tion for future mathematics learning."1 High-quality mathematics education in preschool is not about elementary arithmetic being pushed down onto younger children. It is broader than mere practice in counting and arithmetic. It is about children experiencing mathematics as they explore ideas of more and less, count objects, make comparisons, create patterns, sort and measure objects, and explore shapes in space. Mathematics learning happens throughout the day, and it is integrated with learning and developing in other developmental domains such as language and literacy, social-emotional, science, music, and movement.



Teachers have a significant role in facilitating children's construction of mathematical concepts. They may not always realize the extent to which their current everyday classroom practices support children's mathematical development. For example, when singing with children "Five Little Ducks Went Out One Day," incorporating finger play with counting, the teacher develops children's counting skills and understanding of number. Discussing with children how many children came to school today and how many are missing supports children's arithmetic and reasoning with numbers. Playing with children in the sandbox by filling up

different cups with sand and discussing which cup is the *smallest* or the *largest* or how many cups of sand it would take to fill up a bucket introduces children to concepts of comparison and measurement. Preschool teachers nurture children's natural enthusiasm and interest in learning mathematics. They help children build their knowledge and skills of mathematics over time, by providing a mathematically rich environment, by modeling mathematical thinking and reasoning, and by introducing children to the language of math.² Teachers guide, support, and challenge children in the journey of exploring and constructing mathematical knowledge. As stated by the National Council of Teachers of Mathematics (NCTM):

... adults can foster children's mathematical development by providing environments rich in language, where thinking is encouraged, uniqueness is valued, and exploration is supported. Play is children's work. Adults support young children's diligence and mathematical development when they direct attention to the mathematics children use in their play, challenge them to solve problems and encourage their persistence.³

When teachers join children in becoming keen observers of their environment and in reasoning about numbers, shapes, and patterns, mathematics is enjoyable and exciting for all.

Guiding Principles

The following principles will guide teachers' classroom practices in establishing a high-quality, challenging, and sensitive early mathematics preschool program. These principles are partially based on the ten recommendations in *Early Childhood Mathematics*: *Promoting Good Beginnings* set forth by the National Association for the Education of Young Children and NCTM in 2002.

Build on preschool children's natural interest in mathematics and their intuitive and informal mathematical knowledge

Young children are mathematically competent, motivated, and naturally interested in exploring mathematical ideas and concepts. Teachers should recognize children's early mathematical competence and build on children's disposition to use mathematics as a way to make sense of their world.

Encourage inquiry and exploration to foster problem solving and mathematical reasoning

Mathematical reasoning and problem solving are natural to all children as they explore the world around them. The most powerful mathematics learning for preschool children often results from their own explorations. Teachers should maintain an environment that nurtures children's inquiry and exploration of mathematical ideas and that values problem solving. They should ask children questions to stimulate mathematical conversations and encourage mathematical reasoning through everyday interactions. Teachers' meaningful questions can lead to



clarifications, more advanced challenges, and the development of new understandings.

Use everyday activities as natural vehicles for developing preschool children's mathematical knowledge Children can learn mathematical concepts through play and everyday activities as they interact with materials and investigate problems. Putting toys away, playing with blocks, helping to set the table before snack, or playing with buckets of varying sizes in the sand are all opportunities for children to learn about key mathematical concepts such as sorting, geometry, number, and measurements. Teachers should build upon the naturally occurring mathematics in children's daily activities and capitalize on "teachable moments" during such activities to extend children's mathematical understanding and interest.

Introduce mathematical concepts through intentionally planned experiences

In addition to the meaningful mathematics that preschool children acquire spontaneously through play and everyday activities, teachers should provide carefully planned experiences that focus children's attention on particular mathematical concepts, methods, and the language of math. Mathematical experiences planned in advance would allow teachers to present concepts in a logical sequence and forge links between previously encountered mathematical ideas and new applications. Teachers should build on what the child already knows and reasonably challenge the child in acquiring new skills or knowledge. Teachers can foster children's understanding

of mathematical concepts over time through intentional involvement with mathematical ideas in preschool and by helping families extend and develop these ideas.

Provide a mathematically rich environment

Arranging a high-quality physical environment is important for children's mathematical development. It should offer children opportunities to experiment and learn about key mathematical concepts naturally throughout the classroom and throughout the day.

Provide an environment rich in language, and introduce preschool children to the language of mathematics

Language is a critical element in mathematics. Children should be introduced to mathematical vocabulary as well as to natural language in meaningful contexts. During the preschool years, children learn mathematical language such as the number words, the names for shapes, words to compare quantity (e.g., *bigger*, *smaller*), and words to describe position and direction in space (e.g., in, on, above). Children often have an intuitive understanding of mathematical concepts but lack the vocabulary and the conceptual framework of mathematics. By introducing children to mathematical vocabulary, teachers help "mathematize" what children intuitively grasp. Language allows children to become aware of their mathematical thinking and to express it in words. Children with delays in development, especially in language development, may need more frequent repetition of the words combined with a demonstration of the concept.

Support English learners in developing mathematical knowledge as they concurrently acquire English

Teachers should be aware of the challenges faced by children who are English learners and apply specific instructional strategies to help children learning English acquire mathematical concepts and skills. To provide children who are English learners with comprehensible information, they should simplify the terms they use, make extensive use of manipulatives, illustrate the meaning of words by acting and modeling whenever possible, and encourage children to use terms in their home language. Repetition, paraphrasing, and elaboration by the teacher also help preschool children who are English learners understand the content of the conversation. Teachers are encouraged to use mathematical terms as often as possible and in as many different settings as possible. Teachers' attentive and modified talk helps young children learning English to understand mathematical concepts and to develop the language skills they need to communicate mathematical ideas.4

Observe preschool children and listen to them

Observe children thoughtfully, listen carefully to their ideas, and talk with them. Close observation allows teachers to identify thought-provoking moments through everyday play, where mathematical concepts can be clarified, extended, and reinforced, and children can be prompted to make new discoveries. Observing and listening to children also allows teachers to learn about children's interests and attitudes and to assess children's mathematical knowledge and skills. Take into account that mathematical knowledge is not always expressed verbally. Children may know a lot about number, size, or shape without having the words to describe what they know.

Recognize and support the individual

Provide an environment in which all children can learn mathematics, set appropriately high expectations for all children, and support individual growth. Children differ in their strengths, interests, approaches to learning, knowledge, and skills. They may also have special learning needs. Young children, therefore, may construct mathematical understanding in different ways, at varying rates, and with different materials. To be effective, teachers should respond to each child individually. They should find out what young children already know and build on the children's individual strengths and ways of learning. Teachers should provide children with a variety of materials, teaching strategies, and methods to meet children's different learning styles and promote access to and attainment of mathematical concepts by all children. The strategies presented in the next sections for supporting children's development in the mathematics domain apply to all children. Children with disabilities and other special needs, like all children, benefit from multiple opportunities to experience math concepts through playful activities that build on their interests. They particularly benefit from hands-on activities, using a variety of manipulatives, and from teachers' support and verbal descriptions of what they are doing. If children are receiving special education services,

teachers should ask for ideas from the specialists and families.

Establish a partnership with parents and other caregivers in supporting children's learning of mathematics Parents and other caregivers should be partners in the process of supporting children's mathematics development. Parents serve as role models for children. When parents become involved in their children's mathematics education, children become more engaged and excited. Teachers should communicate to parents what preschool mathematics is about, age-appropriate expectations for mathematics learning at the preschool level, and how mathematics learning is supported in the preschool environment. They should also convey to parents the importance of mathematics and what they can do at home for supporting children's math development. By talking with parents, teachers could also learn about children's interests, natural knowledge, and home experiences related to math. They may need to remind parents about the numerous opportunities to talk with children about number. shape, size, and quantity during everyday home routines and activities. For example, while walking to school or taking the bus, parents can point out the yield signs, stop signs, and so on and say the name of each shape (triangle, rectangle, square) and can count the number of footsteps to the front door. While cooking, they can count the number of cups of rice or beans. Throughout the year, teachers should also provide parents with information about the child's development and progress in learning math concepts and skills.