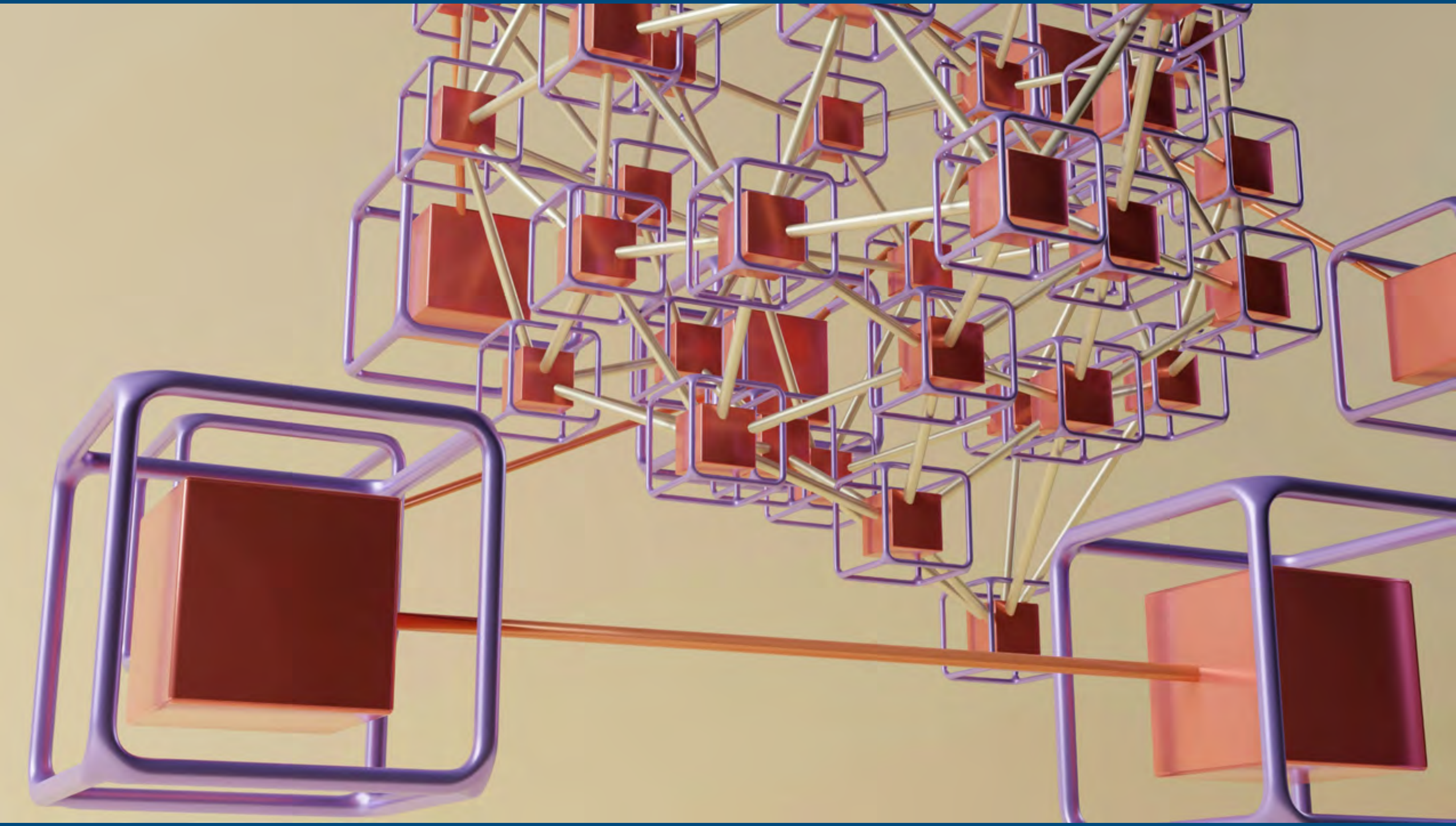
Realizing the Potential of the Science Community to Support Rising Generations in STEM



A report by

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EDITORS' NOTE

Recent and rapid policy shifts within the federally-funded research and higher education ecosystems have raised fundamental questions about our nation's social contract for science, originally articulated in 1945 through Vannevar Bush's groundbreaking *Endless Frontier* report. This changing landscape poses new challenges *and* opportunities throughout the broader science, engineering, technology, and mathematics (STEM) communities. Our ability to meet the moment will determine the long-term health of the nation's STEM endeavor, as well as the critical innovations it produces for health, prosperity, and national security.

America's rising generations—the youth and young adults best positioned to meet the country's growing need for STEM professionals—are on the front lines of this transition. Attracting and supporting their training and development at a time when uncertainty is high and alternative pathways abound will require significant and sustained coordination across STEM sectors. Whether situated in formal and informal learning institutions, industry, government, or civil society, we must all come together to support, reform, and enhance our collective investment in the future leaders of STEM.

This report, developed as part of the Aspen Institute Science & Society Program's 2025 roundtable series, synthesizes insights from practitioners in K–12 education, higher education, science research, professional associations, science communication, and civic science. The project builds on Science & Society's long-standing informal science education work, including the award-winning Our Future Is Science (OFIS) youth initiative.

Over the course of multiple consultations, participants explored how to strengthen the nation's STEM learning continuum, from early exposure to advanced careers. The convenings focused on generating strategies around four core objectives related to rising generations:

1. **Attracting a wide group of youth and young adults to STEM while deepening engagement among those demonstrating existing interest in STEM;**
2. **Achieving learning goals that reflect shifting ideas about STEM education from K–12 through early career;**
3. **Aligning research and technical training with the wide range of jobs and careers that scientists and those in allied fields ultimately pursue, including middle-skilled jobs, industry research, and foundational research paths; and**
4. **Strengthening proven collaborations while drawing on untapped opportunities for partnership.**

The STEM ecosystem in the U.S. is highly complex, with only loose connections at best across institutions. For example, K–12 education systems and youth-oriented informal STEM learning programs within the same community often have little to no direct contact with one another. Instead, individual science teachers are left to serve as connectors, working to the best of their abilities to help students find programs that support their growth. These specific linkages are critical but insufficient to fully realize the joint potential of formal and informal organizations in engaging youth in STEM.

Similarly, higher education institutions, from community colleges to research universities, are driven to help their graduates develop meaningful and marketable job skills. Yet, despite scattered success stories from regional cooperatives around the nation, the dominant experience is one of missed opportunities. Always, but particularly as AI accelerates shifts in workplace needs, there is demand for higher education to coordinate with industry leaders and adapt curricula in responsive ways.

Partnerships require time and resources, often hinging on dedicated individual and organizational "connectors" who help sustain partnerships and keep coalitions moving toward shared goals. Though educational institutions are being squeezed to do more with less, participants noted that the payoff from investing in connective tissue is wide-reaching, helping communities, schools, and industries co-design pathways that reflect both local priorities and national needs.

Across every roundtable, participants identified partnerships and collaborations as both the greatest opportunity and the most persistent challenge in STEM education and workforce development. At the same time, they noted the siloed nature of the STEM community, where opportunities to meet across sectors are all too rare and often too short-term to fully support rising generations in STEM.

Participants emphasized that **no single institution or sector can meet the nation's STEM goals or achieve systemic change on its own**. Fully realizing the country's potential for rising generations in STEM will require durable networks that bridge education, research, workforce, and community spheres. This report offers a roadmap, organized around three fundamental goals:

1. **Attracting and Engaging Youth and Young Adults Through Relevant STEM**
2. **Supporting a Wide Mix of Job and Career Pathways in STEM**
3. **Meeting the Shifting Needs for Skill Development in STEM**

Taken together, the recommendations presented in this report call for a new type of "social contract" for STEM—one grounded in shared purpose and shared responsibility towards all who aspire to participate.

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Core Takeaways

- **Durable partnerships require an infrastructure of "connectors" and clarity around common goals:** Informal STEM organizations, higher educational institutions, and STEM-relevant business enterprises tend to operate in their own siloes, with few cross connections. Science educators, communication and engagement professionals, and civic science experts are often adjacent but too rarely interconnected. Organizations should prioritize hiring staff in "connector" roles who can build and sustain relationships across sectors, identify shared priorities, advocate for responsive programming, and secure joint funding opportunities. To be successful, partnering organizations often need to work through reasonable compromises to align their individual mission priorities with common goals.

- **Informal STEM is a valuable but often overlooked innovation laboratory:** Informal STEM—whether in the form of museums, after-school programs, or mentoring—provides youth and young adults with new entry points into STEM that are typically learner-directed and rooted in local communities. Informal STEM programs can serve as a much-needed complement to formal schooling and as a vital source of innovation for best practices in STEM learning.

- **Relevance is at the heart of attracting and supporting a wide talent net:** For STEM to better represent and serve the country, learners need hands-on experiences as well as role models that allow them to see how science and science-adjacent careers can tangibly connect with their own and their communities' needs, give them agency over their lives, and develop confidence in their abilities, identity and belonging in STEM.

- **Graduate and early-career training programs need to incorporate the broad mix of work pathways in STEM:** There is a shared sense that research training programs at higher education institutions rarely provide relevant training and support for job pathways across the full range of options, from industry-based research and technical roles to mission-driven nonprofits. Nor do they typically incorporate non-linear pathways or graduates working to support the STEM ecosystem through civic science, policy, communication, and engagement roles. Embracing the full range of work pathways in STEM can support retention and help direct talent to pathways that better meet their individual needs. Such changes within the educational system can help build the talent infrastructure needed for a more coordinated STEM ecosystem.

- **The integration of AI in the workplace is creating an urgent need for human-centered competencies in STEM:** The rapid pace of technology development, including the surge of AI across industry sectors, will increase demand for scientists with human-centered skills, such as communication, teamwork, and interpretation of scientific papers, in addition to technical skills. Training young people to adapt to a world where the process of doing science increasingly blends AI with other fields and technologies will require educational and practical experiences that equip them to *learn how to learn*. The pressure on STEM professionals to be effective communicators will intensify as they are increasingly asked to translate complex technical findings to audiences without the same level of technical training or expertise.

Participants

We aim to synthesize and share perspectives from the discussion as a whole rather than to attribute any quotations or viewpoints to specific individuals. Participants—with whom we engaged in roundtable discussions and individual conversations—are listed below (alphabetically by last name):

- **Raven Baxter, Ph.D.** – Executive Director, *The Science Haven*
- **Alejandro de la Puente, Ph.D.** – Director, Society of Physics Students, *American Institute of Physics*
- **Keary Engle, Ph.D.** – Dean of Graduate & Postdoctoral Studies and Professor of Chemistry, *Scripps Research*
- **Robert Fernandez, Ph.D.** – Executive Director and Co-Founder, *Científico Latino, Inc.*
- **Jeanne Garbarino, Ph.D.** – Executive Director, RockEDU Science Outreach, *The Rockefeller University*
- **Beverly Karplus Hartline, Ph.D.** – Emerita Professor and former Vice Chancellor for Research & Graduate Studies, *Montana Technological University*
- **Larry Johnson, D.A.H.** – President, *City University of New York (CUNY) Bronx Community College*
- **Shalin Jyotishi, M.S.** – Founder & Managing Director, Future of Work and Innovation Economy Initiative, *New America*; Visiting Scholar, *Arizona State University*
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- **Corrie Kuniyoshi, Ph.D.** – Senior Program Manager and Portfolio Manager, *American Chemical Society*
- **Anita Krishnamurthi, Ph.D.** – President, *Collective for Youth Empowerment in STEM & Society (CYESS)*; Board of Directors Member, *National Girls Collaborative & STEM Education Coalition*
- **Shirley Malcom, Ph.D.** – Senior Advisor and Director of SEA Change Initiative, *American Association for the Advancement of Science*
- **Heidi Schweingruber, Ph.D.** – Director, Board on Science Education, *National Academies of Sciences, Engineering, and Medicine*
- **Jamie Vernon, Ph.D.** – Executive Director and CEO, *Sigma Xi*
- **Heather Wilson, Ph.D.** – President, *University of Texas El Paso*; Board Member, *National Science Board & Texas Space Commission*
- **Travis York, Ph.D.** – Director, Center for STEMM Education & Workforce, *American Association for the Advancement of Science*

Artwork in this report is by GuerrillaBuzz (cover, headings, 20, 22, 26), Robynne O (2, back), Ayush Kumar (9, 19), Clint Adair (11), Shubham Dhage (13), Perfect Mirror (18), Thomas Peham (21), Steve Johnson (27, 28), and Bohdan Orlov (29).

I. Attracting and Engaging Youth and Young Adults Through Relevant STEM

Expanding access to STEM learning and helping young people interested in STEM to deepen their engagement is an ongoing challenge with an uneven record of progress. The building block nature of STEM education makes it critical that a broad and representative group of youth gain exposure to foundational skills from an early age. Following this initial period of discovery, learners are better poised to continue developing their interests and abilities into young adulthood, though the need for continuing access cannot be overstated.

Attracting and sustaining broad participation in STEM entails more than just sparking interest. Roundtable participants framed the need as opening the door for students and inviting them inside to join a supportive, semi-structured journey that draws on the unique strengths of both formal schooling and informal programming to cultivate a deeply engaged talent pool.

STEM Learning and Engagement Hinges on Relevance

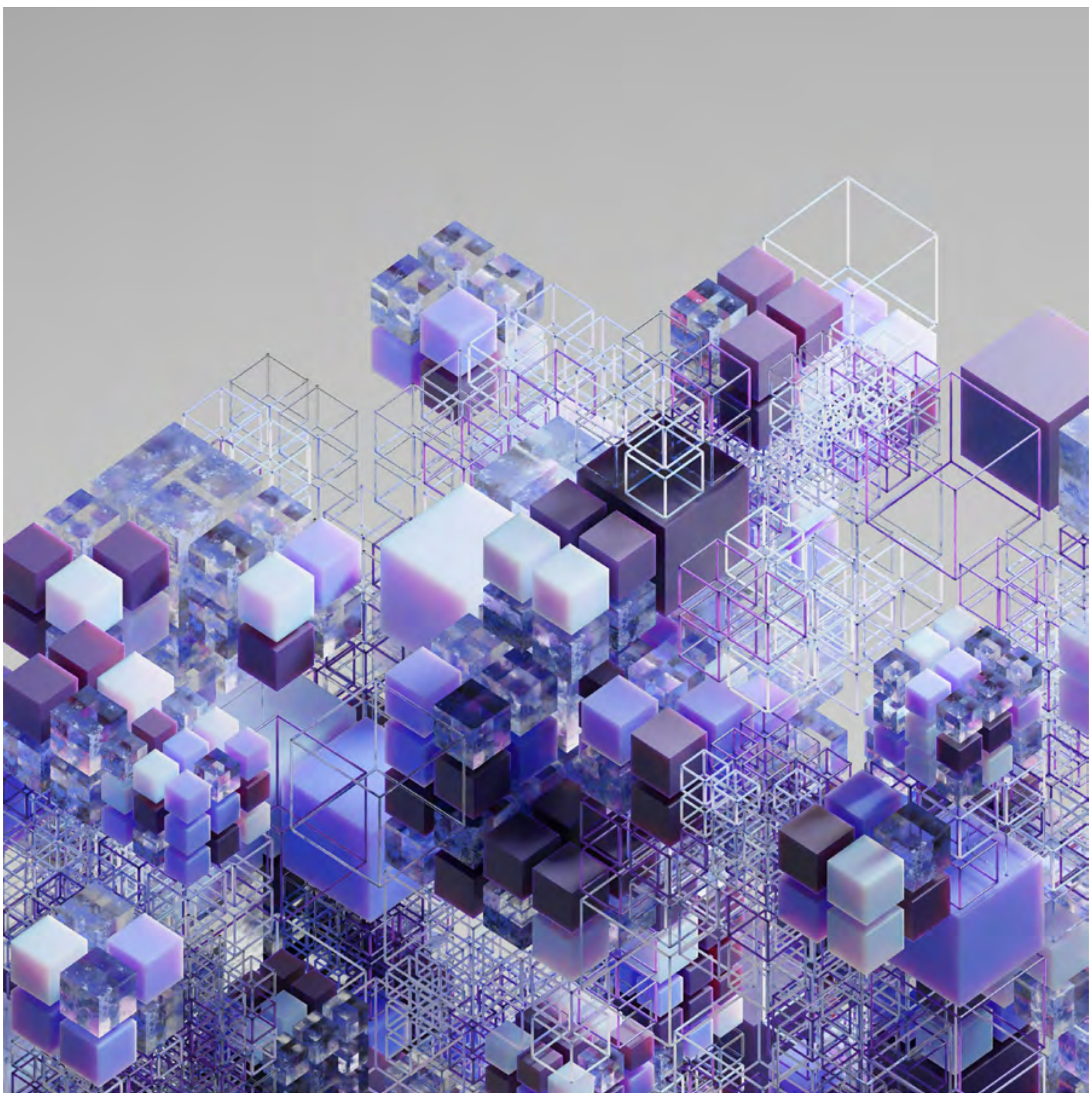
Among programs that seek to attract and deepen engagement with STEM, the most effective approaches demonstrate relevance to youth interests and community interests. Within both formal and informal settings, project-based learning (PBL) provides student-driven, hands-on experiences that foster learning and help youth to see how science can tangibly connect with their own and their communities' needs, give them agency over their lives, and develop confidence in their abilities, identity, and belonging in STEM. Participants highlighted this increased agency—for example, by understanding vaccines, food recalls, beauty products, and surveillance technologies—as important steps to raise "safe and savvy residents of the world" at a time of heavy misinformation and disinformation.

More broadly, participants emphasized the importance of inquiry-based teaching methods, in which science is presented as an "attitude" that values the ongoing, collaborative process of discovery rather than as a stagnant set of facts. "We know that [science] has historically been taught as a set of facts, not a process. And I think students are more stimulated by the idea that they get to pose a question and find the solution through science. But that's not how it's taught, and so their perception of what a career in STEM would be like is not at all presented to them at the educational level," one participant commented. Adopting best practices of STEM pedagogy deepens learner engagement with STEM.

Though some school districts have the resources and flexibility to offer such programming, participants cautioned that pressures on schools to cover a wide range of learning goals, tight staffing, and other resource constraints can also put such programming out of reach. Limiting or "sandboxing" PBL to cover a pre-defined set of topics and providing state-level regulatory flexibility in assessments—as the New York Department of Education is piloting through its Performance-Based Learning and Assessment Networks (PLAN) Program—can help ease these burdens.

While districts should strive to incorporate relevance into their curricula, informal STEM learning (ISL) programs are also well-positioned to provide these opportunities as a much-needed complement to K–12 school programs. ISL programs occur outside the classroom and encompass a wide range of educational experiences. ISL helps contend with the reality that science as an enterprise is moving at a fast pace that formal science education cannot always keep up with. Museums, after-school clubs, and mentor-based learning programs all provide spaces where students can "do their own dot-connecting," often starting from relevant interests and working backward to find the connections to science. Importantly, ISL spaces are examples of trusted settings where students—and ideally parents—feel it is safe to fail, a stark contrast to the popular perception of STEM fields as high-pressure and academically competitive.

Participants noted that this margin for experimentation is particularly important for young people who face overlapping social barriers. For this reason, the ISL ecosystem should expand open programming in addition to the many "boutique" programs that advertise their selectivity and GPA cut-offs.



Embracing Family, Community, and Culture

Participants emphasized the value of ISL programs that prioritize *fully* involving families and communities. Several practitioners explained that families are often overlooked as partners in STEM engagement. Especially in first-generation and immigrant households, parents may not have lived experience navigating higher education systems or may hold misconceptions about STEM careers, encouraging their children to pursue other lines of work despite students' burgeoning interests. Family-inclusive outreach—for example, through parent workshops featuring role models, multilingual "science night" events, and community-wide STEM fairs—was identified as a powerful strategy to demystify pathways and strengthen long-term emotional connectedness.

Several contributors emphasized that culturally responsive approaches to STEM teaching—those that integrate local knowledge systems, community histories, and students' lived experiences—help build a sense of belonging and confidence. Culturally relevant programs, such as initiatives that teach science through rap music, tend to retain participants at higher rates, not only because of representation but because they validate different ways of knowing and actively disrupt oppression. These outcomes align with national findings that students are more likely to persist in STEM when they perceive their studies as connected to real-world challenges that affect their families and communities.

There remains room for greater collaboration between formal and informal STEM education at the K–12 level in communities across the nation. Participants welcomed processes to recognize the achievements of young learners through informal STEM programs, pointing to policy options such as awarding certificates of completion that could be recognized for credit at the local or state level, as Alabama is testing under its Extended Learning Opportunities Act. Another example noted during the roundtable was the Museum of Flight's Aeronautical Science Pathway, which offers high school juniors and seniors in Seattle, Washington a free opportunity to earn both high school and college credit while fast tracking time to a career in aviation.

Locating Out-of-Classroom Engagement

STEM Next is a national initiative linking millions of students with out-of-classroom engagement opportunities. The organization's theory of change rests on a stark disparity: though 80% of learning happens in these extracurricular and cocurricular spaces, only 10% of youth have access to these experiences. "That's nearly 49 million young minds sitting on the sidelines—minds that could create the next breakthroughs in AI, medicine, or space exploration," their website highlights.

STEM Next partners with afterschool leaders in all 50 states, helping them tailor research-based best practices to local realities. Additionally, the group provides informal STEM organizers with access to a Common Instrument Suite that facilitates program evaluation and improvement.

Near-Peer Mentorship as a Valuable Learning and Teaching Experience

Mentorship is a critical tool for helping students develop and actualize goals throughout their educational and professional journeys. One expert noted that the deepest level of change occurs when mentors pair practical tools, such as individual development plans, with a guided journey of self-exploration.

Under the umbrella of mentorship, participants spoke to the value of near-peer mentorship in facilitating learning and a sense of belonging in STEM, sometimes referred to as a "science identity," among mentees. In general, roundtable contributors preferred team-based mentorship. Because near-peer mentors are close in age, they serve as attainable role models. Simultaneously, near-peer programs help mentors develop transferable skills as teachers and leaders. Often, mentors are graduates of the program themselves, serving as valuable advisors and co-creators as the initiative seeks to continue its impact into future cohorts.

Effective mentorship programs provide routine training and institutional support across both technical and socio-emotional matters. Especially when working with K–12 students, mentors should feel equipped to guide their mentees through specific milestones like making the most of a STEM internship and applying for a college STEM degree.

Connecting Rising Generations Across Development Stages

Científico Latino links undergraduates interested in STEM fields with graduate students and early-career professionals who can guide them through the graduate school application process and other professional development goals. In addition to curating resources like a database of paid STEM internship/fellowship opportunities, application timelines, and sample CVs, the organization maintains an emphasis on the human side of STEM. Cientifico Latino hosts in-person socials, is looking to lead expanded campus visits, and maintains a blog where members of the mentorship program post their candid reflections on topics like burnout and embracing identity in the workplace.

Our Future Is Science (OFIS), the flagship youth initiative of the Aspen Institute Science & Society Program's Science & Community pillar, combines a near-peer mentorship model with PBL. Over the course of the academic year, teams of high school mentees and STEM graduate student mentors embark on a virtual journey of informal education featuring thematic modules, weekly team meetings, and monthly dialogues with professionals across the full spectrum of STEM and STEM-adjacent careers. The experience culminates in a group science engagement project that applies scientific principles to identify underlying problems and develop solutions to a relevant issue students have observed in their communities. In recent cohorts, OFIS has partnered with community foundations to create place-based teams, allowing students to specify hyperlocal challenges and propose feasible, evidence-based solutions. Mentees and mentors receive stipends to honor their commitment to the program and encourage continued participation in the future. OFIS boasts a strong network of Ambassadors (alumni) who return to engage with the program, as well as a Champions for Science & Community network, which is open to students who cannot fully participate in the mentorship program.

Evaluation, Accountability and Support for Scaling Up Local Innovation

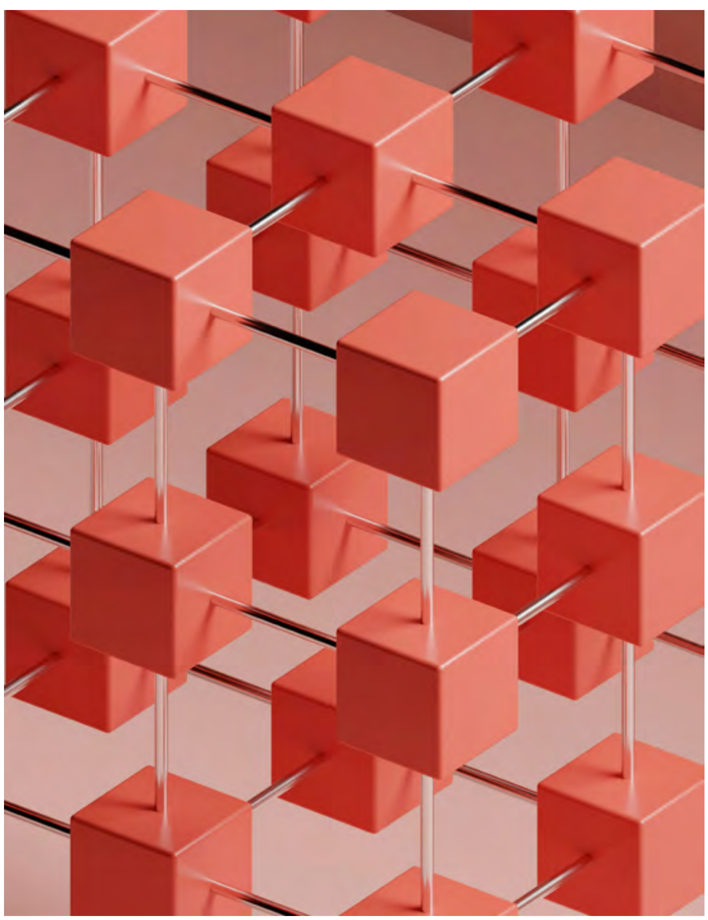
To achieve the dual objectives of improving individual program outcomes and building out a synergistic network of organizations supporting rising generations in STEM, leaders across sectors will need to evolve their evaluation methodologies to better capture the long-term and distributed impacts of partnered work.

One persistent challenge for ISL programs is that they are so closely tied to local context, leading to a tendency to reinvent the wheel in communities across the nation. However, as one participant summarized, "Funding many hothouse innovations isn't going to add up to system change." Networks of networks can help share best strategies across programs and mechanisms to scale up innovations with a proven track record are needed, with the recognition that even proven approaches need to be adapted to local contexts. These communities of practice are also better positioned to develop consistent metrics across their members (such as the Common Instrument Suite for STEM learning) that allow for a bigger-picture view of the youth STEM development space.

Within networks, participants also emphasized that individual organizations should be allowed to play to their mutually-reinforcing strengths rather than being funneled into a "gap-filling" role. For instance, the value of ISL should be recognized independently of formal STEM education because it is, by definition, a space for innovation *outside* an educational system that is otherwise largely "calcified." Participants then called for this logic to translate to the evaluation space, noting that ISL programs cannot and should not be held accountable for producing standardized outcomes within the formal K–12 system, like specific test score increases.

Access: Infrastructure Matters

When it comes to ensuring access to STEM for a broad range of students, removing logistical barriers and other basic inequities continues to make a difference in both formal and informal learning experiences. As one participant phrased it, "Some kids are getting the Cadillac experience and other kids are getting the unicycle experience." Other experts agreed, stating that in addition to being concerned about whether specific formal and informal programs exist in the first place, we should not lose sight of the broader goal of ensuring that all students have the opportunity to participate regardless of their "social address."



Geographic isolation, transportation costs, and limited broadband access were repeatedly cited as barriers for rural learners and students from under-resourced schools. Participants argued that wider participation depends on investments in both physical and digital infrastructure, including transportation stipends and high-speed internet access that can enable students and educators to leverage virtual STEM offerings. The same was also noted regarding the quality and quantity of public services like libraries and leadership organizations like Scouting America and Girl Scouts of the USA, with one participant explaining that a richness of these outlets is important for students who learn best using different modalities.

Wraparound, Holistic Student Advising Systems Help Increase Access to STEM

Students who express enthusiasm about STEM in elementary and middle school too often disengage in high school and college due to limited course offerings, unclear guidance on career pathways, or financial constraints. For example, the expenses of graduate school stack up quickly, beginning during the application process and extending through costs associated with relocation, lab software, and more.

A proven approach to improving access and retention in STEM is wraparound or holistic student advising. These systems, which aim to support financial, social, engagement, and career needs in addition to students' academic needs, are increasingly being embraced at two- and four-year higher education institutions to support overall success. Wraparound services—such as child care, meal vouchers, emergency aid, and mental health support—were repeatedly described as essential for persistence, particularly among nontraditional students.

One participant whose university has developed a strong ethos around holistic advising shared that their number one attribute when hiring advisors is empathy, and that advisors receive training every two weeks. Though the initial level of investment in achieving a 300:1 student-to-advisor ratio was high, the administrator explained that channeling a one-time grant into their holistic advising infrastructure has yielded recurring student and institutional gains, including retention (and the associated tuition received).

Roundtable participants also underscored that academic success in STEM cannot be separated from the social and economic realities students face. Many youth and young adult learners juggle jobs, family responsibilities, or housing insecurity while pursuing degrees. Mentors from urban and rural colleges alike reported that the most effective retention strategies address these intersecting needs.

At community colleges across the country, guided pathways models—in which students follow clearly designed tracks that begin with their "end" educational goals in mind—have become an important component of holistic advising. These pathways were created in response to the prevalent issue of students accumulating significant credit—racking up significant debt in process—but not earning actual degrees. One participant shared that their institution pairs all incoming students with an initial advisor before eventually requiring students to transition to a specific pathway advisor.

Some community colleges, such as within the City University of New York (CUNY) system, also offer "learning communities" consisting of academic advisors, faculty, staff, and students who meet on a regular basis to make connections across courses and troubleshoot issues as they arise.

Building Bridges for Youth to Higher Educational Settings

One direction participants saw as useful for helping early interest in STEM grow into longer-term engagement is supporting programs that help connect high school youth with higher education, whether two-year, four-year, or graduate STEM pathways.

Participants highlighted "kids-on-campus" programs and summer camps as ways to help youth envision themselves participating in STEM at the higher-education level. Though many of these initiatives are funded or partially funded by industry, the roundtable discussants noted the importance of having a dedicated coordinator job on the university- or community college-side.

Dual enrollment is another approach that has shown meaningful promise. By allowing high school students to take higher-level classes and earn transferable credit for their efforts, these programs help affirm students' skills and clarify expectations for the next step in their educational journeys.

Bringing Youth and Young Adults into the Research Ecosystem

The El Paso Collaborative for Academic Excellence, a city-wide partnership hosted by the University of Texas at El Paso, serves as a hub for advancing "K–16" educational outcomes in Region 19 of Texas. The program has particularly benefitted from defining a clear 1:1 relationship between the local community college and university, allowing it to achieve clear wins like a nine percentage point increase in students earning higher education degrees or certificates. Between 2006 and 2015, the Collaborative helped drive a 500% increase in dual enrollment.

The Freshman Research Initiative at the University of Texas at Austin provides over 1,000 first-year students in the College of Natural Sciences with experiential learning opportunities. Freshman are able to conduct faculty-guided research across 30+ research streams, which range from "Big Data in Biology" and "Optical Spectroscopy" to "Sustainable Fashion Materials" and "Urban Ecosystems."

At the Thomas Jefferson National Accelerator in Virginia, local fifth- and sixth-graders have the opportunity to experience life "on campus" through the Lab's Becoming Enthusiastic About Math and Science (BEAMS) initiative. Over the course of a week, students and teachers from under-resourced schools interact directly with scientists and engineers carrying out basic research at a leading Department of Energy lab and synthesize their findings into a writeup.

Recommendations

- **Relevance is at the heart of attracting and supporting a wide talent net:** For STEM to better represent and serve the country, learners need hands-on experiences as well as role models that allow them to see how science and science-adjacent careers can tangibly connect with their own and their communities' needs, give them agency over their lives, and develop confidence in their abilities, identity and belonging in STEM.
- **Proven approaches include "sandboxed" project-based learning (PBL) pedagogies** that allow instructors to reasonably manage varied student interests while inviting community experts to contribute to project evaluations.
- **Collaboration and partnerships across family, community, formal, and informal education are key for ensuring access and engagement with STEM.** Relevance is also generated through programs that connect STEM engagement with family and community. Involving families, particularly immigrant and multilingual parents, across the range of students' formal and informal STEM experiences supports youth learners and can enhance STEM engagement for other family members. Similarly, programming that connects with the community and local context often benefits from multiple touchpoints with community members and organizations, such as public libraries, museums, city government, and local colleges and universities.
- **Foster near-peer mentoring** to facilitate learning and a sense of belonging in STEM. Near-peer mentor programs also help mentors develop their skills as teachers and leaders. Successful mentorship programs incorporate training and support for mentors. Ideally, they include support for specific milestones, such as applications to STEM internships and college programs, as well as tools to help succeed in these programs.
- **Invest in an access infrastructure to broaden participation**, including transportation, broadband, participation stipends, and other logistical barriers to participation in informal STEM programs. High-quality virtual STEM resources can also increase participation for those in rural areas or who have other transportation and scheduling constraints.
- **Encourage wraparound, holistic student services** that integrate academic advising, financial aid, and mental health support under unified structures. These programs are increasingly used for undergraduate advising. These advising systems can help identify solutions to barriers to STEM engagement, ensuring that a wide range of youth and young adults participate in STEM activities.
- **Programs that bridge youth experiences with higher education foster deeper engagement in STEM.** Successful programs increase retention of middle and high school youth in STEM, fostering opportunities for deeper engagement with STEM and providing roadmaps for college and graduate studies in these fields.

II. Supporting a Broad Mix of Job and Career Pathways in STEM

In thinking about how to support the career and workplace needs of rising generations, roundtable participants often highlighted longstanding ways in which higher education institutions could better listen and respond to the broad mix of job and career pathways their graduates follow.

Roundtable discussions revealed a recurring, sector-wide discrepancy. Though the structure of the STEM workforce has transformed, educational institutions largely focus on a shrinking component: researchers working in college and university labs.

Recognize and Support Multiple and Nonlinear Work Pathways

Participants emphasized that the traditional academic model—progressing from graduate study to postdoctoral research to a tenure-track position—does not reflect the reality for most STEM professionals. Though a declining share of STEM Ph.D. holders enter tenure-track roles, the national graduate training system continues to treat academia as the default. The 2025 *Science at Work* report from Science is US illustrates that under half of professionals in STEM and medicine hold bachelor's degrees.

"If we shift [from] pipelines to networks and scenic routes instead of highways, we will be better off," noted one participant. Others looked to more porous professional environments such as business schools, policy schools, and applied math programs, as potential models for revolving doors among academia, industry, and other mission-driven sectors.

Participants called for more on-ramps and off-ramps between higher education and other sectors, noting that academics leaving universities to pursue industry and public engagement careers face significant barriers to reentering research. Faculty externships were discussed as a strategy-of-choice for universities focused on supporting faculty entrepreneurship, tech transfer, and invention. Similarly, MIT's "post-tenure" faculty position was cited as an example of how non-linear paths can be institutionalized more effectively.

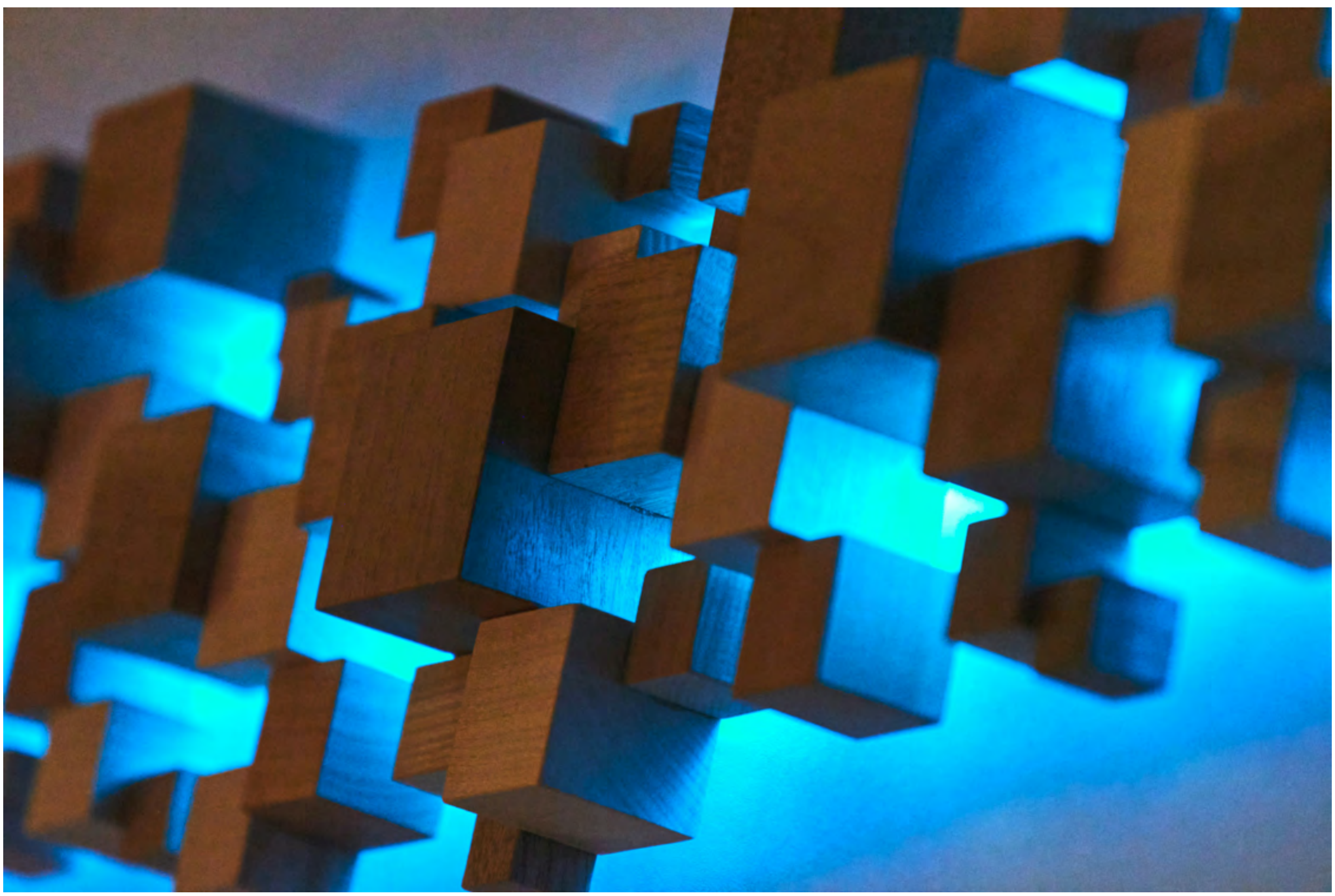
Embedding career exploration earlier in the STEM training process, through options such as interdisciplinary advising, mentorship networks, and short-term experiential learning placements, would also contribute to the goal of encouraging multiple pathways. Doing so, participants argued, would normalize diverse career outcomes and help students envision how their skills can serve both innovation and the public good.

Longitudinal evaluation of graduates needs to be updated to reflect these more varied and nonlinear pathways in STEM. Putting these ideas into practice will also entail a broader re-thinking of the incentives and practices in higher education. There is a shared sense that some current practices can place unnecessary burdens on students, and that the lengthy research training process, combined with extended periods in temporary postdoctoral positions, undermines the retention of talented scholars who feel they are not making independent contributions early enough in their careers. Fully adapting graduate training programs to support multiple, non-linear job pathways is likely to involve a broader discussion around the values and rewarded activities for educators, as well as how such programs support and train students. Efforts like the Modernizing Academic Appointment & Advancement (MA3) Challenge by the Open Research Community Accelerator (ORCA) provide a starting ground for reimagining academic hiring, review, promotion, and tenure (RPT) processes.

Coordinating Higher Educational Programs with Industry Workforce Needs

STEM training, whether at the college or graduate level, often looks to fill multiple needs. There is an abundance of foundational knowledge and technical skills across every field in STEM, and the pressure to master new developments in these fields continues apace. These kinds of learning goals are important building blocks for training the next generation of foundational researchers.

However, as noted above, a relatively small fraction of STEM graduates pursue careers in foundational research. The balance of opinion among roundtable participants is that higher education could do more to help prepare students for other roles in the STEM ecosystem, particularly industry-based STEM jobs, or consider developing "tracked" training programs that serve multiple end goals.



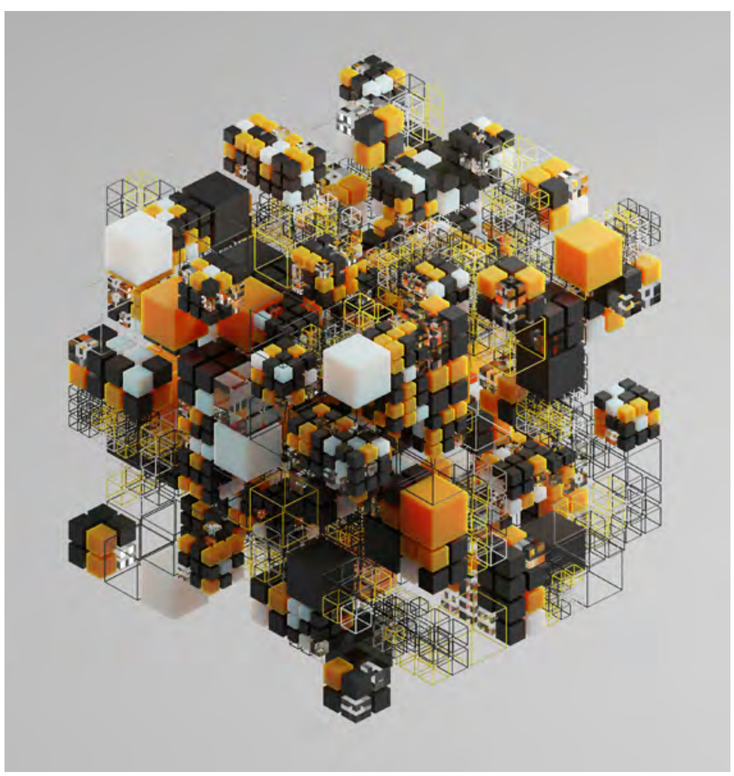
A recurring theme of the roundtable discussions was the persistent disconnect between what students learn and what employers say they need. Participants noted that industry representatives often say recent STEM graduates lack practical competencies for success in these jobs, such as teamwork, technical writing, and project coordination. Conversely, educators expressed frustration that employers frequently fail to articulate evolving skill demands in ways that translate into the timelines needed for curricular change.

This disconnect has inspired a push, led by groups like Grads for Life, for more rigorous measurement and standardization across skills-first careers.

Several roundtables proposed the creation of regional STEM workforce councils—forums bringing together employers, educators, unions, workforce development agencies, chambers of commerce, and elected officials to align training programs with local economic priorities. Participants stressed bottom-up approaches noting that such partnerships are particularly critical in communities undergoing economic transition, where emerging sectors such as renewable energy and biotechnology can provide pathways to upward mobility.

Successful models, such as the Advanced Technological Education partnerships between industry and the National Science Foundation, were cited as evidence that multi-sector collaboration can reduce mismatches between supply and demand.

At the national level, the STEMM Opportunity Alliance (SOA) is an important source for shared vision and collaboration to achieve a thriving STEM workforce. The SOA is a bipartisan effort coordinated by the American Association for the Advancement of Science (AAAS) and supported by more than 300 organizations across philanthropy, industry, professional associations, science and technology centers, hospitals, colleges, and universities. Established at the end of 2022, the SOA is poised to help meet the ongoing calls for the first national STEM workforce strategy.



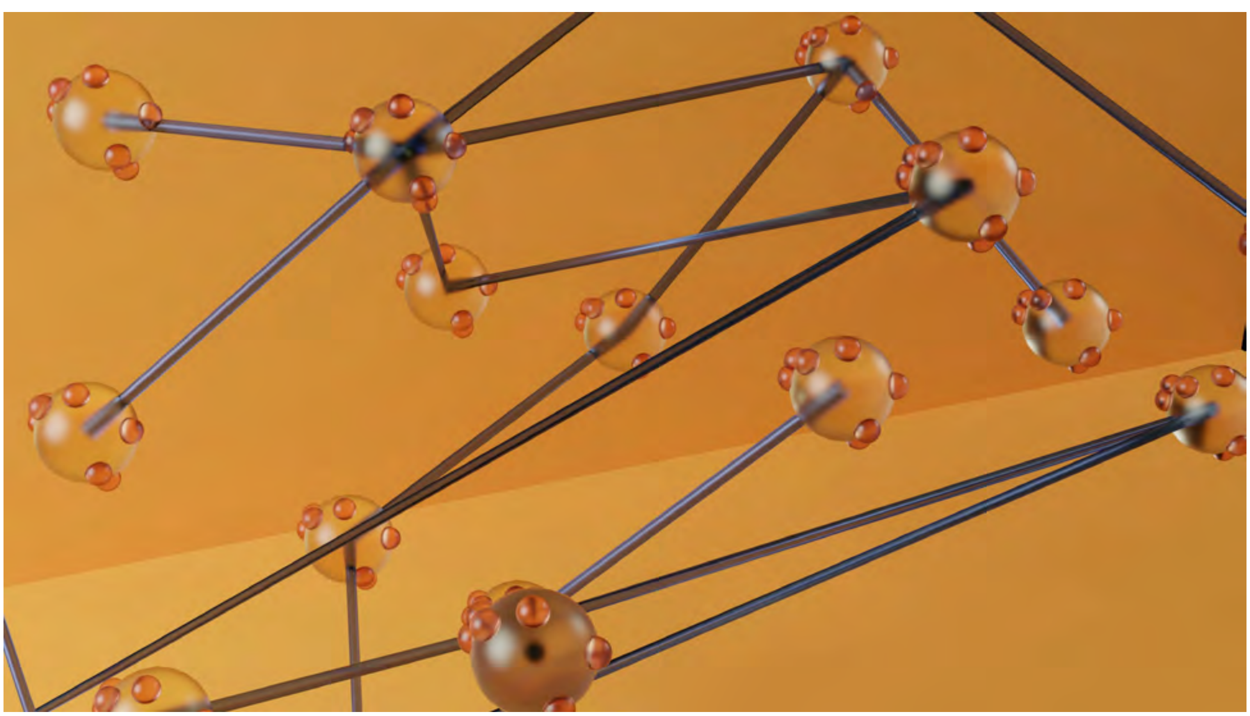
Community Colleges are a Key Hub in the STEM Ecosystem

Community colleges were repeatedly highlighted as an important but undervalued component of the STEM ecosystem. These institutions serve nearly half of all undergraduates in the United States and enroll disproportionate numbers of first-generation, low-income, and underrepresented students. Community colleges are an important training ground for the STEM middle skills workforce. Participants argued that strengthening community colleges should be a national priority for STEM workforce resilience.

"How can we then work with our elected officials, both at the local city, local, state, and federal level, to really get them to understand the ROI and investing in underserved, underrepresented, and underemployed communities when most of those dollars are being reallocated to [the elite research universities] of the world?... To have those opportunities for our young people to see that there is an investment in them, and in turn they can really see themselves in those future positions?" one participant asked. Although community colleges are not typically recognized for their undergraduate research, participants emphasized the importance of these opportunities for persistence to graduation.

Many roundtable participants described innovative community college programs that blur the lines between classroom and career, including apprenticeship-style partnerships with local manufacturers, research internships at nearby universities, and stackable credential systems that allow students to enter the workforce and later return to complete degrees. New America's Partnership to Advance Youth Apprenticeship maintains an updated blog and newsletter with related resources. Land grant universities have also been leaders in the service learning space.

However, participants also noted that these programs often depend on short-term grants rather than sustainable funding. Participants called for expanding federal and state funding streams that reward long-term partnerships and measurable student outcomes rather than temporary pilot projects.



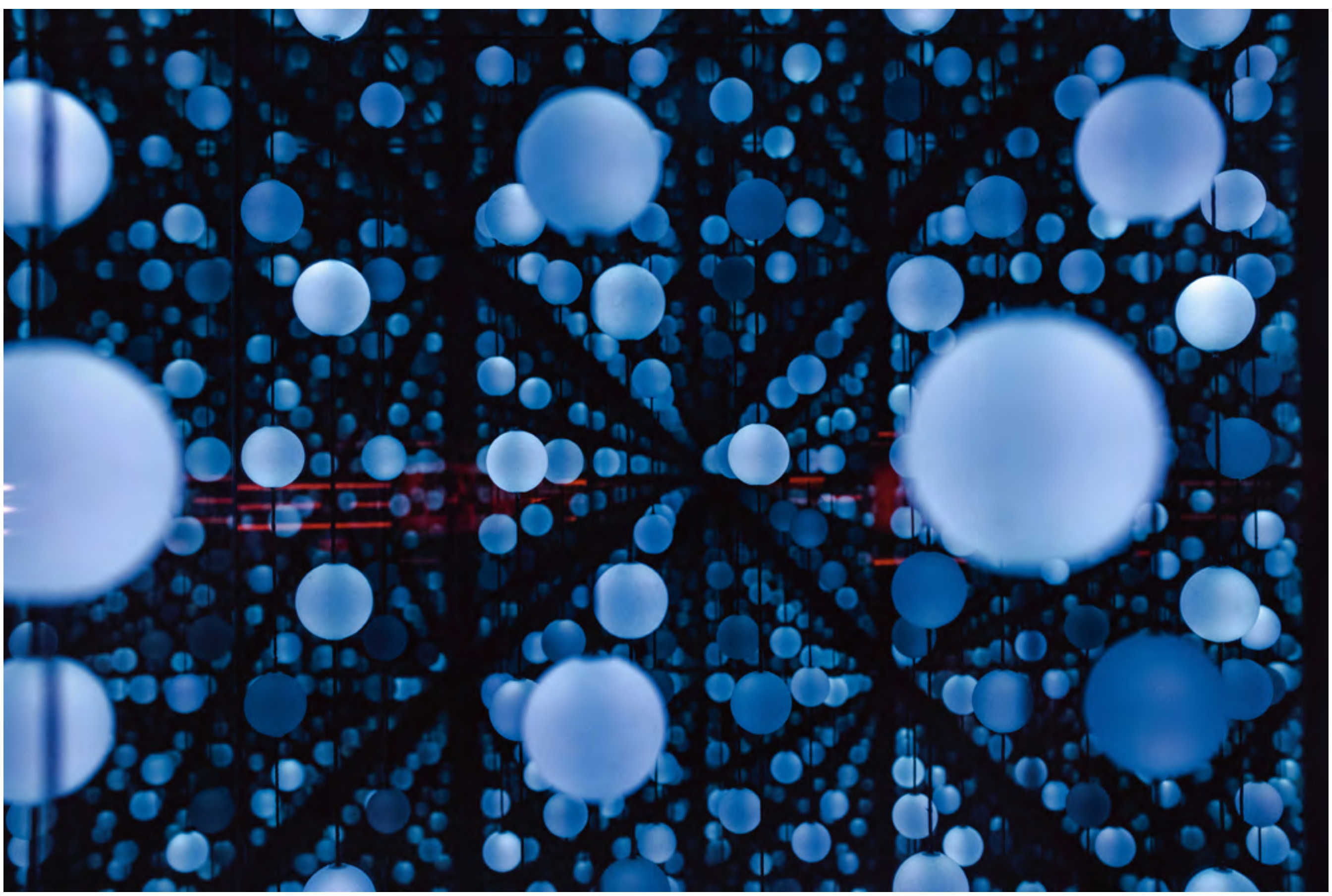
Experts at the roundtable representing the higher-education sector also called for stronger articulation agreements between community colleges and their local and regional four-year counterparts.

Employers in both the private and public sectors have a critical role in building sustainable career pathways. Paid internships, rotational programs, and cooperative education placements were identified as best practices for preparing students to transition into full-time roles. Participants also urged companies to look beyond short-term hiring and invest in long-term talent development.

Training for Future Leaders in Civic Science, Policy, Communication, and Engagement

Many of those with STEM degrees spend time, even whole careers, working in areas such as science policy, communication, and engagement that amplify the STEM enterprise. These STEM professionals take on leadership roles with policy makers and publics that facilitate deeper connections between science and society.

Participants suggested that such "boundary-spanning" careers require training that values both analytical rigor and social context, challenging traditional metrics of success in academia and industry alike. Some participants pointed to a shortage of resources for graduate students to build out their skills in these areas. Further, they argued that integrating more training and skill development into graduate-level STEM training would round out scientists' and allied professionals' training in ways that could make them more effective as scientists, engineers, and technologists.

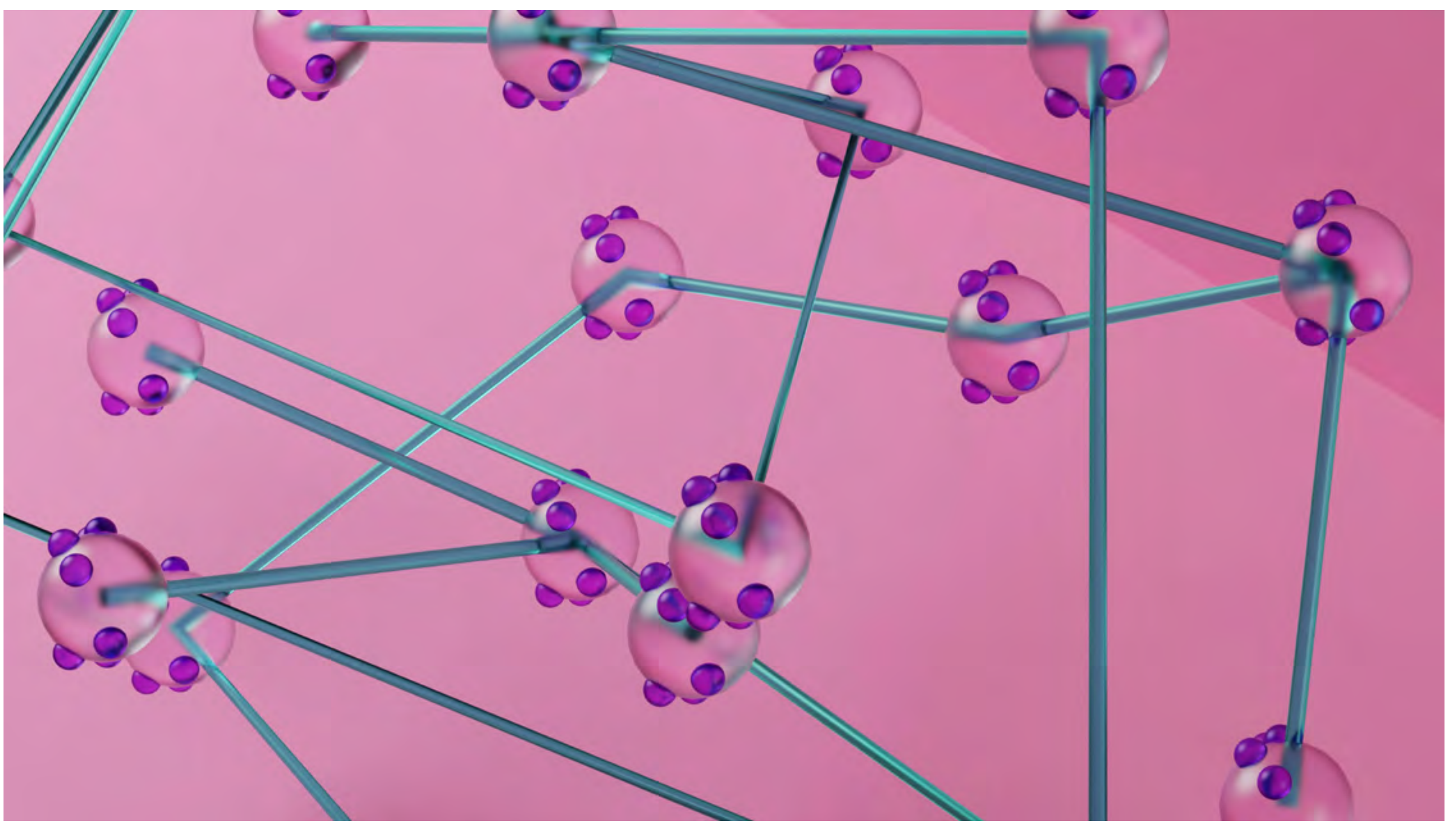


Within the broader category of professional development, one expert drew on internal surveys conducted by their institution to explain that graduate students want training in concrete and translatable scientific skills like using computational tools, reading scientific papers, and understanding the basic tenets of patent law—all skills that are immediately applicable and advance long-term career outcomes.

Writing skills were particularly identified as an area for improvement, with some participants noting that STEM students often feel uncomfortable writing outside of a passive third-person point of view or for ends outside of a thesis.

Participants emphasized the value of universities offering certificate programs in science communication, such as the Alan Alda Center for Communicating Science at Stony Brook University and the Boston University College of Communication, which hosts an entirely online Graduate Certificate in Civic Science Communication with the stated goal of making science "accessible, engaging, and understandable." Similarly, the University of Missouri offers a graduate certificate in Public Engagement, which highlights ISL education and management as a potential career path. This certificate aligns nicely with the university's broader hub, The Connector, which is dedicated to applications and outreach of scientific activities for all ages. Some universities offer courses in science policy and the interconnections between science and society that help expand their skills and understanding.

Participants held up the successes of the AAAS Science & Technology Policy Fellowships, which allow early-career scientists to develop new skills and bring their STEM expertise to policy-relevant roles in agencies across the federal government. The Civic Science Fellows program is a more recent model that is supporting a growing cohort of leaders working across government, professional asso-



ciations, higher education, and philanthropy. The Association of Science Communicators is currently in the process of establishing chapters across the country.

Participants applauded these kinds of efforts and were eager for more. They emphasized that such experiences not only enrich individual careers but also build bridges between science and communities.

Mentorship-Based Programs Support Learning, Identity, Retention in STEM

An ongoing challenge in STEM graduate and early-career training is retaining promising young talent in multi-year programs. Participants across all sessions underscored that the most effective interventions for career persistence are relational *in addition* to structural. Mentorship—especially culturally responsive mentorship—was identified as the single most influential factor in retaining underrepresented students and early-career professionals.

Research corroborates this sentiment: structured mentorship programs improve confidence, self-efficacy, and sense of belonging, all of which correlate with persistence in STEM.

Roundtable discussions also surfaced tensions within mentorship structures. Early-career mentors, themselves, often feel overextended and underrecognized, particularly women and scholars of color who disproportionately carry invisible advising labor. Participants recommended compensating mentorship through workload credits or salary stipends, and building in recognition for such efforts into annual evaluation and promotion criteria.

Peer mentorship and cohort-based programs were cited as particularly effective. These models build community among learners while reducing the hierarchical barriers that can isolate newcomers. And, they support mentors' growth as educators and leaders. To be successful, peer mentorship programs need to equip mentors. Online resources on effective mentoring available through the National Academies of Sciences, Engineering, and Medicine (NASEM) can be a useful starting point.

A number of professional associations offer mentorship programs or resources related to finding or being a mentor. Sigma Xi, an international honor society for scientists and engineers, connects students at local chapters with professionals in their community. The American Physical Society, for example, offers several mentoring programs, including one that connects graduate students with industry professionals. The American Chemical Society (ACS), through its Project SEED initiative, provides students from "underprivileged segments of the nation's populations" with funded access to hands-on summer research experiences, mentors in lab spaces, and a virtual summer camp on professional preparedness. Crucially, ACS funding allows students to travel to and present at identity-relevant conferences run by the Society for Advancement of Chicanos/Hispanics & Native Americans in Science (SACNAS) and the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE), through which they are also able to connect with mentors.

Recommendations

- **Graduate and early-career training programs need to incorporate the broad mix of work pathways in STEM:** There is a shared sense that research training programs in higher education institutions rarely provide relevant training and support for job pathways across the full range of options from industry-based research and technical roles to mission-driven nonprofits. Nor do they typically incorporate nonlinear pathways or graduates working to support the STEM ecosystem in civic science, policy, communication, and engagement roles. Embracing the full range of work pathways in STEM can support retention and help direct talent to pathways that better meet their individual needs. Such changes within the educational system can help build the talent infrastructure needed for a more coordinated STEM ecosystem.

- **Industry-higher education-community partnerships are essential for the STEM ecosystem.** There is a need to establish more regional STEM workforce councils to align education programs with the shifting demands of local employers and community priorities. These councils should include periodic touchpoints to stay abreast of changing developments. These kinds of partnerships are particularly useful for middle-skilled jobs in STEM, where job postings struggle to keep pace with industry needs. Connectors should consider building relationships with labor unions, professional associations, chambers of commerce, and mayoral offices as potential partners in these efforts.

- **Lean into experiential learning programs** to give students hands-on experiences across the full spectrum of job pathways in STEM using tools such as apprenticeship, internship, and fellow programs, cooperative placements, and community-based projects. These approaches should include mechanisms for translating student feedback into the curriculum design process.

- **Consider graduate-level certificate programs and microcredentials**, such as entrepreneurship minors and industry-led short courses, during breaks in the academic calendar to provide skills relevant across different sectors and job roles in STEM.

- **Support a culture of engagement in STEM professional associations** to help students connect with leaders in their specialty and learn more about the career paths ahead. Advisors can help students enroll in chapter organizations (campus-based or community-based), such as Sigma Xi and the American Institute of Physics.

- **Mentorship programs are an important tool for retention and professional development.** There is an ongoing need to support programs that help ensure access and improve retention in STEM programs across a broad network of talent, including those from lower-income households, first-time college students, and those from under-resourced school districts, across college and advanced graduate training programs. Mentorship programs are an important tool for increasing retention, especially when they connect students from underrepresented groups with near-peers and professionals with similar backgrounds.

III. Meeting the Shifting Needs for Skill Development in STEM

Across all roundtable discussions, participants emphasized that the skills required for success in STEM have changed more in the past decade than in the previous half-century. Advances in artificial intelligence (AI), biotechnology, quantum computing, data science, and more are transforming not only the tools scientists use but also the ways they collaborate to develop knowledge and innovations. The rapid pace of innovation driven by convergences across fields is highlighting the need for scientists, engineers, and technologists to consider and address the implications of new developments in STEM for society and the public good.

Ongoing concerns about public trust in and value of the scientific enterprise also highlight a need to prioritize communication skills that help STEM professionals better explain their work to a range of audiences with diverse areas of expertise and, importantly, engage in two-way dialogue and partnerships with groups inside and outside STEM.

Calls to reform and, ultimately, expand learning goals in STEM are found across the K–12, undergraduate, graduate, and early career training landscapes. Meeting these goals will require support for collaborations and teaching approaches that deliver on an expanded set of learning goals efficiently and that are rooted in expertise across a range of disciplines and specialties.

The Future of STEM Highlights Interdisciplinary and Transdisciplinary Learning

In a complex and ever-changing world, there is a need to adapt STEM so that students are not just book-smart or street-smart but "problem-solving smart." Real-world problems and their solutions are almost always cross-disciplinary.

Several contributors described their institutions' efforts to break down disciplinary barriers through collaborative, project-based learning models. This mirrors a broader movement toward transdisciplinary learning, where students learn to apply knowledge from multiple fields to complex, real-world problems. Participants noted that such approaches cultivate systems thinking—a crucial skill for addressing issues like sustainability, health equity, and cybersecurity.

However, implementing these models faces structural challenges for both K–12 and higher education institutions. Departmental funding formulas, credit transfer rules, and faculty reward systems often discourage collaboration. Participants suggested that federal and philanthropic funders could catalyze change by supporting joint teaching appointments, interdisciplinary research centers, and cross-departmental curricula. Practitioners also emphasized that, as budgets are slashed, states must better harmonize any funding streams they do receive across federal programs, such as the Perkins Allocation from the Department of Education, Workforce Innovation and Opportunity Act (WIOA) money from the Department of Labor, and National Science Foundation (NSF) grants. States, institutions of higher education, and employers should also coordinate plans in advance of the new Workforce Pell program's implementation in 2026.

Educator Professional Development

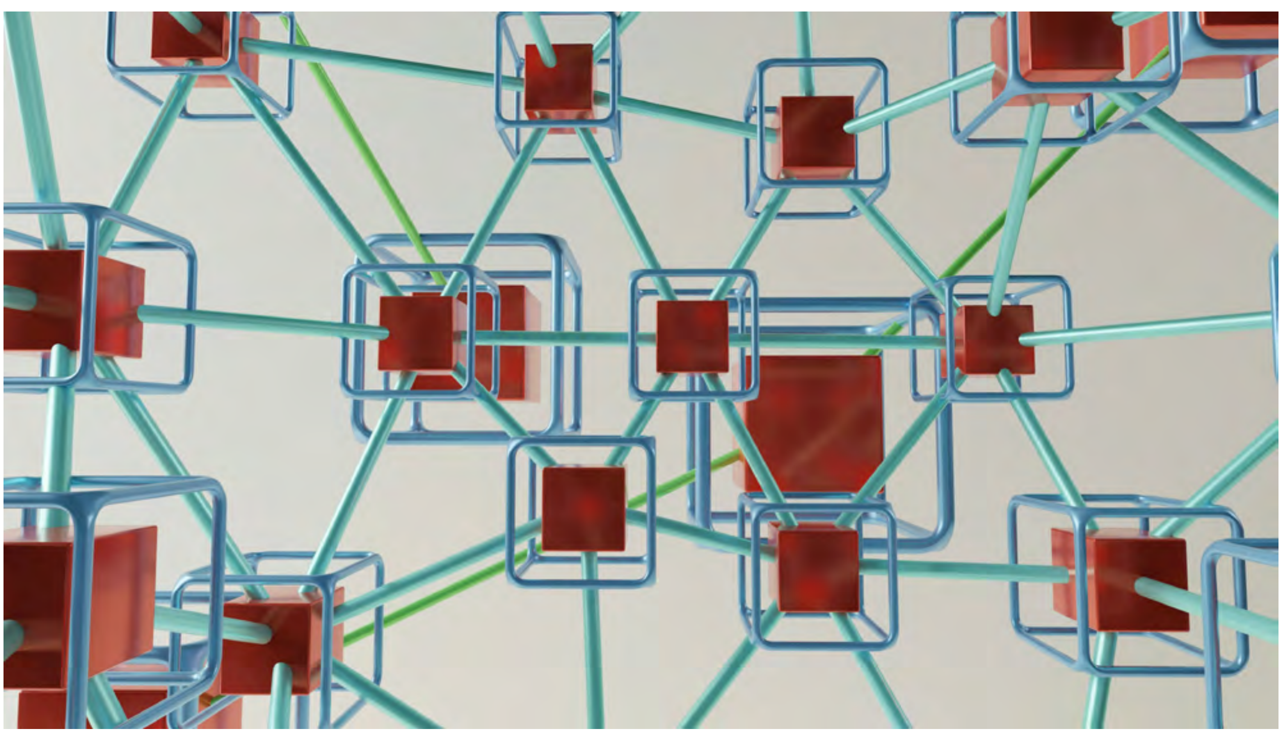
Teachers are the linchpins of skill transformation. Yet, as one participant observed, pressures to deliver interdisciplinary STEM content that keeps pace with rapid scientific and technological change requires educators to teach skills outside their own training areas. Educators are likely to vary in their comfort level and preparedness for these tasks.

K–12 educators, in particular, face unique challenges. Participants noted that while many teachers express interest in introducing computational thinking and data literacy, they often lack the resources, confidence, or administrative support to do so. Professional development that connects classroom teachers with higher education and industry mentors was highlighted as an especially effective bridge.

At the college and university level, roundtable participants described successful faculty development models, including industry externships for professors, collaborative learning cohorts across institutions, and funded sabbaticals to explore emerging technologies. Participants emphasized that such initiatives not only update instructors' technical skills but also model the culture of continuous learning that STEM fields demand, in turn allowing faculty to serve as better mentors for students interested in career paths outside of pure academia.

The Growth of AI Calls for A Strong Mix of Advanced Technical Skills, Human-Centered Competencies, and Increased Attention to Societal Impacts of STEM

The burgeoning use of AI across industry sectors is already impacting STEM education in K–12 and higher education settings. AI is also transforming scientific research, as underscored by developments such as the Nobel Prize-winning AlphaFold, which uses an AI model to predict protein structures.

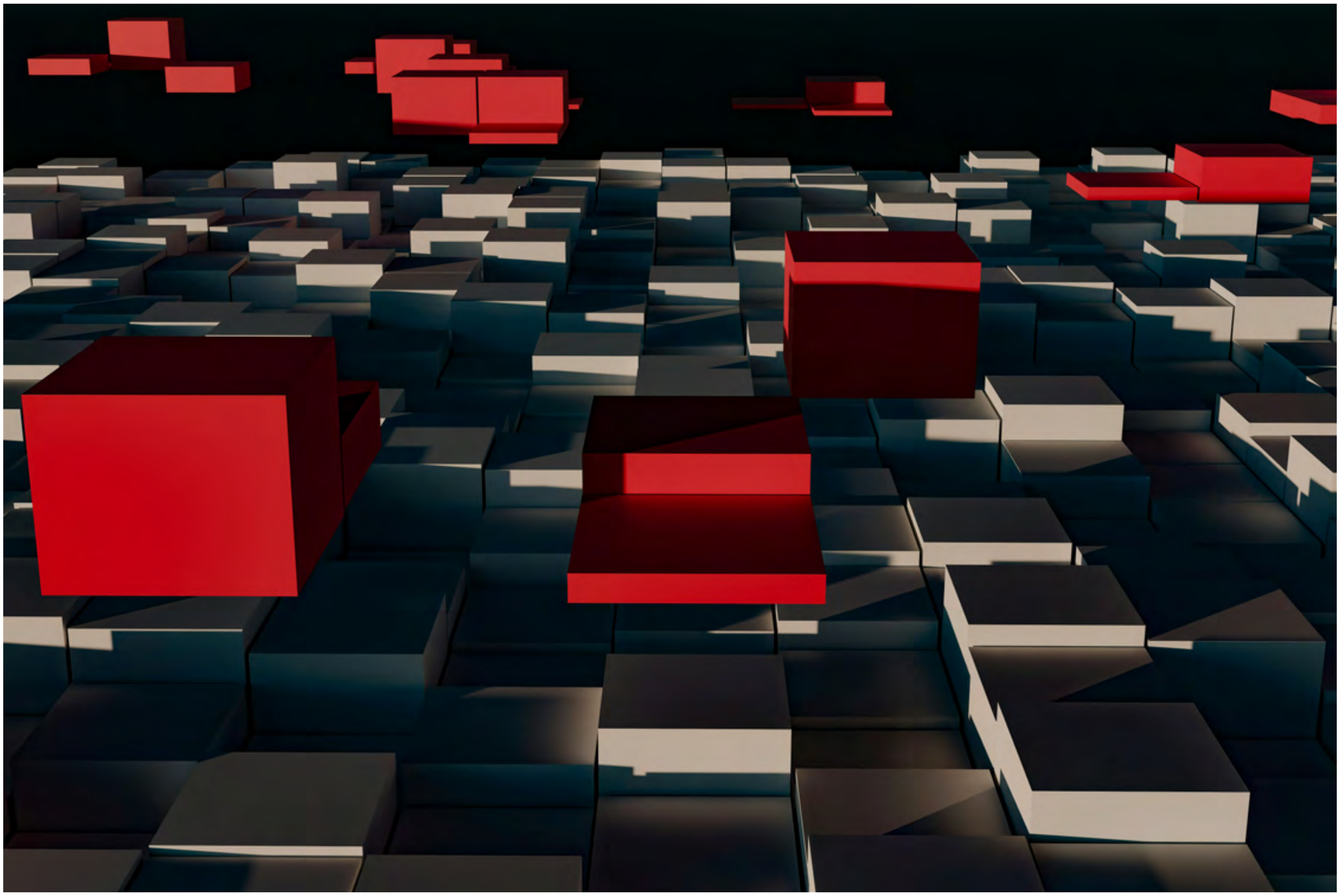


In contemplating the implications of AI for the STEM ecosystem, participants spoke of an urgent need to help young people adapt to a world where the process of doing science increasingly integrates AI with other fields and technologies. One of the lasting needs will be STEM educational and practical experiences that equip young people to *learn how to learn*.

Participants also highlighted an increased demand for scientists with human-centered skills, including creative thinking, problem-solving, socio-emotional capabilities, and moral reasoning. Hiring managers are already emphasizing the importance of human-centered skills for the workplace of the future. Some participants think of these as “meta-skills”—competencies that enable lifelong learning across rapidly evolving fields.

One policy researcher noted that the biggest shortage isn’t coders or lab technicians—it’s people who can translate between domains. Others observed that while coding literacy is now common, understanding *how* algorithmic systems shape social outcomes remains rare.

These conversations supported a growing trend in engineering schools and some other kinds of STEM programs that ask students to better anticipate the social impacts of STEM on society and encourage ethical reasoning around such impacts. Examples include AI-focused undergraduate seminars co-taught by computer scientists and philosophers, or engineering programs requiring ethics-based design reviews before prototypes are approved. Through its national Curious Conversations discussion series, Sigma Xi invites researchers across generations and campuses to focus on the virtues and values, as opposed to the pure academic qualifications, that produce innovation.



A recent review of programs available across higher education pointed to growth in offerings alongside ongoing challenges in sustaining funding and regulatory support for these transdisciplinary learning programs.

Communication and Public Engagement

As public debates over vaccines, climate change, AI, and other emerging developments in science and technology continue, scientists capable of navigating these conversations will play an essential role in the relationship between scientists, policymakers, and the public. Importantly, rising leaders should be able to articulate uncertainty and evolving information sets within their public engagement.

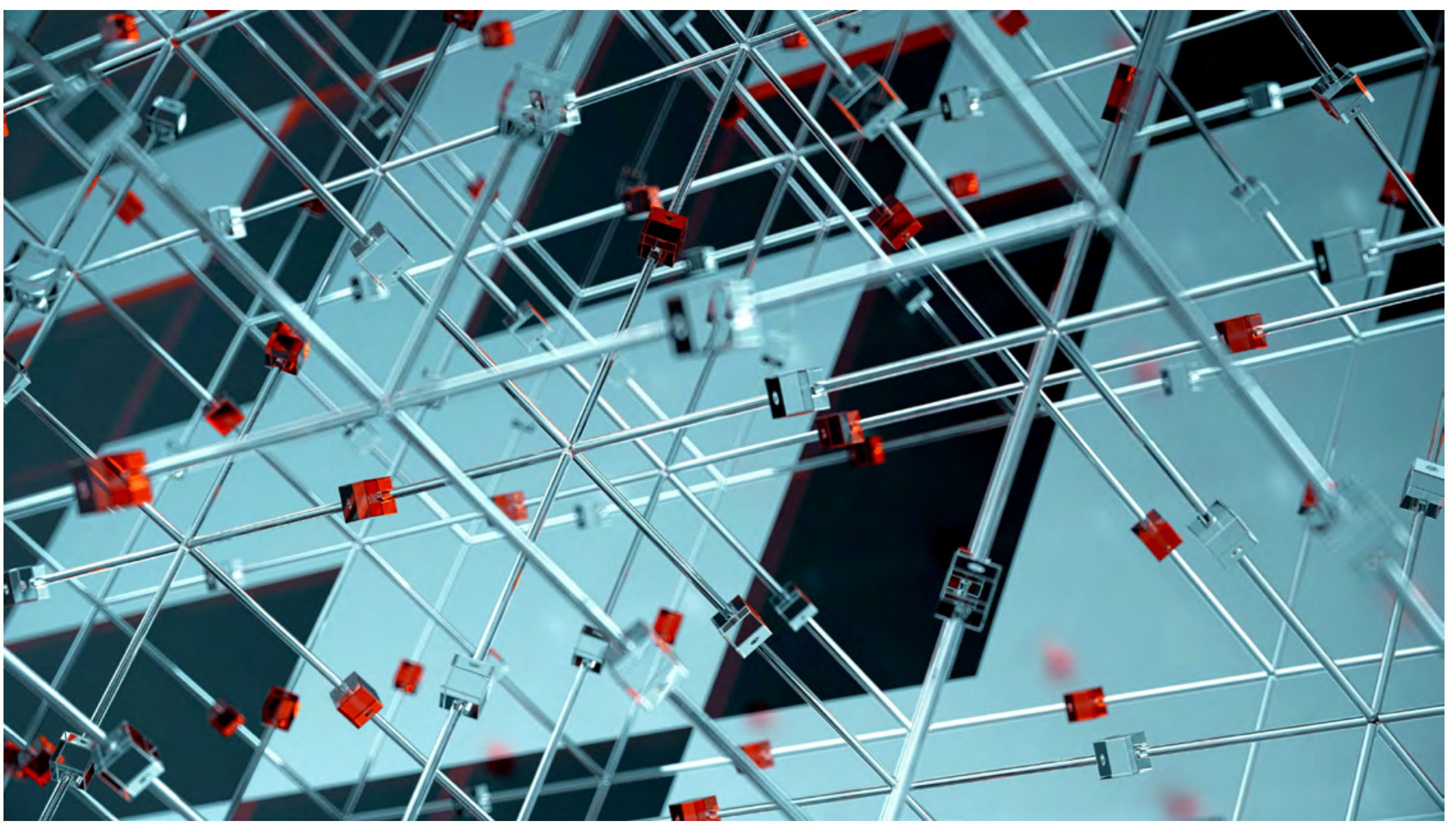
Participants argued that communication is not ancillary to STEM—it is fundamental to "preparing the solutionarians of the future." As one participant underscored, "STEM as an umbrella field has not done a good enough job at making sure that people understand what they're doing, what they're offering the world, the impact they're making, why it's important, why it should be funded. We failed! And because we failed, we're seeing almost a total collapse of the STEM ecosystem."

Participants identified the ability to understand one's audience and context as a skill that is lacking. The ability to explain one's work to someone with a nontechnical background is essential across multiple dimensions: securing funding, connecting with the public, driving policy change, and collaborating with scholars in other disciplines who use different jargon.

Several institutions are doing more to integrate communication training into STEM programs through courses on storytelling, visual design, and public engagement. Participants suggested expanding these opportunities, particularly through partnerships with journalism schools, museums, and community media outlets. A new, open-access book, *Science Communication for Scientists*, serves as a helpful starting point. The University of Michigan's Science, Technology, and Public Policy Program, in conjunction with various Michigan-based community organizations, has co-developed a Community Partnerships Playbook to help build more equitable partnerships between technical and community experts.

Doing more in STEM training programs will likely mean more educational tools that can do double duty to refine both technical and communication skills. Participants likened these tools to "compound exercises." One such idea is to create internal micro-grant opportunities ($1–5k) that teach students or teams of students to effectively develop a project proposal of personal interest with real financial stakes. Research!America also offers Civic Engagement Microgrants of up to $4k for teams of STEM graduate students and postdocs seeking to build trust in science with local communities. Finally, when educators have the opportunity to tweak the assignment type, it can be a free, high-value-added choice. For example, one university professor has adapted the capstone project for their course to involve writing a Wikipedia page that gets audited by the community. This style of writing better reflects an output that "goes somewhere," undergoes fact-checking, and is part of a larger societal dialogue.

Ultimately, these conversations call for a deeper commitment among STEM educators, especially those in higher education, to put more priority on effective communication skills for audiences outside of their specialty area and to think about communication in terms of dialogue and opportunities to build common ground in relationships, rather than a focus on imparting information.



Recommendations

- **The integration of AI in the workplace creates an urgent need for human-centered competencies in STEM.** The rapid pace of technology development, including the surge of AI across industry sectors, will increase demand for scientists with human-centered skills, such as communication, teamwork, and interpretation of scientific papers, in addition to technical skills. Training young people to adapt to a world where the process of doing science increasingly integrates AI with other fields and technologies will require educational and practical experiences that equip them to learn how to learn. The pressures on STEM professionals to be effective communicators will intensify as they are increasingly asked to translate complex technical findings to audiences without the same level of technical training or expertise.
- **Invest in the people and mechanisms that can support transdisciplinary learning projects and integrate attention to societal implications and ethics.** Incorporating interdisciplinary project-based learning raises the need for professional development support, especially for K–12 educators, and for appropriate incentives to encourage interdisciplinary collaboration in higher education. And it would include incentives to support learning goals that integrate attention to STEM's place in society.
- **Integrate communication and public engagement training across all levels of STEM education.** Include training opportunities to communicate with people outside their own specialty area, including policymakers and the general public. It is particularly important for STEM professionals to develop communication skills that support dialogue and relationship-building, rather than focusing solely on imparting information.

Conclusion: Toward a Shared Future in STEM

The insights gathered through the Aspen Institute Science & Society Program's roundtable series on the potential of the science community to support rising generations in STEM reveal a nation at a crossroads. The ongoing policy shifts around the role and scope of federal funding for science research across the nation's universities and research institutions have far-reaching implications for the place of science in society, for the engagement of the citizenry with science, and for how well the nation can meet the talent needs for the STEM workforce in the future.

This changing policy landscape has also highlighted longstanding hurdles across the STEM ecosystem, creating both an opportunity and an urgency to implement reforms. Participants likened the current approach to a "system of nonsystems," a "Rube Goldberg machine," and an environment where "the air traffic control piece is missing altogether." Experts across sectors agreed that the future for rising generations depends on how well the components of the broader STEM ecosystem can coordinate to bolster common goals.

Throughout the roundtable discussions, a consistent theme emerged: the need for **systemic coordination for a shared civic enterprise**. The country's success at expanding access and engagement with STEM, adapting to changing demands for skill development, and supporting the mix of job and career pathways in STEM will hinge on the degree to which organizations and sectors can work together, in partnerships and collaborations, to reach common goals in support of rising generations.

The challenges ahead include building an infrastructure of connectors and funding mechanisms that help sustain systemic coordination over time. Such a transformation will not happen through individual programs alone; progress demands sustained investment, aligned policy, and cultural change across multiple levels of society. Federal and state governments, philanthropic organizations, education, civic, and industry leaders each have a role to play in building the connective tissue that makes the system whole.

STEM education and training are about more than just producing more scientists. Rather, supporting rising generations through STEM is about producing a society that values and participates in science. In short, the goal of this report is to catalyze a move from access to agency, from representation to belonging, and from isolated innovation to shared progress.

The recommendations outlined here—rooted in the lived experiences of educators, students, researchers, and community leaders—provide a framework for action. They are not prescriptive formulas but guiding principles that can be adapted to a range of local contexts. Implemented together, they can ensure that the next generation of learners not only joins the STEM community but also helps redefine it.

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