A Nation At Launch:

THE STEM ECOSYSTEMS BRIEFING BOOK

Collected Thoughts About Our Nation's STEM Needs - An Exploration of How STEM Ecosystems Are Uniquely Positioned to Address Those Needs Compiled as a Part of the $52 Billion Chips and Science Act of 2022

October 2022

Organized, Curated and Edited by TIES, the backbone organization of the STEM Learning Ecosystems Community of Practice

Table of Contents

Foreword

'We're All in This Together'
STEM Education Prepares for Jobs of the Future
By U.S. Senator Mark Kelly, D-Arizona

On my first flight into space, I took off from the Kennedy Space Center in Florida. I'll never forget when I was able to get out of my seat and look out the window for the first time. You look down and see this giant blue ball just floating in the blackness of space.

You get this strong sense that we're all in this together. It's a view I'd never seen before and one I'll certainly never forget. It's hard not to recognize the important role of science and teamwork that make a moment like that possible. Behind each astronaut in space, there is a STEM education that prepared them for these challenges, and there are teams of engineers, researchers, and civil servants that work together to support our mission in many ways.

It was this perspective that informed my commitment to training the next generation of scientists and engineers with the skills to work the jobs of the future. That's why I worked so hard to get our bipartisan STEM Ecosystems Act passed and signed into law through the CHIPS and Science Act.

> *The mission of a science, technology, engineering, and math (STEM) ecosystem is to provide a variety of enriching experiences, both formal and informal, that create learning opportunities for young people and lead to pathways into STEM careers.*

Our legislation, now law, will improve ecosystems' access to federal funding, helping them better connect communities and students to a range of STEM career possibilities. Our work could not come at a more critical time. As the demand for engineers, physicians, and researchers continues to increase, these ecosystems, built of cross- sector partnerships, will play an essential role in building the workforce of the future. After all, these ecosystems have the infrastructure in place to guide and scale up STEM training or initiatives that can expand the talent pipeline to meet workforce needs in new and growing industries.

While it took hard work to get our STEM Ecosystems Act signed into law, now is when the real work begins. I hope this briefing will help make the case for increased support for STEM ecosystem partners, or offer useful information that strengthens your existing efforts.

U.S. Senator Jerry Moran

"STEM Ecosystems are effective at bringing together nonprofits, schools districts, businesses, museums, universities, and more. I have been a longtime supporter of STEM education."

-U.S. Senator Jerry Moran, R-Kansas.

Executive Summary

> *While it took hard work to get our STEM Ecosystems Act signed into law, now is when the real work begins. I hope this briefing will help make the case for increased support for STEM ecosystem partners, or offer useful information that strengthens your existing efforts. - U.S. Senator Mark Kelly, D- Arizona.*

Background

In 2020, as President Biden took office, the STEM Learning Ecosystems Community of Practice and its many partners recognized the need and opportunity to elevate STEM education and workforce development with the new administration. Their voices were clear and conclusive – education must change. STEM Ecosystems, in their various forms, serve as exceptional vehicles to create and then support successful STEM education systems and collaborations.

These thoughts resonated with U.S. Sen. Mark Kelly of Arizona, leading him to champion bi-partisan support for the Strengthening STEM Ecosystems Act, co-authored with Sen. Jerry Moran from Kansas. This Act was absorbed into the CHIPS and Science Act of 2022 and signed into law in August of 2022.

Unprecedented Opportunity

The CHIPS and Science Act provides unprecedented opportunity and funding, calling for the National Science Foundation to scale STEM education and innovation through a select few entities, notably including STEM ecosystems.

In preparation for the roll out of the CHIPS and Science Act, <u>TIES</u>, the backbone organization for the <u>STEM Learning Ecosystems</u>, has rallied diverse STEM stakeholders to share thoughts about our nation's STEM needs as well as the value of STEM ecosystems for addressing those needs.

The <u>STEM Ecosystems Briefing Book</u> details how STEM ecosystems can and are addressing our nation's greatest STEM needs, including improved racial, gender and technological equity and access in STEM education, creating stronger STEM career pipelines in communities, eliminating barriers to early childhood STEM education, and leveraging STEM to improve lives and communities.

To address these needs, the report outlines how STEM ecosystems can serve as proven entities for federal funding to scale programs, practices, and community-based cross sector collaborations. Furthermore, the Report examines how STEM ecosystem efforts are critical to the nation's economy, broadening participation in STEM, and developing the STEM confident and literate workforce of tomorrow.

Key Takeaways and Recommendations:
- STEM must be more accessible to those who have been traditionally underserved and underrepresented in STEM professions.
- Students must be able to feel that they "belong" in STEM.
- Communities must harness their collective strength and resources to provide meaningful, inclusive, and engaging STEM opportunities for all
- Communities and its student-serving organizations can learn from one another and leverage what has worked elsewhere.
- STEM Ecosystems and their proven strengths with driving true gains in STEM and equity must be fully leveraged.

How To Use This Briefing

This report, compiled by <u>TIES</u> - the backbone organization for the <u>STEM Learning Ecosystems Community of Practice</u> - contains a series of reports, summaries and guest columns intended to elevate shared understandings of the value and the role of STEM Ecosystems in America's economy. The report includes a hyperlinked Table of Contents as well as a searchable series of Appendices.

Please contact info@stemecosystems.org with suggestions regarding additions, errors or omissions.

Background

Town Hall Meetings

In early 2020, 500 STEM advocates from across the country participated in a series of Town Hall meetings, organized by the STEM Learning Ecosystems Community of Practice, to share their thoughts on the STEM needs, goals and hopes for the nation. The voices were clear, vocal and decisive. The thoughts of stakeholders in the Town Hall meetings were captured in a report shared with Federal officials, _Restoring America's Position as a World Leader by Reinvesting in STEM._

Strengthening STEM Ecosystems Act Incorporated in CHIPS and Science Act

This report captured the eye of U.S. Sen. Mark Kelly, D-Arizona. Senator Kelly introduced the strengthening STEM Ecosystems Act. He gained bi-partisan support for the bill that was co-authored by Senator Jerry Moran of Kansas. The only constant in Washington DC is change! The bill was merged into the $52 billion CHIPS and Science Act which calls for the National Science Foundation to create Centers for scaling STEM innovation in the K-12 space. It is a huge victory for all STEM ecosystems that the work we have done to advance STEM education is singled out in this bill as STEM

Ecosystems are one of a select few entities eligible for funding from these new NSF Centers.

In preparation for the roll out of the CHIPS and Science Act, we have rallied diverse STEM stakeholders to be thought partners and contributors for this report by drafting essays and offering comments, edits and additions.

Partners include:
- Bedtime Math
- Broadcom Foundation
- The DeBruce Foundation
- Defense STEM Education Consortia (DSEC) a program of the DoD STEM office of the Department of Defense
- Education Development Center (EDC)
- GSV Ventures
- Iowa Governor's STEM Advisory Council
- KC STEM Alliance
- U.S. Sen. Mark Kelly
- Lorain County Community College
- U.S. Sen. Jerry Moran
- National Association of Manufacturers
- New Growth Group
- NextFlex
- Partnerships in Education and Resilience (PEAR)
- Overdeck Family Foundation
- Qualcomm
- Rolls-Royce North America
- RTI International
- SIEMENS
- The Leadership Coordinating Council and the Strategic Advisory Council of the STEM Learning Ecosystems Community of Practice
- STEM Ed Coalition
- STEM Next Opportunity Fund
- TD Williamson
- 100K in 10

> Others, who were instrumental in creating the briefing book, include Ecosystems affiliated with the STEM Learning Ecosystems Community of Practice and they are referenced in Appendix B.

What Are Our Nation's Greatest STEM Needs?

The years 2020 and 2021 were unlike anything we've seen since WWII and the Spanish Flu. Economic and social devastation ripped through communities, leaving a wreckage, confusion and hopelessness that was compounded in some communities by floods, wildfires and hurricanes. And then came an awakening to systemic racism that has permeated nearly all layers of society.

As we emerge from the past few years, the lessons continue to be inventoried and analyzed, but at least one is eminently clear: ***Education must change.***

> We must have students capable of innovating and developing solutions to our grandest of challenges.

Ecosystem leaders from across the world have offered thoughts about the world's greatest STEM needs. Top recommendations, excerpted from STEM Learning Ecosystems Policy Memo-- Restoring America's Position as a World Leader by Reinvesting in STEM:

- Make STEM more accessible and equitable for all, with an emphasis on those who have been underserved.

- Encourage long-term student participation in STEM by increasing its visibility,
- relevance, connections to the real-world and community and global challenges.
- Increase collaboration to engage, leverage and link all relevant community
- resources.
- Support a diverse, well-prepared, and high quality teaching workforce.
- Build a strong early learning STEM system.

The following essay by Paula Golden, President of Broadcom Foundation, further confirms and details the needs and solutions for the US to re-establish our technology primacy, including the development of a STEM-driven, digitally literate workforce through STEM Learning Ecosystems.

2022 CHIPS and Science Act is the Vehicle; STEM Learning Ecosystems Can Provide the Engine

By Paula Golden, President of the <u>*Broadcom Foundation*</u>

As president of the Broadcom Foundation, I have traveled extensively throughout the People's Republic of China, dazzled by a nation in technology hyperdrive that is developing a 21st century workforce to establish global influence: pop-up high-tech education facilities, cutting-edge R&D, world-class universities, digital manufacturing centers, advanced five-year plans, STEM-driven government policies, and an integrated high-tech social and economic infrastructure designed to connect every digital dot-and-dash in support of its national agenda.

Read the full essay:

<u>2022 CHIPS and Science Act is the Vehicle / STEM Learning Ecosystems Can Provide the Engine</u>

What Can be Done to Address Our Nation's STEM Needs?

In the STEM Learning Ecosystems Policy Memo: <u>Restoring America's Position as a World Leader by Reinvesting in STEM</u>, the leaders of STEM Learning Ecosystems explained that their collaborative initiative offers a powerful way to address what it identified as top priorities for STEM Education.

- Improve racial, gender and technological equity and access to STEM education.
- Create stronger STEM career pipelines in communities.
- Eliminate barriers to early childhood STEM education.
- Leverage STEM to improve lives and communities.

> Thoughts about how to achieve these priorities and guarantee that our nation's STEM needs are met are addressed in the following essays and quotes.

Author and Title	Headline and Clickable Link	Summary of Essay
Judd Pittman, Founding Chair of the Global STEM Learning Ecosystem Community of Practice Leadership Coordinating Council (LC2)	Innovation must be fostered through STEM education, workforce development Unwavering commitment needed by government to address nation's challenges	Communities, through STEM Ecosystem structures, can help ensure every scholar has access to and is included in a STEM economy that provides family thriving wages and inspiring American innovations for generations.
Tiffany C. Taylor, Partner: People, Impact, & Community GSV Ventures	A lifelong journey towards addressing our nation's STEM needs	In this essay, a partner at GSV Ventures explores how critical it is to disrupt and acknowledge inequity in our education systems to ensure ALL people have access to reach their full potential and contribute to our future.
Jeff Weld, Ph.D. Executive Director, Iowa Governor's STEM Advisory Council Former White House Senior Policy Advisor, STEM Education, Office of Science and Technology Policy, 2018-2019	The Challenge and Promise of American STEM Education	In this essay, Dr. Weld details how a triad of well-coordinated STEM ecosystems and the support of the CHIPS Act, buttressed by the Federal STEM plan, will overcome five challenges of STEM education and innovation.
Martha McCabe Executive Director KC STEM Alliance	Partnering In School and Out of School Opportunities to Foster Positive STEM Identity	Martha McCabe addresses how a thriving STEM learning ecosystem that includes cross sector partnerships, enhances the experiences for all students and builds positive STEM identities.
Marcia J. Ballinger, Ph.D. President, Lorain County Community College	Unleashing the Power of Community Colleges	In this essay, Dr. Ballinger discusses the creation of the Silicon Heartland in Ohio and the important role community colleges have, and will play in the future.
James Brown, Executive Director, STEM Ed Coalition	Elevating STEM Education Through Reform, Policies, and Spending	James Brown discusses the efficacy of STEM Ecosystems and community-based approaches to elevate and support STEM Education on state and federal levels.

"Early STEM experiences move students toward bright future careers. When students have the opportunity to identify their skills and passions, they start to understand the value they can bring to a field, and they gain confidence to pursue it as their career path."

- Dr. Leigh Anne Taylor Knight, Executive Director and Chief Operating Officer, The DeBruce Foundation

-Laura Overdeck, Chair, Overdeck Family Foundation and Founder, Bedtime Math

"Research shows out-of-school programs can have positive effects on in-school student outcomes, including increased self-confidence, civic engagement, school attendance, and high school graduation rates, as well as decreased delinquency. But these benefits multiply when the school and out-of-school communities work together. That's why strategic partnerships between districts, community- based organizations, out-of-school time educational providers, and national networks are so critical to success."

Why are STEM Ecosystems Critical for the Nation's Economy?

"STEM Ecosystems are vital to achieving the goals of the CHIPS and Science Act of 2022 and to building all robust and diverse STEM workforce pathways."

-Eden Badertscher, Principal Research Scientist, Education Development Center
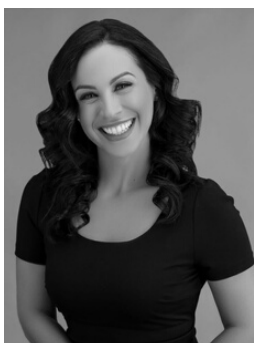
"The law points to the power of regional collaboration as the best mechanism for communities to engage in this time of growth and prosperity centered around STEM fields."

-Veronica Gonzales, Communication Director, STEM Next Opportunity Fund

"To address our nation's STEM needs, we need both short term and long term solutions. The solutions must be defined alongside industry leaders. SAC (Strategic Advisory Council of Industry members) is at the table with our STEM Ecosystems leaders. Our STEM Ecosystems are positioned across the country to provide both. Our ecosystems have resources to inspire and educate early ages about STEM and programs to expose students to current/future workforce needs."

-Reginald McGregor, Global Defense D&I Manager, <u>Rolls-Royce North America</u> and Chair Strategic Advisory Council of Industry Members for SLECoP

Securing Our Nation's Economy With Support of Partnerships

Each of the following essays and additional quotes offer a slightly different take on our country's STEM needs, the value proposition of STEM Ecosystems as well as the definition of STEM Ecosystems. All, however, share at least one common denominator: STEM is a must for our economy, and STEM Ecosystems foster and fuel collaboration. And it is this collaboration that is so critical for the future of our planet.

Author and Title	Headline and Clickable Link	Summary of Essay
Eden Badertscher, Principal Research Scientist, <u>Education Development Center</u>	<u>Why are STEM Ecosystems Critical for the Nation's Economy?</u>	In this essay, EDC explores the important role that cross-sector collaboration can play in securing our nation's future.
Veronica Gonzales, <u>STEM Next Opportunity Fund</u>, Communications Director	<u>Why are STEM Ecosystems Critical for the Nation's Economy?</u>	As a founding partner of the STEM Learning Ecosystem initiative, STEM Next discusses how collaborative partnerships will address the needs and opportunities outlined in the CHIPS and Science Act of 2022.

Angela Baker, Chief Sustainability Officer, Qualcomm Incorporated	Pushing the Limits of Possibilities through Partnership	As a global leader in wireless technology, Qualcomm emphasizes the the impacts and importance of STEM ecosystem partnerships to continue pushing limits of what is possible.
Barbara Humpton, President and CEO of Siemens USA	Modernizing American Manufacturing through the CHIPS Act and Workforce Development	In this essay, Siemens details its views on modernizing American manufacturing by addressing industry challenges via the CHIPS and Science Act of 2022 and technical training pathways to build talent pipelines.
Annie Tomecek, Leader of Global Community Engagement, Grants and Volunteering, TD Williamson	STEM Learning and Thinking for Workforce Development	Annie Tomecek examines the importance of STEM education and STEM thinking for future workforce needs.

"Manufacturers thank congressional leaders from both parties who got this bill across the finish line and President Biden and Secretary Raimondo for their leadership. The industry will also benefit from the new law's funding for programs to support the STEM workforce, advanced technology development, excavation of critical minerals, clean energy and more. Without a doubt, this legislation boosts manufacturers' competitiveness. But there's work to be done."

-Jay Timmons, President and CEO, National Association of Manufacturers

"As a Department of Defense-funded Manufacturing Innovation Institute focused on flexible hybrid electronics and advanced packaging, NextFlex is keenly aware of the workforce development challenges associated with scaling and supporting critical emerging technologies… A crucial component of our workforce development strategy is ecosystem level implementation bringing together community college, higher education, non-profit, and industry stakeholders."

-Emily McGrath, Director, Workforce, Education and Training, NextFlex

Examples of STEM Ecosystems

The term STEM Ecosystem, referenced in the CHIPS and Science Act of 2022, is a broad term for a variety of types of organizations, initiatives and efforts. In the United States, there are networks, hubs, collaborations and other structures that bring together partners from a wide range of sectors, including business and industry, K-12, higher education, out-of-school partners, government, philanthropy and others to improve STEM access and engagement for all.

STEM Ecosystems exist in numerous forms throughout our world. Although this report was compiled by TIES, the backbone organization for the STEM Learning Ecosystems Community of Practice, architects of this document recognize that there are many other organizations driving strong work as examples of STEM Ecosystems. The following pages discuss STEM Ecosystems, including the:

- Battelle STEM Networks
- The Department of Defense office of DoD STEM: Defense STEM Education Consortia (DSEC)
- The STEM Learning Ecosystems Community of Practice

Those included above represent a small fraction of functioning STEM Ecosystems.

Effectiveness of STEM Ecosystems

STEM Ecosystems have a strong track record of leadership on countless fronts, including managing grants, building partnerships, broadening participation, aligning with the needs of workforce and, of course, driving impact.

The following sections detail the unique experiences of the STEM Learning Ecosystems Community of Practice in key areas. While the following information concentrates on the experiences and capacity of STEM Learning Ecosystems specifically, architects of the report recognize that other ecosystems also possess strong capabilities in numerous areas, including:

- Broadening Participation in STEM
- Effectively Managing Grants
- Mobilizing Partners
- Aligning to Workforce
- Partnering with Minority-Serving Institutions

Broadening Participation in STEM

> *"Broadening participation aims to strengthen the STEM fields and STEM literacy by engaging and building capacity in all people in STEM learning and professional training, particularly those from groups that have been traditionally underrepresented in STEM fields." -Community for Advancing Discovery Research in Education*

It has been well researched and documented that students of color and girls are not engaging in STEM at the same rates as their white male counterparts. It's no surprise that STEM professions as well as STEM courses of study are dominated by white men and that women and people of color are woefully under-represented. According to the National Academies of Science, "There are over 20 million young people of color in the United States whose representation in STEM education pathways and in the STEM workforce is still far below their numbers in the general population. Their participation could help re-establish the United States' preeminence in STEM innovation and productivity, while also increasing the number of well-educated STEM workers." (1)

In a previous study published by the National Academy of Sciences in 2018, researchers reported how high "school STEM course enrollment and success is one important focal point for increasing opportunities for the most disadvantaged students." (2) Students who enroll in biology, chemistry, and physics in high school, compared with students who complete fewer science courses, are three times more likely to meet college readiness standards for science. (3)

In order to address these inequities, consortiums like STEM Ecosystems are developing and implementing inclusive and equitable educational strategies, programs, and resources for underrepresented students in STEM.

Broadening Participation in STEM Data

The unCommission, Powered by Beyond100K (formerly 100Kin10), was a massive, diverse, and participatory opportunity through which 600 young people shared their experiences to identify action-ready considerations for the future of STEM learning and opportunity.

From these stories, three insights emerged that point the way forward to achieving equitable STEM education for all of our country's children, particularly for Black, Latinx, and Native American communities.

In just under three months, nearly 600 young people across the country shared their stories with the unCommission. Time and time again, storytellers shared their desire to use STEM to solve real world challenges in their communities and the world.

"We as the youth truthfully want something that we can use in the real world…for example in chemistry, we learn all about the states of matter how they change and the formulas and costs associated with it, which can be pretty mind boggling and frustrating to understand, we never know why it really matters…And this is the instant turnoff so many students have in STEM classes. So, now it raises the exciting question: what if? what if we make education more applicable? we show students how in school learning is directly relevant to their everyday life? I can only imagine what a powerful momentum that could create." — Rhea, 18 years old, Virginia

Ninety-four percent of storytellers discussed belonging or non-belonging in the experiences they shared with the unCommission. Often a single event that brought about feelings of belonging outweighed experiences of non-belonging. In fact, 40% of storytellers who had a self perception that they did not belong in STEM told us about an experience that shifted them to feel like they belonged, indicating that self perception around STEM is very much not fixed! Stories also revealed a positive correlation between feeling a sense of belonging and pursuing STEM coursework in high school and college and, ultimately, as a STEM career.

"During my junior year, they brought a new class to my school, which was introduction to data science…[the teacher] spoke to me, and she's like, there's a really new class that I'm gonna teach. And I think you really like it, like it's right up your alley and what you're interested in, and I was just kind of like, nervous and scared, I'm like, I'm gonna take this brand new math class that no one has ever taken before….And once I started taking the class, and like learning everything, I absolutely loved it….that class was the real pivotal point in my education from there." — Emilio, age 22, California

Sixty eight percent of the time when storytellers reported a shift towards belonging, a teacher facilitated that happening. Storytellers said their teachers fostered belonging 25 percentage points more than any other individual or experience in their lives. In fact, many storytellers were so influenced by their STEM teachers that they became STEM teachers themselves! Black, Native American, and LGBTQ storytellers were 2x as likely to talk about feeling belonging through identifying with their teachers' race or gender than others. Unfortunately, Black, Native American, & LGBTQ storytellers also discussed experiencing teacher racism or sexism 2x as often as other storytellers.

> *"Dr. N, I'll never forget him. He definitely continued their legacy for me, in having Black teachers, Black male teachers, who are able to teach me math and instill that same kind of confidence and self esteem that I could see myself and say, like, 'Oh, you can do it,' or, 'try it this way,' or just kind of held my hand a little bit, which I think a lot of Black students probably do not get…" — Anonymous, 22 years old, Oklahoma*

Broadening Participation in STEM Examples

The STEM Learning Ecosystems Community of Practice (SLECoP) has embedded equity and access as a central pillar to its work on both regional and national levels. While many STEM Learning Ecosystems have committed themselves to identifying and addressing gaps in learning opportunities, leaders and their institutions have still grappled with what that means, especially around racial gaps.
In 2022, the SLECoP held open discussions and shared promising ideas to support the end of systemic racism within their realm of work. Examples of ecosystems embracing equity and working for gains are:

Author and Title	Headline and Clickable Link	Summary of Essay
Pavithra Lakshminarayan, Lead, South Jersey STEM Innovation Partnership Network Kim Case, Executive Director, New Jersey STEM Pathways Network	Building Networks for Student Success in STEM.pdf	This report details how a unique project-based learning challenge for high school students that connects the UN Sustainability Goals, the engineering design process, and the legislative branch of government engages students in improving their communities through STEM and public policy. In addition, it describes Pear's Common Instrument Suite and a unique mentoring platform that connects students with industry mentors.

Lisa Milenkovic, STEM+Computer Science Curriculum Supervisor at <u>Broward County Public Schools</u> Annmargareth Marousky, Computer Science Instructional Specialists for <u>Broward County Public Schools</u> Summer Scarlatelli, STEM+CS Instructional Facilitator for <u>Broward County Public Schools</u>	<u>Embarking on a Scaling for Equity Journey Pitfalls to Avoid and People to Embrace Along the Way.pdf</u>	The authors of this report discuss best practices and pitfalls to avoid in order to spread change in the nation's 6th largest school district. They detail tools and critique a plan for their own scaling journey, ensuring scaling for equity.
Alice Gilchrist, Director of Client Services, <u>South Carolina Coalition of Mathematics and Science</u>	<u>Taking STEAM to the Streets!.pdf</u>	The iMAGINE STEAM Street Festival creates meaningful experiences that promote a culture of lifelong learning and career readiness with an emphasis on science, technology, engineering, arts and mathematics (STEAM), innovation, and entrepreneurial activity in South Carolina. The festival focuses on student preparedness and facilitates collaboration among industry partners, academic institutions, non-profit organizations, and the community.
Sarah Tinsman, Program Director, <u>Project Exploration</u> Ashley Patton, Director of <u>CS Pathways, Carnegie Melon</u> Natasha Smith-Walker, Executive Director, <u>Project Exploration</u> Christine Nguyen, STEM Director, <u>Boys and Girls Clubs of Western PA</u> Walter Lewis, President & CEO, <u>Homewood Children's Village</u>	<u>Youth leadership and mentorship from and for the community. Bridging the Educator Gap .pdf</u>	In this report, organizations will be introduced to Project Exploration and will learn about the STEAMbassador initiative, an investment in people, which impacts prosperity, and affects the planet - on a small and large scale (created by Northwestern University). Authors explain the importance of reflective human resources as a way to engage students on a deeper level in high-quality STEM programming.
Paula Golden, President, <u>Broadcom Foundation</u> Matt Richardson, Executive Director, North America, <u>Raspberry Pi Foundation</u>	<u>Broadcom & Raspberry Pi Foundations Breakout Session.pdf</u>	This report, brought to you by the Broadcom and Raspberry Pi Foundations offers a workshop about Code Club. It also includes a follow-up discussion of various Code Club models by several code club partners.

Julie Paturzo, Senior Manager, Partner Engagement, 100kIn10 Teresa Mooney, Associate Director of Strategic Initiatives, 100kIn10	Elevating the Voices of Our Future Innovators.pdf	This report details how a participatory process--centering those closest to the problem in need of being solved--can yield field-level goals. It draws from the massively diverse & participatory uncommission where 600 young people from communities excluded from STEM, focusing on Black, Latinx, and Native American communities, shared their experiences to help identify goals for the future of STEM learning. Read young people's stories about their STEM learning experiences, grapple with what they shared, and get concrete tools that can be applied to participatory goal-setting in their own organizations and communities.
Toi Massey, Executive Director, JEKL Foundation	First, Not Everyone Is At The Table & Second, None of This Happens In A Vacuum.pdf	In this report, Nuclear Engineer & Six Sigma Black Belt Toi Massey will shares, with humor and data, the journey that found her moving rapidly up the Corporate ladder and ultimate out its doors in pursuit of missing STEM kids everywhere. The report includes easily implementable solutions that support a working model for repeatable success.
Neil Bergenroth, Executive Director, gROW STEM	gROW Rowing STEM - Applied Sport Science.pdf	The gROW Tulsa program provides access to rowing activities for under-resourced populations. The Rowing STEM curriculum has been developed by Tulsa Youth Rowing Association. An innovative mobile app collects data from a Concept2 Rowing Machine and can help students perform data analysis and develop math and science competencies.
Jim Ryan, Executive Director, OpenSciEd	What is OpenSciEd How can the OpenSciEd resources support NGSS implementation.pdf	OpenSciEd was launched to improve the supply of and address demand for high quality, open-source, full-course science instructional materials, while at the same time supporting the implementation of middle school science instructional units. The goals of OpenSciEd are to ensure any science teacher, anywhere, can access and download freely available, high quality, locally adaptable full-course materials. Because all of the materials are open-source, also known as open educational resources, they are free for all educators and students to use, customize, and share.
The STEM PUSH Network and the NSF INCLUDES Alliances	The STEM PUSH Network: An NSF INCLUDES Alliance	The work of the STEM PUSH Network has been a meaningful vehicle of focused work and resources for the SLECoP. TIES serves as the backbone of the STEM PUSH Network, an NSF INCLUDES Alliance. The Network is working to increase the number of ethnically and racialized underrepresented students who are admitted to, matriculate, and persist in post-secondary STEM.

Ecosystems and Grants

Investing in the infrastructure of the STEM Learning Ecosystems Community of Practice (SLECoP) presents a unique opportunity to improve education, strengthen America's competitiveness, and enhance the quality of life for all Americans.

STEM Learning Ecosystems have the power to:

- Improve racial, gender and technological equity and access regarding STEM education.
- Create stronger STEM career pipelines in communities.
- Eliminate barriers to early childhood STEM education.
- Leverage STEM to improve lives and communities.

> STEM Learning Ecosystems are well poised to manage large scale grants and funding in efforts to scale proven, effective STEM resources, programming, and partnership.

Ecosystems and Grants Data

In August of 2022, TIES posted a Request for Information (RFI) to STEM Learning Ecosystems and interested stakeholders to share their work as part of this briefing book and other efforts aimed at catalyzing support for STEM Ecosystems. It should be noted that some respondents answered the question on behalf of their ecosystem or organization, while others answered the question based on personal history, regardless of ecosystem involvement. NSF grant involvement ranges from PI, Co-PI, grant writer, grant reviewer, collaborator, evaluator, senior personnel, advisory board member, sub-awardee, and general support. The following information summarizes responses from 39 organizations involved in ecosystems and NSF grants across the country.
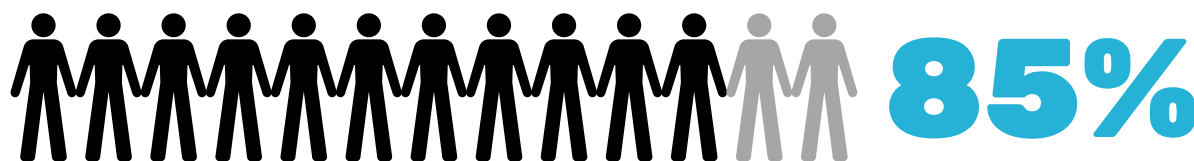
Of the 39 survey respondents, 33 (85%) specified at least some level of involvement with NSF grants.

STEM Learning Ecosystem leads and other STEM Ecosystem stakeholders collectively have a wealth of experience with many types of NSF and other federal funding. Most commonly mentioned NSF grant experiences were CSforAll (4), INCLUDES (4), ITEST (4), AISL (3), ATE (3), and BPE (3); however, STEM Learning Ecosystems have involvement and expertise in all of the funding shown below.
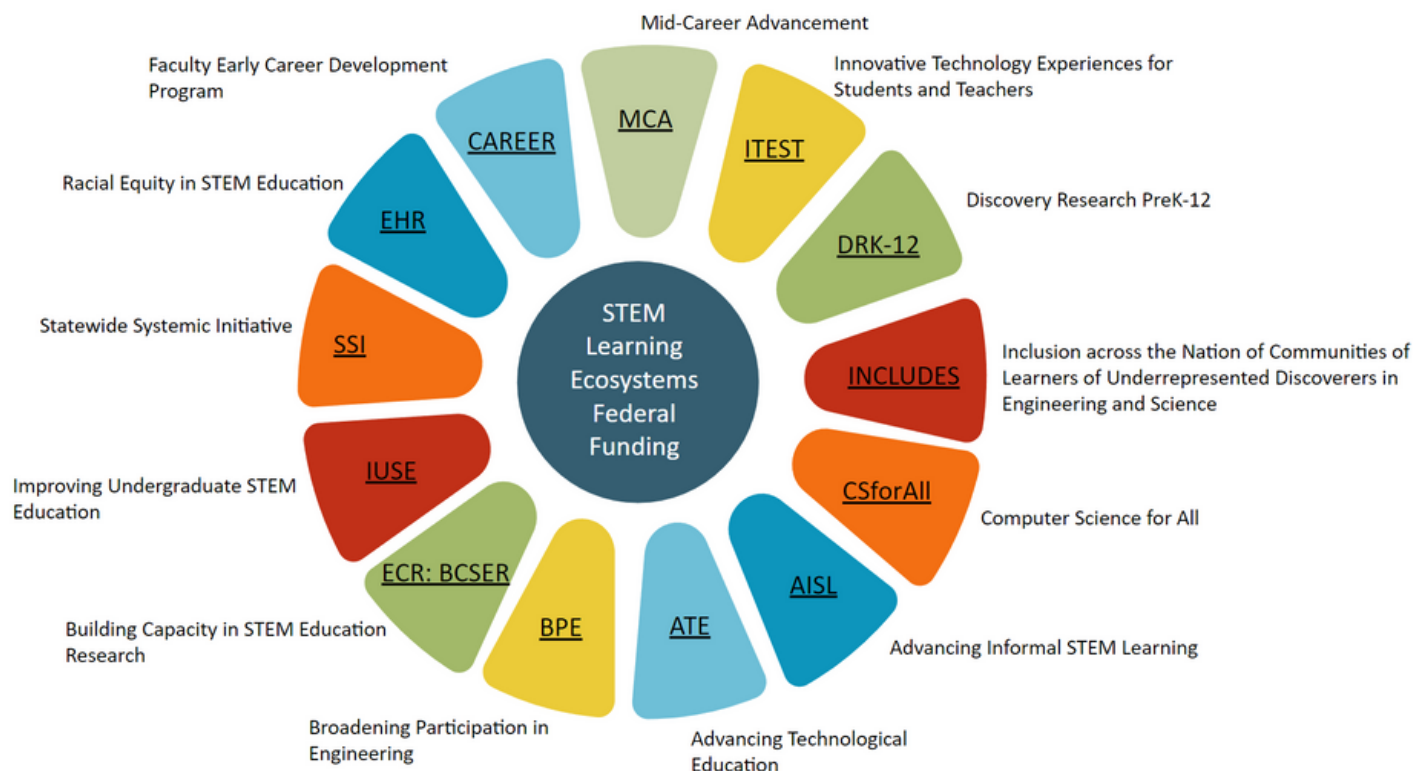
Ecosystems and Grants Exemplars

As shown above, there is a wealth of experience within STEM Learning Ecosystems with NSF funding. The table on the following page details three NSF STEM Learning Ecosystem awardees: The Northeast Florida Regional STEM2 Hub, The Alamo STEM Ecosystem, and The Pittsburgh Regional STEM Ecosystem.

STEM Learning Ecosystem	NSF Funding Overview	NSF Award Links and Announcements	Public Award Reports
First2 Network	In September 2018, First2 received a National Science Foundation (NSF) INCLUDES award of $7.15 million for the next five years to allow us to take the network statewide to engage West Virginia's best innovative stakeholders in solving the STEM persistence problem. Working groups, all of which include first generation college or high school students) will study, improve and replicate promising programs that impact STEM persistence. Specifically, First2 working groups will: 1) improve preparation for and transition to college; 2) replace ingrained institutional practices that stifle the development of STEM self-efficacy and 3) develop the FIRST Ambassador Program. As FIRST Ambassadors, undergraduate students explore the disconnect between home life and STEM study, and conduct outreach to hometown students and K-12 stakeholders, their collegiate institutions, and their state legislators to advocate for policy/practices that better support rural first-generation STEM student success.	Award Abstract # 1834601 NSF INCLUDES Alliance: Expanding the First2 STEM Success Network	Learning to Improve: Early Evaluation of the First2 Network
Alamo STEM Ecosystem	Alamo STEM Ecosystem follows a Recruit, Prepare, Place, and Succeed (RPPS) model to ensure the success and sustainability of a strong DIB base. The MCUSA consortium includes all five community colleges and both four-year public universities in the San Antonio area, six Hispanic-Serving Institutions (HSIs), and one Historically Black College and University (HBCU) for a unified approach to strengthening a diverse STEM Ecosystem in the region. In 2022, this SLE won a Department of Defense grant under the National Defense Education Program (NDEP) to foster the development of Science, Technology, Engineering, and Mathematics (STEM) education consortia. They will receive an initial award of $5 million over a three-year base period, with the possibility of three one-year option periods at $2 million per year, totaling an award ceiling of up to $11 million over six years.	The Military City USA (MCUSA) Consortium	Annual reports expected beginning in 2023
Pittsburgh Regional STEM Ecosystem	Pittsburgh Regional STEM Ecosystem is a 2017 National Science Foundation (NSF) INCLUDES Recipient: The NSF awarded $300,000 to the University of Pittsburgh team in one of the foundation's Ten Big ideas for Future Investments programs. The team's two-year pilot project, "Diversifying Access to Urban Universities for Students in STEM Fields," is a credentialing and badging system for pre-college science, technology, engineering, and math (STEM) programs with the ultimate goal of increasing participation of underserved and underrepresented minority students in postsecondary STEM programs, leading to STEM careers. The STEM Ecosystem serves as a backbone organization to the work.	Award Abstract # 1744446: Diversifying Access to Urban Universities for Students in STEM Fields	Highlights: Diversifying Access to Urban Universities for Students in STEM Fields

Ecosystems and Partnerships

Leaders throughout the United States have concluded that no single organization or entity could or should be responsible for leading STEM for their communities. They recognized that STEM has unlimited power to transform the trajectories of communities and the lives of individuals.

> STEM Learning Ecosystems are formed to launch cross-sector collaborations to transform communities while charting powerful learning and career pathways for all. The current needs as well as those of the future for business and industry must be carefully mapped and integrated with all other sectors, including formal and informal learning settings.

A 2018 Federal report by the Office of Science and Technology Policy ranked developing and sustaining STEM Ecosystems as the top priority for how to improve STEM in communities. (4) Additionally, the CHIPS and Science Act of 2022 defines STEM Ecosystems and notes their function of supporting participation in STEM study, activities and career pathways. (5)

The two major value propositions of STEM Ecosystems are their ability to provide the mechanisms for building stronger communities and economies and their power to engage residents.

Specifically, ecosystems bring together partners from nearly all sectors in a community to align learning, harness resources and plan for the future. Partners from K-12 education, early learning, higher education, business and industry, religious organizations, government, out-of-school, non-profits, philanthropy and others all come together to identify needs, opportunities, resources and goals.

> It doesn't stop with just conversation. Ecosystems go to work implementing action plans with clear priorities, resources and a collective vision.

PILLARS OF A THRIVING STEM LEARNING ECOSYSTEM

Stakeholder **Participation and Impact** Levels

INFORM
Providing balanced and objective information to stakeholders on audit topic and results

CONSULT
Obtaining feedback from stakeholders on issues raised during audit and alternatives to solve them

INVOLVE
Ensuring stakeholder concerns and opinions are reflected in audit reports and providing feedback on how input was considered

COLLABORATE
Collaborating with stakeholders in decision making and identifying preferred solutions

EMPOWER
Final decision making delegated to stakeholders

MEASUREMENT TO KNOW WHAT IS WORKING AND WHY

STEM ecosystems

STEM ecosystems

TIES

Ecosystems and Partnerships Data

Ecosystems engage a myriad of partners, including formal and informal education, business and industry and a variety of community serving organizations.

In the August 2022 Request for Information (RFI), disseminated by TIES, STEM Learning Ecosystems and interested stakeholders shared their work as part of this briefing book and other efforts aimed at catalyzing support for STEM Ecosystems. The following graph summarizes partner organizations/initiatives explicitly mentioned by respondents to TIES' Request for Information, issued in September 2022.

Key Partners, By Category

n=35

Category	Value
Pre-K	16
K-12	35
College	22
Workforce/Adult	15
Business/Industry	22
Government	12
Community/Nonprofits	21
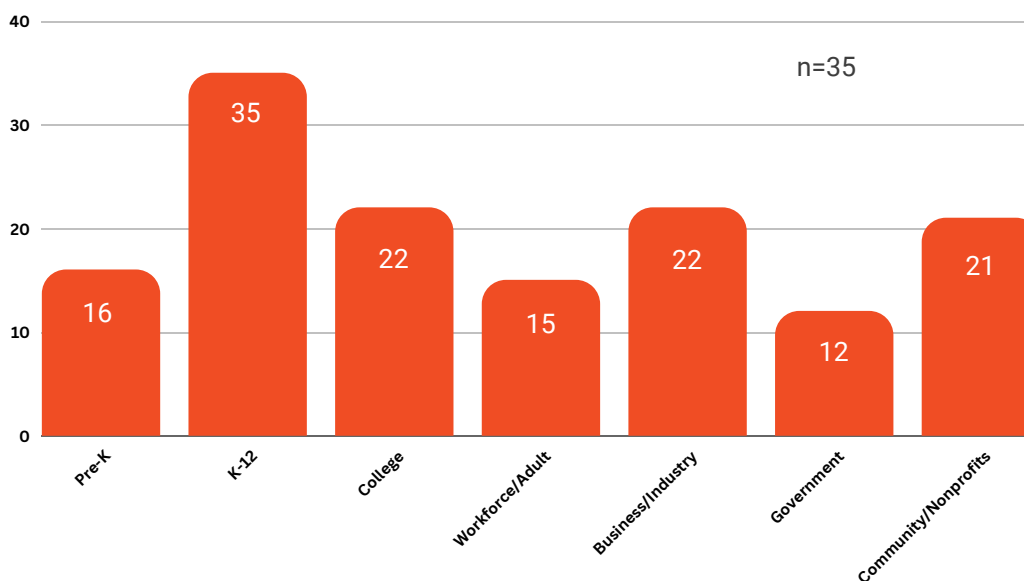
In addition to broad engagement with a variety of community partners, ecosystems also work with other ecosystems.

Of the 30 who answered a question regarding collaboration with other ecosystems:

Ecosystem Collaboration

Seeking
16.7%

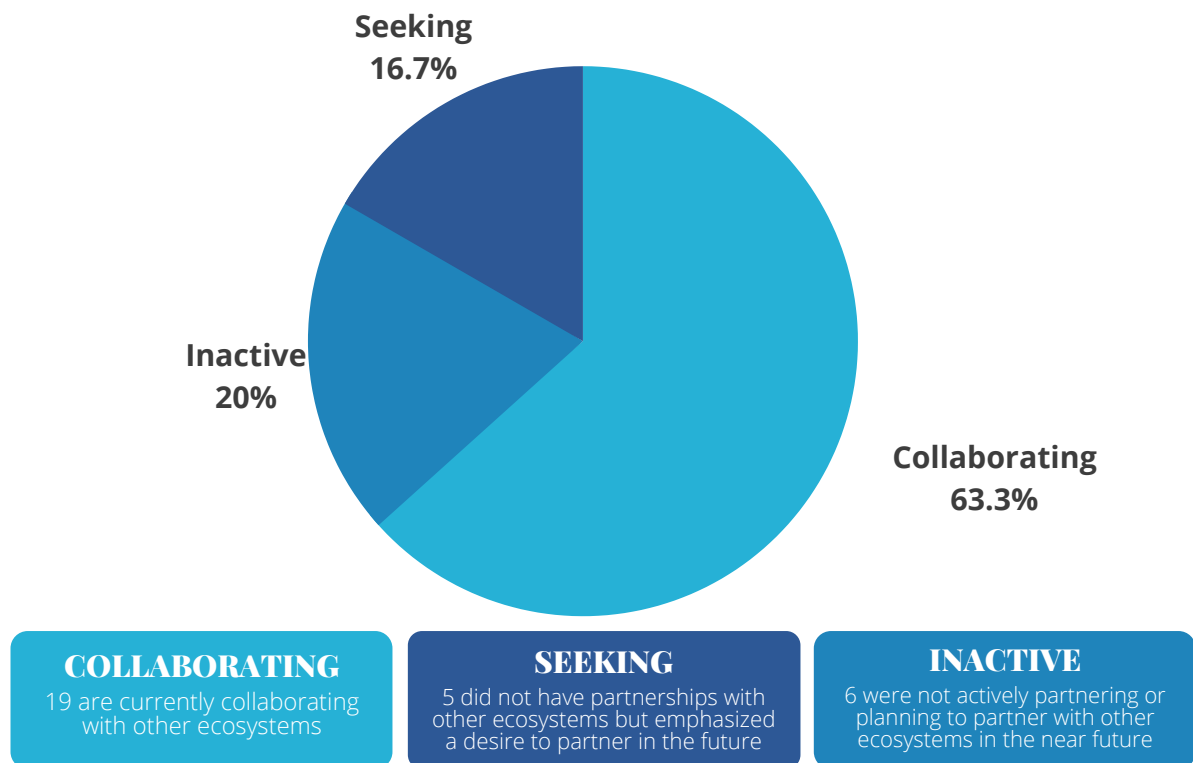**Inactive**
20%

Collaborating
63.3%

COLLABORATING	SEEKING	INACTIVE
19 are currently collaborating with other ecosystems	5 did not have partnerships with other ecosystems but emphasized a desire to partner in the future	6 were not actively partnering or planning to partner with other ecosystems in the near future

Typically, ecosystems are partnering with other Ecosystems in surrounding regions, or across their state. For example, Pennsylvania has a Statewide STEM Ecosystem Leadership Team that supports the PA STEM Coalition, of which all PA STEM Ecosystems are involved. Some Ecosystems participate in "ecospheres", which are groups of STEM Ecosystems connected by geography, audience, or other unifying factors.

On the next page, a graph summarizes the strengths according to each respondent:

Ecosystem Strengths

Item 1: Establish Partnerships

Item 2: Support enhanced STEM education infrastructure

Item 3: Support R&D on scaling practices, partnerships, and alternative models to current approaches

Item 4: Include a focus on the learning needs of under-resourced schools and learners in low-resourced or underachieving LEAs

Item 5: Include a focus on the learning needs and unique challenges facing students with disabilities

Item 6: Support research, development, or education on one or more of the key technology focus areas

Item 7: Support R&D on scaling practices and models to support and sustain highly-qualified STEM educators in urban and rural communities

Ecosystems and Partnerships Exemplars

The STEM Learning Ecosystems Community of Practice (SLECoP) holds collaboration as vital and central to its work on both regional and national levels. In 2022, the SLECoP held open discussions and shared effective strategies on the power of partnership. Exemplars of Ecosystems embracing partnerships are detailed in the table on the following page.

Author and Title	Report	Summary
Willonda McCloud, President, <u>Bright Side Opportunities</u> Karen Schloer, CEO, <u>Boys & Girls Club of Lancaster</u> Isaiah Perry, Program Director, <u>Bright Side Opportunities Center</u> Nav Deol-Johnson, National Program Operations Manager, <u>Imagine Science</u> Olivia Walters, Vice President of Programs, <u>Steinman Foundation/Lancaster County STEM Alliance</u>	<u>Collaborative, Community Based STEM.pdf</u>	The This report examines how local funding enabled the creation of a cohort of organizations which include the local version of the national partners: 4H, Boys and Girls Club and Girls Inc. a local community organization, Bright Side Opportunities Center, and Imagine Science. The collaborative aimed to develop a curriculum to advance STEM to young people in the community. The model was the first of its kind because as it is locally funded by the Lancaster County STEM Alliance.
Lisa Blank, Director of STEM Programs for, <u>Watertown City School District</u> Nancy Rowland, Project Director for DoDEA Grants and the Outreach Specialist for <u>Thomas Jefferson High School for Science & Technology</u> Priscilla Lumbreras, High School Science Teacher and Science Research Club Sponsor, <u>Granbury High School</u>	<u>STEM+M - STEM Engagement Through Military Partnerships.pdf</u>	Explore rich opportunities in STEM available through military connections. All communities, regardless of military connection, can benefit from access to resources available from military partners, including DoD STEM, DoDEA, MCEC and more. Opportunities and resources shared in this report support growth, development, and prosperity of individuals, communities, and ecosystems.
Tom Peters, Executive Director, <u>South Carolina's Coalition for Mathematics & Science at Clemson University</u>	<u>What's Love Got to do With It Lessons in sustainability from a 29 Year Old STEM Ecosystem.pdf</u>	When you start down the ecosystem path, you quickly realize there is no finish line. However you define STEM, whatever you intend do to promote equity or safeguard the planet or promote social mobility, none of it matters if your ecosystem implodes or withers away. How do you keep on making a difference in the lives of teachers, students and communities? Learn sustainability lessons in this report from a 4th generation STEM ecosystem.

Reginald McGregor, Global Defense D&I Manager, <u>Rolls-Royce North America</u> Paula Golden, President, <u>Broadcom Foundation</u> Casey Welch, Co-founder and CEO of <u>Tallo</u>	<u>B2B Forum.pdf</u> <u>Business Partnership Development Boot Camp.pdf</u>	The B2B Forum is an opportunity for business partners of the more than 100+ STEM ecosystems to meet and share best practices around supporting local, regional, state and national STEM ecosystems. In this report, learn from business leaders about emerging best practices in this mission critical work of engaging and inspiring the next generation of innovators. Gain concrete ideas of ways to support STEM education that are field tested and ready to replicate and scale. Readers of this report will gain a better understanding of ways to diversify their business partner portfolio, and the avenues of collaboration open to them in a true business/industry partnership.
Martin Samuels, Head of Content, <u>LabXChange</u> Gaurav Vazirani, Managing Director, <u>LabXChange</u>	<u>LabXchange - Learn to use the world's science classroom. Science Needs Everyone..pdf</u>	LabXchange is an online community for learning, sharing, and collaboration. Labs are places of exploration and discovery for every field imaginable. LabXchange curates and creates world-class digital content, delivered on a free, online platform that lets you integrate your learning and research experiences. Here, you take control of your learning and solve real-world problems as a community. Participation will always be free.
Jan Morrison, CEO and Founder, <u>TIES</u> William Fisher, Researcher, <u>Living Capital Metrics</u>	<u>Measure STEM.pdf</u>	In this report, Jan Morrison and William Fisher discuss the concept of Ecologizing STEM Education: Using Caliper to Measure and Manage for Stakeholder Empowerment. Ecologized learning situated in diverse in-school, out-of-school, and after-school contexts poses daunting challenges to measuring, communicating, managing, and improving outcomes. Formal and informal educators, policymakers, funders, and other key stakeholders engaged in cross-sector collaborations defined five pillars of STEM learning ecosystem success: partnerships, measures, administrative systems, teaching and learning practices, and workforce development connections. Variation in the ecosystem success construct was mapped, existing items from an earlier ecosystem assessment were revised, four parallel survey forms with common items were devised, and an online administration system was created in early 2020.

Ecosystems and Workforce

> Our Nation's economy - both the economy of today as well as the economy we've yet to even imagine - is fully dependent on a strong pipeline of innovators, problem-solvers and those who can lead our existing industries while paving the way for new.

The projected demand for STEM-trained professionals far exceeds the current supply. In fact, STEM professions are expected to grow at faster rates than nearly all other occupations compounding the nation's already pronounced STEM-trained worker shortage.

In Ohio alone, estimates predict that the state will have more than 1 million unfilled jobs - the majority of which need STEM-trained workers. (6) Five existing Ohio STEM Learning Ecosystems are hard at work preparing the next generations of professionals with a range of skills to support the growing STEM economy, beginning as soon as 2022 with escalating demand over the next five years. (7)

> Similar efforts are taking place across the country with STEM Learning Ecosystems spearheading work to foster strong STEM mindsets among students and driving innovation needed to guarantee qualified workforces and continued economic growth for the nation.

Ecosystems and Workforce Data

The following sections highlight the unique experiences of the STEM Learning Ecosystems Community of Practice with workforce development. While the following information concentrates on the experiences and capacity of STEM Learning Ecosystems specifically, architects of the report recognize that other ecosystems also possess strong skills and collaboration for workforce development.

All STEM Learning Ecosystems are aligned with industries in their community to empower and prepare the workforce of today and tomorrow. Of the ecosystems who responded to the September 2021 Request for Information from TIES, 35 answered the question, "Who does your Ecosystem serve?" A total of 15 mentioned "workforce", "workforce development", "adult learners", or other similar terminology. ****

Two STEM Learning Ecosystems have been recognized as models for workforce training and support:

Pennsylvania STEM Experiences for Equity and Diversity, PA SEED Ecosystem, is a collaborative between school districts, libraries, Intermediate Units, post-secondary institutions, and environmental education centers along with growing public/private partnerships like those forged with the United Way, Chester County Economic Development Council (CCED) or Corbett Incorporated. Continue reading about PA SEED here.

Mid America STEM Alliance is a collaborative initiative designed to ensure that area youth have opportunities and resources available to them to discover and develop STEM related skill sets that are aligned with educational and career pathways. The Alliance comprises 17 public school districts, area employers, business professionals, post-secondary education institutions, state and tribal agencies and is coordinated by Mid America Industrial Park's workforce development program. Continue reading about Mid America here.

Ecosystems and Workforce Exemplars

Workforce development and industry partnerships are core elements of STEM Learning Ecosystems Community of Practice (SLECoP). In 2022, the SLECoP held open discussions and shared effective strategies for workforce development. Exemplars of SLE workforce development and industry partnership are detailed in the table below.

Author and Title	Report	Summary
Andrew Garner, Director of Strategic Partnerships, North Museum of Nature and Science Lancaster County STEM Alliance	High School STEM 2D Bridge to Employment (1).pdf	Mentors from Johnson & Johnson join forces with the Lancaster County STEM Alliance, School District staff and post-secondary institutions to offer young people a variety of learning experiences. Together, these partners provide STEM2D (science, technology, engineering, math, manufacturing and design) skills, as well as important college and career readiness skills. The BTE Site Coordinator will be on hand to answer questions and walk you through this program.

Donald Johnson, Coordinator of Career and Technical Education for the Midland County ESA Kristen Wenzel, Chief Operations Officer and EO Officer, Great Lakes Bay Michigan Works! Doug Bush, Associate Superintendent for Career & Technical Education at the Gratiot-Isabella RESD Brian McBride, Assistant Principal and CEPD Administrator at the Bay-Arenac ISD Career Center	6-22 MiWorksSTEM ConfPres.pdf	This presentation describes Great Lakes Bay Michigan Works, its mission, operations, and partners including MiCareerQuest Middle Michigan, the Region's largest, hands-on career exploration experience.
Libby Simpson, Director of STEM Programs at Siemens Toby Bothel, Director Engineering, Design and Fabrication at TIES	A Tale as Old as Time, the Beauty and the Beast of Access, Interest, and Excitement About Engineering and STEM Education	Engineering education that is inspiring, innovative, and builds real-world skills is not a fairy tale. Access to STEM education has come a long way, but in many ways, we are still missing the mark when it comes to engaging all students with the full potential opportunity of paths into STEM careers. This report explores what it takes to be a trailblazer in engineering fields and how to take lessons learned from our experiences to keep the path clear for students today. It further explores actionable ideas to make engineering education interesting, exciting, and easy to integrate.
Sharon Miller, Director Talent Pipeline, Consumers Energy	Consumers Energy - Employer Driven Talent Pipeline Management .pdf	Employers working together to address their shared talent pain points are changing the way education partnerships are formed and executed. In this report, learn about the energy industry efforts – not only in Michigan, but around the country, and how they are meeting the needs of employers through the use of demand data, competency identification, and partnering with the right education programs. The US Chamber of Commerce Talent Pipeline Management (TPM) method they are using has caught on like wildfire across the country.

Casey Welch, President,
Tallo
Jennifer Kolb, Vice
President of Business
Development, Tallo

Precruitment to Recruitment Data you
need to build stronger post-secondary
and corporate partnerships.pdf

This report discusses Tallo's solutions for
strategic recruiting as a leader in early talent
from prerecruitment to recruitment. Gen Z is
already thinking about who they want to work
for... Do they know about you / your
community? What are you doing about it?
What does your precruitment plan look like?

Partnering with Minority Serving Institutions (MSIs)

According to The National Academies of Science, "There are nearly 700 minority-serving institutions (MSIs) that provide pathways to STEM educational success and workforce readiness for millions of students of color—and do so in a mission-driven and intentional manner. They vary substantially in their origins, missions, student demographics, and levels of institutional selectivity. But in general, their service to the nation provides a gateway to higher education and the workforce, particularly for underrepresented students of color and those from low-income and first-generation to college backgrounds. The challenge for the nation is how to capitalize on the unique strengths and attributes of these institutions and to equip them with the resources, exceptional faculty talent, and vital infrastructure needed to educate and train an increasingly critical portion of current and future generations of scientists, engineers, and health professionals." (8)

STEM Learning Ecosystems have a strong history of inclusion of and partnership with minority serving institutions. Of the 35 ecosystems who responded to the question, "Who does your Ecosystem serve?" in the TIES' Request for Information, 20 explicitly used terms such as: diversity, equity, inclusion, underrepresented populations, underserved populations, women/girls in STEM, people of color, rural regions, and other underrepresented/underserved populations. Specific exemplars of this work are highlighted in the following section.

MSI Exemplars

STEM Learning Ecosystems have a proven track record of supporting and partnering with Minority Serving Institutions. The following table details three STEM Learning Ecosystems and the ways they work in concert with MSIs: Colorado STEM, The Broward Area STEM Ecosystem (BASE), and The Tulsa Regional STEM Alliance (TRSA)

STEM Learning Ecosystem	MSI Work Highlights
<u>Colorado STEM</u>	Colorado STEM is led by Metropolitan State University Denver which received its Hispanic Serving Institution (HSI) designation during the Spring of 2019. The STEM ecosystem is committed to serving Latinx students with intentionality, while maintaining a commitment to serve all our students. MSU Denver aspires to become a model Hispanic-Serving Institution (HSI) by creating and sustaining initiatives that support students as they achieve their academic goals and prepare for their careers. Colorado STEM is a coalition of highly engaged business, education, and civic leaders in support of high-quality science, technology, engineering, and math (STEM) education and experience for all students.
<u>Broward Area STEM Ecosystem (BASE)</u>	The Broward Area STEM Ecosystem (BASE) is a regional collaboration of STEM stakeholders in the South Florida community aligned with three primary common goals: (1) Engage and interest youth with hands-on STEM through authentic experiences and competitions; (2) Ensure foundational skills in collaboration, communication, critical thinking, computational thinking, problem-solving and perseverance; and (3) Prepare students to be life-ready for future studies and careers in any area, not only those typically thought of as STEM-related. The mission of BASE is to reach our diverse population with a diverse portfolio of STEM opportunities, assuring that STEM is for ALL students. The ecosystem has several MSI (Hispanic Serving) ecosystem members including the following: Broward College, Nova Southeastern University, Barry University, and Florida Atlantic University. BASE also works on several projects with Florida International University. The Broward Area STEM Ecosystem is also initiating new projects with Miami-Dade College on mixed reality and Kaiser University on esports. Finally BASE has collaborated on grants with Florida Memorial University.
<u>Tulsa Regional STEM Alliance</u>	The founding stakeholders of the Tulsa Regional STEM Alliance (TRSA) agreed that to succeed and deliver on its promise, the TRSA must be: • Inclusive to ensure all impacted and concerned stakeholders would be at the table and have an equal voice. • Flexible in scope to be able to successfully meet the identified needs in the community. • Action-oriented and focused on getting things done. • Accountable and able to measure the impact of the work of the TRSA. TRSA has partnered with Langston University - Tulsa, an HBCU now celebrating its 125th year of service. TRSA has worked with Langston to provide a STEM career expo serving 1500 middle school students / year and professional development for local educators. TRSA also just signed an agreement to partner with Langston University by sharing STEM resources and support aligned with high-quality STEM education.
<u>South Carolina's STEM Ecosystem Community of Practice</u>	South Carolina's STEM Ecosystem Community of Practice - is more than 25 years in the making with origins that date back to a National Science Foundation Statewide Systemic Initiative. Then as now, the ecosystem's drivers for action are access and equity. Over the years, the South Carolina STEM Ecosystem has expanded its understanding of access to include and engage in opportunities in the out of school time learning space. As such, the Ecosystem's purpose is "To inspire learning and leadership everywhere that STEM matters." South Carolina has a robust <u>community of HBCU's.</u> Over the many years of the South Carolina STEM Ecosystem, there have been engagements with Claflin, Benedict and SC State in particular. South Carolina also benefits from this <u>partnership</u> between the SC Chamber and SC HBCU's.

Ecosystem Challenges and Needs

Leaders of the nation's various STEM Ecosystems - while strengthened by their foundation in collaboration - do experience challenges in addressing the country's greatest STEM needs. To enable their work to continue and prosper, STEM Ecosystems have some defined needs.

The following sections address specific needs identified by leaders of STEM Learning Ecosystems. Some of these needs and challenges may also apply to different STEM Ecosystems.

In June 2022, STEM Learning Ecosystem leaders around the country were surveyed to gather more information about the challenges they are facing in guiding their ecosystems.

The largest needs included time, staffing, regaining momentum post-pandemic, measurement and evaluation of ecosystems, fostering collaboration, implementing DEIA in an authentic ways, consistent funding, stable leadership, and technical assistance.

More information regarding consistent funding, stable leadership, and technical assistance can be found in the following sections.

"One of the biggest challenges for the STEM field is the use of measures that are practical, commonly used and help guide educators in their innovative approaches. We are at the cusp of major progress in learning, development and thriving that needs to be evidence-oriented, include student voice, and integrate all ecosystem resources in a community. The NSF CHIPS centers can have a major catalyzing effect"

Dr. Gil Noam
Director of the Institute for the Study of Resilience in Youth at McLean Hospital Founder and Director of PEAR Inc. (Partnerships in Education and Resilience)

Consistent Funding

While many STEM Learning Ecosystems have strong and stable sources of funding, others struggle with ongoing financial support for infrastructure and not just programming. Ecosystems have been hit especially hard with the pandemic and consistent funding resources disappearing due to uncertain times.
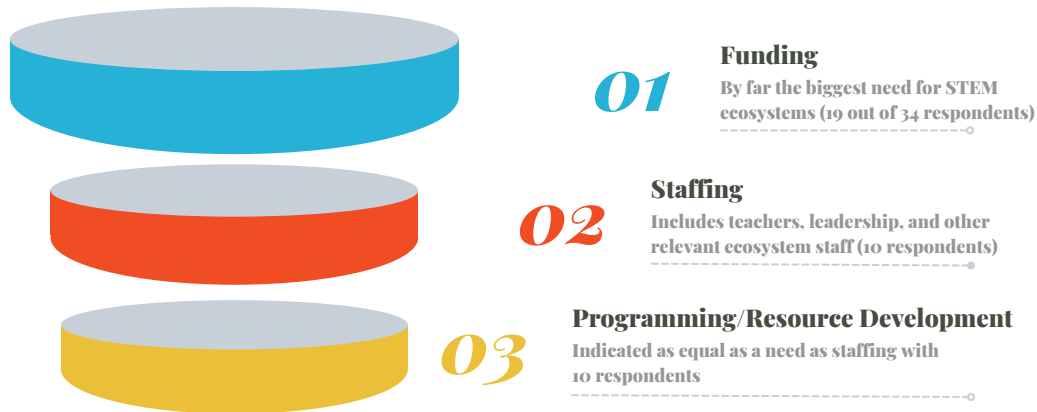
> The STEM Learning Ecosystems Community of Practice has been working diligently to share funding opportunities and strategies for sustainability, including conversations about building business and industry partnerships, as well as technical assistance with navigating state legislation to leverage possible funding streams.

Currently, the ESSRII, III funding and the Title IVA State Funding is being made available to many once they are aware of access. Most notably, TIES helped champion the inclusion of the Strengthening STEM Ecosystems Act into the CHIPS and Science Act of 2022.

According to the data analysis of TIES' Request for Information:

Ecosystems' Biggest Needs
From TIES RFI

01 Funding
By far the biggest need for STEM ecosystems (19 out of 34 respondents)

02 Staffing
Includes teachers, leadership, and other relevant ecosystem staff (10 respondents)

03 Programming/Resource Development
Indicated as equal as a need as staffing with 10 respondents

In some cases, a specific need will cycle into other ecosystem needs. For example, without funding, there is no budget to hire staff. Without staff, there is no one to write grants.

The STEM Learning Ecosystem leadership was surveyed in July 2022 following the Bay City Convening. With 34 leaders participating in the survey, the respondents confirmed this need for funding with 71% of the leaders noting a desire for additional funding support and strategies.

Stable Leadership

In addition to funding, the challenge of Ecosystem leadership transition has been an ongoing challenge for STEM Learning Ecosystems. In any start-up operation, leadership change challenges the momentum of growth and maturity. This situation was made worse during COVID, with about five of 100 STEM Learning Ecosystem leaders leaving their positions as leaders of an ecosystem. That said, the others remaining have gained strength within their own communities and acclaim for their efforts.
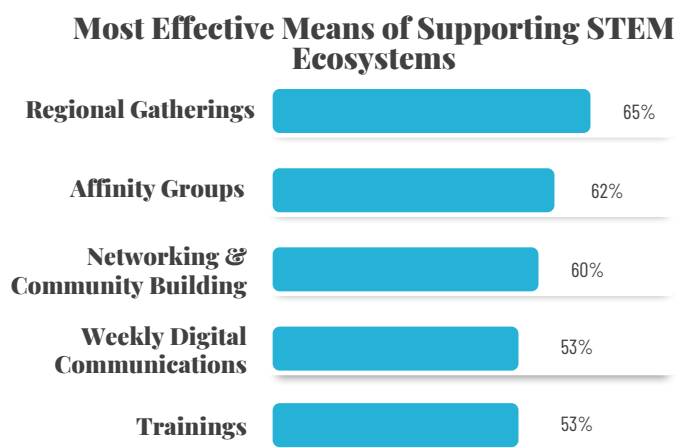
> The SLECoP is working to institutionalize a full process for smooth transitioning of leaders within Ecosystems by offering coaching to new leaders as well as offering various tools that speak to strategies for operating Ecosystems.

The SLECoP has also developed a <u>full online library</u> of onboarding materials to assist new Ecosystem leaders to understand the structure, the strength of the cross-cutting nature of the design and the value proposition of the Community of Practice. With each leader comes strengths and challenges that need to be mitigated with additional support from the STEM Ecosystem itself.

Technical Assistance

Lastly, Ecosystems need specific and targeted support but with over 100 STEM Learning Ecosystems, the ability for individualized technical support has seen shifts. When the STEM Learning Ecosystems formed and for their first four years of existence, TIES was able to offer technical assistance to all Ecosystems. As the SLECoP grew, it was no longer possible to offer the same level of Technical Assistance that many had come to expect.

After two plus years of experimentation with different models of virtual Technical Assistance, TIES has again reinstated a more hands-on form of Technical Assistance through individualized support, partnerships with PEAR to support social-emotional learning needs and tools on the ground within their communities, and nationwide conversations and convenings.

Most Effective Means of Supporting STEM Ecosystems

Category	Percentage
Regional Gatherings	65%
Affinity Groups	62%
Networking & Community Building	60%
Weekly Digital Communications	53%
Trainings	53%

Information obtained via the STEM Learning Ecosystem Leader survey, conducted in July of 2022

The survey determined which types of affinity groups are most needed by the ecosystems. There is strong interest among ecosystem leaders in sharing emerging best practices on the topics of CS, AI, DoD STEM, Early Childhood, Women in STEM and Mathematics education. The survey also revealed interest among the leaders in collaboration on policy, grant applications and becoming involved in the STEM PUSH network. The graph below shows affinity group interest by topic.

Glossary of Terms

Alignment - Organizations need empowered and independent thinkers…within the framework of the organization's goals. Structure brings freedom and innovation. In crew, each rower does his part by following the cadence of those ahead and modeling for those behind in the boat.

Our workforce needs empowered and independent thinkers…within the framework of the organization's goals. Structure brings freedom and innovation. https://talentculture.com/5-steps-to-a-completely-aligned-workforce/

Aligning STEM learning opportunities for youth (K-16) with workforce development (per the STEM SAIL proposal) Workforce and education need to be seamlessly aligned. Communication across these boundaries requires carefully designed and maintained measuring instruments addressing each stakeholder sector in its own terms while not compromising comparability. (9)

Blended learning - Blended learning is the delivery of instruction in a combination of time primarily in a supervised physical location away from home and online delivery whereby the student has some element of control over time, place, path, or pace of learning. (10)

Career Pathway - A career pathway is a collective look at education and training, wage and outlook information for related occupations. (11)

CTE - Career and technical education (CTE) is the practice of teaching specific career skills to students in middle school, high school, and post-secondary institutions. CTE is focused on skill building through practice, hands-on experience, and application. Additionally, CTE is applicable to almost every educational age range. (12)

Digital Divide - the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard to both their opportunities to access information and communication technologies (ICTs), typically internist and digital access.4 (https://stats.oecd.org/) (4)

Ecologized Instruction - "The notion of ecologizing instruction refers to the process of placing abstract content back within its authentic contexts, referring to those contexts outside of schools in which the material serves a functional purpose." (13)

ESC - Education Service Centers (ESC) are shared service centers that provide educational resources and support. Established over 100 years ago, Ohio's ESCs deliver special education services, student programs, and cooperative endeavors, provide high-quality professional development, support the implementation of federal and state regulations and develop strong community partnerships (14)

Evaluation - "Evaluation is a systematic process to determine merit, worth, value or significance." Program evaluation relies on gathering and analyzing data about programs to answer questions about the success of a program, how it might improve its practice, and how it achieves its results. (15)

Experiential learning - Experiential Learning is the process of learning by doing. By engaging students in hands-on experiences and reflection, they are better able to connect theories and knowledge learned in the classroom to real-world situations. (16)

Formative assessment - Integrates assessment and instruction for individual students, STEM learning ecosystems, etc. using test and survey data to map learning progressions in ways supporting custom-tailored improvement recommendations addressing students' and stakeholders' unique response patterns. (17) See personalized learning technologies.

Hybrid learning - Hybrid learning is a method of course delivery that combines face-to-face classroom instruction with online activities. (18)

Interdisciplinary Learning - Interdisciplinary learning is characterized by the integration of multidisciplinary knowledge across a central program theme or focus. With repeated exposure to interdisciplinary thought, learners develop more advanced epistemological beliefs, enhanced critical thinking ability and metacognitive skills, and an understanding of the relations among perspectives derived from different disciplines. (19)

Inquiry - Scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Inquiry also refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world. (20)

Learning Acceleration - Learning acceleration is an approach that gives students laser-focused instruction on the specific skills and content that they need in order to learn the new grade-level material at hand. (21)

Learning Loss - Learning loss refers to shortfalls in a previously envisioned learning trajectory in relation to a previously envisioned future of learning. (22) The concept frequently is used in discussions of pandemic-related educational achievement gaps.

Literacy - Literacy is the ability to use printed and written information to function in society, to achieve one's goals, and to develop one's knowledge and potential. (23)

Measurement - Measurement is the reading of defined quantities from instruments that are (a) calibrated to be metrologically traceable to interval unit standards so that (b) end users are able to coordinate their decisions and behaviors collectively with no need for direct communications. (24)

Opportunity Gap - Arbitrary circumstances in which people are born—such as their race, ethnicity, ZIP code, and socioeconomic status—determine their opportunities in life, rather than all people having the chance to achieve to the best of their potential. (25)

Pedagogy - The strategy of how educators teach, in practice and theory. Pedagogy is shaped by the teaching beliefs of a teacher and relates the interplay between culture and a variety of methods of teaching.Pedagogy relates to the study of teaching strategies and how they influence students. A thoughtfully considered and effective pedagogy is crucial for helping students to learn more successfully and in helping them develop high-order thinking skills. In this article, we are going to investigate the learning process and how it can be advanced using evidence-informed teaching strategies. (26)

Peer learning - Students interact with one another to learn (e.g., classroom groups, one-on-one tutoring, small group work). Peer learning is correlated with improved learning outcomes and provides opportunities to collaborate and tackle information-dense problems. (27)

Personalized learning - Personalized learning is a path in education that takes into account the specific strengths, interests and needs of each student and creates a unique learning experience based on those individual traits. (28)

Problem-based learning - Problem-Based Learning (PBL) is a teaching method in which complex real-world problems are used as the vehicle to promote student learning of concepts and principles as opposed to direct presentation of facts and concepts. (29)

Project Based Learning - Project Based Learning (PBL) is a teaching method in which students learn by actively engaging in real-world and personally meaningful projects. (30)

Professional Learning Community - Professional Learning Communities (PLCs) are groups of educators and curriculum leaders who meet on a regularly scheduled basis to analyze student work, share solutions, develop instruction and work together to improve pedagogical skills and student academic performance. Outcomes measured in unit quantities that remain invariant across assessment items and student samples provide a common language for these conversations, and contextualize unique student response patterns in need of close attention. (10)****

Public-Private Partnership - Public-private partnerships involve collaboration between a government agency and a private-sector company that can be used to finance, build, and operate projects. Financing a project through a public-private partnership can allow a project to be completed sooner or make it a possibility in the first place. Public-private partnerships often involve concessions of tax or other operating revenue, protection from liability, or partial ownership rights over nominally public services and property to private sector, for-profit entities. (31)

SEL - Social and Emotional Learning - SEL is the process through which all young people and adults acquire and apply the knowledge, skills, and attitudes to develop healthy identities, manage emotions and achieve personal and collective goals, feel and show empathy for others, establish and maintain supportive relationships, and make responsible and caring decisions. (32)

STEM - There is no single accepted definition of STEM. Some use STEM, while others use STEAM (Science, Technology, Engineering, Art, and Math). Some view STEM or STEAM as a set of skills. Others see STEM and STEAM as much more of a mindset that trains people to embrace iteration and innovation. The acronym was a recasting from the used term, SMET, from the later part of the former century. NSF and the National Academy of Science as well as others found STEM to be more logical and reasonable for the research community as well as the populace.

TIES has found that defining STEM has less value that speaking about how it is demonstrated in the field. Yet, TIES sees STEM as a transdisciplinary pursuit of teaching and learning that reflects how the natural world exists. In the third decade of STEM, it is rightfully used as a mindset in which problem-solving and innovation are the cornerstones. STEM leads with learning and is driven by design. It seeks to empower all to solve the grandest of challenges from the natural and man-made world while ensuring mastery of knowledge, competency of skills and incorporation of values. It is inclusive of agriculture/agritech, digital arts, computational thinking, AI and much more.

STEAM - (Science, technology, engineering, 'arts' and mathematics) is an approach to learning that uses Science, Technology, Engineering, the Arts and Mathematics as access points for guiding student inquiry, dialogue, and critical thinking.

STREAM - Infusion of reading into the STEAM instructional model to create a holistic curriculum.

STEM Learning Ecosystem - A STEM Learning Ecosystem encompasses schools, community settings such as after-school and summer programs, science centers and museums, and informal experiences at home and in a variety of environments that together constitute a rich array of learning opportunities for young people. A learning ecosystem harnesses the unique contributions of all these different settings in symbiosis to deliver STEM learning for all children. (33)

Transdisciplinary Learning - Transdisciplinary learning enables students to build concepts and skills across subject areas, rather than studying subjects in isolation. Subjects are distinct, yet interconnected, allowing for a holistic learning experience in which students apply what they're learning in a variety of contexts. (34)

Workforce-aligned - Making sure that everybody understands the purpose and objectives of the organization, as well as their holistic role in it. (35)

Appendices

Appendix A

<u>Advocacy Toolkit</u>

Appendix B

<u>STEM Learning Ecosystems</u>

Appendix C

Contributed Essays and "Read More" Articles...continued on next page

- 2022 CHIPS and Science Act is the Vehicle / STEM Learning Ecosystems Can Provide the Engine (1)
- Innovation must be fostered through STEM education, workforce development Unwavering commitment needed by government to address nation's challenges (A lifelong journey towards addressing our nation's STEM needs](https://www.notion.so/A-lifelong-journey-towards-addressing-our-nation-s-STEM-needs-eca6606bae574bc9b146114a54248c00)
- The Challenge and Promise of American STEM Education
- Partnering In School and Out of School Opportunities to Foster Positive STEM Identity
- Unleashing the Power of Community Colleges
- Elevating STEM Education Through Reform, Policies, and Spending
- Why are STEM Ecosystems Critical for the Nation's Economy?
- Why are STEM Ecosystems Critical for the Nation's Economy?
- Pushing the Limits of Possibilities through Partnership
- Pennsylvania STEM Experiences for Equity and Diversity, PA SEED Ecosystem
- Mid America STEM Alliance
- Modernizing American Manufacturing through the CHIPS Act and Workforce Development
- [The STEM PUSH Network: An NSF INCLUDES Alliance](https://www.notion.so/The-STEM-PUSH-Network-An-NSF-INCLUDES-Alliance-109a2c76eeb243a5a73b314e7476f968)
- STEM Learning and Thinking for Workforce Development

Appendix D

Citations

1. National Academies of Sciences, Engineering, and Medicine. 2019. Minority Serving Institutions: America's Underutilized Resource for Strengthening the STEM Workforce. Washington, DC: The National Academies Press. https://doi.org/10.17226/25257.

2. Rozek, Christopher S., G. Ramirez, R. Fine and S. Beilock. 2019: "Reducing socioeconomic disparities in the STEM pipeline through student emotion regulation." Available at https://www.pnas.org/content/116/5/1553? utm_source=EdCan+Network+Newsletters&utm_campaign=3fba409b1___1-Bulletin_ENGLISH_FEBRUARY_2019&utm_medium=email&utm_term=0_82bbb8cbfe-3fba409b11-#ref-5

3. ACT (2013) The condition of college and career readiness, ACT national report. Available at www.act.org/content/dam/act/unsecured/documents/ CCCR13-NationalReadinessRpt.pdf .

4. U.S. Office of Science Technology Policy, U.S. Government, "Charting A Course for Success: America's Strategy for STEM Education." A Report by the Committee on STEM Education of the National Science & Technology Council. December 2018. Available at https://www.whitehouse.gov/wp-content/uploads/2018/12/STEM-Education-Strategic-Plan-2018.pdf

5. H.R.4346 - 117th Congress (2021-2022): Supreme Court Security Funding Act of 2022. (2022, August 9). http://www.congress.gov/

6. https://jfs.ohio.gov/owd/Initiatives/Docs/CSP-PublicComment-FINAL1-16-20.stm

7. The future of work in Ohio. McKinsey & Co. 2022. https://ohioexcels.org/wp-content/uploads/2022/05/20220504-Future-of-Work-in-Ohio-DRAFT-vFINAL-Sh.pdf

8. National Academies of Sciences, Engineering, and Medicine. 2019. Minority Serving Institutions: America's Underutilized Resource for Strengthening the STEM Workforce. Washington, DC: The National Academies Press. https://doi.org/10.17226/25257.

9. National Academies of Sciences, Engineering, and Medicine. 2019. Minority Serving Institutions: America's Underutilized Resource for Strengthening the STEM Workforce. Washington, DC: The National Academies Press. https://doi.org/10.17226/25257.

10. https://education.ohio.gov/Topics/Back-to-School/Online-Blended-Learning-Considerations-for-202-1

11. https://education.ohio.gov/Topics/Career-Tech/Career-Connections/Career-Pathways

12. https://careertech.org/cte

13. Barab, S. A. (1999). "Ecologizing" instruction through integrated units. Middle School Journal, 31(1), 21-28, see p. 22; also see: Barab, S. A., & Plucker, J. A. (2002). Smart people or smart contexts? Cognition, ability, and talent development in an age of situated approaches to knowing and learning. Educational Psychologist, 37(3), 165-182.

14. https://www.oesca.org/

15. Reference: AEA Task Force. (n.d.). What is evaluation? American Evaluation Association. https://www.eval.org/About/What-is-Evaluation

16. https://www.kent.edu/community/what-experiential-learning-and-why-it-important

17. Black, P., Wilson, M., & Yao, S. (2011). Road maps for learning: A guide to the navigation of learning progressions. Measurement: Interdisciplinary Research and Perspectives, 9, 1-52. Confrey, J., Shah, M., & Toutkoushian, E. (2021, August 26). Validation of a learning trajectory-based diagnostic mathematics assessment system as a trading zone. Frontiers in Education: Assessment, Testing and Applied Measurement, 6(654353). doi: 10.3389/feduc.2021.654353. Lysaght, Z., O'Leary, M., & Ludlow, L. (2017). Measuring teachers' Assessment for Learning (AfL) classroom practices in elementary schools. International Journal of Educational Methodology, 3(2), 103-115.

18. https://sites.psu.edu/hybridlearning/what-is-hybrid/

19. Ivanitskaya, L., Clark, D., Montgomery, G., & Primeau, R. (2002). Interdisciplinary learning: Process and outcomes. Innovative higher education, 27(2), 95-111.

20. National Research Council. 1996. National science education standards. Washington, D.C.: National Academy Press.

21. https://www.carnegielearning.com/blog/learning-acceleration-not-remediation/

22. https://www.washingtonpost.com/education/2021/03/10/what-learning-loss-really-means/

23. https://nces.ed.gov/naal/

24. Mari, L., Wilson, M., & Maul, A. (2021). Measurement across the sciences. Cham: Springer. Pendrill, L. R. (2019). Quality assured measurement: Unification across social and physical sciences. Cham: Springer. Wilson, M. (2018). Making measurement important for education: The crucial role of classroom assessment. Educational Measurement: Issues and Practice, 37(1), 5-20.

25. https://www.teachforamerica.org/one-day/top-issues/why-we-say-opportunity-gap-instead-of-achievement-gap

26. https://www.structural-learning.com/post/pedagogy-for-teaching-a-classroom-guide

27. http://hilt.harvard.edu/wp-content/uploads/2019/10/HILT-2019-HANDOUT-FORMATTED-4-PP.pdf

28. https://xello.world/en/blog/personalized-learning/

29. https://citl.illinois.edu/citl-101/teaching-learning/resources/teaching-strategies/problem-based-learning-(pbl)