Infant and Toddler STEAM: Supporting Interdisciplinary Experiences with Our Youngest Learners

ERIC BUCHER, STEPHANIE PINDRA

How do science, technology, engineering, arts, and mathematics (STEAM) relate to infants and toddlers? What can educators do to support the development of infants' and toddlers' STEAM-related skills? The authors—a professional development facilitator with experience in early STEAM and an Early Head Start (EHS) teacher who cares for and educates infants and toddlers—along with a cadre of eight other EHS teachers, were curious about finding answers to these questions. This article shares highlights from our journey together as researchers to explore infant and toddler STEAM, make connections between children's interests and our intentional teaching practices, and create spaces that promote developmentally appropriate STEAM learning.

Teacher researchers

We approached our study of infant and toddler STEAM as teacher researchers, embracing the idea that early childhood professionals are not only teachers but also learners (Henderson et al. 2012; Edwards & Gandini 2015; Bucher & Hernández 2016). Teacher research emphasizes key inquiry skills such as collaborative dialogue, collection and review of teaching data, and opportunities for reflection on practice (Newman & Woodrow 2015; Marsh & Gonzalez 2018). Through teacher research, teachers can study their professional work, connect theory to practice, and hone their teaching craft through inquiry (Dana 2013; Marsh & Gonzalez 2018).

To do this, nine EHS teachers participated in consistent and continuous professional development that was embedded in their jobs and relevant to their specific contexts and children they served. The teachers—Stephanie (coauthor), Ana Sofía, Sally, Ada, Ellen, Adriana, Rosalind, Mae, and Marie—had a range of experience and qualifications. Four

participants held infant/toddler Child Development Associate (CDA) credentials, three held associate degrees in early childhood, and two held bachelor's degrees in child development or elementary education. All the teachers were female and were between the ages of 35 and 53.

As a group, we met regularly to study early childhood development, observed and documented children's learning, reflected on their data, and created action plans based on children's interests. This process helped us to find out more about what STEAM means in the early years, how foundational learning skills relate to STEAM, and what we could do to enhance STEAM in infant and toddler classrooms.

What does STEAM mean in early childhood?

Let us start with what we know about child development. Using the following case studies, which are based on the research group's many observations from experience as preschool and toddler teachers, take a moment to reflect on how young children from infancy to kindergarten engage with learning:

> Curious about what she sees, 9-month-old Emilia scoots toward a flicker of sunlight glimmering from a reflective decoration on the window. She reaches her hand out to try and touch it. She turns her hand around in the flashing light. She clenches her fist a few times and looks up at her teacher, who is observing closely nearby. Emilia furrows her brow as if silently asking about what is happening. Her teacher responds, "It looks like you noticed the light reflecting. Are you trying to catch it, I wonder?"

> Two-year-old Alfonso goes immediately to the large cardboard container boxes that his father has placed on the living room carpet for him to explore. Alfonso stacks them as high as he is tall. As he reaches to place another box on top, the stack topples over. Alfonso pauses, and then points and giggles, "Fall down." His father replies,

"Gravity!" Alfonso stacks the blocks again. This time, he swipes his hand against the middle, and down the boxes fall. Alfonso laughs again and says, "It fall down!" His father encourages him to continue building, deconstructing, and testing out his theories.

Marcus and Sherice, both 5 years old, are investigating the natural desert items displayed on a mirror on an outside table. The teacher has taken time to prepare a variety of natural objects, watercolor paint, permanent markers, and clipboards with paper outdoors as a provocation for children to engage in artistic representation. Sherice chooses to use a magnifying glass to look at the details of a delicate flower more closely before sketching her observations. She uses watercolors to try to capture the hues she sees. Marcus explains to Sherice that he is helping her mix colors to make a shade of red that matches the flower.

What do these case studies have in common? They reveal children's emerging theories about the world and how they can interact with it. They show children as active, competent, and engaged learners. They also show that learning occurs in the context of relationships with materials and with a nurturing caregiver who is attuned to the child's strengths and interests.

Infants and toddlers are young scientists conducting research to find out how the world works.

For infants and toddlers, the exploration of STEAM is part of the development of lifelong learning skills in cognitive development and approaches to learning. Early STEAM experiences help develop wonder, persistence, communication, problem solving, and mental flexibility. It is important to note that these skills depend on a child's developmental abilities and interests and on the extent to which they have a caring, supportive, and secure relationship with their caregiver (Copple & Bredekamp 2009; NAEYC 2019).

When children enter kindergarten, it is very beneficial if they have started to develop foundational learning behaviors such as risk-taking in exploration, close observation, hypothesis formation, analysis based on evidence, and communication. Preschoolers exhibit these skills in a variety of ways. They may use different tools or materials to investigate natural items in their outdoor learning space, identify cause and effect relationships with ramps and pathways in the block center, or represent their ideas through art materials offered in the writing center.

What does STEAM look like in infant and toddler development?

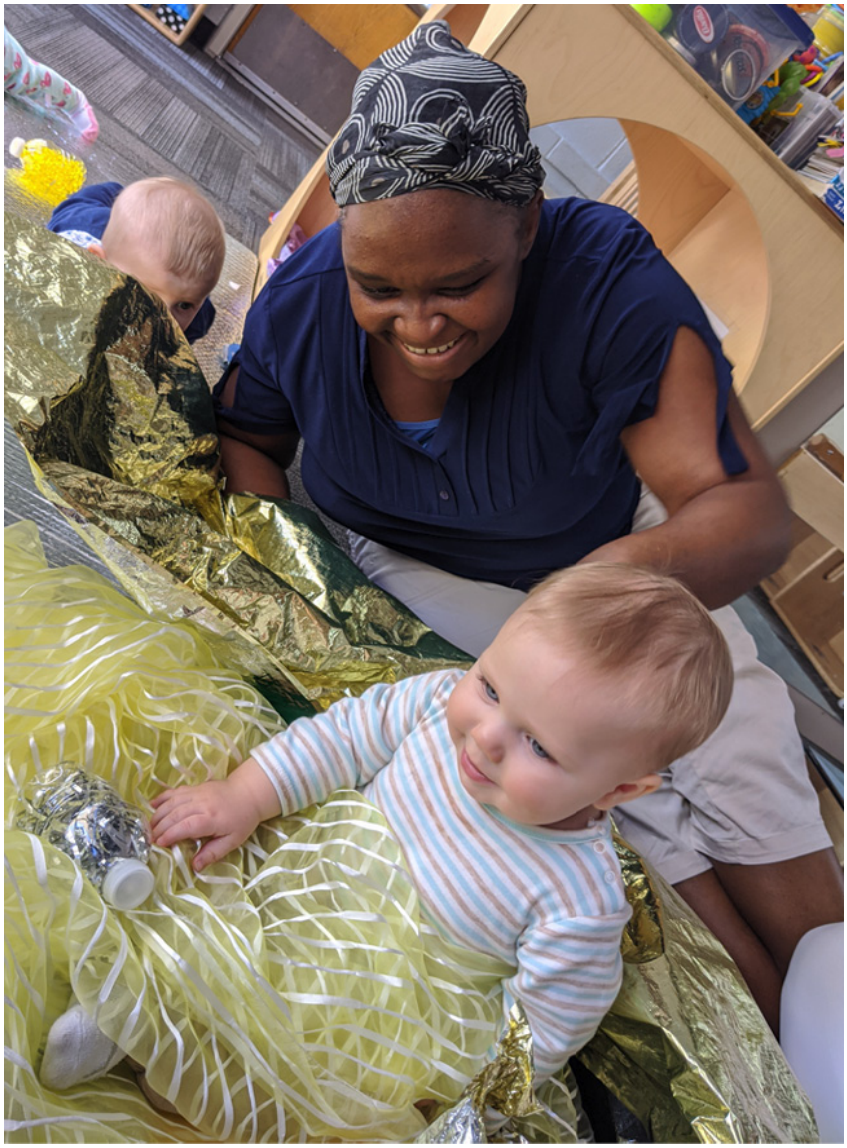
Infants and toddlers are young scientists conducting research to find out how the world works. They are curious to figure things out, like whether they will get the same result when they drop a toy—and have you pick it up—over and over. Infants and toddlers understand concepts, such as cause and effect, that help them build sophisticated reasoning skills and conceptual knowledge (National Research Council 2000; USDHHS 2015; Bucher & Hernández 2016).

Infant and Toddler Approaches to Learning/Cognitive Development Related to STEAM

Developmental skills	**Observable infant and toddler behaviors**
Executive function	• persists • develops confidence • approaches new experiences and takes risks • maintains focus and sustains attention
Initiative and curiosity	• shows eagerness and curiosity as a learner • initiates actions with materials
Creativity and inventiveness	• experiments with different uses for objects • is flexible in actions and behavior

Developmental skills	Observable infant and toddler behaviors
Exploration and discovery	• uses senses to explore • observes • makes things happen, watches for results, repeats • uses understanding of causal relationships
Memory	• recalls and uses information in new situations
Reasoning and problem solving	• uses a variety of strategies, imagination, and creativity to solve problems • uses spatial awareness to understand properties of objects and their movement in space • applies knowledge to new situations

For example, a 2-year-old might roll a ball down a slide to observe what happens. Then the toddler might retrieve the ball and test it out again. If the ball repeatedly bounces underneath the slide, disappearing from view, the child may exhibit problem-solving skills by changing their movement or rolling the ball up the slide instead, adjusting their approach based on what they see happen. These careful observations and flexibility in thinking show the toddler's growing understanding of cause and effect and of the properties of materials. When paired with a sense of curiosity to explore and the openness of the teacher to support these types of experiences, infants and toddlers start to figure out how things work and how they can use their bodies to make things happen.



What is unique about caring for infants and toddlers is that their cognitive skills and approaches to learning are made visible through their interactions, not just through their verbal communication. This requires caregivers to closely observe young children to pick up on cues around what interests them and what ideas they may be testing. Infants and toddlers have many expressive nonverbal forms of communication through which caregivers can see their interests, curiosities, approaches, and hypotheses. Children's observable actions—smiles, hand and body movements, gestures, mimicry, eyebrow furrows, and eye focus—reveal their understandings of the world (Gambetti & Gandini 2014).

The chart on page 18 shows developmental skills and observable actions related to infants' and toddlers' STEAM learning (USDHHS 2015).

Supporting STEAM engagement with infants and toddlers

We know that learning happens within the context of safe, secure, positive relationships (Copple & Bredekamp 2009; Kovach & Patrick 2012). Through a learning environment that values and actively supports healthy relationships, educators can provide learning provocations that foster STEAM knowledge and skills. The following suggestions from the EHS teachers are offered as complements to build upon nurturing relationships and enriching environments for infants and toddlers.

- **Respect children as capable and competent learners.**

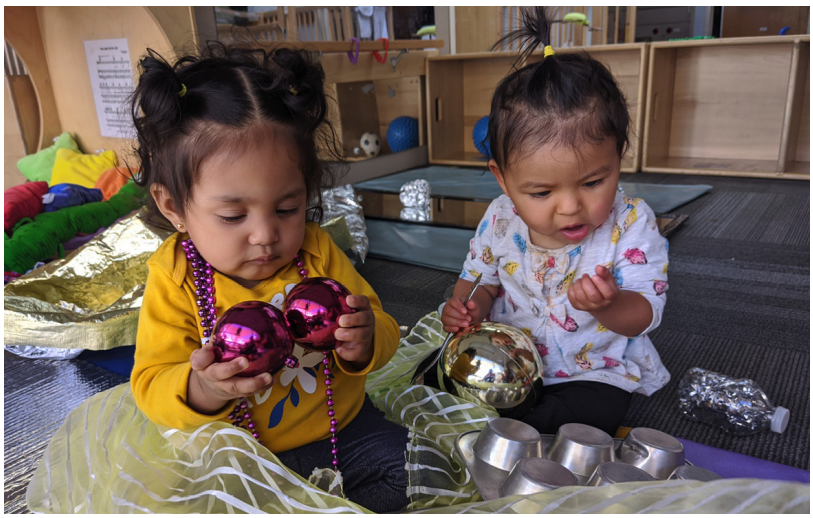
Young children are capable of observing, interacting, and building hypotheses about the world. “The children were always doing science, we’re just focused on it now,” Ana Sofía explained. By carefully examining their documentation of the children’s actions, the EHS teachers noticed—repeatedly with surprise and awe—that toddlers were intentional, competent, and had their own ideas. “People say they will get bored or have short attention spans,” said Stephanie. “But when you observe closely, children are capable of more than we might think.”

- **Set up an environment that supports curiosity and engagement.** The teachers saw themselves as STEAM researchers. They engaged in key inquiry components: collaborative dialogue, collection and close examination of evidence related to classroom teaching, and reflection about their teaching practice (Schroeder Yu 2012; Newman & Woodrow 2015; Marsh & Gonzalez 2018). This required the teachers to step back and allow infants and toddlers to explore with minimal intervention. This "intense awareness" was what influenced them to select their instructional strategies, approaches, and provocations (Reggio Children 2016, x).

Resources for Supporting STEAM with Infants and Toddlers

Age	Developmentally appropriate materials	What educators and children can do together	Vocabulary to include in conversation
Birth to 9 months	Mirror on the floor for looking at or crawling over Pots, pans, wooden spoons, and unbreakable bowls Recycled materials made from plastic or metal Reflective materials near windows/light sources	Offer materials that support children to try a variety of movements (grasp, pinch, roll, squeeze, turn around, mouth, chew) Hold infants closely in lap and point out pictures in books while reading together Model observation skills: "I notice you are interested in using your hand to tap the top of the pots. It makes a metal ringing sound!" Place interesting objects just out of reach so infants problem-solve their movement	Approach Curious—*You are a curious researcher.* Explore Hypothesis Initiative Learning Notice Observe Persist—*I can see that you are persisting to try to solve that problem.* Problem-solving/ problem-solver Reasoning Research—*I am conducting research by observing and documenting your interactions.* Test Theory Think Understand
8 to 18 months	Various shapes, sizes, and types of cardboard boxes Recycled materials made from plastic or metal Light table with interesting transparent objects	Scaffold children to be challenged based on their skills by offering questions: What do you plan to do with these objects? What do you notice? Set up a space where children can engage in light and shadow play. The light table may include interesting objects from the child's home and culture	
16 to 36 months	Sand or water with various measuring, stirring, and sifting tools Rubber balls and open spaces for rolling Stackable or connectable items like cardboard boxes and blocks	Place out materials and tools with which toddlers can scoop, pour, fill, and repeat with varying movements Be open to allowing children to construct and deconstruct materials (e.g., building up and knocking down) by describing what you observe about cause and effect	

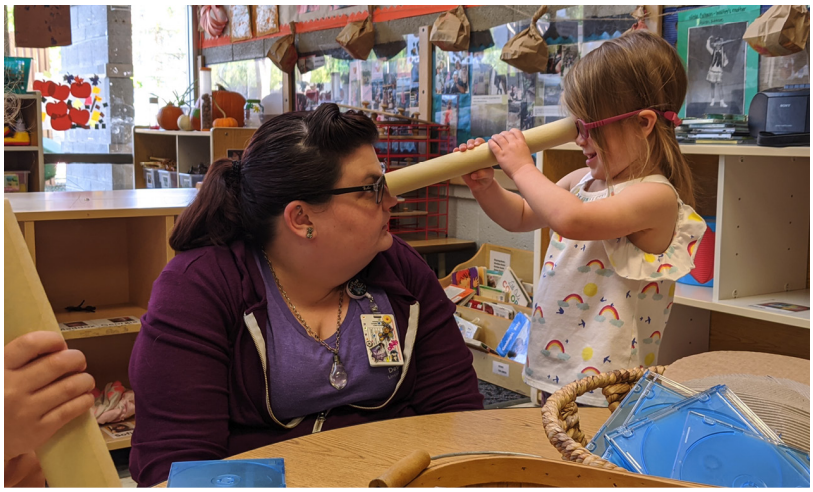
- **Observe and document children's interests and skills.** To capture evidence of STEAM skills, teachers can observe and document children's interactions by taking photos, recording anecdotal notes, and reflecting on their observations (Pelo 2006). Stephanie advised, "It was hard not to do teacher things and interject, but teachers should instead pause to observe children closely. It will help teachers understand what the children are thinking and what they are interested in." Marie added, "The most organic way of learning is their pure interest." Ada said, "We're researching what the children are interested in." They described their responsibilities as the need to listen, observe, reflect, research, and develop activities based on the data. They used their reflective study of documentation to organize thoughts as a method to look at what children were doing and to meet the children where they were.



- **Offer interesting materials and experiences that promote problem solving, creativity, and persistence.** The teachers intentionally selected materials by reflecting on their observations of children interacting in the classroom. The teachers learned that children were engaged for long periods of time when materials and support from teachers were relevant to their interests. Through their research, the EHS teachers noticed infants and toddlers were interested in observing (looking at and touching fresh flowers, translucent materials, and recycled pieces on a light table), building (stacking with and sitting in boxes), and filling and dumping (putting interesting items inside containers and scooping and pouring sand and water).

- **Participate in reflective professional development.**

Quality professional development loops between the teacher's experiences with children and external sources of content; teachers can observe and interpret evidence of children's learning through pedagogical reflection in response to children's, and their own, learning (Scheinfeld, Haigh, & Scheinfeld 2008). In order to better understand how children were developing STEAM knowledge and skills, the EHS teachers reflected on their documentation together. First, the teachers looked for details in the photos and videos. Next, they discussed their observations, which made them more aware of what was happening with children's development in the classroom. They asked several questions of their work, such as Is the experience engaging? How do the children solve problems? How did the materials or my interactions impact children's learning? Then they planned their next steps regarding materials and engagement strategies. Stephanie explained, "For me, reflection was the most important part. It forced me not only to look at how children were learning but also how I was learning to better guide them." Having developed hypotheses about what the data in their observations meant, the teachers planned to scaffold, reassess, and adjust the environment based on what they learned.



- **Plan for intentional interactions.** Building on children's interests and evidence of their current abilities and understandings, extend their learning by being intentional. Sally and Ada suggested that educators
  - Ask open-ended questions like What do you notice? Why do you think that happened? What are you thinking about?
  - Provide new, interesting, developmentally appropriate materials for children to investigate, such as placing mirrors on the floor for an infant's tummy time or offering a basket of recycled materials to toddlers outside. Teachers may also offer the same materials or variations of a material that infants and toddlers show interest in exploring. For example, teachers can offer smaller boxes to add on to large cardboard boxes that were offered previously.
  - Model vocabulary and conversations during interactions with children. Teachers might describe the green color of paint a toddler mixed as the hue of steamed broccoli, use phrases like "I think. . ." and "I wonder. . . "
    or narrate their actions during diaper changing (La Paro, Hamre, & Pianta 2007).

It is through these intentional interactions that teachers enhance children's inquisitiveness, observation of details, and descriptive communication. The table on page 20 offers additional ideas for materials and interactions that support infants' and toddlers' STEAM learning.

Conclusion

Even very young children are capable of developing STEAM knowledge and skills. As the EHS teachers gathered and reflected on data to get to know children's interests and abilities, their practices and interactions became individualized to the unique strengths of the infants and toddlers in their classrooms. For our youngest learners, STEAM is the development of essential cognitive skills and approaches to learning—like problem-solving, persistence, creativity, and reasoning—that are crucial to early learning and that serve as the foundation for more complex understanding of STEAM content as children

grow older. When teachers provide safe and secure relationships, practice intentional observation and documentation strategies, and approach their teaching as learners themselves, they can enhance infant and toddler STEAM.

References

Bucher, E., & M. Hernández. 2016. “Beyond Bouncingthe Ball: Toddlers and Teachers Investigate Physics.” *Young Children* 71 (3).

Copple, C., & S. Bredekamp, eds. 2009. *Developmentally Appropriate Practice in Early Childhood Programs Serving Children from Birth through Age 8, 3rd Edition*. Washington, DC: National Association for the Education of Young Children.

Dana, N.F. 2013. *Digging Deeper into Action Research: A Teacher Inquirer’s Field Guide*. Thousand Oaks, CA: Corwin.

Edwards, C.P., & L. Gandini. 2015. “Teacher Research in Reggio Emilia: Essence of a Dynamic, Evolving Role.” *Voices of Practitioners* 10 (1): 89–103.

Gambetti, A., & L. Gandini. 2014. “Reflections on the Little Ones of Silent Movies: Make-Believe with Children and Fish at the Infant-Toddler Center.” *Innovations in Early Education: The International Reggio Emilia Exchange* 21 (2): 22–25.

Henderson, B., D.R. Meier, G. Perry, & A.J. Stremmel. 2012. “The Nature of Teacher Research.” *Voices of Practitioners* (2012): 1–7. https://www.naeyc.org/sites/default/files/globally-shared/downloads/PDFs/resources/pubs/Nature%20of%20Teacher%20Research.pdf.

Kovach, B.A., & S. Patrick. 2012. *Being with Infants & Toddlers: A Curriculum that Works for Caregivers*. Tulsa, OK: LBK Publishing.

La Paro, K.M., B.K. Hamre, & R.C. Pianta. 2007. *Classroom Assessment Scoring System Manual: Toddler*. Baltimore: Brookes Publishing.

Marsh, J.P., & D. Gonzalez. 2018. “Practitioner Research: Inquiry that Impacts Adolescent and Adult Literacy Learning and Teaching.” *Journal of Adolescent and Adult Literacy* 62 (2).

NAEYC (National Association for the Education of Young Children). 2019. Developmentally Appropriate Practice in Early Childhood Programs Serving Children Birth to Age 8, rev. 2nd draft. Position statement. Washington, DC: NAEYC.

National Research Council. 2000. *How People Learn: Brain, Mind, Experience, and School: Expanded Edition*. Washington, DC: The National Academies Press.

Newman, L., & C. Woodrow, eds. 2015. *Practitioner Research in Early Childhood: International Issues and Perspectives*. London: Sage Publications.

Pelo, A. 2006. "Growing a Culture of Inquiry: Observation as Professional Development." *Exchange* (November/December 2006): 50–53. http://ececompsat.org/docs/as-cultureofinquiry.pdf.

Reggio Children. 2016. *The Hundred Languages in Ministories: Told by Teachers and Children from Reggio Emilia*. Worcester, MA: Davis Publications.

Scheinfeld, D.R., K.M. Haigh, & S.J.P. Scheinfeld. 2008. *We Are All Explorers: Learning and Teaching with Reggio Principles in Urban Settings*. New York: Teachers College Press.

Schroeder Yu, G. 2012. "Professional Development Through the Study of Children's Interests: The Use of Collaborative Inquiry and Documentation Protocol Among Early Childhood Teachers." PhD diss., University of Illinois at Urbana-Champaign. https://bit.ly/38HGi4l.

USDHHS (United States Department of Health and Human Services). 2015. *Head Start Early Learning Outcomes Framework*. Washington, DC: Administration for Children and Families.

Photographs: courtesy of Eric Bucher

Audience: *Administrator (director or principal)*, *Faculty*, *Family*
Age: *Infant/Toddler*
Topics: *Child Development*, *Other Topics*, *Technology and Media*, *STEM*, *YC*

ERIC BUCHER

Eric Bucher, EdD, works to advance equity in early childhood as executive director of the Arizona AEYC. Eric collaborates on initiatives to elevate the voices of early childhood professionals, provide reflective professional development, and increase access to quality early learning. ebucher@azaeyc.org

STEPHANIE PINDRA

Stephanie Pindra has been an Early Head Star teacher in New Mexico and Arizona and has worked with extraordinary toddlers for more than 20 years. She has recently delved into research focusing on toddlers and science.

1313 L St. NW, Suite 500, Washington, D.C. 20005 | (202)232-8777 | (800)424-2460 | help@naeyc.org