2022

STATE OF STEM EDUCATION REPORT

Reagan Flowers, PhD | June 10, 2022

C-STEM is a 501 (c) 3 organization that provides engaging hands-on learning opportunities to underserved and underrepresented PreK-20 students to encourage entry into the workforce talent pipeline, inspire innovative thinking, bolster self-confidence, and foster a well-rounded mastery of the areas of communication, science, technology, engineering, and mathematics.

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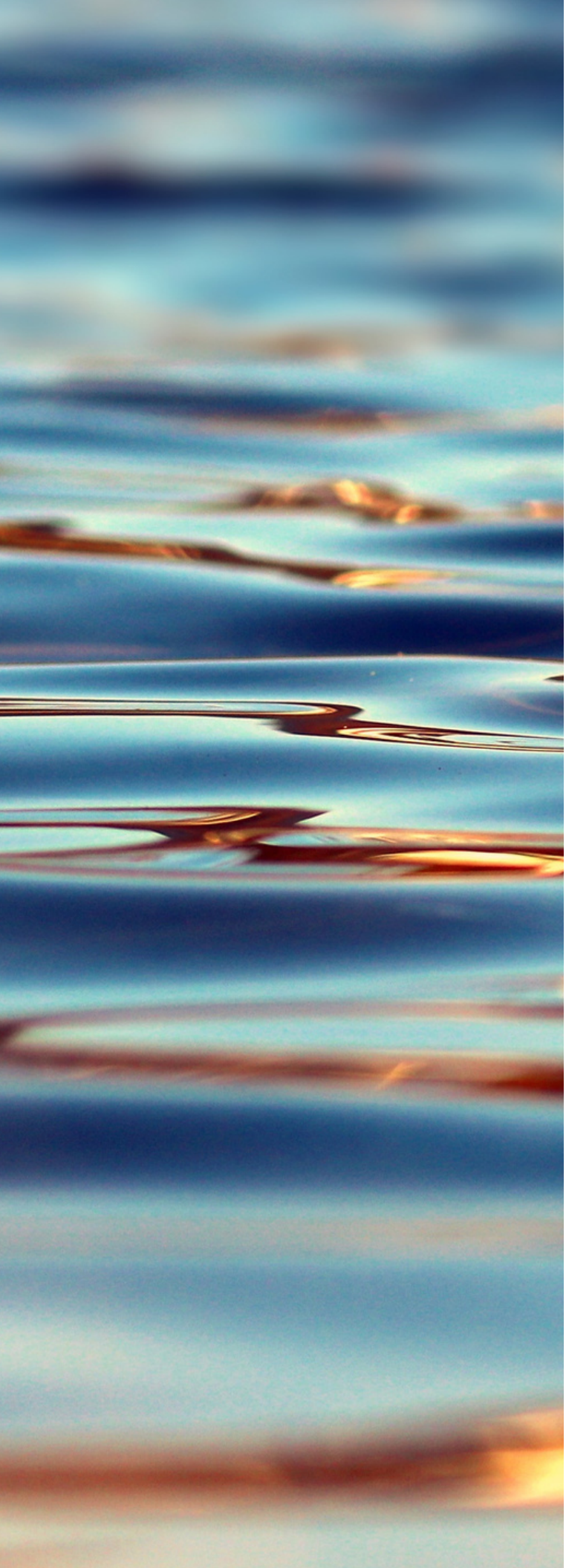

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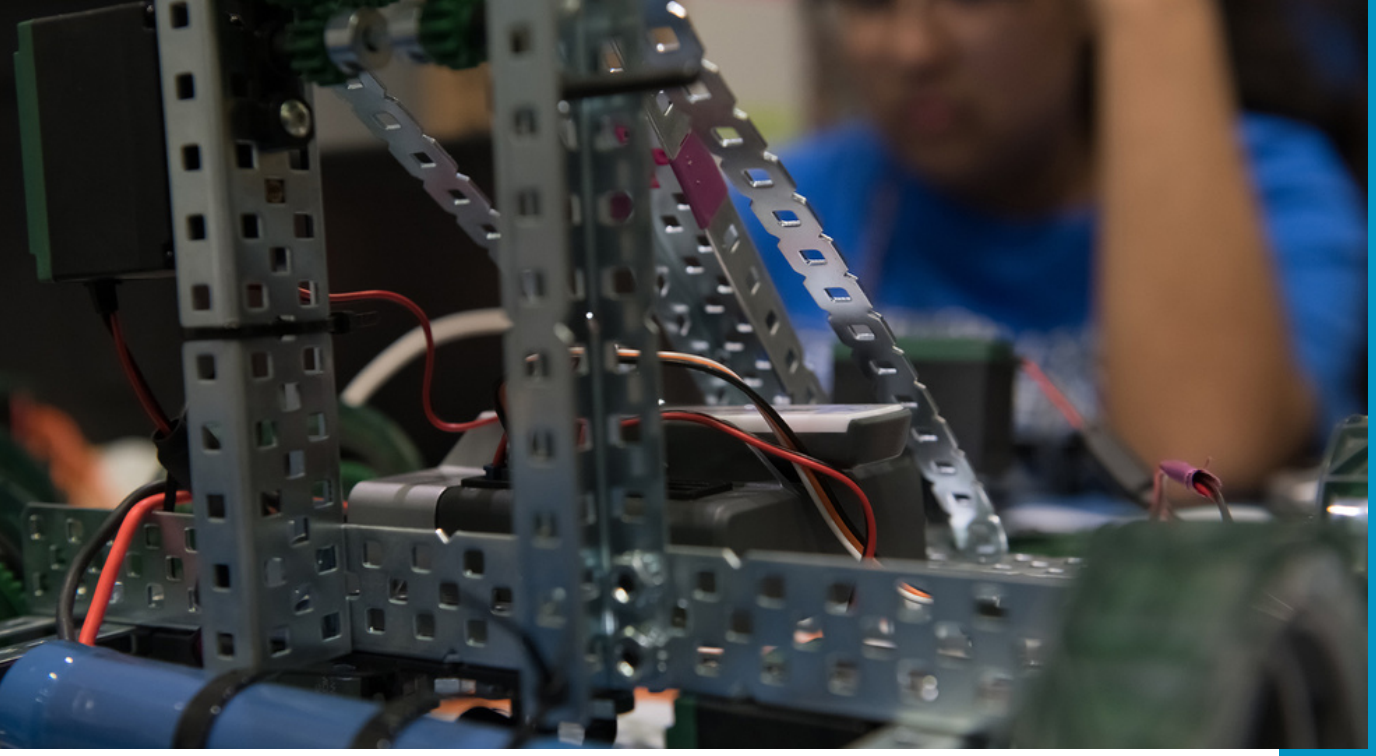


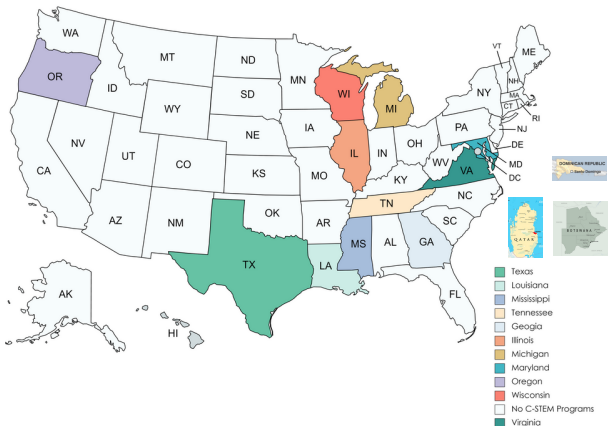
Introduction

C-STEM has been thoughtfully and analytically collecting data on students and teachers who have participated in the organizations programs since 2002. The C-STEM interviews and surveys have captured the experiences, perceptions, demographics, and understanding of several thousand students, teachers, parents, and community volunteers.

Largely, the demographics of survey participants are Black and Hispanic—the population most underrepresented in the growing STEM economy and with the least access to high-quality math and science courses, broadband internet, and technology. This population's inequities cause greater separations in knowledge, skills, and capital.

A constant in the mission-driven work of C-STEM is "Industry and P-12 schools need for quality STEM education data from its non-profit partners." In 2009, C-STEM expanded outreach efforts nationally and then internationally (see Figure 1). In 2010 in response to the under-representation of minorities and females in STEM, C-STEM began to collect more comprehensive, high-quality STEM education data.

Figure 1
C-STEM National Footprint Map



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The aim with STEM education data collection has always been to capture longitudinal data to inform the practice of STEM teaching and learning. This data is shared with community stakeholders—industry, pre-K to 12 (P-12) schools, higher education, community organizations, and public servants. Good information drives both processes and outcomes in high-performing systems. This is why it has been essential to C-STEM that student and teacher voices are heard.

The information shared by survey and interview participants shines a brighter and broader spotlight on the importance of STEM education and the need to do more to reach untapped talent not participating in the economic opportunity spaces that STEM holds. It is widely acknowledged that vital STEM education policy and funding conversations have been underway for decades. These are conversations about increasing the rigor and relevance of high school, improving teacher quality, promoting higher graduation rates, reducing achievement gaps among student populations, reducing the skills gap, and responding to workforce needs. One would think, with all the efforts being made that there would be greater evidence that this intense focus is achieving positive results, particularly with Black, Hispanic, female, and low socioeconomic status students. Yet our studies (2016-2022) show that female students in 2nd - 12th grade still, on average, are less confident than their male student counterparts in math and science (see Figures 2 and 3).

Figure 2

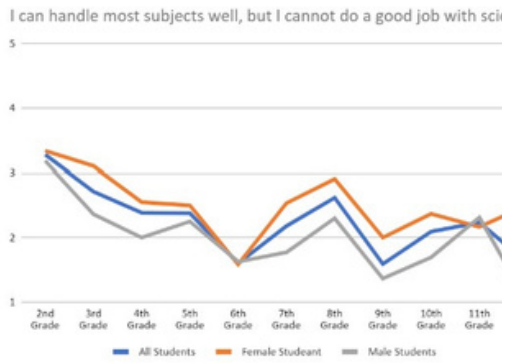


Figure 3

The gender and racial disparities in STEM can often be attributed to social bias and lack of representation as physical examples. The barriers many students face daily can be seen in their neighborhoods that exhibit economic and education roadblocks that contribute to the lack of diverse talent in STEM industries. We can no longer accept institutions built on the assumption that minorities or women are not interested in or cannot do well in STEM. Unfortunately, many of these biases still exist, from how schools provide career guidance to the "boys' clubs" that still exist across many sectors.

As with most subjects, early exposure to STEM makes a long-term difference. And students must know how STEM careers fit into their value systems.

Inequity by Proximity

Sometimes a student's fate is based on whether you live on one side of a street or the other and, in some cases, you live just over a mile radius from the higher-performing school. Unfortunately, even after decades of increases in per-pupil spending and ongoing waves of reform, there are considerable disparities in the quality of public schools, even those within the same district and just blocks away from one another. C-STEM has largely serviced schools with majority minority student enrollment (see Figure 4).

An attendance zone boundary can determine whether a student attends high-performing or low-performing schools, giving the appearance of racially/ethnically re-segregated public schools. For example, the neighborhoods with higher concentrations of Black, Hispanic, and low socioeconomic residents have schools with lower academic performance ratings than neighborhoods with higher concentrations of White students. Because of these attendance zones, access to the best public schools is often restricted based on where you live.

Students who grow up in a neighborhood with low socioeconomic status public schools are generally rated as Title I (See Figure 5) with more than 40% of students receiving free and reduced price lunch. This can also mean growing up in households with low academic attainment and continually confronting set social perceptions. There is also the likelihood that children shoulder additional responsibilities such as being called upon to take care of younger siblings, elderly or sick relatives, or required to work to earn money to help support the household. For example, the Kinder Houston Area Survey reports that 47% of Black respondents and 40% of Hispanics (20% of overall respondents) lacked the resources to cover a $400 emergency (Bozick & Klineberg, 2022). It is startling to know that more than 50% of U.S. students qualify for free and reduced priced lunch.

Figure 4

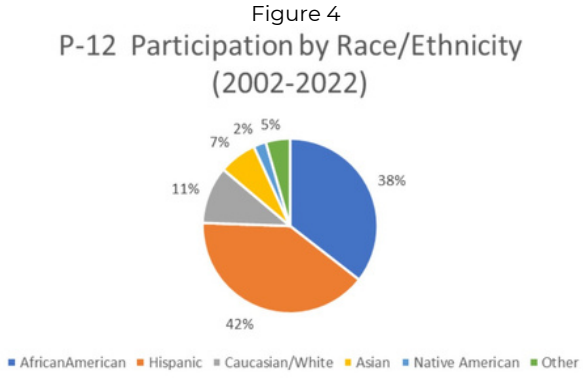
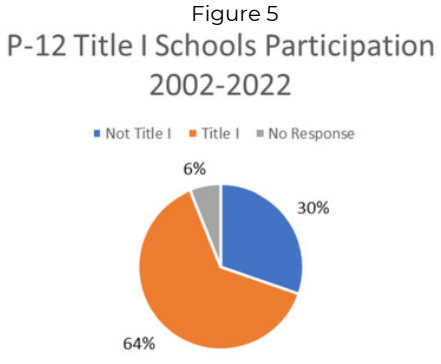


Figure 5



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Relevant Teaching and Learning

The point of school is to provide students with relevant information for their future. At the rapid pace by which technology and research are advancing, classroom learning can leave many students feeling disengaged from school and feeling as if the curriculum is not relevant to their goals and interests. In the U.S., we have one of the highest levels of educational spending per student globally, yet students' performance is low compared to other developed nations. The quality of education is not exceptional in the U.S., especially for Black and Hispanic students.

The role of the teacher is critically important in helping students become what is in the curriculum. Teachers control the curriculum and therefore influence future generations. The respondents to the 2020 C-STEM national research study about STEM education technology resources, brands, and tools had varied education backgrounds (see Figure 6), and did not all have a STEM degree in addition to their teaching credentials (see Figure 7).

The point of ongoing professional development is to support mastery of content and teaching methods and remain up to date on their understanding of the curriculum's relevancy. The low academic performance of Black and Hispanic students compared to their White counterparts indicates the variations in instruction and learning expectations from one school and classroom to another. In addition, data and trends indicate lower academic standards based on race/ethnicity and socioeconomic status as these students continue to fall behind, many of whom never catch up.

Figure 6

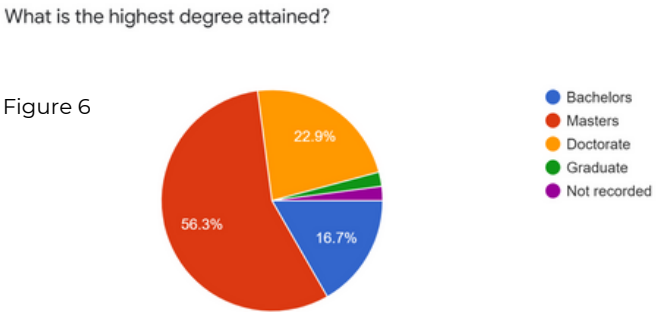
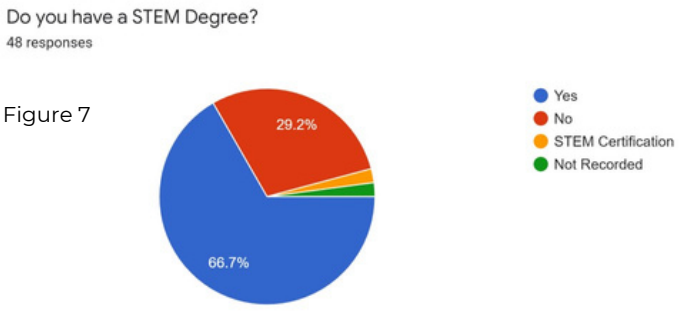


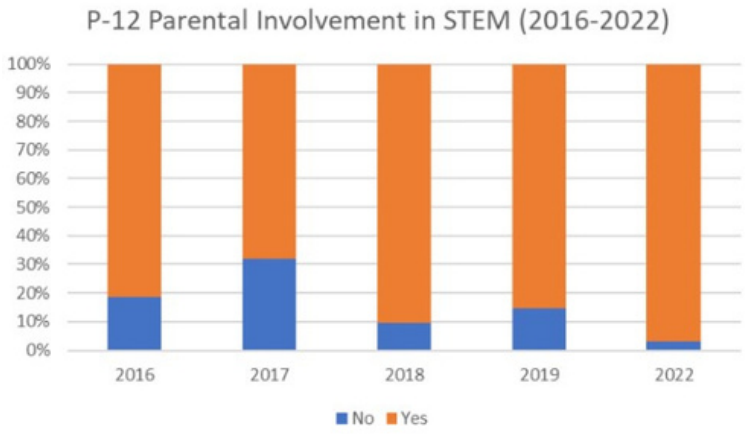
Figure 7



Continued Investments Matter

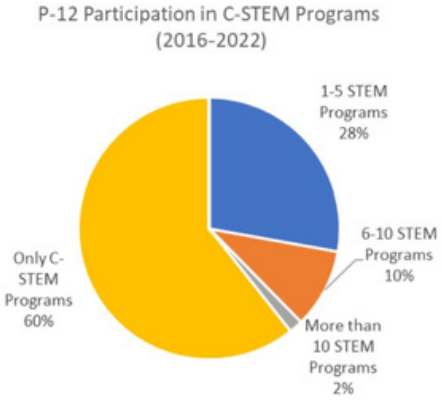
The time allocated to relevant STEM teaching and learning in classrooms is insufficient to prepare students. Out-of-school time is necessary, and there are many reasons why students struggle in school. In some cases, it is attributed to the parent's education level or the lack of time the parent spends at home due to the demand of their career. Figure 8 shows the level of parental involvement in their children's STEM education in our studies. The challenges that Black, Hispanic, and low socioeconomic status students face with receiving a mediocre education is further compounded in overcrowded classrooms. Increased technology use in classrooms and remote learning further challenges students who have varied knowledge and skills and are working at a different pace. Increasingly, schools recognize that they must look beyond standardized methods to determine students' knowledge and skills.

Figure 8



Now is the time to fund what matters most, STEM education for P-12 students. From 2016 to 2022, 60% of students who participated in a C-STEM program indicated that C-STEM was the only STEM program they have ever participated in (see Figure 9).

Figure 9



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Continued Investments Matter, Cont'd

The 2022 recent Houston area survey by the Kinder Institute for Urban Research revealed that Houstonians see an urgent need for new investments into the educational system to support continued improvement - from birth through college (Bozick & Klineberg, 2022). From the 1990s to the first decade of the 21st century, more than half of the Kinder respondents agreed that "The (Houston public) schools have enough money if it were used wisely, to provide a quality education." However, when the question was asked again in 2022, only one-third of the respondents agreed with this statement.

With STEM industries evolving at such a rapid pace, our students and teachers must keep up with the changes. Instruction and curriculum must reflect the demands of current and future workforce trends — most importantly, the cultural shifts to meet global demand. It is not enough to tout high percentage graduation rates when less than half are proficient readers, can make their own judgments about what they read, can do basic math, or are ready to pursue a STEM postsecondary degree or workforce program. In addition to obtaining a high school diploma, students should have options available that point them in the direction of rising above their situations, particularly shifting Black and Hispanic students away from the school to prison pipeline to the school to work and college pipeline. Removing barriers and making learning relevant to students' daily lives is essential in closing the learning gap and leveling the playing field for all students.

> "The general public seems to have gotten the message: If Houston is to thrive in the new global, Knowledge-based economy, it will need to become a 'learning society,' drawing on its considerable resources to ensure that the young people in this city, who are disproportionately African-American and Hispanic - the two groups most likely to be living in poverty - will be prepared to succeed in the high-tech knowledge-based economy of the twenty-first century."
> (Bozick & Klineberg, 2022)

Safe Schools

Safety is another reason many children struggle in school. Concentrating on new concepts or class projects can be challenging when worried about personal safety. In Texas, there have been 27 school shootings in 2022. The most recent mass shooting occurred on May 24, 2022, in Uvalde, Texas, despite all the reinforced gun laws.

Measures are being taken to help make schools safer, with uneven results at best. With increased violence in schools and suicide rates climbing among minority students, there is a need for increased funding to support additional mental health services and improve school safety.

Safe Schools, Cont'd

The Texas Education Agency (TEA) instituted the Safe and Supportive School Program (SSSP) to ensure wellness, learning, and physical and psychological safety across the learning community. SSSP is a multitiered system that appears to be well thought out and inclusive of collaboration with the district, county, and state organizations; conducting behavioral threat assessments; and implementing a multi-hazard approach to prevent, prepare for, respond to, and recover from crisis situations.

In 2013 the Texas Legislature voted to create a school marshal program, allowing schools to identify someone on staff who would be trained and authorized to respond to an active shooter or other emergencies before the arrival of police that threaten the lives of public-school students on campus. The legislation passed but did not provide schools with enough state money to make necessary improvements. As a result, to date, very few school employees have signed up to bring guns to work, and many school districts either don't have an active shooting plan or produced plans that are not sufficient.

When the ACT Center for Equity and Learning asked students if teachers and staff members with special training should be allowed to carry guns in school buildings, 46 percent of students said they opposed the idea.

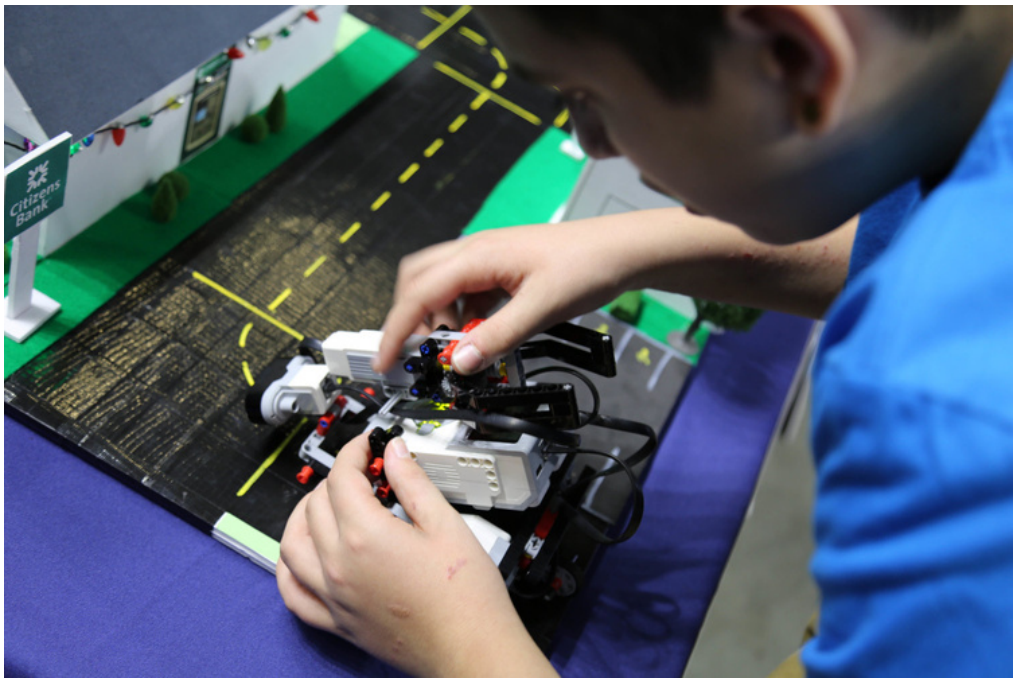
When there is a mass shooting, we can expect student enrollment at local public and private schools to drop. This is because higher-income families can more readily leave the area, and low-income families remain, causing shifts in student demographics that could worsen existing disparities, lead to the decline of schools, and create concentrated socioeconomic segregation.

Students participate in STEM courses and programs during and after school, and a safe environment is essential. Unfortunately, even with schools having always been thought to be the safest buildings for youth, the current climate keeps students and teachers on high alert and in constant fear of external and internal threats (i.e., gunmen, fighting, bullying, etc.). All this beyond their control has lingering effects that negatively impact students' academic achievement and successful participation in STEM programming.

A Pandemic

The P-12 continuum contains obstacles that hinder the success of Black, Hispanic, female and socioeconomically disadvantaged students. The academic pathways for these students are not inclusive or do not contain equitable solutions that appropriately and most effectively address social mobility and literacy issues. The systemic barriers perpetuate disparities that the COVID-19 pandemic has further exacerbated. Renewed attention to inequality in K-12 education in the United States is a necessity. Some schools and systems have quickly transitioned to high-quality distance learning, while others have struggled to provide students with effective learning experiences. For example, a report from McKinsey and Company stated that in grades 1 through 6, the gap between majority-White schools and those that were predominantly Black (>75% Black) has increased (Dorn et al., 2021). Before the pandemic, Black students were about nine months behind their White peers in math. In the fall of 2021, this gap increased to a full year. While the context is new, these inequalities predate the pandemic.

It is safe to say that the COVID-19 pandemic that began in early 2020 and continues to the time of this report's writing has forever changed the landscape of education. Moreover, public school systems, private institutions, and third-party organizations, whether non-profit or for-profit, rely on technology now more than ever before.



Technology in the Classroom

The pandemic inspired C-STEM to conduct an additional research study to seek data behind the changes being seen within the education technology landscape. Interviews were conducted with individuals at all levels of education leading to conclusions on what role technology currently plays, what impacts technology has had, and where technology is going in the future. As various institutions find new and innovative ways to incorporate technology into learning, it is important to know what is working and what needs improvement.

We took many of the concepts put forward in the National Education Technology Plan Update (NETP) and formulated questions to ask a pool of interviewees. C-STEM analyzed the responses to better understand the use of technology in education going forward. The respondents in the study were from multiple states across the U.S. (see Figure 10). Largely, respondents work for a public or charter school system (33 of 48); however, there was also representation across non-profit, university, federal, and industry sectors. More than 60% of the respondents who participated in the interviews were Black, Hispanic, or Asian, with 75% female. Twenty-three percent of respondents held a doctorate, 56% had a master's, and 17% held a bachelor's degree. Of these degrees, 67% were in STEM fields.

Figure 10

The qualitative data gathered can inform STEM infrastructure. For example, some of the study participant's responses include:

> On the topic of powerful STEM technology learning devices for students, respondents shared that "Anything that has to do with data collection and probes, and again the ability to test materials or collect large amounts of data in real-time. For instance, Adreno's raspberry pie can be shipped to students to set up their own probes and collect data. So, something that is fast and inexpensive is a great way for teachers to provide and for students to learn science." And, that we must keep top of mind that, "Kids don't necessarily think in a physics or math mindset they think in the mindset of 'I am trying to get this robot to do something and how I'm going to do it.' And then when we start discussing how it ties into the physics, the kids get it."

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Technology in the Classroom, Cont'd

When asked how STEM technology is transforming assessments of learning, respondents shared that "Technology allows us to see our organization and allow students to curate their process, be it an engineering design process, a process of research, a process of the scientific method." Further, respondents shared that "Assessment should be utilized to actually develop the skills that students are trying to master. I think technology should give kids the real-world experiences that we are trying to prepare them for to let them apply their conceptual knowledge, which would be a better gauge of whether students are grasping those concepts or not."

When asked what type of STEM technology resources leaders are more inclined to utilize in the future, respondents shared that "Teachers don't want the technology to take away from the community of their classroom, and so the apps and resources that I think teachers prefer to use are community building resources. So, anything that will allow team building between students, anything that will allow group discussions to happen with like a positive mindset to them." In addition, it was shared that "It's technology that is more focused on the ability for students to do real-world science, and a lot of times real-world science is not something to be done in the classroom, students are able to gather information from the field in a more real-world science way. The technology resources have to be able to allow students, even on the elementary levels, to participate in real-world science."

On the topic of STEM Technology resources that could be implemented differently to have a greater impact on learning, respondents shared that "If you do not have a good support system, not just at the top but even in your department, it does not push technology integration systems to be successful. Additionally, as a leader, you have to be mindful that you can't train teachers one time and think that they are going to use this lovely STEM technology tool that you've come up with that is great for the classroom. They must have multiple opportunities to be trained." Respondents further shared, "So until that that process for innovation and creativity is started in elementary school with freedom, we're not going to solve the same problem in high school." Further, it was shared, "I think we have to start looking at the equable use of technology and resources and looking at it from an introduction and an exploratory learning experience, as opposed to everybody having to be a master." Also worth sharing is, "I have gone into classrooms where there is no road map in place, and you have to have that road map, and the technology piece is critical but you have to have the materials and instruction. They have to have several ways to attack a problem. They are really teaching problem-solving. We have to give them the opportunity to problem solve in multiple ways."

Two Decades Later

For two decades C-STEM Teacher and Student Support Services, Inc. has endeavored to increase participation in STEM, particularly with underserved and underrepresented students. Teachers (all years) are approximately 50% White and 40% Black. Students are primarily Hispanic (42.4% over all years), with African Americans at 39.5%, Whites 10.9%, Asian 7.4%, Other 8.4%. Student's were provided the option to choose multiple races, which increases the percentages to over 100% in some cases (see Figure 11). The gender of C-STEM students varied greatly over the years but averages out to 50/48, with girls slightly ahead (see Figure 12).

Figure 11

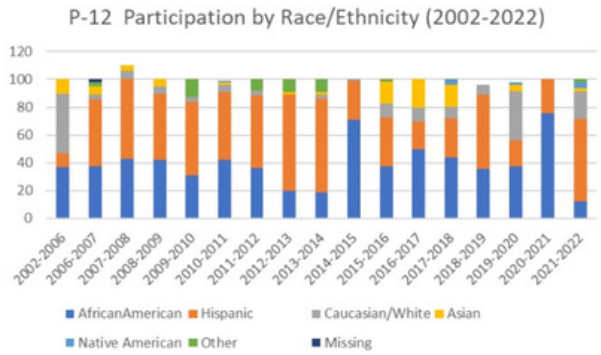
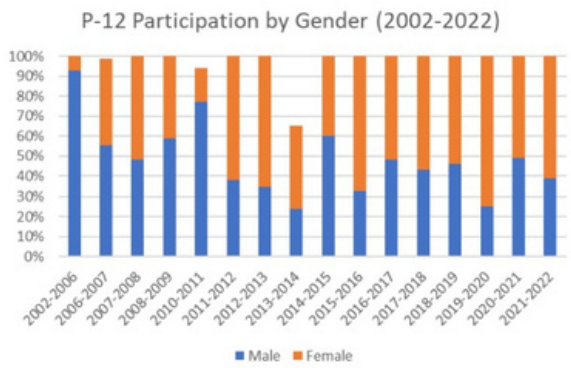


Figure 12



In an era when inflation is rising and GDP is down, STEM careers are resilient to economic fluctuations. The future workforce will rely on P-12 education in communication, science, technology, engineering, and mathematics. Compared to other developed nations, the U.S. has shown no improvements in math and science over the last decade, which places the U.S. in the middle globally. Interdisciplinary and application-based learning experiences that leave students better prepared to matriculate into the workforce are essential. These should be provided via continuum pathways that interconnect P-12 education, higher education, and industry.

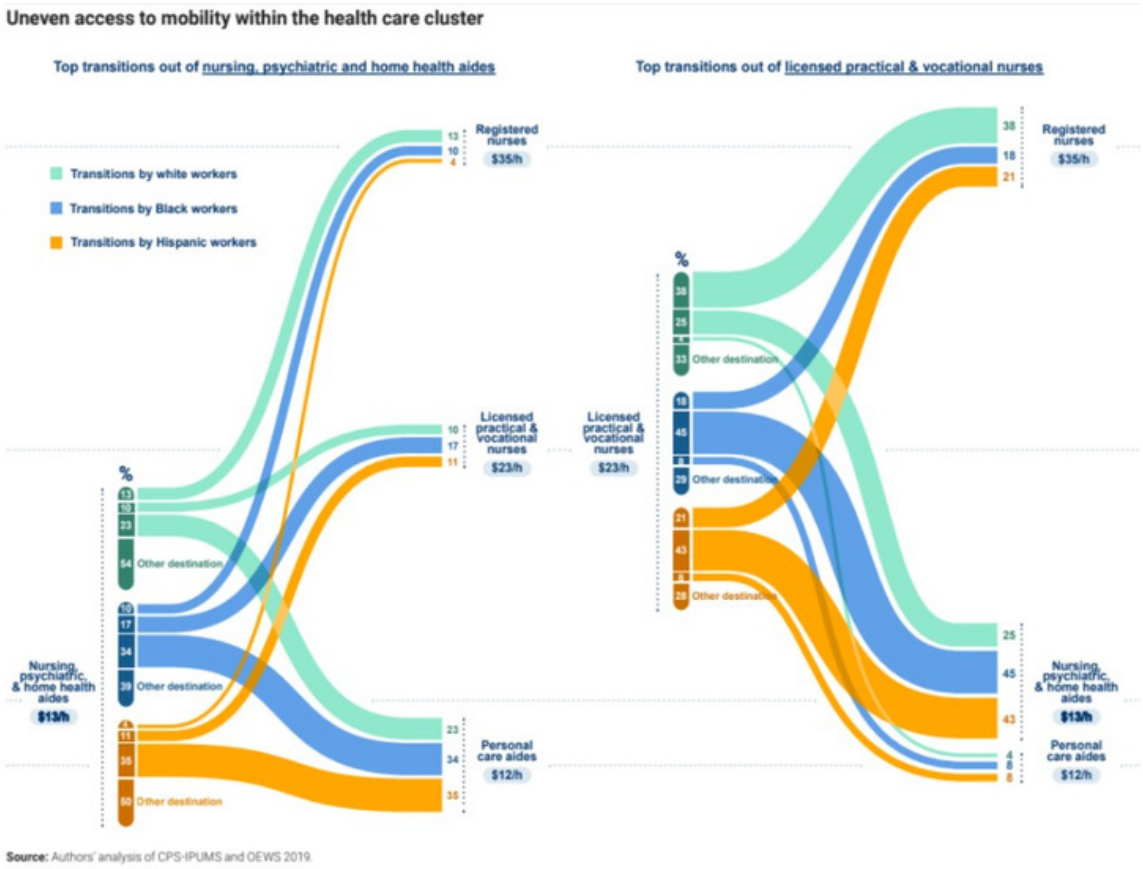
STEM as Economic Equalizer

A June 2021 report from Brookings found that some occupations offer more mobility than others, even for similar workers (Escobari et al., 2021). Only about a third of the differences in upward mobility could be explained by education, gender, race, tenure, experience, and hours worked. Escobari et al. (2021) even went so far as to say that the gaps in mobility between Black and Hispanic workers and their White and Asian counterparts hold for workers with a bachelor's degree, so they are not driven by racial or gender differences in educational attainment (Escobari, 2021, p 12). Instead, workers tend to move within clusters of similar occupations, and pathways within these clusters exist but are frequently blocked by racial, ethnic, and gender barriers.

Even when the occupation clusters have "well-traveled pathways," Black, Hispanic, and women workers are often disproportionately represented in the low-paying occupations. In the first example (see Figure 13) Escobari uses the health care cluster to show the differences in these pathways between White, Black, and Hispanic workers. Workers tend to move within clusters of similar occupations, and pathways within these clusters exist but are frequently blocked by racial, ethnic, and gender barriers.

> STEM is at the heart of our nation's innovation, prosperity, and global competitiveness. STEM goes beyond science, technology, engineering, and mathematics and encompasses the non-technical skills and competencies needed to succeed in the workplace, no matter the industry. We must work collaboratively across sectors to educate, recruit, and retain the next generation of STEM leaders and champion inclusive environments where current and future diverse STEM leaders can thrive.
> (Richards, n.d.)

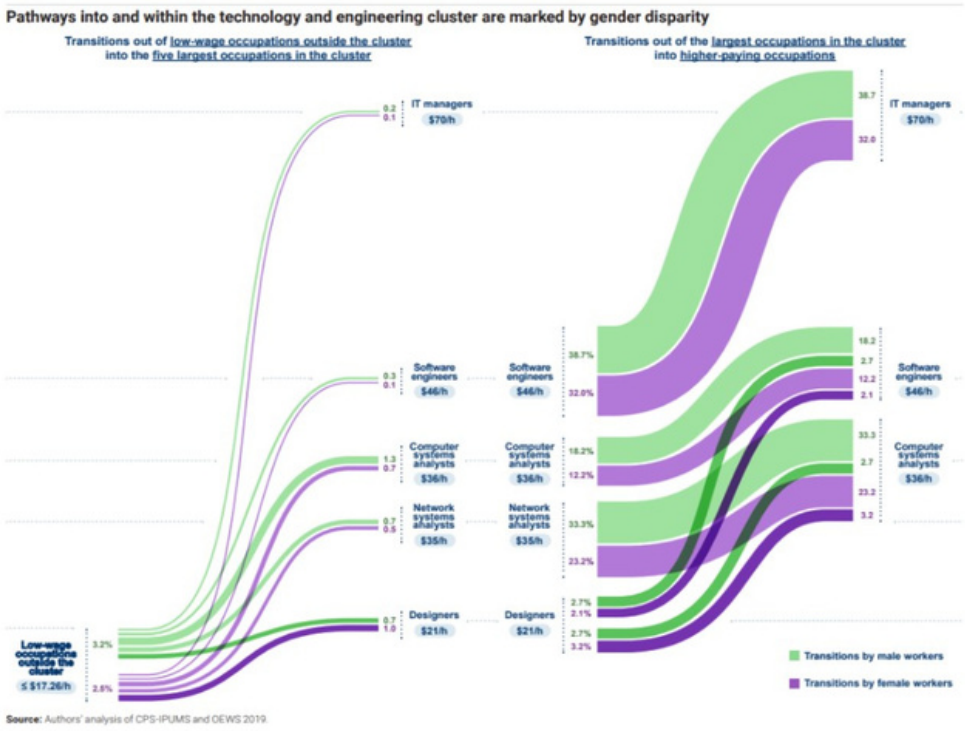
Figure 13



STEM as Economic Equalizer, Cont'd

Next, Escobari (2021) used the technology and engineering cluster to look at the differences in the pathways for men and women (Figure 14).

Figure 14



According to the U.S. Bureau of Labor Statistics, between 2020 and 2030, employment in STEM occupations will increase by 10.5%, compared to 7.5% for non-STEM occupations (see Figure 15). The increase is supported by the fact that between May 2009 and May 2015, STEM employment grew by 10.5 percent, or 817,260 jobs, compared with a 5.2 percent net growth in non-STEM occupations (Fayer et al., 2017). Locally this was even higher. Texas was second only to California in the number and percentage of STEM jobs added during this time period. Texas added 102,190 STEM jobs, a 15.6% employment change (Fayer et al., 2017).

Figure 15

Table 1.11 Employment in STEM occupations, 2020 and projected 2030
(Numbers in thousands)

Occupation category	Employment, 2020	Employment, 2030	Employment change, 2020–30	Percent employment change, 2020–30	Median annual wage, 2021(1)
Total, all occupations	153,533.8	165,413.7	11,879.9	7.7	$45,760
STEM occupations(2)	10,204.2	11,278.7	1,074.5	10.5	$95,420
Non-STEM occupations	143,329.5	154,135.0	10,805.5	7.5	$40,120

Footnotes:

(1) Data are from the Occupational Employment and Wage Statistics program, U.S. Bureau of Labor Statistics. Wage data cover non-farm wage and salary workers and do not cover the self-employed, owners and partners in unincorporated firms, or household workers.

(2) Science, technology, engineering, and math (STEM) occupations include computer and mathematical, architecture and engineering, and life and physical science occupations, as well as managerial and postsecondary teaching occupations related to these functional areas and sales occupations requiring scientific or technical knowledge at the postsecondary level. For more information, see https://www.bls.gov/oes/topics.htm#stem.

Source: Employment Projections program, U.S. Bureau of Labor Statistics

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STEM as Economic Equalizer, Cont'd

Going forward, there will be more employment in STEM fields, and the pay will be more competitive. Ninety-three out of 100 STEM occupations had wages above the national average. Further, industries covered by the U.S. Bureau of Labor Statistics that include more STEM occupations generally pay higher wages. Finally, it is also important to point out that the unemployment rates for technology roles have remained low through the pandemic, pointing to the high demand for tech jobs.

Many STEM jobs are "skyways" or occupations that allow workers to make a leap to a more promising occupational cluster without having to start at the bottom of that cluster. Escobari et al. (2021) created the term "skyway" for occupations into which allow workers from the five low-wage, low-mobility "sandpit" clusters to feasibly make upward, cross-cluster transitions. "While fairly rare, skyway occupations typically pay higher wages, are expected to grow, and have low barriers to entry. One notable example is the computer systems analyst (or computer user support specialist) occupation, a promising skyway into the tech sector. While job postings commonly list a bachelor's college degree as a prerequisite, 39 percent of computer systems analysts have less than a bachelor's degree."

In 2021 the American Petroleum Institute declared that developing STEM skills at all education levels is a top priority for their industry. Supporting STEM instruction will help prepare for the "major energy and environmental challenges to come" (Smith, 2021).

STEM students are taught the basic engineering design process: define problems, conduct background research, develop multiple ideas for solutions, develop and create a prototype, and then test, evaluate, and redesign them. All skills that are useful in all industries and even in their personal and community life. In addition, STEM education improves their mental alertness, critical thinking skills, and collaboration skills and encourages more creativity and inquiry.

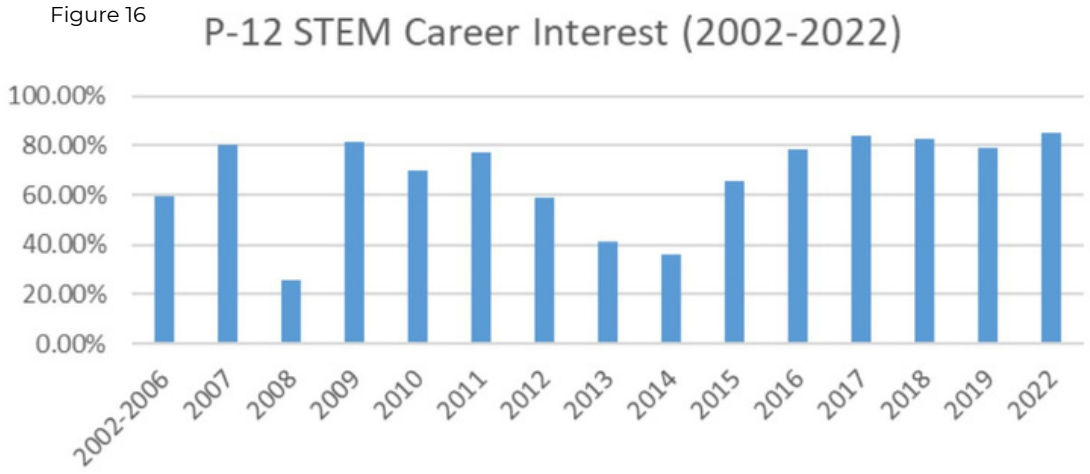
In 2019, women made up 48% of the workforce but only 27% of STEM workers. This number has remained relatively the same since 2010. Specifically, the number of women in science and engineering rose from 23% in 1993 to 28% in 2010 but has stalled since. During the same period (1993-2010), women in biological, agricultural, and environmental life sciences doubled.

These numbers do not include healthcare, where women represent much higher numbers. In fact, in 2019, 36.3% of physicians and 50.5% of medical students were women. The higher numbers are promising, but a STEM inequity remains across the board. Specifically, the growing demand for data science, computer science, and engineering is projected to cross over into every industry and career field.

Teaching to Engage and Inspire

C-STEM students annually share their interests in pursing a STEM career and perceptions about their STEM learning experiences. Longitudinally, C-STEM students have shown great enthusiasm regarding future participation in STEM. The average response to "Are you interested in a STEM career" has been around 80% as shown in Figure 16.

Figure 16



In addition to the emphasis C-STEM places on student interest and achievement in STEM, the Integrated C-STEM Training Institute (ICTI) provides teachers the training and support needed to work on instructional methodology to successfully engage Black, Hispanic, female, and low socioeconomic status students in relevant STEM learning.

Figure 17 shows the average scores of teachers' responses to the C-STEM survey, asking how well prepared they felt to teach STEM to various underserved groups. They rated their preparedness on a scale of 1 to 5, where one was least prepared and five the most. The scores are colored white for under three and green for over 3, with the green getting darker, the higher the score and the more prepared the teachers felt they were.

Figure 17

	How Well Prepared do you feel to teach STEM to students who -							
All Grades	are at different levels of achievement	have learning disabilities	have physical disabilities	are English-language learners	female	are of racial or ethnic minorities	are from low socioeconomic backgrounds	How well prepared do you feel to encourage students' interest in STEM?
2017	3.67	3.33	3.28	3.41	4.11	4.07	4.11	4.11
2019	3.88	3.33	2.94	3.69	4.88	4.75	4.80	4.69
2022	3.75	3.63	3.88	4.25	4.50	4.75	4.50	4.38

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Conclusion

All indicators point to the need for Texas and the U.S. to do more to educate minorities and females who are largely missing from the STEM talent pipeline.

The progress C-STEM has made over the past two decades is encouraging, but there is still much work to be done. Therefore, C-STEM must continue to build high impact programming and data collection systems to help with:

- Increasing the number of Black, Hispanic, female, and low socioeconomic status students with competitive STEM academic knowledge and skills
- Understanding the achievement levels in PreK, elementary, and middle school that indicates that a student is on track to succeed in rigorous STEM courses in high school
- Increasing the number of students with high school diplomas that are ready for what's next, whether it is college or the workplace—proficient in reading and mathematics and reducing the need for remedial courses if enrolled in college
- Understanding which high school STEM performance indicators are the best predictors of students' success in college or the workplace
- Improving communication and collaboration between STEM sectors to inform better and support postsecondary and P–12 systems
- Teacher preparation through the accredited C-STEM Training Institute to produce STEM talent pipelines of student's competitive academic indicators

Providing equitable and inclusive pathways to successful STEM careers is not optional to successfully compete in the global economy. However, to meet STEM workforce demands, we must have competent, diverse, inspired, and engaged students. So let's continue to provide STEM opportunities that create unlimited possibilities. Our future depends on it!

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