclusive and supportive learning environments is essential to foster interest and confidence in STEM subjects. This involves promoting diversity among educators, implementing culturally responsive teaching practices, and encouraging collaborative learning and hands-on experiences.
- Mentorship programs and the presence of diverse role models in STEM fields can inspire and guide underrepresented students. Encouraging professionals from diverse backgrounds to engage as mentors and offering opportunities for students to interact with successful individuals in STEM can help broaden their horizons and build a sense of belonging.
- Collaborations between educational institutions, community organizations, industry, and government can create comprehensive and sustainable solutions to address the disparities. These partnerships can pool resources, share best practices, and coordinate efforts to provide holistic support for underrepresented groups in STEM.

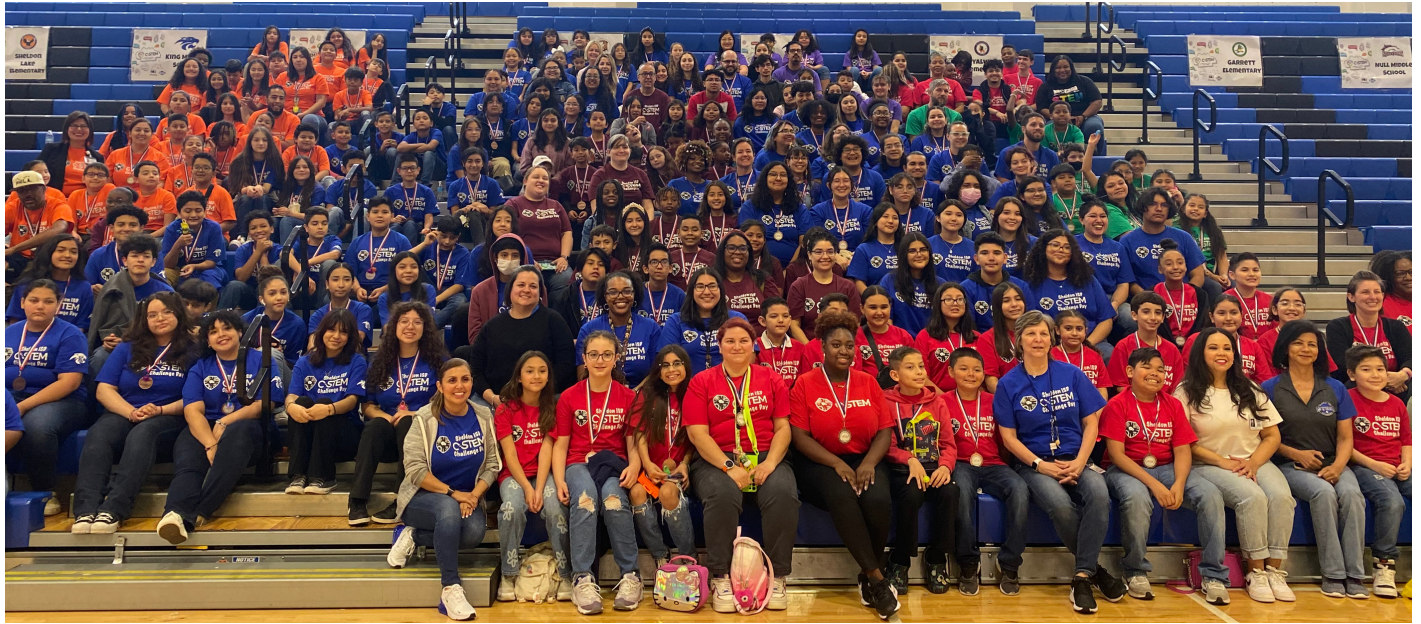
By utilizing the data collected by C-STEM and implementing targeted interventions, it is possible to narrow the gaps in knowledge, ability, and wealth, thereby promoting social and racial equity in STEM education and employment opportunities.



References

- C-STEM Teacher & Student Services. (2016 - 2023). [unpublished raw data on teacher and student experience in the C-STEM Challenge]. C-STEM Teacher & Student Support Services.
- CoxSunsetBeach. (2023, March 17). Carbon Footprint of Digital Technologies in Agriculture. Aspexit, <https://www.aspexit.com/reflecting-on-the-carbon-footprint-of-digital-in-the-agtech-and-precision-agriculture-sectors/>
- Diliberti, Melissa Kay and Heather L. Schwartz, Educator Turnover Has Markedly Increased, but Districts Have Taken Actions to Boost Teacher Ranks: Selected Findings from the Sixth American School District Panel Survey, RAND Corporation, RR-A956-14, 2023. (May 30, 2023) https://www.rand.org/pubs/research_reports/RR-A956-14.html
- Jones, A., II. (2023, February 17). Most of the US is dealing with a teaching shortage, but the data isn't so simple. ABC News. <https://abcnews.go.com/US/map-shows-us-states-dealing-teaching-shortage-data/story?id=96752632>
- Statista. (2023, May 5). Global climate technology venture capital investments, 2009-2020. <https://www.statista.com/statistics/1197389/global-climate-tech-venture-capital-investment/>
- U.S. Census Bureau. (2021, October 8). Women Are Nearly Half of U.S. Workforce but Only 27% of STEM Workers. Census.gov. <https://www.census.gov/library/stories/2021/01/women-making-gains-in-stem-occupations-but-still-underrepresented.html#:~:text=of%20STEM%20workers.,By%202019%2C%20the%20STEM%20proportion%20had%20increased%20to%2027%25%20and,1970%20to%2064%25%20in%202019.>
- Why do girls lose interest in STEM? New research has some answers — and what we can do about it - Stories. (2018, May 2). Stories. <https://news.microsoft.com/features/why-do-girls-lose-interest-in-stem-new-research-has-some-answers-and-what-we-can-do-about-it/>





C-STEM thanks the following sponsors for their continued support of our mission to provide underserved and underrepresented students engaging learning opportunities that inspire the next generation of thought leaders and innovators.



**Additional support comes from individual donors who are Champions for C-STEM.
Thank you for donating your time and investing your treasures!**