EDUCATION COMMISSION OF THE STATES

POLICY BRIEF

APR 2021

Teacher Training for Quality P-3 STEM Education

Jennifer Zinth and Matt Weyer

Evidence of the positive impact of science, technology, engineering and math (STEM) education on young children's development makes a compelling case for engaging early learners in regular, high-quality STEM experiences. Instruction in prekindergarten through third grade (P-3) lends itself to authentic, project-based and playful experiences that immerse learners in STEM activities and instruction. In an era of increased focus on literacy and math skills, STEM provides an interdisciplinary approach that may prove more effective for young students to acquire skills across several subject areas. For example, a 2017 literature review points to the benefits of combining literacy instruction with STEM instruction in contrast to teaching literacy in isolation.

P-3 teachers need specific training to understand what comprises high-quality early STEM learning experiences and to be equipped to offer learners these experiences on a consistent basis. However, the experiences of most P-3 educators do not prepare them to provide integrated STEM instruction, as demonstrated by the limited requirements for pre-service and in-service elementary teachers in STEM subjects — only 10 states mention science or other relevant subjects in their preparation or professional development policies.

A critical component of explicit STEM training for early educators is acknowledging and overcoming math anxiety, which has been defined as "feelings of apprehension and increased physiological reactivity when individuals deal with math." Research bears out that teachers unknowingly pass on math anxiety to their students, which can have negative implications for affected students' self-perception as STEM learners and their subsequent math achievement.

P-3 teachers need specific training to understand what comprises high-quality early STEM learning experiences and to be equipped to offer learners these experiences on a consistent basis.

States use a variety of early STEM professional development delivery models, from a single statewide hub to a cadre of trainers with different specializations serving statewide and local needs.

While teacher training is key to effective early STEM instruction, it is maximized when implemented in tandem with additional supports, such as STEM principal training and high-quality curricular resources.

Additional research demonstrates detrimental effects on young females, and effects are relatively unknown for Black students. However, effective teacher training in math can alleviate teachers' math anxiety, leading to better outcomes for students.

This Policy Brief explores the critical components for early STEM training and professional development for teachers, which includes acknowledging and overcoming math anxiety and implementing teacher training in tandem with other supports, such as principal training and high-quality curricular resources. This brief also provides examples of the types of approaches state policymakers use to create a policy environment that supports implementation of these components. This includes statewide approaches, those that blend in regional approaches and innovations in designing training content. Lastly, policy considerations are provided to build out a comprehensive approach.

Statewide and Regional Approaches

At least five states offer P-3 teachers specialized professional development to support them in delivering high-quality instruction, either in individual STEM disciplines or in integrating STEM into other content instruction. What follows are examples, drawing on specific programs or initiatives in states and the key components of each.

Statewide Hub

The mission of the **Iowa** Regents' Center for Early Developmental Education at the University of Northern Iowa includes conducting early childhood education research, developing research-based curricular resources and offering professional learning to P-3 educators statewide to support practitioner use of these research-based materials.

The Regents' Center offers a menu of professional learning sessions that are held not only at the Regents' Center, but also at school sites around the state, and to a limited extent, remotely. The focus of each session falls under any of five categories: infants and toddlers, early chemistry and engineering, early physics and engineering, early math, and classroom community building.

KEY PROGRAM COMPONENTS

- **Use an immersive, hands-on approach.** Rather than teachers passively learning STEM pedagogy and vocabulary, sessions require participating teachers to

interact with the same materials students will use in classroom investigations. Master teachers with personal experience teaching young children lead these sessions.

- **Ground curriculum and resources in research.** Regents' Center STEM curriculum builds upon research in child development and how children learn. Recognizing where children are already dabbling with STEM, teachers can bring these experiences into the classroom and create a learning environment that empowers children to engage in scientific inquiry in what can be called developmental engineering.

- **Use social media to create an ongoing community of professional learning.** The first face-to-face session on integrative STEM and literacy challenges teachers to use research-based materials to fuse together literacy instruction with science and engineering explorations. Teachers have the opportunity to continue to connect and share best practices using a private social media page.

Statewide Team of Professional Development Providers

The **Arkansas** Department of Education maintains nine statewide computer science specialists — educators who offer computer science professional development to K-12 teachers year-round. Although each statewide computer science specialist is housed in one of the regional Education Service Cooperatives (ESCs), specialists provide professional development to educators across the state.

Largely a result of statewide computer science specialists' efforts, over half of Arkansas' 30,000 public school K-12 teachers have completed some computer science training since the first specialist was hired in late 2016. These specialists were initially funded in 2015 through Gov. Asa Hutchinson's Computer Science and Computing Initiative in the Arkansas Department of Education's Office of Computer Science.

KEY PROGRAM COMPONENTS

- **Calibrate specialist and generalist capacities.** Given that the nine specialists are housed at ESCs across the state, each specialist is equipped to deliver basic computer science integration training, as well as training in their areas of specialization, to K-8 educators statewide. For example, one trainer specializes in K-8 content and integration, and one specializes in K-8 robotics.

- **Build local capacity for training and professional development.** The Arkansas K-4 computer science and computing standards call for computer science "to be taught in an integrated manner, not in isolation." To incentivize more elementary educators to complete training in order to train their peers to integrate computer science concepts across content areas, Arkansas' K-8 Computer Science Lead Teacher Bonus and Training Program offers a $1,000 bonus to any licensed K-8 educator who completes a five-day summer PD program, achieves an approved score on the computer science (CS) assessment and adds the CS endorsement to their teaching license.

Regional STEM Schools

The **Ohio** STEM Learning Network (OSLN) Innovative Leaders Institute (ILI) convenes a one-year cohort of 20-25 school teams — each comprising a K-12 principal or assistant principal and one to three teachers at their school — to learn from each other in addressing a team-selected problem of practice. During each professional development session, the cohort tours a model Ohio STEM school to witness STEM learning in action. It then breaks into grade-level groups to discuss curriculum, school culture and climate, and leadership, including teacher leadership, and apply the group's collective expertise in addressing their team's chosen issue. During the 2020-21 school year, teams have participated in virtual tours and group discussions.

KEY PROGRAM COMPONENTS

- **Apply design thinking to a community of practice approach**. ILI utilizes design thinking, defined as "an iterative process" in which participants work to understand the problem of interest, "challenge assumptions, and redefine problems in an attempt to identify alternative strategies and solutions that might not be instantly apparent with [participants'] initial level of understanding."

- **Recognize the value of a team approach.** Initially, ILI trained individual building representatives but later changed to a team-based approach, leading to more successful integration into classroom practices and allies in their building to support them with STEM integration.[1]

- **Encourage the support to extend beyond the year-long training.** Following the yearlong training, ILI participants can reach out to OLSN for continued support in addressing STEM problems of practice.

1. Dee Martindale and Stephanie Johnson, Ohio STEM Learning Network, in a Zoom interview with author, February, 2021.

Network-Based Professional Development

The **Tennessee** STEM Innovation Network (TSIN) offers teacher professional development through its Professional Learning Series. Most commonly, schools seek professional development on issues the school needs to address in order to attain the Tennessee STEM School Designation. TSIN tailors the content of each training to each participating school's identified needs and desired outcomes. TSIN leadership noted that Tennessee elementary schools are increasingly requesting training on project-based learning construction and the design process, perhaps from a growing realization that STEM integration can begin in the elementary grades rather than wait until middle or high school.

TSIN also applies a hybrid regional-statewide approach in designating an area of specialization for each of the seven Regional STEM Innovation Hubs. Each hub provides teacher professional development to educators in its region and around the state on its topic of expertise.

KEY PROGRAM COMPONENTS

- **Apply a "flipped" classroom approach:** As trainings moved online, participants were asked to view and reflect on a short video before the training. One goal of the approach was to improve the effectiveness of the training time by coaching and facilitating in real time in breakout rooms, where participants could apply the skills demonstrated in the video.
- **Apply the design process to current and future trainings:** Rather than providing hypothetical scenarios for teachers to work on, trainers ask teachers to bring their lesson plans, calendars, etc., to receive support from the trainer and other participants. Following each training session, trainers debrief and adjust the content or delivery as needed.

A Train-the-Trainer Approach

The **Maryland** Center for Computing Education (MCCE), housed in the University System of Maryland, was statutorily established in 2018 to develop a Maryland State Computer Science Education Implementation Plan, to serve as a statewide hub for quality computer science instruction and to provide pre-K through 12 teacher professional development. In 2019, the center allocated $100,000 to launch the Elementary School CS Coaches' Program, to train a cadre of elementary educators statewide to serve as computer science instructional leaders in their school and

district. Coaches provide best practices in computer science instruction to other teachers in their building and district, and engage in a community of practice to share challenges and successes with their fellow coaches.

KEY PROGRAM COMPONENTS

- **Ground training in state standards and a commonly used computer science platform.** All of the training program's curriculum is tied to the state's K-12 Computer Science Framework and Standards and linked to a platform such as Scratch Jr.
- **Support training with online resources.** SparkCS, a Maryland grassroots computer science advocacy organization, has developed ECSNet, an online vehicle to support coaches' training and the teacher professional development they deliver, as well as ongoing classroom practice. Coaches vet resources, and the resources that pass their systematic review are posted to ECSNet.
- **Customize training around what motivates teachers.** MCCE personnel have pointed out that teacher onboarding needs to help educators understand the value of integrating computer science into ongoing instruction. If a teacher is most interested in Lexile measures, for example, training can be focused on computer science approaches demonstrated to improving students' reading.

State Innovations in Designing Training Content

In addition to state-by-state structural differences in who offers early STEM teacher professional development where and how, some states have developed innovations in their approach to developing their early STEM teacher professional development content. What follows are state examples.

Vetted K-12 STEM Curricular Options

The **Iowa** STEM Scale-Up Program, hosted by the Iowa Governor's STEM Advisory Council and funded primarily by an annual legislative allocation, invites STEM education program providers to propose their program for scaling to P-12 education providers across the state. A review process identifies programs with proven effectiveness in engaging diverse learners and supporting students' academic success. Selected programs are made available to applicants, P-12 schools and out-

of-school educators interested in bringing an approved STEM Scale-Up program to their students. STEM Scale-Up programs offer awardees teacher professional development and, as applicable, teacher resources and classroom materials, technical support, and other learning supports to help implement the program. Since 2012, STEM Scale-Up has provided up to 100,000 Iowa P-12 learners each year with access to high-quality STEM programming.

Professional Learning Grants

Utah STEM Action Center's Professional Learning Grant program awards funding to applicants, both schools and districts, to support professional learning opportunities that address a locally determined area of need. Professional development activities may include "coaching, mentoring, self-reflection, off-contract work, and effective professional learning communities (PLCs)." The scoring rubric for evaluating Professional Learning Grant applications requires funded professional learning activities to align with the statutory definition of effective professional learning, to enhance teachers' leadership skills and to demonstrate alignment with a school's long-term plans. Program outcomes data indicate participating teachers overwhelmingly agree that STEM Professional Learning participation has increased their STEM content knowledge and pedagogy, and has helped them guide students to be more effective communicators, collaborators, critical thinkers and self-directed learners.

Training on Inclusivity

The **Idaho** STEM Action Center, the Boise State University (BSU) College of Education and the Boise State University Children's Center collaborate on professional development to support early childhood professionals in inclusive STEM experiences for children receiving special education services and those who are not. BSU developed 10 instructional videos on such topics as early STEM learning with infants and toddlers, the importance of family involvement, ways to address teacher STEM anxiety and an introduction of engineering challenges within inclusive settings.

Policy Considerations

Research demonstrates that well-designed and effectively implemented professional development can lead to improvements in teacher practice and student achievement. However, early childhood teachers vary significantly in their experience in teaching STEM and their awareness of its importance, giving rise to a unified call for action for professional development. Policymakers may consider the following options to support their P-3 teacher training efforts to achieve the goal of ensuring equitable access to high-quality, ongoing early STEM learning experiences.

- **Improve connections between pre-K and kindergarten.** States can set students up for success in their transition into kindergarten by exposing them to the concepts that will help them see themselves as STEM learners. Joint professional development for pre-K and kindergarten teachers is one approach states are increasingly taking up. These opportunities could provide a solid platform to infuse STEM education and make connections across pre-K and kindergarten.

- **Identify and address policies that pose barriers to STEM integration.** State or district policies that require a dedicated block of daily reading or math instructional time can keep teachers from delivering the integrated instruction in these subjects. Researchers have long advocated for an integrated STEM curriculum rather than teaching subjects in isolation.

- **Create principal buy-in and training.** To lead a school that embraces STEM integration, building-level administrators need an understanding of the research base supporting P-3 STEM integration and training to acquire the essential knowledge, skills and dispositions to provide effective instructional leadership.

- **Develop tools that demonstrate the natural connections between standards in two or more disciplines.** Such resources can identify science, math, engineering or computer science standards that lend themselves to instruction on specific K-3 English language arts standards, social studies, literacy and vice versa.

- **Create a state-supported online repository of high-quality P-3 STEM curricular and instructional resources and materials.** For example, the Utah STEM Action Center hosts a STEM lesson library that includes state standards-aligned lesson guides for kindergarten through second grade and third grade through fifth grade students across multiple STEM disciplines. And while many P-3 classroom explorations in STEM can be conducted with everyday classroom resources, STEM equipment lending libraries, such as the Utah STEM Action Center's STEM Equipment Library, can support STEM learning experiences that require specialized materials.

Final Thoughts

Research underscores the benefits to P-3 learners of ongoing exposure to developmentally appropriate STEM experiences. Only a handful of states have policies and funding in place to begin ensuring all P-3 teachers are well-versed in this research — and prepared to engage all learners in ongoing, effective early STEM learning. The experiences of these early adopter states can offer helpful direction to states interested in leveraging P-3 teacher professional development to increase equitable access to high-quality STEM experiences for the youngest learners.

Acknowledgments

The authors wish to thank the following individuals, whose valuable insights informed this brief:

- **Becky Ashe**, director of professional learning and innovation, Tennessee STEM Innovation Network
- **Kathy Benson**, retired elementary teacher and STEM education consultant, Immersive STEAM
- **Megean Garvin**, director of research, Maryland Center for Computing Education
- **Tami Goetz**, executive director, Utah STEM Action Center
- **Stephanie Johnson**, senior relationship manager, Battelle
- **Dee Martindale**, district STEM coordinator, Lakewood Schools, and director, Lancer Virtual Academy
- **Dianne O'Grady-Cunniff**, director, Maryland Center for Computing Education
- **Anthony Owen**, state director of computer science education, Arkansas Department of Education
- **Beth Van Meeteren**, director, Regents' Center for Early Developmental Education
- **Jeff Weld**, executive director, Iowa Governor's STEM Advisory Council
- **Kellie Yates**, collaboration and program development manager, Utah STEM Action Center

About the Authors

Jennifer Zinth

Jennifer is a national expert on STEM/computer science and high school to postsecondary transition issues. As a consultant and previously in a leadership role at Education Commission of the States, she has worked with numerous state leaders, nonprofit organizations and philanthropies to develop a wide range of policy supports, including in-state and cross-state convenings, 50-state policy compilations, state policy gap analyses, recommendation reports, customized memos, presentations and legislative testimony. Jennifer's expertise includes state legislative, statutory and regulatory tracking and analysis; qualitative evaluation; policy evaluation; report development; and in-person and virtual meeting development and execution. Contact Jennifer at jennifer.zinth@gmail.com.

Matt Weyer

As a senior policy analyst, Matt focuses on early learning issues. Prior to joining Education Commission of the States, Matt worked for over four years covering early learning issues for the National Conference of State Legislatures, earned his doctorate in educational leadership and policy studies from the University of Denver and was a kindergarten teacher in a bilingual classroom for Denver Public Schools. When Matt is not working, he can be found snowboarding or mountain biking in beautiful Colorado. Contact Matt at mweyer@ecs.org.