

Building Early STEM Identity for Future STEM Success

Delran STEM Ecosystem Alliance

HSMC Tri-County STEM Ecosystem Consortium

South Jersey STEM & Innovation Partnership Ecosystem

Summary

STEM has the power to improve lives and communities. It is important that early childhood and early elementary education (both formal and informal settings) provide children with STEM content experiences as they lay the foundation for building children's STEM identities early on, as highlighted in the section Building Strong Foundations for STEM Literacy in the National Science and Technology Council and White House Office of Science and Technology Policy's 2018 report *Charting a Course for Success: America's Strategy for STEM Education*¹. Early STEM identity is critical for ensuring all students, especially those from underrepresented populations, maintain interest and have the skills to continue a STEM pathway throughout their middle and high school years. Important work is needed to build these STEM identities from ensuring young children experience multiple STEM exposures at home, in school and within the community.

Challenge and Opportunity

Two challenges to the development of strong STEM identities in young children are the lack of universal preschool experiences and gaps in early childhood and elementary teacher expertise in facilitating effective STEM experiences for their students. Since many STEM experiences, for children from underrepresented communities, come from community partners such as the local daycare centers, home daycare, and informal learning centers, these institutions are equally important. The disparities that exist in access to high quality Pre-K programs for underserved populations widen equity and equality issues even more. Two main levers that have the greatest potential to impact early STEM identity are improving equity in and access to early childhood education, including family education, and enhancing STEM instructional capacity of early childhood and elementary school teachers.

Increasing Equity & Access in STEM Identity in Early Childhood Education

Inequity in access and exposure to quality early childhood education, especially in STEM, is a means of perpetuating an early imbalance in the building of foundational acquisition of knowledge and skills as well as developing a lifelong passion for STEM. Maltese and Tai (2010)⁶, note in their study of 116 chemists and physicists, that the majority (65%) of the scientists interviewed became interested in science prior to their middle school years. In Archer et al's (2010)⁷ seminal article about children's science identity, researchers found that children tend to express an interest in science fairly consistently through age 10 but that sharp declines in this interest occur before age 14. These findings were mirrored in future work across STEM disciplines and emphasize the urgency in building experiences that lead to positive STEM identities in children and their teachers prior to the age of 10. Maltese, Melki, and Wiebke, (2014)⁸, illustrated that: "the importance of having both early and informal learning experiences, like visiting a nature reserve, tinkering with objects, and engaging with mathematical puzzles" all helped to craft an early and sustained STEM identity. These early and often informal exposures to STEM are proven to have long lasting and life-impacting results in the development of a child's STEM identity. Additionally, research from the University of Chicago, in the *Journal of Experimental Psychology: General*², shows that students whose parents reflected math anxiety did worse in 1st-3rd grade math as a result. When parents share their dislike, or make children believe that

they themselves aren't capable of performing math, the child believes they cannot be capable either. This creates a self-perpetuating cycle of poor math identity. Reframing the way parents/guardians speak to their children is an opportunity to increase STEM proficiency, in a very simple reframe of how we discuss learning in our homes and classrooms.

Enhancing Early Childhood and Elementary Teacher STEM Instructional Capacity

Most early childhood and elementary school teachers and after school providers are not math/science/STEM experts, with the bulk of their teacher preparation in literacy and mathematics. Even in cases where elementary or early childhood educators develop expertise in the STEM disciplines during their pre- or in-service teacher preparation, those teachers are often deployed in middle and high school positions, in an effort to fill much needed positions in the later years. High-quality, effective professional development for early childhood and elementary school teachers focused on classroom practice and connected to other areas in which they excel such as literacy, would increase their capacity and confidence in facilitating high-quality STEM experiences for their students.

Plan of Action

Increasing Equity & Access in STEM Identity in Early Childhood Education

Ensuring universal access to preschool experiences has the potential to considerably narrow the STEM experiential gaps that already exist by the time students enter kindergarten. Funding of local programming, by State Departments of Education, could be part of an update to the Every Student Succeeds Act, of 2015. "Recognizing the importance of early childhood education (ECE) in ensuring children are prepared for kindergarten and do not fall behind later in life, for the first time, the nation's comprehensive K-12 education legislation incorporates early learning across the law, including the first-ever dedicated funding stream for ECE, the [Preschool Development Grant Birth through Five program](#) (PDG B-5), which provides competitive grants for states to improve ECE coordination, quality, and access. The overwhelming evidence shows that children who enter kindergarten without the academic and social skills associated with high-quality preschool are likely to remain behind throughout their educational careers and beyond. These gaps in opportunity are difficult and expensive to close with K-12 education alone, and they can last a lifetime, particularly for children from low-income families."³ Since this year's budget agreement includes, among other increases, an \$85 million increase for the Child Care and Development Block Grant and a \$135 million increase to Head Start and Early Head Start..⁴ This funding, appropriated by the House and Senate Appropriations Committees, needs to increase exponentially to make a difference in the 56.6 million students in U.S. schools.

In addition to increasing opportunities for children to attend quality preschool across the nation, additional focus should be placed on free and accessible technology opportunities to build early STEM skills. For example, Bedtime Math offers a free app for preschool through grade 3, and research by the University of Chicago shows that even intermittent use of the app promotes long-term growth in mathematics skills, which persists even after app usage has stopped.

A Public Service Action campaign to educate parents about what STEM is, and the importance of STEM in their child's lives, including the messages parents send to their children when they express things like "I've never been any good at math." The More You Know campaign by NBC and El Poder de Saber on Telemundo, as well

as other U.S. broadcast networks with similar campaigns, namely *CBS Cares*, [Disney-ABC's *Be Inspired*](#), and PBS's *Be More*, could be the platform for sharing this important message with families. Television viewing is a nearly ubiquitous experience for children and affords an opportunity to provide clear and consistent messaging regarding STEM to children across all demographics.

As noted by scholars at American University (2020)⁵: “A lack of alignment between preschool and first grade STEM curriculums results in some children being left behind while others repeat material during a crucial period of learning development. Adequate training of preschool educators in teaching STEM concepts is critical, but another discrepancy between preschool institutions and kindergarten through 12th grade schools remains a barrier: compensation. Consider the median annual pay for US teachers as reported by the BLS:

- High school teachers: \$60,320
- Kindergarten and elementary school teachers: \$57,980
- Preschool teachers: \$29,780

Such a pay gap has made attracting and retaining highly trained teachers a perennial challenge in preschool education.”

Enhancing Early Childhood and Elementary Teacher STEM Instructional Capacity

Early childhood and elementary school teachers must be provided with high quality professional development opportunities in order to equip them with the skills necessary to create and facilitate engaging and effective STEM experiences for their students, experiences which contribute to building a strong STEM identity prior to middle school.

- One model that works is providing professional development that include hands-on experiences for teachers to engage in STEM themselves. These types of experiences help break down the teachers’ own discomfort with STEM activities, and allows teachers to begin to see possibilities for STEM activities in their own classrooms. In Delran Township Schools, the [Delran STEM Ecosystem Alliance](#) supplies professional development opportunities in their Delran Innovation & Fabrication Lab, including after school workshops where teachers learn how to [laser cut ornaments at the holidays](#), or [vinyl cut classroom signs for their rooms](#). These experiences help teachers feel excited and see the possibilities for real-world, STEM-based projects with their students.
- Leveraging partnerships with higher education institutions to ensure access is available for educators to continue to refine their STEM skills, receive advanced training and/or credentials, can provide a platform for the continuum of learning.
 - An opportunity for early childhood educators is to pursue short term courses through which they can earn micro-credentials surrounding STEM education. This will also allow early childhood educators in informal learning settings, including parents, to get trained in specific skill sets or pedagogy in their field of early childhood education.
 - Creating a peer-to-peer network for teachers to share best practices in STEM education is another valuable experience. Creating a channel for teachers to communicate between peers, regarding their proven models, whilst giving them an opportunity to earn credits could improve the total educational system. Kornack and LiBetti (2021)⁸ in *Broader, Deeper, Fairer: Five Strategies to Radically Expand the Talent Pool in Early Education* note that the Nation should look to: “Develop a single national repository for all Child Development Associate credential

(CDA) training options, including pass rates, credit articulation, and information on standardized indicators of quality [and] create a second national credential that layers onto the current CDA and indicates that educators have an increased level of understanding across key subject areas and is held in equal esteem to a four-year degree.”

- For example, a partnership between [HSMC STEM Ecosystem](#) and [The College of New Jersey](#) has offered ongoing free peer-to-peer training and professional development opportunities focused in [K-5 STEM education](#) (best instructional practices, exemplar lessons, hands-on learning opportunities to bring back to students). Through these partnerships, over 100 teachers were able to attend and bring back new learning to their students. Thinking of STEM learning impacts, if each teacher has approximately 20 students in her/his class, this would result in over 2,000 students being impacted. If each of these teachers shared these practices with 3-4 colleagues who then in turn brought these lessons into their classrooms, we are looking at exponential growth of 6,000-8,000 students. The one professional development could have a cumulative effect on 10,000 students.
- Excellent professional development builds off of teachers’ strengths. Many early childhood and elementary school teachers are highly skilled in literacy instruction. Using strategies such as *Novel Engineering* (Montgomery & Madden, 2019¹⁰), in which children use the engineering design process to build solutions to problems that come up in a text allow teachers to build on their existing strengths to integrate STEM. Likewise, professional development focused on skills that are shared in STEM and literacy (e.g. prediction, communicating findings) or STEM and mathematics (e.g. measuring, counting, analyzing data) can help teachers to start with their strengths.

Summary & Recommendations

To launch these policy goals, the Offices of the Secretary of Education, the Secretary of Health and Human Services (specifically the Office of Early Childhood Development), and the House and Senate Appropriations committees should consider:

- **Support sustained, long term funding opportunities for schools and organizations that support early childhood and elementary school STEM experiences, including funding that is not contingent upon competitive grants, as those most in need tend to have the least time and manpower to write grant proposals, further exacerbating the inequity that exists in early childhood and elementary STEM opportunities for children.**
- **Support sustained, long term funding and opportunities for teacher Professional Development, specifically focusing on STEM education, and specifically targeting early childhood and elementary school teachers.**
- **Support infrastructure that allows STEM Learning Ecosystems to leverage private-public partnerships, including K-12 school districts and higher education, to provide the best possible STEM learning opportunities for both learners and teachers.**

About the Authors

Our Ecosystems:

[DelranSTEM Ecosystem Alliance](#)

[HSMC Tri-County STEM Ecosystem Consortium](#)

[South Jersey STEM & Innovation Partnership Ecosystem](#)

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Mary Jo Hutchinson is a K-12 Supervisor of Mathematics, Business, & Robotics; Coordinator of Gifted & Talented Education; Co-Coordinator of STEM Initiatives for the Delran Township School District and the Delran STEM Ecosystem Alliance. With 20 years of experience in education, including 14 as a classroom teacher, Mrs. Hutchinson has spoken nationally on the importance of equity in access to STEM education for all students, family engagement in STEM, and the K-12 pathway for college & career readiness in STEM fields.

Pavithra Lakshminarayan is the Creator & Chief, Mindbytes, Lead of the South Jersey SIP, Chairwoman for Early Childhood Education for the NJ STEM Pathways Network. She has over 23 years of experience in learning design, teaching, designing curriculums, building and running programs from ground up. She has not only built and delivered a variety of skill development programs for children of all ages (Pre-K-12), but also beyond students through workshops for parents and teachers (state and nationally) on how they can support the learning process. She has partnered with various school districts, higher-ed and community-based organizations to architect programs to improve the interest and retention of students in Pre-K-12 STEM programs, especially in underserved and under-represented communities. She leads projects for the South Jersey STEM Innovation Partnership (a STEM Ecosystem) and for the Early Childhood Education group at the NJ STEM Pathways Network.

Ralph Losanno is the Supervisor of Technology Flemington-Raritan School District and Co-lead of the HSMC STEM Learning Ecosystem serving Hunterdon, Somerset, and Mercer counties in New Jersey. Starting his professional career in network television before returning to school to earn his masters in education, Mr. Losanno has taught in grades K-5 for over a decade, served as a district-wide technology and STEM coach for other teachers for three years, and has been the Supervisor of Technology for Flemington-Raritan School District for the past several years. Mr. Losanno has presented nationally on STEM Identity, family and community engagement, and the role of STEM in early education.

Dr. Lauren Madden is an associate professor of Elementary Science Education and the coordinator of the Environmental Sustainability Education program at The College of New Jersey, and higher education member of the HSMC STEM Learning Ecosystem. She has published more than 40 peer-reviewed journal articles and book chapters on STEM and environmental education. Her work seeks to advocate for scientific literacy and the health of our planet through teaching and learning.

Citations:

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