Standards for Grades Pre-K–2

Introduction

During the years from birth to age four, much important mathematical development occurs in young children. Whether they are cared for by family members during their preschool years or receive care from persons outside their families, all children need their innate desire for learning to be nurtured and supported. In kindergarten through grade 2, considerations such as high-quality educational settings and experiences become paramount. Throughout the early years, the Standards and specific expectations for mathematics learning recommended here can help parents and educators give children a solid affective and cognitive foundation in mathematics.

Mathematics for the Youngest Learner

The foundation for children's mathematical development is established in the earliest years. Mathematics learning builds on the curiosity and enthusiasm of children and grows naturally from their experiences. Mathematics at this age, if appropriately connected to a child's world, is more than "getting ready" for school or accelerating them into elementary arithmetic. Appropriate mathematical experiences challenge young children to explore ideas related to patterns, shapes, numbers, and space with increasing sophistication.

The principle that all children can learn mathematics applies to all ages. Many mathematics concepts, at least in their intuitive beginnings, develop before school. For instance, infants spontaneously recognize and discriminate small numbers of objects (Starkey and Cooper 1980). Before they enter school, many children possess a substantive informal knowledge of mathematics. They use mathematical ideas in everyday life and develop mathematical knowledge that can be quite complex and sophisticated (Baroody 1992; » Clements et al. 1999; Gelman 1994; Ginsburg, Klein, and Starkey 1998). Children's long-term success in learning and development requires high-quality experiences during the "years of promise" (Carnegie Corporation 1999). 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.

Children learn through exploring their world; thus, interests and everyday activities are natural vehicles for developing mathematical thinking. When a parent places crackers in a toddler's hands and says, "Here are two crackers—one, two," or when a three-year-old chooses how she wants her sandwich cut—into pieces shaped like triangles, rectangles, or small squares—mathematical thinking is occurring. As a child arranges stuffed animals by size, an adult might ask, "Which animal is the smallest?" When children recognize a stop sign by focusing on the octagonal shape, adults have an opportunity to talk about different shapes in the environment. Through careful observation, conversations, and guidance, adults can help children make connections between the mathematics in familiar situations and new ones.

Because young children develop a disposition for mathematics from their early experiences, opportunities for learning should be positive and supportive. Children must learn to trust their own abilities to make sense of mathematics. Mathematical foundations are laid as playmates create streets and buildings in the sand or make playhouses with empty boxes. Mathematical ideas grow as children

count steps across the room or sort collections of rocks and other treasures. They learn mathematical concepts through everyday activities: sorting (putting toys or groceries away), reasoning (comparing and building with blocks), representing (drawing to record ideas), recognizing patterns (talking about daily routines, repeating nursery rhymes, and reading predictable books), following directions (singing motion songs such as "Hokey Pokey"), and using spatial visualization (working puzzles). Using objects, role-playing, drawing, and counting, children show what they know. »

High-quality learning results from formal and informal experiences during the preschool years. "Informal" does not mean unplanned or haphazard. Since the most powerful mathematics learning for preschoolers often results from their explorations with problems and materials that interest them, adults should take advantage of opportunities to monitor and influence how children spend their time. Adults can provide access to books and stories with numbers and patterns; to music with actions and directions such as up, down, in, and out; or to games that involve rules and taking turns. All these activities help children understand a range of mathematical ideas. Children need things to count, sort, compare, match, put together, and take apart.

Children need introductions to the language and conventions of mathematics, at the same time maintaining a connection to their informal knowledge and language. They should hear mathematical language being used in meaningful contexts. For example, a parent may ask a child to get the same number of forks as spoons; or a sibling may be taller than the child is, but the same sibling may be shorter than the girl next door. Young children need to learn words for comparing and for indicating position and direction at the same time they are developing an understanding of counting and number words.

Children are likely to enter formal school settings with various levels of mathematics understanding. However, "not knowing" more often reflects a lack of opportunity to learn than an inability to learn. Some children will need additional support so that they do not start school at a disadvantage. They should be identified with appropriate assessments that are adapted to the needs and characteristics of young children. Interviews and observations, for example, are more appropriate assessment techniques than group tests, which often do not yield complete data. Early assessments should be used to gain information for teaching and for potential early interventions rather than for sorting children. Pediatricians and other health-care providers often recognize indicators of early learning difficulties and can suggest community resources to address these challenges.

Mathematics Education in Prekindergarten through Grade 2

Like the years from birth to formal schooling, prekindergarten through grade 2 (pre-K–2) is a time of profound developmental change for young students. At no other time in schooling is cognitive growth so remarkable. Because young students are served in many different educational settings and begin educational programs at various ages, we refer to children at this level as students to denote their enrollment in formal educational programs. Teachers of young students—including parents and other caregivers—need to be knowledgeable about the many ways students learn mathematics, and they need to have high expectations for what can be learned during these early years.

Most students enter school confident in their own abilities, and they are curious and eager to learn more about numbers and mathematical objects. They make sense of the world by reasoning and problem solving, and teachers must recognize that young students can think in sophisticated ways. Young students are active, resourceful individuals who construct, modify, and integrate ideas by interacting with the physical world and with peers and adults. They make connections that clarify and » extend their knowledge, thus adding new meaning to past experiences. They learn by talking about what they are thinking and doing and by collaborating and sharing their ideas. Students' abilities to

communicate through language, pictures, and other symbolic means develop rapidly during these years. Although students' ways of knowing, representing, and communicating may be different from those of adults, by the end of grade 2, students should be using many conventional mathematical representations with understanding.

It is especially important in the early years for every child to develop a solid mathematical foundation. Children's efforts and their confidence that mathematics learning is within their reach must be supported. Young students are building beliefs about what mathematics is, about what it means to know and do mathematics, and about themselves as mathematics learners. These beliefs influence their thinking, performance, attitudes, and decisions about studying mathematics in later years (Kamii 2000). Therefore, it is imperative to provide all students with high-quality programs that include significant mathematics presented in a manner that respects both the mathematics and the nature of young children. These programs should build on and extend students' intuitive and informal mathematics knowledge. They should be grounded in a knowledge of child development and take place in environments that encourage students to be active learners and accept new challenges. They should develop a strong conceptual framework while encouraging and developing students' skills and their natural inclination to solve problems. Number activities oriented toward problem solving can be successful even with very young children and can develop not only counting and number abilities but also such reasoning abilities as classifying and ordering (Clements 1984). Recent research has confirmed that an appropriate curriculum strengthens the development of young students' knowledge of number and geometry (Griffin and Case 1997; Klein, Starkey, and Wakeley 1999; Razel and Eylon 1991).

Mathematics teaching in the lower grades should encourage students' strategies and build on them as ways of developing more-general ideas and systematic approaches. By asking questions that lead to clarifications, extensions, and the development of new understandings, teachers can facilitate students' mathematics learning. Teachers should ensure that interesting problems and stimulating mathematical conversations are a part of each day. They should honor individual students' thinking and reasoning and use formative assessment to plan instruction that enables students to connect new mathematics learning with what they know. Schools should furnish materials that allow students to continue to learn mathematics through counting, measuring, constructing with blocks and clay, playing games and doing puzzles, listening to stories, and engaging in dramatic play, music, and art.

In prekindergarten through grade 2, mathematical concepts develop at different times and rates for each child. If students are to attain the mathematical goals described in Principles and Standards for School Mathematics, their mathematics education must include much more than short-term learning of rote procedures. All students need adequate time and opportunity to develop, construct, test, and reflect on their increasing understanding of mathematics. Early education must build on the principle that all students can learn significant mathematics. Along with their expectations for students, teachers should also set equally » high standards for themselves, seeking, if necessary, the new knowledge and skills they need to guide and nurture all students. School leaders and teachers must take the responsibility for supporting learning so that all students leave grade 2 confident and competent in the mathematics described for this grade band.

The ten Standards presented in this document are not separate topics for study but are carefully interwoven strands designed to support the learning of connected mathematical ideas. At the core of mathematics in the early years are the Number and Geometry Standards. Numbers and their relationships, operations, place value, and attributes of shapes are examples of important ideas from these Standards. Each of the other mathematical Content Standards, including Algebra, Measurement, and Data Analysis and Probability, contributes to, and is learned in conjunction with, the Number and Geometry Standards. The Process Standards of Problem Solving, Reasoning and Proof, Communication, Connections, and Representation support the learning of, and are developed

through, the Content Standards. And learning content involves learning and using mathematics processes.

The mathematics program in prekindergarten through grade 2 should take advantage of technology. Guided work with calculators can enable students to explore number and pattern, focus on problem-solving processes, and investigate realistic applications. Through their experiences and with the teacher's guidance, students should recognize when using a calculator is appropriate and when it is more efficient to compute mentally. Computers also can make powerful and unique contributions to students' learning by providing feedback and connections between representations. They benefit all students and are especially helpful for learners with physical limitations or those who interact more comfortably with technology than with classmates (Clements 1999a; Wright and Shade 1994).

Young students frequently possess greater knowledge than they are able to express in writing. Teachers need to determine what students already know and what they still have to learn. Information from a wide variety of classroom assessments—classroom routines, conversations, written work (including pictures), and observations—helps teachers plan meaningful tasks that offer support for students whose understandings are not yet complete and helps teachers challenge students who are ready to grapple with new problems and ideas. Teachers must maintain a balance, helping students develop both conceptual understanding and procedural facility (skill). Students' development of number sense should move through increasingly sophisticated levels of constructing ideas and skills, of recognizing and using relationships to solve problems, and of connecting new learning with old. As discussed in the Learning Principle (chapter 2), skills are most effectively acquired when understanding is the foundation for learning.

Mathematics learning for students at this level must be active, rich in natural and mathematical language, and filled with thought-provoking opportunities. Students respond to the challenge of high expectations, and mathematics should be taught for understanding rather than around preconceptions about children's limitations. This does not mean abandoning children's ways of knowing and representing; rather, it is a clear call to create opportunities for young students to learn new, important mathematics in ways that make sense to them.