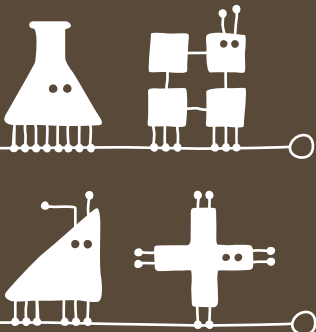


Executive summary

# STEM starts early

Grounding science, technology,  
engineering, and math education  
in early childhood



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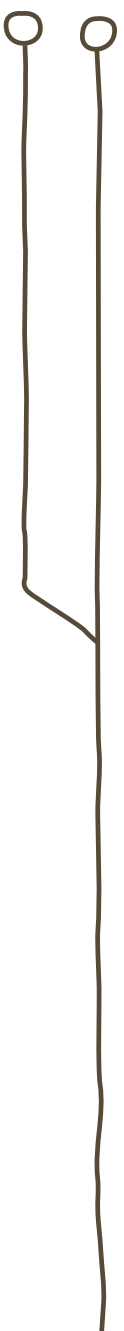
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## I. executive summary



Watch a group of very young children engaged in planting a community garden. What are they learning? They are starting to grasp fundamental concepts about science and the natural world—how much water is needed, what roots are for, how a plant’s growth changes with the seasons, and so forth. These are ideas that lay the groundwork for deeper learning about environmental science and plant biology, critical thinking skills, problem solving, and trial and error. Whether it is gardening, building forts, stacking blocks, playing at the water table, or lining up by height in the classroom, children demonstrate a clear readiness to engage in STEM learning early in life. And research from several disciplines is converging to show the importance of a new national commitment to early learning generally. Brain and skills-building experiences early in life are critical for child development, and high-quality early STEM experiences can support children’s growth across areas as diverse as executive function and literacy development.

In fact, just as the industrial revolution made it necessary for all children to learn to read, the technology revolution has made it critical for all children to understand STEM. To support the future of our nation, the seeds of STEM must be planted early, along with and in support of the seeds of literacy. Together, these mutually enhancing, interwoven strands of learning will grow well-informed, critical citizens prepared for a digital tomorrow.

So why is science, technology, engineering, and math (STEM) learning not woven more seamlessly into early childhood education? An examination of the environments and systems in which children live reveals that it is not due to a lack of interest or enthusiasm on the part of children, teachers, or parents. The barriers to STEM learning for young children are more complex, subtle, and pervasive than decision-makers currently realize. For example, in December 2013, the National Science Foundation (NSF), the Smithsonian Institution, and Education Development Center cohosted a *STEM Smart* workshop to reach early childhood practitioners. Participants were delighted to learn of evidence-based practices and tools, but many declared that they felt too constrained by current school structures and policies to apply what they were learning. They voiced concerns about the misapplication of new

education standards, disconnects between preschool and elementary school practices, and an underprepared workforce.

In response to these concerns and the growing scientific consensus about the importance of early STEM learning, the Joan Ganz Cooney Center at Sesame Workshop and New America embarked on an exploratory project, funded by the NSF, to: (a) better understand the challenges to and opportunities in STEM learning as documented in a review of early childhood education research, policy, and practice; (b) make recommendations to help stimulate research and policy agendas; and (c) encourage collaboration between pivotal sectors to implement and sustain needed changes. We also accounted for new research on widely held public assumptions about what young children need and how they learn, assumptions that may be barriers to progress. This report is the culmination of those efforts.

To gain perspectives from stakeholders in each of the early childhood areas—research, policy, and practice—we invited their input. First, we interviewed prominent early STEM researchers, policy makers, and teacher educators. Second, we conducted two focus groups with teachers, one with child care and preschool educators and one with early elementary school teachers. The insights we gained from the interviews and focus groups shaped the focus of this report; quotes from them are featured throughout.<sup>a</sup> Third, we commissioned experts to contribute to an early draft of this report, and their work is evident throughout this paper. Once a working draft of the report was complete, we invited experts from research, policy, and practice to discuss it and to help inform a national action agenda at a two-day meeting at New America in Washington, DC.

The multiple perspectives that shape this report are a reminder that no child develops in a vacuum. Children are affected by their home and school environments, the policies and practices that inform those environments, the cultural values that scaffold them, and the complex relationships between these factors. Many of the experts we consulted during this project were eager to see these factors considered more often in concert, and to see leaders from multiple sectors engaged in more consistent dialogue and collaboration. For this reason, we have presented the evidence and our recommendations using Urie Bronfenbrenner’s ecological systems theory.

## Findings

Our examination of the STEM landscape and the players in it produced five key findings:

### **1. Both parents and teachers appear to be enthusiastic and capable of supporting early STEM learning; however, they require additional knowledge and support to do so effectively.**

- Many parents and teachers experience anxiety, low self-confidence, and gendered assumptions about STEM topics, which can transfer to their children and students.
- Both groups can benefit from reconsidering STEM in the context of developmentally-informed, playful learning—like block play, gardening, and exploring puzzles—which engages their own and their children’s curiosity and wonder.

<sup>a</sup> The names of interview and focus groups participants are not revealed in the report.

- Teachers will benefit especially from a greater understanding of children’s developmental learning progressions, which they can use to tailor instruction.
- Parents and teachers are receptive to high-quality training in these areas.

## **2. Teachers in early childhood environments need more robust training and professional development to effectively engage young children in developmentally appropriate STEM learning.**

- Pre- and in-service training must be substantive, interconnected, and ongoing, and instruction must include STEM content, child developmental learning progressions in STEM, and well-modeled and practiced pedagogy.
- STEM learning is already present in classrooms and can be emphasized to both teachers and students. Teachers should be trained to think of STEM as mutually inclusive of their other teaching domains and encouraged to weave STEM seamlessly into their existing curricula and play times.
- To counter pre-existing anxiety and attitudes about STEM topics, teachers need to experience the very same hands-on, engaging learning environments and practices as we hope to see for America’s young children. Teacher educators should encourage intrinsic curiosity and joy, and model sensitivity to developmental trajectories and best pedagogical practices.

## **3. Parents and technology help connect school, home, and other learning environments like libraries and museums to support early STEM learning.**

- Parents, teachers, technology, museums, and libraries create a web of charging stations where children can power up and extend their STEM learning. Immersion in this web of STEM learning leads to STEM fluency.
- Parents can help activate a child’s in-school learning by engaging in related activities at home or outside the home.
- Museums and other learning environments are effective engagement points for both parents and children, and even brief parental instruction at these venues can have an important impact on how parents support STEM learning.
- High-quality educational media, like the Bedtime Math app and those created by the PBS Ready to Learn initiative, can support and extend school learning into the home and beyond. These tools provide an important scaffold for parents who may experience anxiety about supporting STEM learning.

## **4. Research and public policies play a critical role in the presence and quality of STEM learning in young children’s lives, and both benefit from sustained dialogue with one another and with teachers in the classroom.**

- Education policies must focus on greater alignment (the coherence of policy expectations and instruments) and continuity (connections across grade levels) across the early grades, starting with preschool.

- Researcher-practitioner partnerships, in which practitioners are involved as ongoing partners as early as the research design stage, play an essential role in supporting the iterative process of education reform.
- Current early STEM research funding appears to be skewed toward older children.

#### **5. An empirically-tested, strategic communications effort is needed to convey an accurate understanding of developmental science to the public, leading to support for meaningful policy change around early STEM learning.**

- The public holds misconceptions about STEM learning (i.e., it is for older students, children should learn other topics first, it is only important for those who especially excel in these areas, that STEM and other learning topics must be taught separately). When communicators do not carefully frame their messages, they can inadvertently activate and strengthen these misconceptions.
- The use of research-tested messages about early STEM learning makes a statistically significant, meaningful, and positive difference in the public's support for early STEM learning. A one-page Communications Guide is included on the final page of this Executive Summary.

### **Recommendations**

To successfully integrate STEM learning into early childhood education, we should consider all the systems surrounding children: We must prioritize STEM learning, while also engaging members across the child's environments. Both small and large steps can be taken, both sequentially and simultaneously, to move in the direction of greater STEM learning in early childhood.

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#### **Engage parents: Support parent confidence and efficacy as their children's first and most important STEM guides.**

- Parent educators, advocates, and researchers should reach out to parents about early STEM learning *where they are* in engaging ways, through blogs, child care centers, pediatricians, parenting magazines, and publications like *Zero-to-Three* and *Young Children*.
- Communicators should emphasize what early STEM learning actually looks like, providing a variety of clear and accessible examples of early STEM exploration (e.g., participating in a community garden, testing which bath toys float and sink) that make it clear that STEM can happen anytime, anywhere, even with minimal resources.
- Resources for parents should go beyond simple early STEM tip sheets for parents; policy makers, community leaders, and media producers should work to make comprehensive, long-term training on early parental STEM support more accessible to more parents using mobile technology.

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## Support teachers: Improve training and institutional support for teaching early STEM.

- Education leaders should ensure that efforts to improve the workforce include interconnected and ongoing STEM training and support, which is meaningfully woven into teachers' existing classroom practices.
- Teacher preparation and training programs—both pre- and in-service—should include, in interconnected and meaningful ways: STEM content, training in children's developmental learning progressions in STEM, and well-modeled and practiced pedagogy situated in the classroom.
- To counter existing attitudes towards STEM, preparation and training programs should be designed to allow teachers to experience STEM learning in the same ways that the children will. Teacher education should be driven by curiosity, should allow for tinkering and exploration, and should help teachers weave a holistic understanding of the topic areas so they can empathize and model this learning for their students.
- Researchers should disseminate findings in formats accessible to teachers, addressing teacher concerns (for an excellent example, see the new report *Early STEM Matters*). Demonstrations of successful early STEM teaching should be made more accessible, enabling educators to easily find, understand, and apply the lessons in their work.

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## Connect learning: Support and expand the web of STEM learning “charging stations” available to children.

- Leaders in museums, libraries, and community organizations should prioritize early STEM in informal learning environments. Exhibits and interactive features should engage children, and also provide direct instruction to parents on how to engage with their children around STEM features and continue their learning beyond that environment.
- Education and technology leaders should ensure digital equity by providing access to high-speed Internet and other Digital Age infrastructure for all families with young children and the professionals who work with them.
- Public and private funders should continue to fund initiatives like Ready to Learn, which support family engagement in STEM learning.
- Media officials should undertake projects that build public interest in early STEM and form a bridge for home-school learning connections.

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## Transform early childhood education: Build a sustainable and aligned system of high quality early learning from birth through age 8.

- All levels of government, along with state and community leaders, should apply existing and new funding resources to improve general early childhood teaching and quality.



- Special attention should be paid to address professional preparation, staff development, and continuing education, with attention to the vast disparities in compensation, benefits, and work conditions that exist between K–12 educators and their counterparts in early learning settings.
- Federal and state policy leaders should look to the recent report from the Institutes of Medicine and the National Research Council, *Transforming the Workforce for Children Birth Through Age 8*, for 13 important recommendations for creating the professional standards to support high quality early learning.

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## Reprioritize research: Improve the way early STEM research is funded and conducted.

- Leaders at the federal and state levels should take stock of what research is being funded on early STEM learning across agencies and research organizations, in order to identify knowledge gaps and form the basis for a government-wide strategy to support early STEM learning research and development.
- Program designers should encourage studies that enable a two-way street between research and practice. Use insights from communications science to build public will for integrating early STEM learning into early education.
- National research agency leaders should establish an interagency and interdisciplinary research program with emphasis on early learning and STEM.
- Philanthropic organizations should continue to use their research grants and convening power to engage policymakers, community leaders, and private investors in early STEM efforts.
- The National Science Foundation, an exemplary agency for early STEM funding, should take the following steps to model changes for other funding organizations: increase funding for research on STEM learning among very young children, linking the preschool years to the early elementary school years; prioritize cross-disciplinary research and dissemination on early learning; and reward innovation in design and expand project funding for applied work.

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## Across all these recommended actions, use insights from communications science to build public will for and understanding of early STEM learning.

- All stakeholders and advocates of early STEM, across all the child’s environments, should use a unified communications plan to ensure that they do not activate negative pre-existing cultural attitudes about early STEM. A one-page Communications Guide is included on the final page of this Executive Summary.
- National, state, and local leaders should convene multi-sector summits on the future of early learning and STEM to build awareness and maintain a cohesive action plan across stakeholders.



With generous support from the National Science Foundation

The complete findings and a more detailed set of recommendations can be found in the full report. <http://joanganzcooneycenter.org/stemstartsearly>





## Using effective STEM communication to frame national dialogue

*According to a series of qualitative and quantitative research studies completed by the FrameWorks Institute, many discrepancies exist between what the public thinks and what research says about early STEM. Strategies based in communication science can help to change the pictures in people's heads and enable them to see the value of research-based approaches. Here are some examples of how communications science can help galvanize public engagement and policy action to promote a shared commitment to investing in early STEM learning. See Appendix B for the detailed report.*

**Research says:** Children are born scientists.

**The public says:** Some children are born scientists, and others not. And then some are encouraged or discouraged to pursue science by their family cultures. Not every child can learn STEM subjects, nor do they need to. Not every kid needs to be a math or science kid.

**Communications science suggests:** Watch a group of very young children who are engaged in planning and planting a community garden. What are they learning? The beginnings of environmental science and plant biology, critical thinking skills, problem solving, trial and error, and more. All young children can be engaged at this level and can begin to think of themselves as "math and science kids" who can use their skills and knowledge to put food on the lunch table.

**Research says:** Children who engage in scientific activities from an early age develop positive attitudes toward science.

**The public says:** Children need to learn the "basics" first, before they are able to address more complex STEM subjects. First come reading, writing, and arithmetic. Then kids can decide whether they are ready for STEM.

**Communications science suggests:** STEM learning opportunities are like charging stations that power up kids' learning. Some kids live in charging systems with lots of opportunities for

learning, while other kids have very few. If we increase the number of STEM charging stations in kids' environments, we will see more interest and fluency in STEM. Our current system is patchy; this explains why some children never develop STEM fluency, which has significant consequences for their overall learning.

**Research says:** Early introduction to science and math "talk" helps children build STEM vocabularies and acquire the background or prior knowledge they need for deeper understanding of STEM topics.

**The public says:** Children need to wait until they can understand complicated scientific concepts. Little kids should be focusing on learning their ABCs.

**Communications science suggests:** Just as people need to be immersed in a language in order to become fluent, children, too, need to be given many opportunities in many different settings to become fluent in STEM subjects. They need real-world exposures to STEM activities, like planning a community garden. These types of activities help whet kids' appetites for STEM learning and build their skills. When we give *all* children STEM opportunities, they learn to speak fluent STEM.

**Research says:** Preschool math skills predict later academic achievement more consistently than early reading or attention skills.

**The public says:** Children who are motivated will achieve. Not everyone can be good at math. But everyone can read.

**Communications science suggests:** Developing STEM skills is an integral part of weaving strong skills ropes. As we learn new skills, our brain weaves skill strands into ropes that we can use to solve problems, meet challenges and, in turn, acquire new skills. STEM skills are vital in many different kinds of skills ropes. When kids have opportunities to collect evidence and solve scientific problems, they build strong ropes that can be used in many ways later in life.



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