Early Math - Math Matters[1]

Mounting evidence indicates that the mathematics knowledge children develop before entering elementary school is critical to later academic achievement. Children begin Kindergarten (K) with huge differences in their exposure to math and their opportunities to develop their math skills, which can lead to significant differences in achievement that typically persist through the grades. Opportunities to learn math in children's early years are important because early learning forms the foundation for later learning. Math activities are also important because they help young children develop executive function skills—working memory, attention, and cognitive self-regulation—that are important to development in both the academic and social realms. Young children's learning in mathematics is firmly rooted in their experiences in the world, which is why play is important to supporting the development of children's informal math understandings. High-quality and effective instruction draws and builds on these understandings.

A central goal of instruction, which is well represented in the Common Core standards, is to develop flexible and conceptual understanding, reasoning, and problem-solving skills which form a strong foundation for later math learning. This goal has implications for early childhood teaching practices. The *California Mathematics Framework* explains that students learn best when they are actively engaged in questioning, struggling, problem solving, reasoning, communicating, making connections, and explaining in the context of authentic problems.

The National Council on the Teaching of Mathematics offers the following principles of teaching:[2]

1. Establish mathematics goals to focus learning
2. Implement tasks that promote reasoning and problem solving
3. Use and connect mathematical representations
4. Facilitate meaningful mathematical discourse
5. Pose purposeful questions
6. Build procedural fluency from conceptual understanding
7. Support productive struggle in learning mathematics
8. Elicit and use evidence of student thinking

Observers of an effective classroom are likely to see children using manipulatives to solve problems, frequently working in dyads or small groups. The tasks are presented as games or playful activities, and may be differentiated to be appropriate for children's varying learning needs. Rather than teaching a particular method for solving a problem, the teacher asks children to figure out different ways to solve problems on their own or

[1] Deborah Stipek, Stanford University
[2] National Council on the Teaching of Mathematics (2014). Principles to Action: Ensuring Mathematical Success for All.

with classmates, and asks them to explain or show how they arrived at their answer or how they know it is correct. The teacher pays close attention to children's strategies in solving problems and asks questions to further surface and build on their thinking.

Observers are also likely to see the teacher asking children questions as they engage in free play: "How many blocks are in your tower? Whose tower is the tallest? Shortest? How do you know?" She may also embed math in everyday routines: "If you are first in line, raise your hand. Who is second? Third? Fourth?" The teacher may repeat questions in children's native language if it is not English, or if she doesn't know their language, use gestures and props to facilitate their understanding, such as raising her hand high when she says "tallest" and lowering it when she says "lowest."

Regarding the content, early math is more than counting and shapes. All of the following interconnected strands should be covered:[3]

1. **Number and Operations:** Numbers can be used to tell us how many, describe order, and measure; they involve numerous relations and can be represented in various ways. Operations are mathematical processes or activities used to model real-world situations or solve problems.
2. **Data Analysis:** Data is used to organize our world. Data analysis includes classifying, sorting, comparing, counting, and measuring. We use data to make sense of the world, inform our questions, and solve problems.
3. **Measurement:** Comparing and measuring can be used to specify "how much" of an attribute (for example, length, weight, heat) objects possess. Measures can be determined by repeating a unit or using a tool.
4. **Geometry:** Geometry can be used to understand and to represent the objects, directions, locations in our world, and the relationships between them. Geometric shapes can be described, analyzed, transformed and composed and decomposed into other shapes.
5. **Algebra:** Patterns can be used to recognize relationships and can be extended to make generalizations.

Taking a step back to look at the larger context of teaching young children mathematics, the National Association of the Education of Young Children offers the following general principles:[4]

- Young children, no matter their age or background, bring with them diverse cultural and linguistic resources and robust mathematical understanding to learning situations.

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[3] Adapted from Clements, D. H., & Conference Working Group. (2004). Part one: Major themes and recommendations. In D. H. Clements, J. Sarama, & A.-M. DiBiase (Eds.), *Engaging young children in mathematics: Standards for early childhood mathematics education* (pp. 1–72). Erlbaum.

[4] Turrou, A., Johnson, N., & Franke (2021). *The Young Child & Mathematics*. Third edition. National Association for the Education of Young Children, Washington DC.

- The role of early childhood educators is to build on children's intuitive ideas about math, drawing on the resources that children bring as productive learning supports. This can occur across a range of informal and formal spaces in playful, intentional, and developmentally appropriate ways.
- Research documents the development of children's mathematical understandings in early childhood. Attending to the details of children's thinking through the lens of research-based principles supports teachers in recognizing what children understand and making instructional decisions that build from what children know and can do.
- Mathematics identities are socially constructed in ways that privilege and marginalize groups of individuals differently; challenging the status quo of who gets positioned as "good at math" is critical to disrupting inequities.
- Deep mathematical learning occurs through multiple modes of communication—spoken, language, gesture, movement, tools, and written representation together play an important role in supporting mathematical development for all children, especially dual language learners.
- Early childhood educators are professionals with vast experience and knowledge about supporting the development of young children. As lifelong learners, they should be supported to try new things, take risks, innovate, and reflect as these processes are critical to long-term learning that is generative.

The table below provides additional resources to inform early math instruction and development.

Resource	Description	Source
California Early Math Project	The California Early Math Project promotes awareness of the importance of math in early education (birth to age eight), provides tools to parents and educators, and collaborates with agencies and organizations working to advance mathematical learning.	Visit the California Early Math Project website at https://www.earlymathca.org.
California Mathematics Framework (2002)	The framework is important guidance designed to help educators align classroom teaching with California's rigorous math learning standards. It also provides guidance for mathematics learning for all students at all levels of math and ensures students have a wide variety	For the *California Mathematics Framework*, visit the California Department of Education (CDE) website at https://www.cde.ca.gov/ci/ma/cf/.

Resource	Description	Source
	of options including pursuing Science, Technology, Engineering, and Math (STEM) in college and career.	
Young children's mathematics: Cognitively guided instruction in early childhood education	This book helps teachers recognize opportunities for making connections to math for young children.	Citation: Carpenter, T. P., Franke, M. L., Johnson, N.C., Turrou, A. C., & Wager, A. A. (2016). *Young children's mathematics: Cognitively guided instruction in early childhood education*.
Learning and teaching early math: The learning trajectories approach, third edition	This book summarizes current research into how young children learn mathematics and how best to develop foundational knowledge to realize more effective teaching.	Citation: Clements, D. H., & Sarama, J. (2014). *Learning and teaching early math: The learning trajectories approach*. Routledge.
Development and Research in Math Education (DREME)	The DREME network focuses on math from birth through age eight years, with an emphasis on the preschool years. Network members and affiliates collaborate to conduct basic and applied research and develop innovative tools that address high-priority early math topics and inform and motivate other researchers, educators, policymakers and the public.	Visit the DREME network's website at https://dreme.stanford.edu/.
Choral counting and counting collections: Transforming the PreK-5 math classroom.	This book provides a vision for how deeply and creatively children can engage with ideas of number and operations and mathematical reasoning through counting.	Citation: Franke, M. L., Kazemi, E., & Turrou, A. C. (Eds.). (2018). *Choral Counting and Counting Collections: Transforming the PreK-5 Math Classroom*. Stenhouse Publishers.
"Playful Math Instruction in the Context of Standards and Accountability." *Young Children*, 72(3), 8-13	This article illustrates that children are not likely to notice any difference between playing and learning mathematics concepts and skills. Teaching described in the article implores teachers to	Citation: Stipek, D. (2017). "Playful Math Instruction in the Context of Standards and Accountability." *Young Children*, 72(3), 8-13.

Resource	Description	Source
	be intentional, to plan lessons carefully, and to be somewhat directive.	
The Young Child & Mathematics, third edition.	Grounded in current research, this book focuses on how teachers working with children ages three to six years can find and build on the math inherent in children's ideas in ways that are playful and intentional.	Citation: Turrou, A., Johnson, N., & Franke (2021). *The Young Child and Mathematics,* third edition. National Association for the Education of Young Children, Washington DC.