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7-2011

Focusing a New Lens: STEM Professional Development for Early Education and Care Educators and Programs

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Recommended Citation

Stone-MacDonald, Angi; Bartolini, Vicki L.; Douglass, Anne; and Love, MaryLu, "Focusing a New Lens: STEM Professional Development for Early Education and Care Educators and Programs" (2011).

Curriculum and Instruction Faculty Publication Series. 4.

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***Focusing a New Lens:
STEM Professional Development for Early Education and Care
Educators and Programs***

Final Report, July 2011

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***“Science, Technology, Engineering and Mathematics are not just disciplines to be mastered
but are instead reflections of the whole child's development and evolving conversation
with the world . . . (Greg Nelson, President of MA Association of Early Childhood
Teacher Educators).”***

Background on the Project

Together with experts in the field, eighteen STEM Fellows developed this set of recommendations to the state and the field for improvements to professional development for early childhood educators in STEM education. This project was a collaboration between STEM Fellows, STEM faculty, University of Massachusetts Early Childhood faculty and was funded by the Professional Development Partnerships in Regions 4 and 6. This seminar came out of a grant partnership between Regions 4 and 6, the Readiness Centers, Massachusetts Department of Early Education and Care and the UMass Boston. STEM Fellows were selected from the two regions to represent advanced early childhood educators across the range of ages served, communities served, and program types. STEM Fellows examined the gaps that exist and ways to strengthen STEM education.

FOCUSING THE FIELD: INTRODUCTION

The purpose of this groundbreaking grassroots report is to engage early childhood educators and policy makers in understanding the urgency and importance of early childhood educator professional development in STEM education (Science, Technology, Engineering, and Mathematics). This report focuses on the teaching of children birth to five years old and out of school time students.

STEM...Science...Technology...Engineering...Math. These are not curriculum topics that early childhood educators traditionally call to mind when planning activities. However, the evidence supporting the importance and emphasis on STEM education in early childhood is overwhelming. Children are engineers, problem solvers, and collaborators at heart- with boundless potential for leadership, creativity and innovation. Filling their days building and creating with blocks and manipulatives, wooden sticks and Legos, finger-paints and clay, they naturally seek solutions to challenges, discuss multiple options and, when necessary, start over! Essential to supporting, extending and deepening children's STEM learning is the presence in classrooms of well-prepared educators, in both content and appropriate instructional strategies. Thus, this report urges educators to view their role, the children they teach and the early childhood environment through a powerful "new lens," one that focuses on STEM education and professional development.

Policy makers will find that this report offers:

- 1. *General recommendations for professional development***
- 2. *Age and discipline specific recommendations***
- 3. *State, program, community & family, and individual educator action items***

1. General Recommendations for Professional Development

ADJUSTING THE FOCUS: EDUCATOR PROFESSIONAL DEVELOPMENT

“We need to answer some big questions: What do teachers need to know and be able to do? How can we effectively build a workforce that has this capacity?” (Ingrid Chalufour, 2010)

Recommendation 1a: The Need for Professional Development

According to data collected by the Massachusetts STEM Initiative (2009), *there is an increasing demand* for a highly skilled workforce while, at the same time, there exists *decreasing interest* in STEM fields nationally and in Massachusetts. The report suggests the need for fostering interest in STEM careers as early as preschool, because high school may be too late. It is recommended that educators deepen their understanding of the sequence of math and science skill development and look for opportunities to integrate engineering and technology into their curriculum. Educators must be supported in the realization that it is *their* presence in the classroom that will improve science, technology, engineering and mathematics experiences for their young students.

After reviewing relevant literature and working with STEM experts, the Fellows agree with the Wheelock College Aspire Institute’s Strategic Report (2010) that many early childhood educators are not well-prepared in content knowledge and related instructional skills, including adequate preparation in the four STEM disciplines. Reflecting on their own experience, the Fellows note, *“As twenty of these professionals sat in the room to learn about STEM, the fear was a reality. As a population, many of us are uncomfortable with the subjects.”* Thus they question: Is it possible for early childhood educators to teach effectively when they are unsure of the subject matter? And, without the professionals who teach young children enjoying STEM, is it likely that they will inspire their students in STEM learning? Historically, early childhood educator preparation has focused on reading and writing literacy, so much so that STEM preparation has often been ignored. This focus is no longer sufficient for the world children will enter. To prepare students to engage with the “flat” world of the 21st century, the STEM Fellows argue for relevant curriculum with high expectations for all students and, thus, for their teachers. The Fellows agree that, “Increased knowledge in the areas of science and math will not only help improve educators’ confidence and enthusiasm, but will

also help them to build connections with technology and engineering, thereby creating strong programs for STEM in early childhood” (Ahern, et al., 2011).

“Teachers do their best work when the culture of their program defines quality teaching and expects and supports this vision (Ingrid Chalufour).”

The ways in which STEM have been presented to educators affects the ways they in turn present information to students. A lack of knowledge, coupled with a fear of these fields of study, plays a key role in how involved teachers and, thus, children become in their interactions with STEM.

The Fellows recognize that higher education programs provide limited pedagogical content knowledge training in science, technology, engineering, and math curriculum for young children. Review of the research also indicates that there is an insufficient pool of higher education early childhood faculty who can provide adult learners with STEM education. Beyond higher education, program administrators also report the need for sustained, in-depth training and technical assistance to develop and facilitate a content-rich, inquiry-based math, technology, science and engineering curriculum. Furthermore, as teachers begin to apply new learning, they must be supported by skillful mentors and knowledgeable administrators to truly transform their practices.

To better understand the needs for professional development, a group of Fellows developed and disseminated a survey to 64 early childhood educators, who represent the range of settings and ages across the field. Respondents work with children from infancy through school age. Respondents reported frequent use of STEM activities. However, only two respondents expressed knowledge of inquiry based learning or recognized that opportunities for learning STEM concepts, processes and skills were embedded in everyday classroom activities. The Fellows did not ask the respondents to define the activities offered, however, but did ask about the materials provided in their settings. Responses suggest that the materials most respondents have on hand offer limited applicability to open-ended inquiry, with the exception of blocks. This perception is supported by sample comments in response to the question: “Please describe how you are doing an effective job of teaching science, technology, engineering or math.” Table 1 provides selected responses to this question.

Table 1: Select Responses

	Select responses
Technology	Computer labs to help teach how to use the computer (school age)
Math	Calendar, counting, patterns in everyday things, simple additions (kindergarten) Cubes, blocks, worksheets (PreK-K) Lots of counting, passing out, adding (pre-K)
Engineering	Legos (PreK-K)
Science	Big unit on taking care of the earth, composting, recycling, reusing, reducing, unit on snow, oceans (kindergarten) School garden program with curriculum about seeds and growth (pre-K)

Further study is needed to confirm the impressions from this limited survey conducted by the STEM Fellows. The survey confirms the need for in-depth and ongoing professional development. Fortunately, respondents also indicated their interest in STEM professional development.

Recommendation 1b: Professional Development Models

The Fellows researched models for best practices in professional development, particularly in STEM education. First, the Fellows cite identify six characteristics of effective professional development for educators from the literature (Keengwe and Onchwari, 2009; Rodriquez and Knuth, 2000). These include: 1) intentional connection to student learning, 2) hands-on use and practice, 3) on-going time for planning and curriculum integration and collegial learning, 4) administrative support and resources, 5) technical assistance (fix/replace broken materials, etc.), and 6) built-in evaluations of effectiveness (if not working identify what needs to be changed).

A second recommended model, *Foundations of Science Literacy or FSL*, a course developed by Education Development Center, Inc., recognizes the critical role teachers play in planning content rich curriculum and facilitating meaningful science experiences. The FSL approach builds teachers' pedagogical knowledge within a supportive framework of instruction, mentoring, and curriculum. This model uses an inquiry-based approach for science teaching and learning with educators, modeling what teachers can then use with young children. Through both direct instruction and hands

on learning, educators develop conceptual background knowledge to deepen their understanding of the underlying science of their investigations. Significant attention is also paid to developing educators' abilities to facilitate children's meaning-making through intentional conversations and documentation of their observations, theories, and questions (Hoisington, 2010).

A common foundation for STEM curriculum in all age groups begins with professional development that revisits the fundamental principles of how children learn and develop. For math, professional development should begin with an understanding of the developmental sequence of math skills. For science, technology and engineering, educators must build a strong foundation in the inquiry model of learning and, at the same time, develop content knowledge in the physical and natural sciences. For all STEM disciplines teachers must develop the skills to engage children in STEM inquiry, observe and assess children's thinking and skill development, and then, of utmost importance, develop strategies to scaffold next steps to learning.

High quality professional development models encourage educators to introduce STEM content vocabulary to young students. Improving educator modeling of the language used for framing, perspective taking, and problem solving will increase students' use of STEM vocabulary in meaningful contexts.

General Recommendations: Guiding Principles for Professional Development

“This professional development model builds on the essential understanding of children’s intellectual capacity (Ingrid Chalufour).”

After examining the gaps that exist in professional preparation, as well as investigating strategies for strengthening STEM education, the STEM Fellows developed the following set of general recommendations and guiding principles to the Massachusetts Department of Early Education and Care for the systemic transformation of educator professional development. As with this report, the recommendations should be developed in collaboration with the early childhood community and STEM experts.

Recommendations:

1. Create a 21st century educational **vision** that recognizes and values the competencies of all children from birth through school age and one that highlights the importance of STEM education for the youngest members of our society.
2. Respect and publicly acknowledge the important **role of the teacher** in STEM education.
3. Embed into curriculum frameworks and guidelines what research suggests regarding *how* children learn STEM **concepts, processes and skills** as well as *which* concepts, skills and processes are appropriate for each stage of development to promote best teaching practices.
4. Develop, fund and implement high quality comprehensive **STEM professional development** programs for early childhood educators to include:
 - respect for the **diversity of the early childhood workforce** (background knowledge, scheduling, transportation, etc.)
 - emphasis on **inquiry** as a path to learning in STEM areas
 - competent **mentoring** and **administrative support** to ensure sustained change in professional practices
 - professional development **study groups** to share documentation and reflections
 - **alignment** of early childhood professional development with recommendations from such groups as NAEYC, NCTM, NSTA and EDC
 - in-depth offerings for **ongoing study** of the four STEM disciplines conducted with discipline experts who are also knowledgeable of early childhood education
5. With families and caregivers from diverse backgrounds, develop a community understanding about the interrelatedness of **science, technology, engineering and mathematics** with language, reading and writing.

2. Age and Discipline Specific Recommendations

A NEW LENS REQUIRES A TRANSFORMATIVE VISION

“Even a simple teething ring can be used as a science lesson to show the difference in solid and liquid, when the ice melts to water in a clear ring (Adrade et al., 2011).”

Children's learning in the early years has long-lasting outcomes. Therefore, early childhood educators must be knowledgeable of the expectations for specific age groups and corresponding developmental milestones. To effectively scaffold learning at each age, educators must provide ample time for exploration and manipulation; observe and listen to children's comments and questions; model, challenge and coach children during their interactions; encourage children to reflect and self-correct; provide children with the language for mathematic and scientific properties, processes and relationships; play games with mathematical and scientific content; and encourage peer interaction and collaboration (Epstein, 2006).

In the following sections, the STEM Fellows provide specific recommendations for infants and toddlers, preschoolers, and out of school time students and educators.

Recommendation 2a: Infants and Toddlers (birth – 3 years)

The cognitive development of infants and toddlers is influenced by the quality of their relationships with adults. Healthy relationships provide a secure base from which children grow and learn. Two key components for supporting learning for this age level include: 1) a stimulating, nurturing and safe environment where infants and toddlers can explore using all of their senses, and, 2) educators who respond positively to extending children's natural learning experiences.

Educators need to provide opportunities for children to explore both the indoor and outdoor environments. In the indoor environment, for example, infants and toddlers can engage in simple cooking activities to experience cause and effect, measurement, and the concepts of full and empty. Outdoor explorations provide opportunities for young children to build collections and to bring those collections back into the classroom for closer investigations and classification.

To enhance STEM learning experiences for infants and toddlers in both the indoor and outdoor environments, the Fellows make the following recommendations:

- build on children's intuitive understanding of quantity and cause and effect
- offer shared technology time with an adult
- provide access to toy versions of digital devices (cell phones, cameras, laptops, CD players)
- provide access to toys that roll, including vehicles and balls

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- read and talk about information books, including science and math concepts
- engage children in opportunities that involve repeating actions
- encourage children to explore properties, discover shapes and patterns, discriminate tastes, smells and sounds
- allow children to discover how things work by handling, shaking and banging
- provide push and pull toys

Recommendation 2b: Preschool (3-5 years)

“By providing materials and serving as a sounding board and guide, educators can encourage young children to follow through on their ideas while challenging them to think about how things work, what materials work best, problems that arise, and alternate solutions they might explore” (Worth & Grollman, 2003).

As with infants and toddlers, teachers can support preschool children’s learning by setting up the environment for the exploration of materials (Hoisington, 2010). Guided by their teachers, preschoolers then begin to make sense of objects, using their prior knowledge combined with new ideas and theories. Inquiry continues when teachers support open conversations and children’s representations. Preschoolers must be empowered to observe phenomena, make predictions, develop theories about their observations, reflect, and re-design if necessary. As children engage in problem solving, teachers scaffold their learning by asking challenging questions to guide play schemes. Children need to know that there is not always a right or wrong answer, for in reality there are often many solutions to a challenge. These critical understandings start with the attitudes and perspectives of knowledgeable and confident educators.

Dramatic Play centers offer problem-solving opportunities for using math, literacy, and technology and engineering concepts (i.e. labs, workshops, inventions, veterinary hospitals, and flower shops). Additionally, simple switches and “cause and effect” toys add technology to the block and manipulative centers. Wood and recyclable building materials become engineering projects with the additions of gears, hinges, and pulleys.

Teachers should provide appropriate materials to support the learning of numbers and operations, spatial sense and geometry, as well as place value.

Specific recommendations for preschool educators also include:

- provide experiences that are conducive to scientific inquiry and/or the engineering design process
- make screens available with interactive media such as *Puppet Pals* for the iPad (Malone, 2011)
- give children access to mouse and keyboard applications on the computer (NAEYC, 2011)
- use digital cameras (still and video) to document, assess and reflect on children's learning
- provide support and assistive devices for children with different learning needs and styles
- read and discuss information books related to current activities in the classroom

Recommendation 2c: Out of School Time (5 -13 years)

“As the director of a school-age after school program that serves upwards of 150 students per year in a largely low-income, immigrant community in Boston, I have seen firsthand the ways in which education can open doors that are oftentimes otherwise closed to this population. My program serves students between the ages of 5-13, which means that, in order to effectively serve such a diverse program population, my staff must be able to provide intentional learning opportunities within the STEM subject areas at multiple levels.” (STEM Fellow)

Professional development opportunities for out of school time programs increase their capacity to support effective STEM learning. Though program educators often work part-time schedules, multiple jobs, and earn significantly lower wages than their full-time teaching peers, their work in the out of school time setting is no less important. The hours between school dismissal and when most parents are finished with work and/or school are prime time for experiential learning opportunities. By providing diverse professional development opportunities for out of school time educators, their students' STEM learning will improve.

Professional development tailored to the needs of out of school time programs for older elementary and middle school-aged students is vitally important. Far too often professional development

trainings are shaped with early elementary in mind, leaving teachers of older students having to modify the content. STEM professional development should be adapted to the out of school time community by providing training on how to connect the Massachusetts Curriculum Frameworks to out of school time activities and opportunities. By explaining how the frameworks and various activities and projects connect, students will receive instruction towards consistent educational goals.

Specific recommendations for out of school time programs include:

- Align activities with the Massachusetts Curriculum Frameworks (2011)
- Develop curriculum based on the Massachusetts Department of Early Education and Care Preschool guidelines (2003, 2010), as well as curricula available from such educational organizations as the Boston Children’s Museum for out of school time programs
- Enhance professional knowledge regarding assessment and documentation
- Plan developmentally appropriate activities rich in scientific inquiry
- Plan activities using the engineering design process
- Provide support and assistive devices for children with different learning needs and styles
- Introduce technology applications that foster creativity (NAEYC, 2011)
- Read and discuss age-appropriate information (non-fiction) books related to current activities in the classroom

Providing strong, intentional, capacity-building professional development opportunities for out of school time programs will enhance the likelihood that educators working in these settings will provide meaningful, appropriate STEM learning opportunities for their students.

Recommendation 2d: Science, Technology, Engineering, and Mathematics Content Recommendations

Contributing STEM expert Greg Nelson states:

“It is important to clearly identify both the differences and similarities of the processes of mathematical problem solving, scientific inquiry, and engineering and design technology. Such clarity then leads to appropriate integration. In the young years there is enormous overlap, but it is important that teachers have a sense for the

differences. In planning professional development offerings, it is important what skills and knowledge are needed for the four STEM domains and what is specific to each STEM domain.”

In the following section, the STEM Fellows propose discipline specific recommendations for Science, Technology, Engineering and Mathematics.

Science

Since young children are infinitely curious about the world around them, science instruction must involve extended exploration and engagement with objects, items, and phenomena found in the natural environment (Chalufour, 2010). Teachers must utilize the scientific process or inquiry cycle so that children develop a structured framework to investigate their world. The goal of science instruction in the early childhood years is to encourage children’s understanding of this process as well as to build upon their current understandings or schema about the world. Through this planned and purposeful process, children will make meanings about their environment. This process requires time to reflect, document, and share with others.

Early childhood teachers do not need to be experts in science. However, they do need an understanding of science content, the inquiry framework, and how to engage children in purposeful, intentional activities and conversations about their discoveries. Teachers do need to become expert *questioners*, posing thought-provoking, open-ended questions that will extend children’s learning, while observing and assessing throughout the learning process. Science can and should be embedded in children’s daily work, and can and should be integrated with other domains such as math, language and literacy.

Specific recommendations for the professional development of educators in science include:

- Provide training for educators and administrators to learn to create environments and activities that are conducive to discovery and inquiry
- Encourage focus on one topic for in-depth, extended inquiry

Technology

The STEM Fellows note that, according to the National Research Council (1996), the goal of science is to understand the natural world, whereas the goal of technology is to make modifications in the world to meet human needs. Children need opportunities to use technological tools (from pens, Velcro and flashlights to computers and video cameras) to learn about and solve problems encountered in their world. The STEM Fellows refer to *Blocks to Robots – Learning with Technology in the Early Childhood Classroom* (Bers, 2007) which outlines the following steps for children’s problem solving: identify problems and constraints, brainstorm solutions, construct prototype, test and evaluate, redesign, and communicate the solution.

Incorporating technology into the classroom will enhance and extend literacy, math and science learning (NAEYC, 2011). A multitude of technology learning materials are available to educators to promote learning, including: computers/internet, software, smart boards, cause and effect and electronic toys, digital technology – digital cameras, video – DVD players, CD players, microscopes, etc. Unfortunately, many teachers are reluctant to use these materials because they are not confident about how to effectively use them as teaching tools. Thus, materials are underutilized and promising learning opportunities are often missed. Despite these challenges, the integration of technology in the classroom offers children with different learning styles and abilities options for learning and communication.

The Fellows recommend that early childhood educators engage in the following teaching behaviors regarding technology:

- Implement the use of open-ended applications, unique to the particular device, that require children’s active engagement
- Provide safe access to the internet to enhance and support the curriculum
- Emphasize co-participation between adults and children (NAEYC 2011)
- Encourage the use of photographs by both children and adults to further discussion and learning

Though technology is potentially beneficial in early education settings when used in a developmentally appropriate manner, Karen Worth, noted science educator, cautions, “. . . it is

mainly direct experience that children need and inappropriate use of technology as a substitute for that experience is a danger.”

Engineering

Developing an understanding of the engineering design process allows educators to provide students with a framework with which to solve problems. Through challenge questions and parameter setting, students may invent solutions, complete projects to meet a defined need, and expand their working knowledge of the interaction between materials that results in technology. Using such models as the Five Step Engineering Design Process (Boston Museum of Science), teachers can encourage their students to test and revise their models. Recording outcomes and reflecting on how, what, where, when and why a project worked, or did not work, will enhance children’s critical thinking skills.

“By providing materials and serving as a sounding board and guide educators can encourage young children to follow through on their ideas while challenging them to think about how things work, what materials work best, problems that arise, and alternate solutions they might explore”. (Worth & Grollman)

The STEM Fellows make the following recommendations:

- Encourage documentation and discussion of children's experimentations focusing on the strategies used
- Train administrators and educators in the engineering design process, which involves identifying a problem, brainstorming solutions, constructing a prototype, testing and evaluating, designing, and communicating solutions.
- Provide learning opportunities and materials for children to create and design technological projects based on their interest and ideas (Bers, 2007)

Mathematics

Mathematics is the process of solving problems. The STEM Fellows suggest that teachers need to allow students opportunities to solve math problems independently, providing guidance rather than responses to their problems. As with science, the Fellows argue that it is more important to allow

children the opportunities to attempt to answer questions rather than to ensure the answers are always correct. Research has shown that young children are able to acquire and practice early math concepts; however, many early childhood teachers have not received adequate math education nor do they possess strong understanding about children's development of math concepts (NAEYC, 2002).

Teachers need to enhance children's natural interest in math as well as model and nurture positive attitudes towards math while, at the same time, building a strong conceptual foundation. To accomplish this, teachers need to understand student's current schema related to math concepts and build upon their knowledge and experiences.

Specific recommendations for early childhood educators include:

- Listen as children verbalize their thinking and reasoning as well as comment on children's actions that illustrate their thinking. Provide hints to children so they can learn to self-correct (Epstein, 2007)
- Extend math study to embrace the five areas cited in the 2011 Massachusetts Curriculum Frameworks in Mathematics (grades Pre-Kindergarten to 12):
 1. Counting and Cardinality (pre-kindergarten and kindergarten)
 2. Operations and Algebraic Thinking
 3. Measurement and Data
 4. Geometry
 5. Number Operations in Base Ten, for kindergarten and higher grades

3. State, Program, Community & Family, and Individual Educator Action Items

FRAMING A STRONG FOUNDATION

To realize a 21st century vision that recognizes the competencies of all children to learn STEM concepts, processes and skills, it is imperative that experts, businesses, communities, policy makers, families and educators work together. Policy decisions to develop, fund and implement a comprehensive system of professional development for early childhood educators contributes towards this vision. According to Dr. Greg Nelson, President of the Massachusetts Early Childhood

Association for Teacher Educators (MAECTE), any short- and long-term decisions must ultimately be linked:

“... to a broader set of early childhood initiatives (the work of the regional Readiness Centers; the rollout of Common Core standards; ... the Race to the Top Early Learning Grant ...)”

To effectively integrate STEM education into the daily early childhood and out of school time curriculum requires affirming the vital role of the teacher and subsequent investment in professional development. Envisioning, developing, resourcing and implementing a high quality comprehensive plan will take time, collaboration and resources. In the meantime, however, the STEM Fellows endorse the following short-term action steps that state policy makers, program administrators, community organizations and individual educators can take to begin the process of integrating STEM education into the early childhood and out of school time programs.

Action Steps: At the State Level, Massachusetts can:

- Embed into curriculum frameworks and guidelines what research suggests regarding *how* children learn STEM concepts, processes and skills as well as *which* concepts, skills and processes are appropriate for each stage of development to promote best teaching practices.
- Align early childhood professional development with recommendations from such organizations as NAEYC, NCTM, NSTA , and EDC.
- Identify funding sources for systematically expanding STEM professional development.
- Review early childhood courses required by higher education programs.
- Promote emphasis on inquiry as the path to learning in STEM areas.
- Demonstrate respect for the diversity of the early childhood workforce (background knowledge, scheduling, transportation, etc.) in planning professional development offerings.
- Provide in-depth offerings for the ongoing study of the four STEM disciplines conducted with discipline experts who are knowledgeable of early childhood education.
- Provide competent mentoring and administrative support to insure sustained change in professional practices.
- Provide professional development study groups to share documentation and reflections.

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- Host regional statewide sessions to review, assess and reflect on STEM education efforts.
- Provide funding opportunities for early childhood providers to take children to area museums, aquariums, and other community resources. Funding, in the form of grants, allowances, or discounts, is especially important for communities serving low-income families.
- Compile and disseminate a list of free and low cost STEM resources to all early childhood practitioners, communities and families.

Actions Steps: Early Childhood and Out of School Time Programs Can:

- Support educators in the use of inquiry-based pedagogical approaches for facilitating children's learning.
- Prepare educators in the method and use of documentation as a teaching tool; support documentation efforts by providing cameras, printers, etc.
- Provide hands-on workshops for educators on specific curricular topics
- Assess available community resources.
- Host family meetings with hands on learning opportunities to build understanding of learning through inquiry. Encourage parental involvement in STEM related discussions and family experiences to build background knowledge.
- Hold Make & Take Sessions to assist educators and families in preparing materials that facilitate STEM learning.

Action Steps: Communities Can:

- With families and caregivers, develop a community understanding about the interrelatedness of science, technology, engineering and mathematics with reading and writing. Work together to publicize this mission.
- Promote understanding of families as their child's primary educator
- Build partnerships with local community service projects, church groups, garden clubs, nature centers, museums, aquariums, colleges, libraries, and businesses to sponsor family STEM events.

Actions Steps: Individual Educators Can:

- Collaborate with other educators to gain new ideas and resources.
- Welcome children's questions.
- Allow children to use their senses while they explore and examine materials, gather information, develop conclusions, and act upon their discoveries.
- Document children's observations. Encourage children's to document their own observations.
- Provide age-level appropriate information books, using resources from such programs as the Boston Museum of Science Teacher Partner Program.
- Invite a carpenter, engineer, gardener or computer technician to your class.
- With children, build ramps, roll balls and record what happens.
- At the water table, provide buckets, clear tubing, funnels, and squirt bottles.
- Play math games.
- Go outside. Bring pails, bug catchers, magnifying glasses, and cameras.

CONCLUSION: A VIEW FROM THE BOTTOM UP

Though a high quality professional development system is recommended, the STEM Fellows also recommend that early childhood educators should reconsider their current practice as it relates to STEM education. This includes deepening their understanding of the sequence of math and science skill development and looking for opportunities to integrate engineering and technology concepts into their curriculum. Additionally, educators must hone their observational skills to be able to reflect on the STEM processes and content they see students engaging in. Finally, they must be supported in the realization that it is *their* presence in the classroom that will improve science, math, engineering and technology experiences for their young students. High quality professional development in STEM education will influence how they view their role, the children in their settings, and the early childhood and out of school time environments with a “new and sharper lens.”

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