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## Connections Standard for Grades Pre-K–2

Instructional programs from prekindergarten through grade 12 should enable all students to—

- recognize and use connections among mathematical ideas;
- understand how mathematical ideas interconnect and build on one another to produce a coherent whole;
- recognize and apply mathematics in contexts outside of mathematics.

The most important connection for early mathematics development is between the intuitive, informal mathematics that students have learned through their own experiences and the mathematics they are learning in school. All other connections—between one mathematical concept and another, between different mathematics topics, between mathematics and other fields of knowledge, and between mathematics and everyday life—are supported by the link between the students' informal experiences and more-formal mathematics. Students' abilities to experience mathematics as a meaningful endeavor that makes sense rests on these connections.

When young students use the relationships in and among mathematical content and processes, they advance their knowledge of mathematics and extend their ability to apply concepts and skills more effectively. Understanding connections eliminates the barriers that separate the mathematics learned in school from the mathematics learned elsewhere. It helps students realize the beauty of mathematics and its function as a means of more clearly observing, representing, and interpreting the world around them.

Teachers can facilitate these connections in several ways: They should spotlight the many situations in which young students encounter mathematics in and out of school. They should make explicit the connections between and among the mathematical ideas students are developing, such as subtraction with addition, measurement with number and geometry, or representations with algebra and problem solving. They should plan lessons so that skills and concepts are taught not as isolated topics but rather as valued, connected, and useful parts of students' experiences.

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### What should connections look like in prekindergarten through grade 2?

Young children often connect new mathematical ideas with old ones by using concrete objects. When a preschool child holds up three fingers and asks an adult, "Am I this many years old?" he is trying to connect the word *three* with the number that represents his age through a set of concrete objects, his fingers. Teachers should encourage students to use their own strategies to make connections among mathematical » ideas, the vocabulary associated with the ideas, and the ways the ideas are represented. For example, students frequently use objects and counting strategies as they develop their understanding of addition and subtraction and connect the two operations.

Students can better understand relationships among the many aspects of mathematics as they engage in purposeful activities. Often activities that include making estimates provide links among concepts in multiple Standards (Roche 1996). Consider the following example:



Cranberries  
(video vignette)

In a second-grade class in which students were investigating filling jars with scoops of cranberries, the teacher had students first estimate the number of scoops needed. They organized the estimates into a graph and talked about the range of numbers. After pouring some scoops into one jar as a referent, the students refined their estimates and talked about how and why the range was narrowed. Throughout the lesson, which included several more activities, students worked in groups and repeatedly came back to whole-class discussions that involved mathematics expectations about number and operations, data analysis, and connections.

In another example, the process of making a string of cubes by using only two colors of connecting cubes helps students understand addition. It also involves pattern and relates ideas from number and geometry. As students try to find different ways of building a string of four cubes, if order does not matter and there are only two different colors, they may discover that only five different solutions are possible. Further investigation can reveal that there are six ways to build a string of five cubes (see fig. 4.31). Using this knowledge, some students may generalize and predict that a string of six cubes can be built in seven different ways.

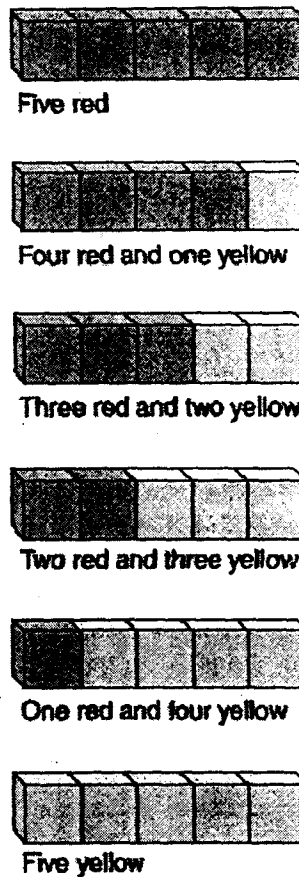


Fig. 4.31. Building a string of five cubes by using only two colors

Mathematics is embedded in many activities that young students do throughout the day. For example, in physical education class, children may count the number of times they can jump rope successfully. They may measure and compare the amount of time the members of a team take to sprint from one end of the gym to the other. Concepts involving geometric shapes are reinforced as children form a circle to play a game, take their places around the outer edge of a parachute, or assume their positions to play a game on the field. Students explore symmetry in art class as they make hearts by folding and cutting paper. They classify leaves collected on a nature walk in science lessons. In music, they sing songs rich in patterns.

In one first-grade classroom, children used the mathematics of patterns to investigate and quantify syllables in names, as related in this episode drawn from a classroom experience:

The teacher clapped out a student's name (one clap for each syllable) and asked the students if they could figure out whose name she was clapping. They realized that her clapping matched the names of several students. When the class began to try to determine which students had

the same number of claps in their names, the teacher drew the chart shown in figure 4.32 on the board. She added students' names as the class identified the number of beats in a name.

3 beats	4 beats	5 beats	6 beats
John Gosha	Sarah Andrews	Bobby Erickson	Sylvia Matherson
Timmy Simms	Carlos Sanchez	Anisha Johnson	Miguel Herrera

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Fig. 4.32. A chart showing the number of beats in students' names. One student stated that he could not find a name with seven beats. Another student disagreed and illustrated seven beats by including » the beats in her middle name in her total. Other students then began to experiment with middle names and nicknames to match the number of beats in other names. One student looked at the chart and questioned whether John Gosha and Timmy Simms were actually "beat twins." Even though the number of beats was the same, the names sounded different. This encouraged the students to record their name-beat patterns in a more specific way using the number of syllables in each word to help them write different equations with the same sums (see fig. 4.33).

John Gosha  $1 + 2 = 3$

Timmy Simms  $2 + 1 = 3$

Fig. 4.33. Recording name-beat patterns

As the students determined the best ways to describe name beats through number, they also were reinforcing their arithmetic skills. They were also actually creating a function that assigned a number to each student's name. Such interplay, in which mathematics illuminates a situation and the situation illuminates mathematics, is an important aspect of mathematical connections.

Seeing the usefulness of mathematics contributes to students' success in situations requiring mathematical solutions. When students measure the field for the hundred-yard relay, they truly know the purpose of learning to measure. Determining when they have saved enough allowance money to purchase a prized toy helps students realize the usefulness and importance of the knowledge of counting, of addition, and of the value of coins.

Pointing to the hexagonal pattern in a honeycomb illustrates the use of mathematical ideas in describing nature. Surveying friends and family members about a favorite vacation site gives meaning and purpose to data collection. Observing the patterns on the fences in town demonstrates how mathematics is used in construction. These associations add purpose and pleasure to the learning of mathematics.



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### **What should be the teacher's role in developing connections in prekindergarten through grade 2?**

In classrooms where connecting mathematical ideas is a focus, lessons are fluid and take many different formats. Teachers should ensure that links are made between routine school activities and mathematics by asking questions that emphasize the mathematical aspects of situations. They should plan tasks in new contexts that revisit topics previously taught, enabling students to forge new links between previously learned mathematical concepts and procedures and new applications, always with an eye on their mathematics goals. When teachers help students make explicit connections—mathematics to other mathematics and mathematics to other content areas—they are helping students learn to think mathematically.

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Often connections are best made when students are challenged to apply mathematics learning in extended projects and investigations. As » they formulate questions and design inquiries, students decide on methods of gathering and recording information and plan representations to communicate the data and help them make reasonable conjectures and interpretations.

Teachers can find in the way a child interprets mathematical situations clues to that child's understanding. They should listen to students in order to assess the connections students bring to their situation, and they should use this information to plan activities that will further students' mathematical knowledge and skills and establish new and different connections. A teacher can, for example, notice the different understandings represented by different students' comments or questions about pattern blocks: one student may ask the teacher to name a pattern-block shape; a second student might build a pattern-block design and direct the teacher's attention to its symmetry; a third student may explain to the teacher that two pattern-block trapezoids together make a hexagon.

It is the responsibility of the teacher to help students see and experience the interrelation of mathematical topics, the relationships between mathematics and other subjects, and the

way that mathematics is embedded in the students' world. Teachers should capitalize on unexpected learning opportunities, such as the lesson in which syllables in students' names were recorded as equations. They should ask questions that direct students' thinking and present tasks that help students see how ideas are related.

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