Voices from the Field:

A Snapshot of STEM Education Today

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FOREWORD

In less than a decade, STEM education has become a top priority for our nation's leaders in government, business, and education. It is not difficult to see why. In 1950 the global population was 2.5 billion people. By 1990 it had more than doubled to 5.3 billion. The world population reached 7.3 billion in 2015, and while estimates vary, a reasonable estimate for the world population in 2050 is about 10 billion.[1] As the increasing population converges with climate change and other environmental concerns, the need for healthcare and housing, affordable energy and transportation, food security, and clean air and water will continue to grow. While an understanding of how the natural world functions (science) is clearly important in tackling these problems, today's students will need a solid education in all four STEM fields—science, technology, engineering and mathematics—to meet future challenges and to help strengthen the economy while preserving what remains of the natural environment.

The shift from science to STEM first took root in the nation's school systems, fueled by the increasing number and sophistication of computers and other digital technologies in classrooms and labs, as well as the widespread adoption of new state standards that include practical engineering skills alongside more traditional science and mathematics. The hands-on nature of STEM education also appealed to informal educators in afterschool and summer settings, where students have opportunities to pursue extended projects, and leaders are less concerned with test performance than they are with increasing student interest in STEM and helping them develop career skills such as collaboration, critical thinking and problem-solving—skills that are essential for success in a technologically-oriented workforce as well as for life in general.

Given our rapidly changing educational landscape, in April 2018, FHI 360, under the leadership of Maryann Stimmer and Merle Froschl, convened a meeting of thought leaders in Washington, D.C. to capture a "snapshot" of STEM education

1 United Nations Population Division: https://population.un.org/wpp/

in the United States. They subsequently conducted additional interviews with more than 50 local and national policy leaders; public and private funders; researchers; PreK-12 and post-secondary educators; parents, and leaders of afterschool programs, science centers and youth-serving organizations.

The purpose of this summary report is to identify current trends and gaps to inform research, policy, and practice in order to reinforce findings and recommendations from prior reports and spark new thinking and action by researchers, policy leaders, community partners, and other stakeholders. The premise of the effort is that a "snapshot" of STEM education today from leaders in the field can help the nation's public and private leaders prepare our students to meet the challenges of tomorrow.

Ron Ottinger, *Executive Director*
STEM Next Opportunity Fund

The Findings

In 2018, FHI 360 conducted a "landscape analysis" through a convening and interviews with field and policy leaders and funders to determine what is being done—and what still needs to be done—in STEM education today. The findings, presented below, discuss current trends and gaps with the goal to provide a guideline and spur action for what's next in terms of research, policy and practice in both formal and informal education.

1. Equity based on gender, race, disability and income is a critical issue in STEM

STEM is at the heart of our fast-moving, technology-driven world, and it is essential that every person have equal access to learn, be engaged and be fully prepared for the future. Access to higher education, authentic experiences and participation in out-of-school time programs and STEM classes, as well as funding and resources, are not equally available. While there is still a long way to go, the good news is that equity is at the forefront of the conversation when it comes to STEM education.

2. STEM conversations need to consider the workforce of the future

A STEM-skilled workforce is vital to the U.S. economy, to our competitiveness in today's technological world and to national security. [2] STEM-related jobs grew at three times the rate of non-STEM jobs between 2000 and 2010. By 2018, it is projected that 2.4 million STEM jobs will go unfilled.[3]

3. Research and practice need to be more aligned

There is a significant gap between what research has identified as quality STEM teaching practices and experiences and what is actually happening in classrooms and informal learning environments. Research is not shared widely enough, it is often misinterpreted, and educators often lack access to research-based professional development and curricula.

2 https://www.americansecurityproject.org/the-stem-jobs-shortfall-is-a-national-security-issue-we-can-fix/

3 https://ssec.si.edu/stem-imperative

4. STEM education is a difficult task

Educators have an awareness of how important STEM is to students' futures, but STEM education is a difficult task for a variety of reasons including lack of funding, lack of confidence, limited opportunities for professional development, experienced educators not starting the program or intervention earlier, and educational approaches that alienate young people.

a. STEM education is largely siloed despite several national initiatives and local/regional collaborations
b. Training, technical assistance and coaching are essential for quality teaching and youth programming, but opportunities are limited
c. New science and math standards get mixed reviews by educators
d. Informal and formal STEM learning professionals need to connect to redefine their roles
e. In-school and afterschool need to connect
f. STEM education is grossly under-resourced

5. How STEM is taught needs to change

How we teach STEM has started to change in positive ways, for example, more inquiry-based learning, hands-on activities and authentic experiences. Research has revealed that a focus on STEM identity, student interest and engagement are essential keys for learning. However, teaching methods are often not based on research or, in some cases, are based on research that has been misinterpreted. The following are the ways to effect the change needed.

a. Identify and share what is and is not working with educators to inform practice
b. Address math that reflects the needs of the STEM pipeline
c. Make STEM fun
d. Identify key informal learning opportunities
e. Engage families

The Interviews

Between May and September 2018, FHI 360 conducted more than 50 interviews. They represent national and local perspectives of policy leaders; public and private funders; researchers; PreK-12 and post-secondary educators; and informal educators including families, afterschool programs, science centers and youth-serving organizations.

Overall Comments

Quality STEM education is being recognized as an important issue for the nation's future. This may be the greatest accomplishment to date. Both educators and industry are coming to view STEM as a national agenda.

> *There is increased buy-in from communities about the potential for STEM in afterschool, breaking down the importance for business and industry.*

> *Businesses, employers and major industry leaders are engaged in STEM education at a new level. They are driving, influencing and getting involved, with a primary goal to prepare young people entering the workforce with the talent and skills needed for their industries. There is an urgency to address skills gaps that have an impact on current and future productivity.*

Concerns remain, however, that there is a lack of clear direction.

> *It's good that educators are finally realizing the importance of STEM education and it is important to talk about. But…there is no uniform approach, no unified design, no consistency. While we have elevated the topic of STEM, are we really having any effect? What works? Why does it work? The needle is not moving.*

With technology changing so rapidly, there is a concern that STEM education is just another trend.

> *Education tends to follow the buzz words (Social Emotional Learning [SEL], hands-on, etc.) but doesn't stick with anything…always moving on…before there can be a depth of knowledge.*

Comments by Findings

Equity based on gender, race, disability, and income is a critical issue in STEM

It is widely agreed that all students need access to STEM learning opportunities. This is particularly true for underrepresented and underserved students—girls, students of color, students with disabilities, students with low-income backgrounds—who may have limited access to technology. As one interviewee stated, "…real equity would be giving every kid what they need to be engaged in STEM." STEM opportunities should also be culturally appropriate. Measuring progress to increase equity in STEM opportunities is also important to be able to demonstrate success.

The message related to girls and STEM also needs to change. There is an idea that STEM must be different for girls and other underrepresented groups. Instead of seeking to fit girls into STEM, we need to level the playing field so that all students have access to high quality authentic programs that are meaningful to them. We need to highlight female role models who are diverse and who have advanced in STEM fields.

> *Whatever STEM is taking place should work for everyone in the room. Because girls are typically not encouraged in STEM, it is essential to be proactive about engaging them.*

Financial equity is another important issue:

> *Where resources are concentrated has a great impact on equity. Who has the resources? Where is the money being spent? Wealth and means can impact students more than anything else. Financial equity is an important part of equity overall.*

STEM conversations need to consider the workforce of the future

Effective STEM conversation will go beyond the classroom and consider the "workforce of the future." As one interviewee said, "There is an opportunity to educate on skills development, not just content." The content being taught needs to connect to skills development, and students need to understand that connection. In doing so, STEM becomes "a quality experience and not just another activity."

> *STEM is transitioning to workforce development and we should be leveraging this opportunity.*

As we make these connections between STEM and the workforce, opportunities surface for partnering with industry and business. This can be challenging, however, both in terms of funding to facilitate such connections, and equipping educators to approach business. We need to help "break down language barriers between afterschool educators and business/industry." Facilitating discussion between industry and business educators—from K-12 to post-secondary—can help these groups better understand what is needed and what is possible, and help them speak the same language.

We can further strengthen the limited connections between STEM and industry by taking advantage of the many existing pathways, such as apprenticeships, associate (two-year) degrees, internships, and job shadowing.

> *A great example… is a partnership with an historically black college in Orangeberg, SC. Fifteen students went to a STEM camp and worked with researchers. They each had a project and worked in a lab. They had the chance to experience the career, bond with researchers, find out it's not boring, and be a scientist. These are the kinds of programs the field has to provide and market to kids.*

> *… Pathways need to include a connected series of learning opportunities where students at different grade levels can explore and pursue STEM interests and passions in schools and the community. Students and families need help to connect the dots to existing resources and intersections.*

Beyond helping students make the connection between STEM in the classroom and the workforce, STEM education needs to prepare students to keep up with technology.

> *Workforce demands are not aligned with what we're preparing in students.*

A data-driven approach is necessary to understand the needs of the workplace and ensure the curricula and technology being used align with the demands.

Educators, business leaders, and the community at large need to be educated about STEM education. Several interviewees noted that educators, school counselors, and families all need to understand that STEM doesn't necessarily require a four-year degree. And business needs to understand that this is a long-term investment.

Research and practice need to be more aligned

Research on STEM education exists, but as several interviewees noted, educators are not equipped to put that research into practice, and they often "lack access to research-based professional development and curricula."

> *It is essential that research be translated and available to practitioners to create meaningful change. Research on the importance of the field is still not being shared widely.*

Professional development can help keep teachers current with the latest research-based practices, but a larger struggle is the lack of professional development (PD) and funding required to bridge the gap between research and practice. One interviewee summed up this disconnect:

> *Many educators are not informed about the research, don't know what to do with it and how to translate it into practice, or don't have the time to integrate new learning with current teaching practices.*

While there was consensus among interviewees that more research is needed, they also agreed that it is important to put existing research into practice. One interviewee put it this way: "The field needs to disseminate the evidence we have so that more practice is informed by it." Another stated:

> *Now we have to figure out how to give feedback/provide PD that uses that information to improve programming. It is useful to have a standard tool because it allows comparisons across the field (formal and informal).*

STEM education is a difficult task

Interviewees agreed on the many reasons that achieving quality STEM education is a challenge. Their thoughts are described in the issues below.

a. STEM education is largely siloed despite several national initiatives and local/regional collaborations

There was general consensus among interviewees that we need to break down the silos in STEM — between K–12 and post-secondary schools; between STEM content areas, especially between science and math; between in-school and afterschool activities; and between STEM educators and those in STEM fields in the workplace (e.g., between science and math teachers and engineers). One interviewee suggested further alliances among "school and afterschool, community-based organizations, museums, and higher education." Another mentioned efforts such as the Connectory, Charles Stewart Mott Foundation's 50-State Afterschool Network, National Girls Collaborative Project, and the STEM Learning Ecosystem Initiative.

Beyond breaking down the siloes, we need to encourage better communication between constituencies and seek out opportunities for collaboration.

> *Even when there is good communication, there is little true collaboration.*

A positive example one interviewee mentioned is the work of the Charles Stewart Mott Foundation in supporting afterschool networks and emphasized the promising work of partnerships with networks and industry. There is great opportunity for "partnerships and communications to be sustained and grown."

b. Training, technical assistance and coaching are essential for quality teaching and youth programming, but opportunities are limited

Teachers need the know-how and proper resources to implement STEM programming in the classroom and stay "abreast of the most current research-based practices," but as one interviewee noted, often state education departments are "not equipped on how to implement STEM standards." One interviewee summed up the problem:

"Tech in the classroom is only as good as the training the educators have on how to use it."

One interviewee mentioned how the PEAR Institute's Dimensions of Success (DoS), a tool that looks at quality of implementation, has "helped the field look objectively at STEM programming." The interviewee went on to suggest a need to figure out how to use that information to improve the design of PD. One interviewee mentioned the idea of developing micro-credentials "aligned with DoS."

Likewise, interviewees agreed on the need for coaching, TA and accountability in teacher professional development. One interviewee emphasized the need to "build capacity of educators to teach students flexible learning skills, problem-solving and how to teach themselves."

Afterschool staff also need access to training, TA and coaching, as well as materials. As one interviewee pointed out, afterschool staff are often still in college themselves. If they were recognized as educators, the support would likely follow.

Along with professional development for both teachers and afterschool staff, some interviewees noted a need for curriculum that supports STEM. As well, they agreed that support for staff from site directors and coordinators is critical.

As with STEM itself, many interviewees mentioned a lack of funding/budget for PD. One interviewee noted that there is "more PD available…and more funding for PD, but we need a new structure to support PD in an ongoing way" for example, Click2SciencePD, ACRES.

Several interviewees mentioned the importance of recruitment to emerging STEM fields. In particular, they identified a need for leaders in the field, and an opportunity for "coaching principals and administrators of low-performing schools to go after new STEM initiatives."

c. New science and math standards get mixed reviews by educators

Several interviewees mentioned a lack of consensus in how educators view STEM and the Next Generation Science Standards. Some feel the standards (NGSS, Common Core) have only added an additional layer of work. Implementation of standards in STEM fields is a learning curve for the teachers.

It is important to get middle and elementary school[s] to focus on NGSS and Common Core so students are prepared for secondary and post-secondary education.

Informal educators have to develop the skills and confidence to deliver quality programming. This is an issue for many afterschool programs, since there is high staff turnover.

However, all agree that STEM education needs to be student-focused. As one interviewee stated, "What needs to happen next is for kids to be seen as individual learners in STEM…STEM should include play and exploration, not just curriculum and activities." They went on to state that "this is why the maker movement is so important. It gives kids the opportunity to play, explore and use different learning modes." Likewise, engineering and NGSS inclusion have helped make science relevant to kids, helping kids to "see STEM as a career."

d. Informal and formal STEM learning professionals need to connect to redefine their roles

Formal educators have less turnover but are fleeing the field. Informal educators have a high turnover rate but will show up in other places. Training, TA and coaching are essential for quality programming. PD is needed across the field but especially in afterschool. PD is focused on specific curriculum in the informal space but on improving skills/practice in the formal space.

The outstanding current trends are connecting formal and informal education and computer science. Computer science in the early grades in and out of school can be life-changing and is essential.

Educators need to build more alliances that include businesses and industry.

It would be great to build on what the kids are doing in school, but there's no communication from the school to informal educators on what is being taught.

e. In-school and afterschool need to connect

Professional development for afterschool staff could and should prepare them for working with teachers in the formal classroom. One suggestion was to provide PD for in-school and afterschool educators together; doing so would provide an opportunity for peer-to-peer learning, as well as combat stereotypes and cultural differences.

More than one interviewee suggested that, while STEM needs to be integrated into both in-school and afterschool, it's important that afterschool maintains its distinct function and purpose.

f. STEM education is grossly under-resourced

Funding issues are related to a lack of an understanding about STEM and a clear course of action. Of primary importance is helping funders understand the link between youth development and STEM, the implications of a lack of equity where STEM is concerned, and ultimately, the lack of STEM workforce. One interviewee would like to see a forum of funders gathered for a one-day workshop to design an action agenda. Agreement on common

goals and actions would provide some needed direction.

Funding alone, however, is not enough. Sustainable funding is key.

> *Sustained funding is an issue because so much time and effort goes into finding resources. Incremental funding is problematic and doesn't support longevity of programming or staff.*

> *A big concern in the field is sustainability. How do we keep doing what we do? Programs are rarely sustainable. Grants are usually project-based, not unrestricted funds. How do we keep going without burdening families for fees? There needs to be more competitive salaries for educators (in high need STEM fields).*

How STEM is taught needs to change

The classroom is a good opportunity to lift up and replicate the good work happening in the field. Interviewees focused on three areas of potential.

- First, there should be an emphasis on math that reflects the needs of those entering the STEM pipeline.
- Second, project-based learning and evaluation, where students work on "long-term projects that tie the different disciplines together…[and] bring the soft skills together."
- Third, there is a need for integrated learning, where students can "make connections across curricula and understand that math, STEM, and other subjects are interrelated and relevant to the world they live in."
- And lastly, students need engaged learning, which emphasizes experiences over activities and allows students to be immersed into real-world type projects.

As well as changing how STEM is taught, interviewees emphasized that student-focused learning is critical. One interviewee shared how teaching paradigms like Universal Design for Learning contribute to the creation of learning environments that support individual learning styles and allow students to develop their unique talents.

Focusing on student engagement, identity, youth voice, and subject matter relevance to students' lives are essential keys for learning.

We need to consider how new technologies influence learning, including how the use of networked computing and communications technologies can support learning. We should

identify best practices and innovations, as well as how DoS has helped the field look objectively at STEM programming and consider how to leverage these learnings to improve STEM programming. And it's important to focus on program quality improvement—as one interviewee said, "not just doing STEM, but doing good STEM."

a. Identify and share what is and is not working with educators to inform practice

Research on effective STEM education needs to be translated and articulated into practice for both formal and informal educators.

There is a need to build effective, reflective systems and processes.

High quality initiatives aren't comprehensive across the continuum (PreK–12 and post-secondary).

Teach students flexible learning skills, problem-solving and how to teach themselves.

b. Address math that reflects the needs of the STEM pipeline

Right from the start the math students learn should prepare them for retention in the STEM pipeline. There should be more focus and interest in math interventions and/or augmentations.

Math is scary for staff because they didn't always have a good experience. So, we need to recognize that staff are resistant and uncomfortable and find strategies to build confidence and comfort.

c. Make STEM fun

Sometimes just getting kids in their seats can be a challenge, as can maintaining enthusiasm as students move into high school. Interviewees agreed it's important to convey a message to students that STEM can be fun—not boring or hard.

Kids need opportunities to make a mess and "fail" without consequences.

d. Identify key informal learning opportunities

Afterschool is an opportunity to step into the gap created by high stakes testing and offer students experiences that develop creativity, imagination and other non-tested skills. Its focus on youth development should be the foundation for STEM programming. There is a growing awareness that the "soft skills valued by employers are essentially the same as youth development skills that have been the traditional focus of afterschool."

The formal education field is also recognizing the importance of youth development ("social-emotional") in academic achievement. While public and private funding has led to a trend

to hold afterschool accountable to similar academic goals as schools, there is a growing appreciation of the importance of getting back to the core of youth development and finding ways to measure this.

While afterschool is a viable pathway for introducing and supporting STEM education, challenges remain that can limit receptivity and effectiveness. One interviewee expressed the opinion that for some, including educators and the general public, "afterschool is still seen as child care." As previously mentioned, training and PD are limited for afterschool staff.

There is a growing "awareness that the soft skills valued by employers are essentially the same as youth development skills that have been the traditional focus of afterschool." As well, as one interviewee noted, there is increased awareness that STEM is happening outside of school (e.g., museums, science centers, Girl Scouts). Yet equity is again an issue here: not all students have the same access to afterschool programs, resulting in fewer opportunities to develop essential STEM and soft skills. Changes in federal and state policy, as well as public investment, are needed to address these equity issues.

Several interviewees pointed to the maker movement as an entry point to STEM, both in afterschool and K–12 settings. And at least one suggested looking for opportunities to integrate STEM into every aspect of students' lives.

e. Engage families

Interviewees agreed on the importance of involving parents in STEM education. One interviewee went so far as to say parents are "like magic," when it comes to building interest. We need to bridge the gap between schools, programs, and families by supporting parents and kids. We need to approach STEM as a system-wide element rather than as another agenda item overlaid onto everything else.

Recommendations

After talking with over 50 leaders in the field of STEM education, all of whom spoke with passion and commitment, it is clear that they believe the field is ready for change. They all emphasized the critical need for equity, and the need for connections—connections between research and practice, connections between formal and informal learning and, perhaps most urgently, the need for connections between themselves. As they point out, STEM education is largely siloed despite several national initiatives and local/regional collaborations.

A recommendation arose from the conversations to hold a national convening with the various constituencies to address the "silo effect," and foster ongoing connection through a Networked Improvement Community (NIC). NICs are designed to "create the purposeful collective action needed to solve complex educational problems." Through the NIC other recommendations that were made during this project could be addressed:

a. Create an interactive, lively resource where people can share with each other and have uniform access to knowledge.

b. Create a resource database where practitioners can easily get resources they need.

c. Mobilize a movement using social media to engage people in STEM in new ways.

e. Create opportunities to lift up practitioners as important leaders.

f. Make research and practice a two-way street.

As one interviewee summed it up, "the field needs to implement quality programming, build a relationship to the workforce, and sustain on-going programming. We need to value youth voice. We need to be innovative. The field needs to know that formal and informal need to work together."

INTERVIEWEES

Jen Atkinson, Maine Math and Science Alliance
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Molly Blankenship, Association of Chambers of Commerce
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Jeff Cole, Beyond School Bells
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Monique Flores, University Settlement Afterschool Program
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Merle Froschl, Director of Educational Equity at FHI 360, has more than 35 years experience in education and publishing, developing innovative programs and materials that foster equality of opportunity for students regardless of gender, race/ethnicity, disability, or level of family income. She provides leadership and oversight to projects that include curriculum development, professional development, parent education, research and evaluation. Prior to coming to FHI 360, Ms. Froschl was Co-Founder and Co-Director of Educational Equity Concepts, a national nonprofit organization whose mission was to create bias-free programs and materials beginning in early childhood. Since the 1970s she has developed outstanding curricular and teacher training models in the field of educational equity and STEM and is a nationally-known speaker on issues of gender equity and equality of opportunity in education. She is the author and co-author of numerous journal articles and book chapters.

Ron Ottinger, Executive Director, STEM Next. A national leader and expert in STEM learning, Ron Ottinger is known for his expertise in informal and out-of-school time STEM education and in building collaborations among schools, science centers, communities and afterschool programs that increase STEM learning opportunities for young people. Ron is Executive Director of STEM Next and served as past co-chair of the national STEM Funders Network. Additionally, Ron is the co-chair for the National STEM Learning Ecosystem Initiative. As the Executive Editor of STEM Ready America, Ron convened the nation's leading STEM experts presenting bold and persuasive evidence—as well as real-world examples of effective practices, programs, and partnerships on how science, technology, engineering and mathematics knowledge and skills are preparing young people to be successful in school today and the workforce tomorrow. For the past nine years, he led the Noyce Foundation which for a quarter-century was dedicated to helping young people become curious, thoughtful, and engaged learners. Prior to joining Noyce, Ron served for fourteen years as National Associate Director of the non-profit AVID Center. He was elected to three terms on the San Diego City Schools' Board of Education from 1992-2004, during a period of major reform of the school system, and was the longest running board president.

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