Ontario

A Guide to Effective Instruction in Mathematics

Kindergarten to Grade 3

Measurement

2007

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A Guide to Effective Instruction in Mathematics

Kindergarten to Grade 3

Measurement

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Introduction

This document is a practical guide that teachers will find useful in helping students achieve the curriculum expectations for mathematics outlined in *The Kindergarten Program, 2006* (on page 46, under the subheading "Measurement") and the expectations outlined in the Measurement strand for Grades 1 to 3 in *The Ontario Curriculum, Grades 1–8: Mathematics, 2005.* It is a companion document to *A Guide to Effective Instruction in Mathematics, Kindergarten to Grade 6, 2006*.

The expectations outlined in the curriculum documents describe the knowledge and skills that students are expected to acquire by the end of each grade. In *Early Math Strategy: The Report of the Expert Panel on Early Math in Ontario* (Expert Panel on Early Math in Ontario, 2003), effective instruction is identified as critical to the successful learning of mathematical knowledge and skills, and the components of an effective program are described. As part of the process of implementing the panel's vision of effective mathematics instruction for Ontario, *A Guide to Effective Instruction in Mathematics, Kindergarten to Grade 6, 2006* provides a framework for teaching mathematics. This framework includes specific strategies for developing an effective program and for creating a community of learners in which students' mathematical thinking is nurtured. The strategies described in the guide focus on the "big ideas" inherent in the expectations; on problem solving as the main context for mathematical activity; and on communication, especially student talk, as the conduit for sharing and developing mathematical thinking. The guide also provides strategies for assessment, the use of manipulatives, and home connections.

Purpose and Features of the Document

The present document was developed to provide practical applications of the principles and theories behind good instruction that are elaborated in *A Guide to Effective Instruction in Mathematics, Kindergarten to Grade 6, 2006*.

The present document provides:

- an overview of each of the big ideas in the Measurement strand;
- four appendices (Appendices A–D), one for each grade from Kindergarten to Grade 3, which provide learning activities that introduce, develop, or help to consolidate some aspect of each big idea. These learning activities reflect the instructional practices recommended in *A Guide to Effective Instruction in Mathematics, Kindergarten to Grade 6, 2006*;
- an appendix (Appendix E) that lists the curriculum expectations in the Measurement strand under the big idea to which they correspond. This clustering of expectations around each of the two big ideas allows teachers to concentrate their programming on the big ideas of the strand while remaining confident that the full range of curriculum expectations is being addressed;
- a glossary that provides definitions of mathematical terms used in this document.

"Big Ideas" in the Curriculum for Kindergarten to Grade 3

In developing a mathematics program, it is vital to concentrate on important mathematical concepts, or "big ideas", and the knowledge and skills that go with those concepts. Programs that are organized around big ideas and focus on problem solving provide cohesive learning opportunities that allow students to explore concepts in depth.

> All learning, especially new learning, should be embedded in well-chosen contexts for learning – that is, contexts that are broad enough to allow students to investigate initial understandings, identify and develop relevant supporting skills, and gain experience with varied and interesting applications of the new knowledge. Such rich contexts for learning open the door for students to see the "big ideas", or key principles, of mathematics, such as pattern or relationship. (Ontario Ministry of Education, 2005, p. 25)

Students are better able to see the connections in mathematics and thus to *learn* mathematics when it is organized in big, coherent "chunks". In organizing a mathematics program, teachers should concentrate on the big ideas in

mathematics and view the expectations in the curriculum policy documents for Kindergarten and Grades 1 to 3 as being clustered around those big ideas.

The clustering of expectations around big ideas provides a focus for student learning and for teacher professional development in mathematics. Teachers will find that investigating and discussing effective teaching strategies for a big idea is much more valuable than trying to determine specific strategies and approaches to help students achieve individual expectations. In fact, using big ideas as a focus helps teachers see that the concepts represented in the curriculum expectations should not be taught as isolated bits of information but rather as a network of interrelated concepts.

In building a program, teachers need a sound understanding of the key mathematical concepts for their students' grade level and a grasp of how those concepts connect with students' prior and future learning (Ma, 1999). They need to understand the "conceptual structure and basic attitudes of mathematics inherent in the elementary curriculum" (p. xxiv) and to know how best to teach the concepts to students. Concentrating on developing this knowledge and understanding will enhance effective teaching.

Focusing on the big ideas provides teachers with a global view of the concepts represented in the strand. The big ideas also act as a "lens" for:

- making instructional decisions (e.g., choosing an emphasis for a lesson or set of lessons);
- identifying prior learning;
- looking at students' thinking and understanding in relation to the mathematical concepts addressed in the curriculum (e.g., making note of the way in which a student compares the perimeters of two shapes);
- collecting observations and making anecdotal records;
- providing feedback to students;
- determining next steps;
- communicating concepts and providing feedback on students' achievement to parents[1] (e.g., in report card comments).

Teachers are encouraged to focus their instruction on the big ideas of mathematics. By clustering expectations around a few big ideas, teachers can teach for depth of understanding. This document provides models for clustering the expectations around a few major concepts and includes activities that foster understanding of the big ideas in Measurement. Teachers can use these models in developing other lessons in Measurement, as well as lessons in other strands of mathematics.

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1. In this document, *parent(s)* refers to parent(s) and guardian(s).

The "Big Ideas" in Measurement

> *Measurement concepts and skills are directly applicable to the world in which students live. Many of these concepts are also developed in other subject areas, such as science, social studies, and physical education.*
>
> (Ontario Ministry of Education, 2005, p. 8)

Overview

From a young age, children develop concepts about measurement as they explore the length, mass, temperature, capacity, and so on, of objects in their daily lives. Everyday experiences, such as the following, help students think about ideas related to measurement:

- comparing two towers of blocks by height
- finding whether a collection of blocks will fit inside a box
- choosing a large enough glass to hold a small carton of milk
- deciding how many sheets of paper are needed to cover a table
- deciding which clothes to wear outside on a cold day

Upon entering school, students have already acquired some informal notions about measurement. Learning opportunities in the primary grades help them further develop concepts about what can be measured and about how to measure. These learning experiences occur not only in the mathematics program, but throughout the school day in various subject areas.

This section focuses on the two big ideas that form the basis for the curriculum expectations in Measurement for Kindergarten to Grade 3. An understanding of these big ideas assists teacher in providing instructional and assessment opportunities that promote student learning of important concepts in Measurement.

The big ideas for Measurement are the following:

- attributes, units, and measurement sense
- measurement relationships

Teachers should recognize that these big ideas are conceptually related and interdependent, and that many instructional experiences reflect both big ideas. For example, students need to possess an understanding of length and how it is measured (attributes, units, and measurement sense) in order to compare two objects by length (measurement relationships).

The discussion of each big idea in this section contains:

- an **overview**, which includes a general discussion of the big idea in the primary grades, an explanation of some of the key concepts inherent in the big idea, and in some instances additional background information on the concepts for the teacher;
- **grade-specific descriptions** of (1) characteristics of learning evident in students who have been introduced to the concepts addressed in the big idea, and (2) instructional strategies that will support those learning characteristics. In order to address a range of student learning needs, teachers should examine instructional strategies for grade levels other than their own.

General Principles of Instruction

The following principles of instruction are relevant in teaching Measurement in the primary grades:

- **Student talk is important.** Students need to talk about and talk through mathematical concepts, with one another and with the teacher.
- **Representations of concepts promote understanding and communication.** In Measurement, concepts can be represented in various ways (e.g., through the use of manipulatives, diagrams, words, symbols). Teachers need to help students make connections between different representations of a mathematical concept (e.g., between a representation of the concept of area using manipulatives and one using diagrams).
- **Students learn through problem solving.** Problem-solving situations provide students with a context and a meaningful purpose for reasoning about mathematical concepts and ideas. As well, organizing learning activities within a three-part lesson based on problem solving prompts students to engage in a problem-solving process of learning mathematics. The main parts of the three-part lesson structure recommended in *A Guide to Effective Instruction in Mathematics, Kindergarten to Grade 6, 2006* are Getting Started, Working on It, and Reflecting and Connecting. For examples of the three-part lesson structure, see the learning activities in this guide.

- **Students need frequent experiences using a variety of learning strategies (e.g., investigations, problem-solving activities, games) and resources (e.g., manipulatives, measurement tools).** A variety of learning strategies should be used in instruction to address the learning styles of all students.
- **Teachers can help students acquire mathematical language by using correct mathematical vocabulary themselves.** Beginning in Kindergarten, teachers should model appropriate mathematical terminology and encourage students to use mathematical vocabulary that will allow them to express themselves clearly and precisely.

Working Towards Equitable Outcomes for Diverse Students

All students, whatever their socio-economic, ethnocultural, or linguistic background, must have opportunities to learn and to grow, both cognitively and socially. When students can make personal connections to their learning, and when they feel secure in their learning environment, their true capacity will be reflected in their achievement. A commitment to equity and inclusive instruction in Ontario classrooms is therefore critical to enabling all students to succeed in school and, consequently, to become productive and contributing members of society.

To create effective conditions for learning, teachers must take care to avoid all forms of bias and stereotyping in resources and learning activities, which can quickly alienate students and limit their learning. Teachers should be aware of the need to provide a variety of experiences and to encourage multiple perspectives, so that the diversity of the class is recognized and all students feel respected and valued. Learning activities and resources for teaching mathematics should be inclusive, providing examples and illustrations and using approaches that recognize the range of experiences of students with diverse backgrounds, knowledge, skills, interests, and learning styles.

The following are some strategies for creating a learning environment that acknowledges and values the diversity of students, and enables them to participate fully in the learning experience:

- providing mathematics problems with situations and contexts that are meaningful to all students (e.g., problems that reflect students' interests, home-life experiences, and cultural backgrounds and that stimulate their curiosity and spirit of enquiry);

- using mathematics examples drawn from diverse cultures, including those of Aboriginal peoples;
- using children's literature that reflects various cultures and customs as a source of mathematics examples and situations;
- understanding and acknowledging customs and adjusting teaching strategies, as necessary. For example, a student may come from a culture in which it is considered inappropriate for a child to ask for help, express opinions openly, or make direct eye contact with an adult;
- considering the appropriateness of references to holidays, celebrations, and traditions;
- providing clarification if the context of a learning activity is unfamiliar to students (e.g., describing or showing a food item that may be new to some students);
- evaluating the content of mathematics textbooks, children's literature, and supplementary materials for cultural or gender bias;
- designing learning and assessment activities that allow students with various learning styles (e.g., auditory, visual, tactile/kinaesthetic) to participate meaningfully;
- providing opportunities for students to work both independently and interdependently with others;
- providing opportunities for students to communicate orally and in writing in their home language (e.g., pairing English language learners with a first-language peer who also speaks English);
- using diagrams, pictures, manipulatives, sounds, and gestures to clarify mathematical vocabulary that may be new to English language learners.

For a full discussion of equity and diversity in the classroom, as well as a detailed checklist for providing inclusive mathematics instruction, see pages 34–40 in Volume 1 of *A Guide to Effective Instruction in Mathematics, Kindergarten to Grade 6, 2006*.

Attributes, Units, and Measurement Sense

Adults often think of measurement in terms of formulas, rulers, and graduated cylinders. But young children encounter measurement in many contexts every day as they explore and try to make sense of their world.

(Copley, 2000, p. 135)

Overview

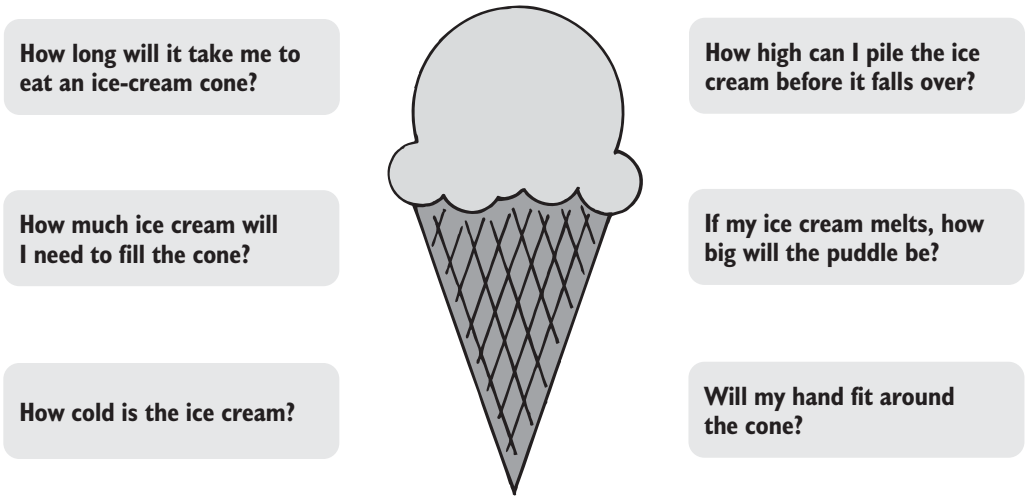
Measurement involves identifying an attribute to be measured (e.g., length, mass, area) and then using definable, consistent units to find the "howmuchness" of the attribute. It is important for students to engage in learning situations that help them understand different measurable attributes and that teach them to measure those attributes in meaningful ways. When students are taught measurement procedures and rules (e.g., formulas) before they understand measurement concepts, they will not fully grasp the meaning of different attributes, the processes involved in measuring, and the significance of the units used to indicate measures.

The following are key points that can be made about attributes, units, and measurement sense in the primary grades:

- Objects and events have a variety of attributes that can be measured.
- Measuring an attribute involves finding the number of non-standard or standard units that are needed to match, cover, or fill the object being measured.
- Measurement sense involves an understanding of appropriate measurement units in various situations, of the "howmuchness" of measurement units, of measurement processes, of the use of measurement tools, and of estimation in measurement.

Measurable Attributes

Measurable attributes are quantifiable characteristics of objects or events. Students need opportunities to explore how an object or an event can have many different measurable attributes. For example, students might discuss possible ways to measure an ice-cream cone.



Discussions about possible ways to measure objects and events allow students to think about measurable attributes and help them develop measurement vocabulary. Teachers can support students in learning measurement terms by modelling the proper vocabulary and by encouraging students to use appropriate mathematical language.

Students can also discuss which units (both non-standard and standard) might be used to measure the various attributes of an object. Such discussions help students realize that different kinds of units are needed to measure different attributes. Measuring the area of the ice-cream puddle requires units that can cover a surface, whereas measuring the capacity of the cone requires units that measure how much the cone can hold.

The diagram at the top of page 10 provides examples of questions related to the measurement of an object, and identifies the measurable attribute associated with each kind of question.

How long/wide/high/deep/far is it?	Length Width Height Depth Distance
What is the distance around it?	Perimeter
What is the size of its surface?	Area
What is its mass?	Mass
How much does it hold?	Capacity
How much space does it occupy?	Volume
How hot/cold is it?	Temperature
How long does it take?	Time

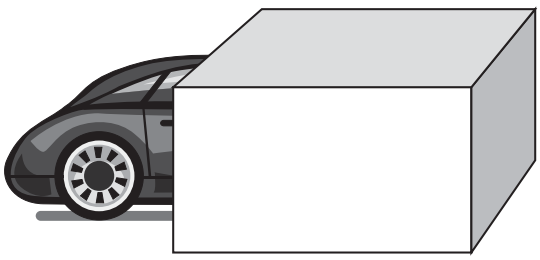
In the following section, a brief explanation of each attribute is provided. This section also includes important information for teachers about how students develop concepts related to the different attributes.

Length. The length of an object can be found by determining the number of units, laid end to end, that make up the distance from one point to another.

Linear measurements are given specific names in particular contexts:

- *Length* is the distance along an object from end to end.
- *Width* is the distance from one side of an object to the other side.
- *Height* is the distance from the lowest point to the highest point of an object or a person.
- *Depth* is the distance from the top of something to its bottom, from front to back, or from the outside in.
- *Distance* is the amount of space between two points.

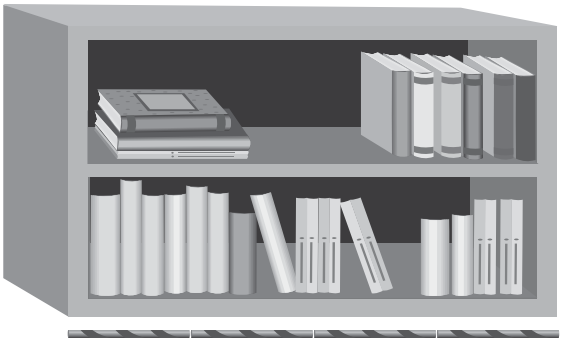
Length is the most visible attribute of many objects, and is one of the first attributes discovered by children. In everyday situations, children explore the attribute of length in objects in their environment.



"The toy car is longer than the garage I made from a box."

In the early primary grades, students continue to develop concepts about length by comparing objects directly (e.g., by lining up two objects side by side to see which is longer). They also compare objects indirectly by length. For example, they might use a string to measure the width of a door, use the same string to measure the width of a desk, and then compare the two widths.

Young students use non-standard units (e.g., straws, cubes, paper clips) to investigate length before they use standard units (e.g., centimetres, metres) to measure length.



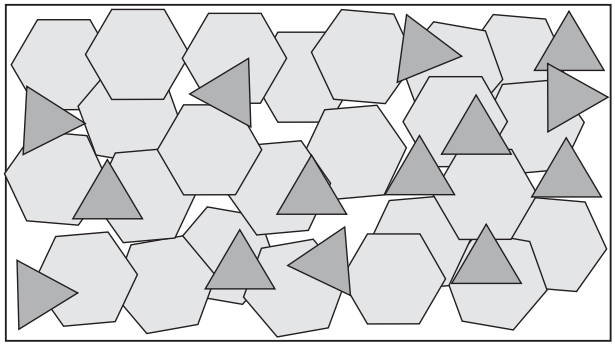
"The bookshelf is about 4 straws long."

Perimeter. Perimeter refers to the length of the boundary of a shape, or the distance around a shape. It is important that students have experiences that allow them to focus on the meaning of perimeter before they are introduced to generalized procedures for finding the perimeter of a shape (e.g., measuring the length of each side and then adding the side lengths). Such experiences include walking around the boundary of a large space (e.g., gym, school building), and laying a string around the perimeter of an object and then examining the length of the string.

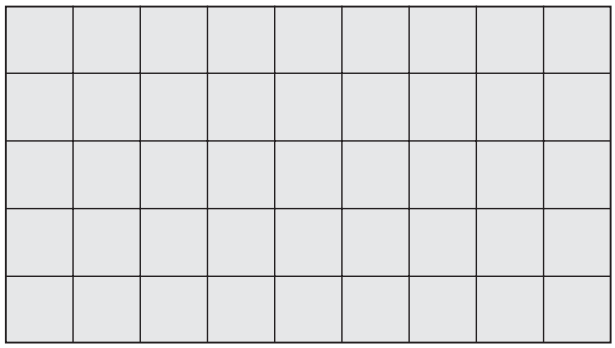
Students should have opportunities to explore perimeter in a variety of shapes (e.g., rectangles, squares, irregular polygons). They might also explore the distance around a circle. Although circumference is a topic of study in the junior grades, teachers may introduce the term *circumference*, and explain that it is similar to *perimeter* because both measurements involve finding the distance around an object or a shape.

Since perimeter is a length, students learn to use standard linear units (e.g., metre, centimetre, kilometre) to express perimeter.

Area. Area is the amount of surface within a closed shape. Young students develop concepts about *surface* by using a variety of materials to cover shapes. Experiences in covering shapes help students understand how the area of a shape is different from the length or perimeter of a shape. Initially, students may leave gaps or may overlap materials when they cover the surface of a shape, and they may not recognize the importance of using a consistent unit.



With experience, students learn that some materials can be arranged to tile a surface (i.e., completely cover a surface without gaps or overlays).



With guidance from teachers, students learn that square units (e.g., square tiles) arranged in rows and columns can completely cover a surface, and that such arrangements provide a way to measure area.

Towards the end of the primary grades, students measure area, using materials such as square tiles and grid paper. Experiences with these materials allow students to begin making generalizations about ways to find the area of a rectangle (e.g., by multiplying the number of squares in a column by the number of squares in a row). In the junior grades, students learn to express area, using square units such as square centimetres and square metres.

Mass. Mass refers to the amount of matter in an object. Young students often refer to the *weight* of an object, rather than its *mass*. Scientifically, weight is a measure of the pull or force of gravity on an object. The weight of an object can vary, depending on its location in space, whereas the mass of the object remains

constant. For example, the weight of an object is less on the moon than on the earth, while the mass of the object remains the same. Although students in the primary grades do not need to distinguish between mass and weight, teachers can model proper language and can encourage students to refer to *mass* rather than *weight*.

Students develop concepts of mass through comparison activities. They might hold an object in each hand and determine which object is heavier. In the primary grades, students also use balances to compare objects by mass. For example, they might use a balance to find which of two objects is heavier or to find collections of objects that have approximately the same mass. In Grade 3, students compare the mass of an object with the mass of the standard unit of a kilogram or with the mass of a part of a kilogram (e.g., half, quarter).

A common misconception among young students is that large objects have a greater mass than small objects. Opportunities to compare the masses of objects of different sizes informally will allow students to address their misconceptions about relationships between size and mass.

Capacity. Capacity is the greatest amount that a container can hold. Students explore the capacity of containers, using materials that can be poured (e.g., water, rice, sand).

Students develop concepts about capacity when they compare two containers. For example, they might observe that a large juice bottle holds more than a small yogurt container. Comparing containers that have approximately the same capacity is more challenging for students. To compare the capacities of the containers, students might fill one container with water, pour the water into the other container, and determine which container holds more water. Students might also use a scoop to fill both containers with rice, and then determine which container holds more scoops of rice. In Grade 3, students compare the capacity of a container with the capacity of the standard unit of a litre or a part of a litre (e.g., half, quarter).

Young students often think that taller containers hold more than shorter containers. It is important that teachers provide students with opportunities to compare a variety of containers by capacity so that students develop an understanding that two different-shaped containers can have the same capacity.

Volume. Volume is the amount of space occupied by an object, measured in cubic units (e.g., cubic centimetres). Learning about volume is not a focus in the primary grades. However, teachers should be aware of opportunities to introduce ideas about volume incidentally (e.g., find the number of cubes that fit inside a box).

Notions about volume and capacity are sometimes confused. To distinguish between these attributes, it may be helpful to consider how the volume of a juice box and its capacity differ. The box has volume because it takes up space, and its volume can be measured by finding the number of cubic units that represent its space. The box also has capacity because it can be filled (e.g., with 200 mL of juice).

Time. Time is the duration of an event from its beginning to its end. Because time is intangible, it is an abstract concept for young students and can be difficult for them to understand. Teachers can help students develop concepts about time by referring to the passage of time (e.g., "It took us only two minutes to tidy our desks") and to the actual time in the context of daily classroom activities – for example, "It will be 10:30 in fifteen minutes. At that time, we will go to the gym."

Learning experiences related to time should be ongoing. Teachers should help students estimate, measure, and describe the passage of time, using non-standard units (e.g., find the time it takes for students to form a line by counting the number of times the teacher claps his or her hands) and eventually standard units (e.g., use a stopwatch to find the time it takes to complete a puzzle). Teachers should also provide students with opportunities to read digital and analogue clocks, and to relate daily events to certain times of the day (e.g., "Recess begins at 10:30 and ends at 10:45").

Temperature. Concepts about temperature involve having a "sense" of temperature (e.g., understanding the meaning of *hot*, *cold*, *warm*, and *cool* in different situations) and of how temperature relates to everyday experiences (e.g., "When the temperature is cold outside, I need to wear a hat, mittens, and a coat").

Students learn that a thermometer measures temperature. Initially, they recognize that a thermometer indicates changes in temperature (i.e., shows whether temperature is rising or falling), and eventually they learn to read temperatures on a thermometer. With experience, students develop a sense about a range of temperatures (e.g., water freezes at 0°C; the air temperature on a warm day is about 20°C).

Measurement Units

A measurement involves both a number and a unit. To say that the length of a ribbon is 15 is meaningless unless a unit is specified (e.g., 15 paper clips, 15 cm, 15 m). Units can be non-standard or standard. Measuring with non-standard units involves the use of arbitrary units (e.g., paper clips, square tiles, cubes); measuring with standard units involves the use of conventional units (e.g., metric units, such as metre, kilogram, and litre).

The process of measuring any attribute involves the same steps:

- **choosing a unit:** The unit (non-standard or standard) must have the same attribute as the object being measured. For example, a unit for measuring length must have length itself (e.g., a metre). It must also be an appropriate size for the given context (e.g., kilometres rather than centimetres for measuring the distance between two towns).
- **comparing that unit with the object being measured:** Comparing the unit with the object being measured indicates the number of units that are needed to match, cover, or fill the object. The number of units can be found by counting, by using a measurement tool (e.g., ruler, balance), or by using a formula (developed in later grades).
- **reporting the number of units:** The result of a measurement is reported by stating the number of non-standard or standard units and the name of the unit itself – for example, "The length of the pencil is 6 paper clips" or "The capacity of the bottle is 2 L."

Non-Standard Units

The use of non-standard units allows students to focus on the attribute being measured. For example, using square tiles to measure area emphasizes the idea that area involves finding the number of square units needed to cover a surface. Students should have experiences in using a variety of non-standard units to measure attributes before being introduced to more abstract, standard units.

A non-standard unit must possess the attribute it is to measure. For example, paper clips, straws, and toothpicks are appropriate non-standard units for measuring length; square tiles, square cards, and square pattern blocks are appropriate non-standard units for measuring area. The following chart lists materials that might be used as non-standard units for attributes that are investigated in the primary grades.

Attribute	Non-Standard Units
Length Perimeter	toothpicks, straws, paper clips, Cuisenaire rods, markers, blocks, paint brushes, paper strips
Area	square tiles, pattern blocks, cards, sticky notes, sheets of paper
Mass	metal washers, marbles, cubes
Capacity	cups, scoops, plastic containers
Time	steady hand claps, sand timers, pendulums, metronomes

Note: It is difficult to find non-standard units for measuring temperature. Instead, students can relate temperatures with familiar objects and experiences (e.g., "as cold as an icicle", "warmer than a hot summer day").

Learning experiences in measuring with non-standard units become opportunities to emphasize important concepts with students:

- Initially, students should receive a sufficient quantity of non-standard units, enough to match, cover, or fill the object being measured completely, without gaps or overlays. Counting the non-standard units stresses the idea that measuring involves finding the number of units that represent a measure.
- Later, students use one unit and move it repeatedly to measure. For example, students might measure the length of a table by moving a pencil in consecutive positions along the length of the table and keeping track of the number of pencil lengths that match the length of the table. This process of *unit iteration* is important when students learn to use a ruler to measure objects and distances that are longer than the ruler.
- Students benefit from opportunities to use more than one kind of material to measure the same object. Using a variety of materials helps students understand the relationship between the size of the unit and the number of units needed (e.g., a greater number of small units than large units are needed to cover a surface).
- Students also learn from experiences in using the same non-standard unit to measure different objects. For example, teachers could challenge students to find the perimeter of a book and of a large carpet, using paper clips. This activity would allow students to observe that a paper clip is an appropriate non-standard unit for finding the perimeter of a small object, such as a book, but an inappropriate unit for measuring a large object, such as a carpet.

As students become familiar with measuring with non-standard units, they begin to explore ways to construct rudimentary measurement tools. For example, students might connect interlocking cubes in a row to create a non-standard ruler, or they might tape square cards together to create a mat for measuring area.

Standard Units

Standard units are conventional units of measure. The following chart identifies standard units and symbols that are commonly used.

Attribute	Units	Symbol
Length Perimeter	kilometre metre centimetre millimetre	km m cm mm
Area	square metre square centimetre	m^2 cm^2
Mass	kilogram gram	kg g
Capacity	litre millilitre	L mL
Volume	cubic metre cubic centimetre	m^3 cm^3
Temperature	degree Celsius	°C
Time	hour minute second	h min s

Students are exposed to standard units in everyday conversations at home and at school – for example, "I need about two metres of cord." "Could you pick up a litre of milk at the store?" "The movie was almost three hours long." "Tomorrow the temperature might reach twenty degrees." It is important that students learn to use standard units to measure, but not before they have explored concepts about measurable attributes through the use of non-standard units.

Once students have had opportunities to measure objects, using non-standard units, they begin to realize the need for standard units. For example, they might observe that the area of a book cover can be expressed as both 60 square tiles and 18 square cards. They also realize that it is difficult to compare objects if they are measured with different units (e.g., a pencil having a length of 8 paper clips and a pencil having a length of 5 erasers). Teachers should help students understand that standard units:

- provide consistent units for measuring the same attribute of different objects;
- are needed to communicate measurements effectively;
- can be used to compare the measurements of two or more objects.

When students are introduced to standard units, the use of non-standard units should not be eliminated completely. Learning activities that link non-standard units with standard units (e.g., measuring a length with both centimetre cubes and a centimetre ruler) help students make connections between concrete materials and measurement tools. Students should also be encouraged to use non-standard units when the use of standard units is unnecessary (e.g., pacing the length between bases for an impromptu T-ball game).

Measurement Sense

Having measurement sense involves more than knowing measurement skills and procedures. It involves an understanding of what it means to measure, rather than simply knowing how to measure. Having measurement sense involves a number of components, including the following:

- choosing appropriate units for measuring different attributes
- understanding the "howmuchness" of measurement units
- choosing appropriate-sized units
- understanding measurement processes
- understanding the use of measurement tools
- understanding how to estimate measurements

Choosing appropriate units: Having measurement sense involves knowing which units are used to measure particular attributes. The unit itself needs to possess the attribute that it measures. For example, kilometres, metres, and centimetres are standard units that possess length; square centimetres and square metres possess area; and kilograms and grams possess mass. Experiences in using non-standard and standard units to measure different attributes help students develop a sense of which units are used to measure which attributes.

Understanding the "howmuchness" of units: People with measurement sense have an understanding of the "howmuchness" of different standard units. They have internalized measurement benchmarks that allow them to judge other measurements. For example, knowing that the length of a baseball bat is approximately one metre allows a person to estimate the length of a room.

Teachers should provide students with opportunities to connect standard units with familiar objects, and to use these objects as measurement benchmarks. For example, teachers might challenge students to find an object that has a mass of one kilogram and then use that object to determine whether other objects have masses that are more than, less than, or equal to one kilogram.

Students can also develop a set of personal referents that help them understand the size of standard units. When students know their height, the width of the tip of their little finger, the length of their arm, their mass, and so on, they can use these measurements to estimate other measurements.

Choosing appropriate-sized units: The size of the unit chosen to measure an object or event depends on the degree of precision that is required. When a precise measurement is necessary, small units provide a more accurate measurement than large units. For example, when the width of a window is measured, a measurement of 105 cm is more accurate than a measurement of 1 m.

Informal measurement activities help students develop an understanding of the relationship between the size of the unit and the degree of precision of the measurement. For example, students using straws to measure the length of a table might find that the length is "a little more than 4 straws". After using toothpicks to measure the same table, the students discover that the length is equal to 15 toothpicks.

In later grades, students learn that certain conventional units are used in different circumstances, and that the precision of a measurement can be expressed by the use of factional or decimal notation. For example, the mass of fresh produce at a grocery store is usually measured in kilograms as a decimal number (e.g., a bag of apples with a mass of 1.235 kg).

Understanding measurement processes: An important component of measurement sense is an understanding of the processes involved in measuring. For example, a painter needs to understand the processes involved in solving a measurement problem:

- identifying the problem that can be solved by the use of measurement (e.g., finding the amount of paint needed to cover a wall);
- identifying the attribute that needs to be measured (e.g., recognizing that the area of the wall needs to be determined);
- choosing an appropriate unit for measuring the attribute (e.g., choosing to measure the area of the wall in square metres);
- selecting and using an appropriate measurement tool or technique (e.g., using a metre stick and a formula to find the area of the wall);
- identifying the specific measurement (e.g., noting the area of the wall as a number and unit, as in 20 m^2);
- using the measurement to solve the problem (e.g., determining the amount of paint needed to cover the wall).

The purpose of instructional activities is to help students understand what it means to measure and how they can measure, using meaningful procedures. By presenting measurement tasks in problem-solving contexts and by encouraging students to follow the measurement process outlined above, teachers can help students realize that measurement is purposeful and practical.

Understanding the use of measurement tools: Measurement tools, such as rulers, balances, graduated containers, and thermometers, have been developed to facilitate measurement. Such tools allow people to find measurements quickly and easily. Having students create and use their own informal measurement tools (e.g., construct rulers by linking paper clips, construct sand timers, construct balances) helps them understand how measurement tools work and how they can be used to measure. As standard units of measure are introduced, teachers can also demonstrate how standard measurement tools (e.g., centimetre rulers, masses and balances, graduated containers, thermometers, clocks) are used to measure.

Work with a variety of measurement tools helps students understand two important ideas:

- **partitioning.** Measurement tools, such as rulers, graduated containers, thermometers, and clocks, are subdivided into equal parts. These parts are compared with the object being measured.
- **unitizing.** Unitizing refers to the idea that a group of individual units can be combined to create a new unit. For example, a metre stick represents a unit (1 m) that comprises 100 cm.

Understanding how to estimate measurements: Estimation involves finding an approximate measurement without the use of measuring instruments. It is a practical skill that is used in situations in which an exact measurement is not needed. People with measurement sense are able to apply different estimation strategies, including the following:

- **using benchmarks.** A benchmark refers to an internalized measurement that is used to estimate other measurements. For example, knowing that the length of a baseball bat is approximately 1 m allows a person to estimate the length of a board.
- **using personal referents.** A knowledge of a person's own height, mass, length of hand span, length of arm, and so on, can be used to estimate. For example, knowing that the length of one's hand span is approximately 20 cm allows a person to estimate the length of a table.
- **chunking.** Chunking involves visually breaking an object into parts and then estimating each part. For example, a person could estimate the length of a room by breaking the length into parts, estimating the length of each part, and then adding the estimates of the parts together.

Van de Walle and Folk (2005) identify three reasons for including estimation in classroom measurement activities:

- Estimation helps students focus on the attribute being measured and on the measuring process. For example, when students measure the area of a table, they need to think about what area is and how it can be measured.
- Estimation offers intrinsic motivation for measuring. It encourages students to try to make estimates that are as close as possible to actual measurements.
- Estimation helps develop familiarity with the unit being used, especially when standard units are used (e.g., thinking about the size of one metre helps estimate a distance in metres).

Students can have opportunities to make estimates when they estimate the measure of an object (e.g., the mass of a hockey puck), or when they need to find objects that have a given measure (e.g., find objects in the classroom that have a mass of approximately 1 kg). Instruction should focus on the strategies that students use to estimate and on the effectiveness of various methods. Throughout measurement activities, teachers should help students understand that estimation is more than a good guess – it requires using available information to produce a reasonable estimate. Students should also recognize that estimates are neither right nor wrong. Frequent opportunities to estimate allow students to understand that experience and the refinement of estimation skills help to produce more accurate estimates.

Characteristics of Student Learning and Instructional Strategies by Grade

Kindergarten

Characteristics of Student Learning

In general, students in Kindergarten:

- describe measurable attributes of objects, using informal language (e.g., *big*, *long*, *heavy*);
- use non-standard units to match, cover, or fill objects being measured (e.g., use blocks to match a length, use pattern blocks to cover an area, use scoops to fill a container);
- intuitively choose non-standard units that possess the attribute being measured (e.g., toothpicks to measure length, pattern blocks to measure area), but might not choose an appropriate-sized unit (e.g., toothpicks to measure the length of the classroom);

- might use inconsistent units to match, cover, or fill objects (e.g., use blocks of different sizes to measure length);
- might leave gaps or overlaps when using multiple units to measure (e.g., leave gaps between blocks when laying them end to end to measure length);
- demonstrate a beginning awareness that various tools are used to measure different attributes (e.g., a ruler measures length, a clock measures time, a balance measures mass);
- associate daily events with times of the day (e.g., breakfast in the morning, sleeping at night);
- relate temperatures to seasons (e.g., winter is cold);
- estimate measurements by guessing (i.e., without using estimation strategies).

Instructional Strategies

Students in Kindergarten benefit from the following instructional strategies:

- discussing measurable attributes (e.g., length, mass, area, temperature, capacity) of objects, and ways to measure them (e.g., discuss ways to measure the length of a toy car);
- using children's literature as a springboard for discussions about measurement concepts (e.g., compare the heights of chairs in "Goldilocks and the Three Bears");
- demonstrating measurement concepts, using concrete materials (e.g., show that a row of 20 interlocking cubes is longer than a row of 10 interlocking cubes);
- modelling of measurement language by the teacher – for example, "Bring me the *short* pencil." "It feels *warm* outside.";
- discussing ways of using non-standard units to measure different attributes (e.g., place blocks end to end to measure the length of an object);
- providing opportunities to engage in problem-solving activities that involve measuring (e.g., find the length of a doll to see if it will fit in a toy bed);
- discussing and demonstrating how one unit (e.g., a straw) can be used to measure a length by repeatedly moving it along the length of an object (unit iteration);
- providing opportunities to explore concepts of area by having students cover different surfaces with a variety of non-standard units;
- discussing and demonstrating ways to avoid gaps and overlays when covering a surface with non-standard units;

- providing opportunities to explore different containers by capacity (e.g., find which of two containers holds more sand);
- providing opportunities to explore different objects by mass (e.g., find objects that are lighter than a book);
- demonstrating how measurement tools are used to measure different things (e.g., a balance for measuring mass, a tape measure for measuring length, a sandglass for measuring time);
- providing opportunities to measure and discuss body measurements, such as height, length of foot, and area of handprint, using a variety of non-standard units;
- relating daily events to times of the day (e.g., waking up in the morning, going to bed at night);
- discussing temperatures in everyday contexts (e.g., "It is warm today, so I don't need to wear a sweater");
- modelling the difference between an estimate and a count of non-standard units (e.g., estimate the number of square tiles needed to cover a book, and then find the actual number of square tiles).

Grade 1

Characteristics of Student Learning

In general, students in Grade 1:

- describe measurable attributes of objects, using mathematical language (e.g., *long*, *short*, *high*, *heavy*, *warm*);
- use non-standard units to match, cover, or fill objects being measured (e.g., use straws to match the length of an object, use pattern blocks to cover an area, use cups to fill a container);
- begin to select appropriate-sized non-standard units for a given situation (e.g., use straws to measure the length of a skipping rope, use index cards to measure the area of a desk);
- recognize the importance of using a consistent non-standard unit to measure (e.g., use same-sized blocks to measure the length of an object);
- begin to measure length, using a single unit – for example, by repeatedly placing a craft stick along the length of an object and counting the number of times the craft stick is placed along the length (unit iteration);
- identify the metre as a benchmark for measuring length (e.g., use a metre stick to find objects that are one metre long);

- recognize the importance of avoiding gaps or overlaps when using multiple units or one unit repeatedly (e.g. avoid leaving gaps between blocks when laying them end to end while measuring length);
- demonstrate an early understanding of area (e.g., use a variety of non-standard units, such as pattern blocks, square tiles, and index cards, to cover shapes);
- demonstrate a beginning understanding of capacity (e.g., count the number of scoops of sand needed to fill a container);
- demonstrate a beginning understanding of mass (e.g., measure the mass of an object, using a balance and non-standard units such as metal washers or marbles);
- understand that a measurement must include the number of units and the type of unit (e.g., the length of the box is 12 straws);
- measure the passage of time, using non-standard units (e.g., number of claps, number of flips of a sand timer);
- demonstrate an awareness that various tools are used to measure different attributes (e.g., a ruler measures length, a clock measures time, a balance measures mass);
- begin to develop estimation strategies (e.g., consider the size of one non-standard unit and then think about the number of units that are needed to measure an object);
- read analogue clocks to the hour and half-hour, and are able to identify benchmark times for everyday activities (e.g., the starting time of recess);
- are able to read the date on a calendar;
- are able to name the months of the year in order;
- relate temperature to the seasons (e.g., the temperature in the fall is often cool).

Instructional Strategies

Students in Grade 1 benefit from the following instructional strategies:

- discussing measurable attributes (e.g., length, area, mass, capacity, temperature) of objects, and having students explain ways to measure them (e.g., discuss ways to measure the area of a desk);
- using children's literature as a springboard for discussions about measurement concepts (e.g., discuss the lengths of objects in a picture book);
- modelling of measurement language by the teacher (e.g., "We will need to measure the *capacity* of the bottle to see if the bottle is *large enough* to hold the juice");

- providing opportunities to engage in problem-solving activities that involve measuring (e.g., find the length of a shelf to determine whether the shelf is long enough to hold a collection of boxes);
- providing opportunities to use a variety of non-standard units to measure and discussing how some units are more appropriate than others in particular situations (e.g., large sheets of paper are more appropriate than index cards for measuring the area of the classroom carpet);
- discussing and demonstrating how one unit (e.g., a straw) can be used to measure length by repeatedly moving the straw along the length of an object (unit iteration);
- providing opportunities to find objects that are approximately one metre long (e.g., find objects that have the same length as a metre stick);
- providing opportunities to estimate and measure area by covering surfaces with various non-standard units;
- discussing and demonstrating ways to avoid gaps and overlays when covering a surface with non-standard units;
- providing opportunities to estimate and measure the capacity of different containers, using non-standard units (e.g., find the number of scoops of rice that are needed to fill a container);
- providing opportunities to estimate and measure the mass of different objects, using non-standard units (e.g., use a balance to find the number of cubes that have the same mass as a book);
- having them use measurement tools (e.g., a metre stick for measuring length, a balance for measuring mass, a sandglass for measuring time);
- providing opportunities to construct measurement tools (e.g., construct a ruler by connecting interlocking cubes in a row);
- having them describe measurements as approximations – for example, "The table is about 4 straws long. It is a bit more than 3 straws wide.";
- having them compare measurements obtained by using different units – for example, "The shelf is about 4 straws long. It is exactly 7 markers long.";
- providing opportunities to estimate measurements, and to discuss estimation strategies (e.g., estimate that a container holds 10 scoops by observing that 5 scoops fill half the container);
- providing opportunities to read demonstration analogue clocks to the hour and half-hour;
- relating daily events to times of the day (e.g., discuss the times of events in the daily classroom schedule);
- discussing temperatures in everyday contexts (e.g., "It is warm today, so I don't need to wear a sweater").

Characteristics of Student Learning

In general, students in Grade 2:

- describe measurable attributes of objects, using mathematical language (e.g., *height*, *area*, *mass*);
- identify the attribute to be measured in problem-solving situations (e.g., "I need to measure the area of a tablecloth to determine if it will cover a table");
- select appropriate-sized units for a given situation (e.g., use centimetres to measure the length of a pencil; use square tiles to measure the area of a photograph);
- measure and record length, height, and distance, using non-standard and standard units (e.g., centimetre, metre);
- possess a sense of the size of a centimetre and of a metre, and relate the units to benchmarks – for example, "A centimetre is about as wide as my little finger." "A metre is about the length of a really big step.";
- use one unit to measure length – for example, by repeatedly placing a metre stick along the length of a room and counting the number of times the metre stick is placed along the length (unit iteration);
- measure and record the distance around objects, using non-standard units;
- estimate and measure area, using non-standard units (e.g., determine the number of square tiles it takes to cover a shape). Generally, students arrange non-standard units without gaps and overlays;
- estimate and measure capacity, using non-standard units (e.g., determine the number of scoops of sand it takes to fill a container);
- estimate and measure mass, using non-standard units (e.g., use a balance to determine the number of cubes that have the same mass as an apple);
- understand that a measurement must include the number of units and the type of unit (e.g., the pencil is 15 cm long);
- understand that small units provide a more precise measurement than large units – for example, "The desk is a little more than 7 markers long. It is exactly 28 paper clips long.";
- express measurements as partial units – for example, "The window is one metre wide and a bit more." "The shelf is two and a half metres long.";
- develop and apply estimation strategies (e.g., consider the size of one unit and then think about the number of units that are needed to measure an object);
- read analogue clocks to the quarter-hour;
- determine whether temperature is rising or falling by observing a thermometer.

Instructional Strategies

Students in Grade 2 benefit from the following instructional strategies:

- discussing measurable attributes (e.g., length, perimeter, area, mass, capacity, temperature) of objects, and having students discuss ways to measure them (e.g., discuss ways to measure the capacity of a bottle);
- using children's literature as a springboard for discussions about measurement concepts (e.g., discuss the areas of shapes in a picture book);
- modelling of measurement language by the teacher (e.g., "We can measure the *masses* of the different vegetables, using a *balance*");
- providing opportunities to engage in problem-solving activities that involve measuring (e.g., find the area of the table by determining the number of sheets of paper needed to cover it);
- having them measure and record length, height, and distance, using non-standard and standard units (e.g., centimetre, metre);
- discussing the size of a centimetre and of a metre by relating the units to benchmarks (e.g., a centimetre is about as wide as a paper clip or the tip of a student's little finger);
- providing opportunities to measure the length of an object that is longer than a given ruler, so that students are required to move the ruler repeatedly along the length of the object (unit iteration);
- providing opportunities to measure and record the distance around objects, using non-standard units;
- providing opportunities to estimate and measure the area of objects by covering surfaces with various non-standard units;
- discussing strategies for finding the number of non-standard units that cover a surface (e.g., find the number of square tiles that cover a shape by counting or using repeated addition);
- providing opportunities to estimate and measure the capacity of different containers, using non-standard units (e.g., find the number of scoops of rice that are needed to fill a container);
- providing opportunities to estimate and measure the mass of different containers, using non-standard units (e.g., use a balance to find the number of cubes that have the same mass as a book);
- having them use measurement tools (e.g., a metre stick for measuring length, a balance for measuring mass, a sandglass for measuring time);
- providing opportunities to construct measurement tools (e.g., construct a ruler by connecting centimetre cubes in a row);

- having them describe measurements as approximations – for example, "The table is about two metres long. It is a bit more than one and a half metres wide.";
- having them compare measurements obtained by using different units – for example, "The shelf is about 4 straws long. It is exactly 7 markers long.";
- providing frequent opportunities to estimate measurements, and to discuss estimation strategies (e.g., estimate that a container holds 20 scoops after observing the quantity represented by 5 scoops);
- providing opportunities to read demonstration analogue clocks to the quarter-hour;
- providing opportunities to measure time intervals, using non-standard units (e.g., count hand claps to measure the time it takes to tie a shoelace);
- discussing how a thermometer indicates changes in temperature.

Grade 3

Characteristics of Student Learning

In general, students in Grade 3:

- describe measurable attributes of objects, using mathematical language (e.g., *perimeter*, *area*, *mass*, *capacity*);
- identify the attribute to be measured in problem-solving situations (e.g., "I need to measure the *capacity* of the bottle to determine if we will have enough juice");
- measure and record length, height, distance, and perimeter, using standard units (e.g., centimetre, metre, kilometre);
- choose the most appropriate standard unit (e.g., centimetre, metre, kilometre) in a given situation (e.g., "I would measure the distance to Toronto in kilometres, because kilometres are much larger than centimetres and metres");
- know how to use measurement tools (e.g., centimetre ruler, metre stick, trundle wheel) to measure length, height, distance, and perimeter;
- estimate and measure area, using arrays and grid paper;
- possess a sense about the "howmuchness" of a kilogram and of a litre, and relate the units to benchmarks (e.g., a kilogram is the same mass as a litre of milk);
- estimate and measure the mass of objects in kilograms or parts of a kilogram (e.g., half, quarter);
- estimate and measure the capacity of containers in litres or parts of a litre (e.g., half, quarter);

- express measurements as partial units (e.g., "The bottle has a capacity of about two and a half litres");
- develop and apply estimation strategies (e.g., estimate, using benchmarks);
- read analogue clocks to the nearest five minutes;
- read thermometers to the nearest degree Celsius;
- identify benchmarks for freezing, cold, cool, warm, hot, and boiling temperatures (e.g., water freezes at 0°C; the air temperature on a warm day is about 20°C).

Instructional Strategies

Students in Grade 3 benefit from the following instructional strategies:

- discussing measurable attributes (e.g., length, perimeter, area, mass, capacity, temperature) of objects, and having students explain ways to measure them (e.g., discuss ways to find the area and perimeter of a table top);
- using children's literature as a springboard for discussions about measurement concepts (e.g., discuss the masses of different animals in a reference book);
- modelling of measurement language by the teacher (e.g., "We can measure the *masses* of the different books, using a *balance*");
- providing opportunities to engage in problem-solving activities that involve measuring (e.g., measure the perimeter of a bulletin board in order to determine how much paper border is needed);
- having them measure and record length, height, distance, and perimeter, using centimetre rulers, metre sticks, measuring tapes, and trundle wheels;
- providing opportunities for them to draw items of specific lengths, using a ruler (e.g., "Draw a rectangle that is 10 cm long and 6 cm wide");
- providing opportunities to estimate and measure the area of shapes, using arrays and grid paper (e.g., centimetre grid paper);
- discussing strategies for finding the number of units that cover a surface (e.g., find the number of square tiles that cover a rectangle, using repeated addition, skip counting, or multiplication);
- discussing the "howmuchness" of a kilogram and of a litre by relating the units to benchmarks (e.g., find familiar objects that have a mass of approximately one kilogram; find containers that have a capacity of one litre);
- providing opportunities to estimate and measure the capacity of different containers, using the litre and parts of a litre (e.g., half, quarter);
- providing opportunities to estimate and measure the mass of objects, using the kilogram and parts of a kilogram (e.g., half, quarter);

- providing frequent opportunities to estimate measurements, and to discuss estimation strategies (such strategies as using benchmarks, using personal referents, and chunking are described on p. 20);
- providing opportunities to measure and record the daily outdoor temperature;
- discussing benchmarks for freezing, cold, cool, warm, hot, and boiling temperatures (e.g., water boils at 100°C);
- providing opportunities to read and record time in meaningful contexts;
- discussing strategies for finding precise and accurate measurements – for example, using appropriate-sized units, counting units carefully, and combining units (e.g., 3 m and 20 cm).

Measurement Relationships

Measurement should not be taught as a simple skill. It is a complex combination of concepts and skills that develops slowly over years.

(Clements & Stephan, 2004, pp. 307–308)

Overview

Investigating measurement relationships provides students with opportunities to reason mathematically and to apply measurement skills in problem-solving situations.

The following are key points that can be made about measurement relationships in the primary grades:

- Objects can be compared and ordered according to measurable attributes.
- Relationships exist between measurement units.

Comparing and Ordering Objects According to Measurable Attributes

Comparing objects according to a measurable attribute is a skill that is often applied in real-life situations (e.g., comparing two containers to determine which holds more). A direct comparison involves observing which of two objects possesses more or less of a measurable attribute, without using a measurement tool. Examples of direct comparison include:

- placing one object beside another to see which is longer;
- laying one surface on top of another to determine which has a greater area;
- holding an object in each hand to feel which has a greater mass.

An indirect comparison of two objects involves the use of an intermediary object. Examples of indirect comparison include:

- using a string to compare the widths of two doorways;
- using square tiles to compare the areas of two surfaces;
- using a balance to compare the masses of two objects.

Initially, young students use direct comparison to determine which of two objects possesses more or less of a measurable attribute. Later, they learn that they can compare objects indirectly by using other objects (e.g., a string for comparing lengths) and tools (e.g., a balance for comparing masses). Opportunities to compare objects directly and indirectly help students understand that comparisons cannot be based solely on the appearance of the objects being compared. For example, students might assume that a tall, narrow container has a greater capacity than a short, wide container because the tall container "looks bigger". To test their assumption, students might fill one container with a pourable material and then pour the material into the other container to see which holds more, or they might fill both containers with a pourable material and then use a measuring cup to compare the capacities.

Transitivity is an important reasoning process that students need to develop in order to make indirect comparisons. Transitive reasoning involves the comparison of two objects by understanding their relationship to a third object. For example, if a red bench is longer than a string, and a yellow bench is shorter than the same string, then the red bench is longer than the yellow bench.

In the early primary grades, students learn to use non-standard units to compare objects (e.g., a container that holds 10 scoops of sand has a greater capacity than a container that holds 8 scoops). In later grades, students apply their understanding of standard units and of measurement tools (e.g., rulers, balances) to make comparisons (e.g., a bench that is 280 cm long is shorter than a bench that is 300 cm long).

Students' mathematical language develops through experiences in comparing objects. Initially, students use simple terms to express comparisons (e.g., *bigger*, *smaller*). As they develop an understanding of various measurable attributes, they begin to use vocabulary that expresses comparisons more precisely (e.g., *wider*, *heavier*, *greater capacity*).

Ordering objects involves arranging three or more items from least to greatest (or vice versa) according to a measurable attribute. Students order objects by comparing the items directly or indirectly and then organizing them in a sequential arrangement.

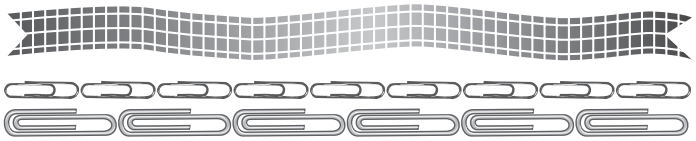
Relationships Between Measurement Units

Learning activities in the primary grades should help students understand relationships between measurement units. Specifically, students should develop an understanding of:

- the relationship between the size of a unit and the number of units needed to measure an attribute;
- relationships between standard measurement units.

Understanding these relationships enables students to measure accurately, and helps them make appropriate decisions about which unit of measure to use in a particular situation.

Relationships between the size of the unit and the number of units: An important measurement concept involves an understanding of the inverse relationship between the size of a unit and the number of units needed to measure an attribute. As the following diagram illustrates, more small paper clips than large paper clips are needed to measure the length of a ribbon.



Initially, students do not recognize the relationship between the size of a non-standard unit and the number of units that are needed. As a result, young students may choose inappropriate units for measuring objects. For example, students might choose paper clips to measure the length of a chalkboard ledge. The tedious experience of measuring a long object with short units allows students to recognize the importance of using appropriate-sized units.

Students require many experiences of using a variety of materials to investigate the relationship between the size of a unit and the number of units needed. Such experiences involve counting and comparing the numbers of small units and large units that are used to measure the same object (e.g., comparing the numbers of baby steps and giant steps needed to measure the length of a room, comparing the numbers of small scoops and large scoops needed to fill a container). Learning activities should also include opportunities for students to predict the results of measuring an object with two different-sized units (e.g., predicting whether more hexagon pattern blocks or more triangle pattern blocks will be needed to cover a book). In such activities, teachers should encourage students to explain why more small units than large units are needed.

Experiences in choosing appropriate-sized non-standard units (e.g., choosing straws rather than small cubes to measure the length of a table) prepare students for measuring with standard units. For example, students in the later primary grades learn to select the most appropriate standard unit (e.g., centimetre, metre, kilometre) to measure length in specific situations.

Relationships between measurement units: Comprehending the relationship between measurement units (e.g., 1 m is composed of 100 cm) depends on unitizing – the ability to recognize that a group of items can be considered as a single entity (e.g., a group of 10 objects can be considered as one group of 10). An understanding of unitizing can be fostered through learning activities in which students group a number of non-standard units to create a larger unit of measure. For example, after using interlocking cubes to measure length, students might connect 10 cubes in a row to create a non-standard ruler. Students can then use the ruler to measure objects by length, reporting measurements in terms of both the number of rulers and the number of cubes.

In the later primary grades, students learn relationships between standard units of time (e.g., 60 minutes in an hour, 24 hours in a day, 7 days in a week, 52 weeks in a year, 12 months in a year). They also begin to recognize relationships between standard units of length (e.g., 100 cm in a metre, 1000 m in a kilometre).

It is not an expectation that primary students will complete exercises involving unit conversions (e.g., answering fill-in-the-blank questions such as _____ cm = 3 m). Instead, they should apply their understanding of unit relationships to reporting measurements precisely. For example, a student might measure the length of a table and find that it is one metre and ten centimetres long. The student might report the length of the table as 1 m 10 cm or as 110 cm.

Characteristics of Student Learning and Instructional Strategies by Grade

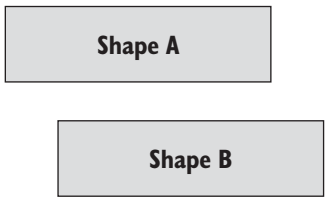
KINDERGARTEN

Characteristics of Student Learning

In general, students in Kindergarten:

- compare and order objects according to measurable attributes (e.g., length, mass, area, temperature, capacity), and describe the objects, using mathematical language (e.g., *longer*, *heaviest*, *colder*);
- compare the lengths or heights of objects directly by placing the objects side by side. Students may have difficulty comparing lengths or heights correctly

if the objects do not have a common starting point – for example, students might assume that Shape B in the following diagram is longer than Shape A;



- begin to compare objects indirectly (e.g., use a string to compare the lengths of two tables);
- begin to develop an awareness that more small units than large units are needed to match, cover, or fill the object being measured (e.g., more playing cards than letter-sized sheets of paper are needed to cover a table).

Instructional Strategies

Students in Kindergarten benefit from the following instructional strategies:

- providing opportunities to sort objects according to a measurable attribute (e.g., sort objects according to length by organizing them into groups of short and long objects);
- providing opportunities to compare and order two or more objects according to a measurable attribute (e.g., length, mass, area, temperature, capacity);
- providing opportunities to discuss measurement comparisons – for example, "What takes longer: eating dinner or brushing your teeth?" "Which is colder: an ice cube or a cup of hot chocolate?";
- modelling of comparative language by the teacher (e.g., "Please place the book on the *longest* shelf");
- providing opportunities to compare two objects indirectly by using a third object (e.g., use a stick to compare the heights of two towers made with blocks).

Grade 1

Characteristics of Student Learning

In general, students in Grade 1:

- compare and order objects according to measurable attributes (e.g., length, height, width, area, temperature, mass, capacity), and describe the objects, using mathematical language (e.g., *taller*, *heaviest*, *coldest*);
- compare and order objects, using direct comparison (e.g., compare objects according to length by placing them side by side) and indirect comparison (e.g., compare objects according to length by using a string);

- understand the relationship between the size of a linear unit and the number of units needed to measure an object (e.g., more toothpicks than straws are needed to measure the width of a door, because toothpicks are shorter than straws);
- apply the concept of unitizing in combining units to make a new unit – for example, "I used 10 cubes to make a ruler. The table is 2 rulers or 20 cubes wide.";
- order units of time from least to greatest (e.g., second, minute, hour, day), but may not know the relationships between units.

Instructional Strategies

Students in Grade 1 benefit from the following instructional strategies:

- providing opportunities to sort objects according to a measurable attribute (e.g., sort objects according to length by organizing them into groups of short and long objects);
- providing opportunities to compare and order two or more objects according to a measurable attribute (e.g., length, height, width, area, temperature, mass, capacity);
- providing opportunities to compare and order objects, using indirect comparison (e.g., use a string to order the heights of three chairs);
- encouraging them to develop strategies for comparing and ordering objects according to a measurable attribute (e.g., "How could you determine which of these containers has the greater capacity?");
- having them predict which of two containers has a greater capacity, or which of two surfaces has a greater area, and then verify their predictions by measuring;
- modelling of comparative language by the teacher (e.g., "Please put the *heavier* pumpkin on the *tallest* chair");
- having them use different-sized non-standard units to measure length, and discussing why more small units than large units are needed (e.g., "It takes more toothpicks than markers to measure the length of the table, because toothpicks are shorter than markers");
- providing opportunities to construct measurement tools (e.g., connect 10 paper clips to create a tool for measuring length);
- having them use measurement tools (e.g., rulers, balances) to compare and order objects according to a measurable attribute.

Characteristics of Student Learning

In general, students in Grade 2:

- compare and order objects according to a measurable attribute (e.g., length, mass, area, temperature, capacity), and describe the objects, using mathematical language (e.g., *taller*, *heaviest*, *coldest*);
- compare and order objects by length, using non-standard and standard units (i.e., centimetre, metre);
- compare and order objects by area, mass, or capacity, using non-standard units (e.g., square tiles for area, metal washers for mass, scoops for capacity);
- understand the relationship between the size of units and the number of units needed to measure area (e.g., more square tiles than playing cards are needed to measure the area of a desk, because square tiles are smaller than playing cards);
- understand the relationships between centimetres and metres and between metres and kilometres;
- measure and report length in terms of two standard units (e.g., "The puppet stage is 1 m and 15 cm long, or 115 cm long");
- understand the relationships between days and weeks and between months and years.

Instructional Strategies

Students in Grade 2 benefit from the following instructional strategies:

- providing opportunities to compare and order objects by their linear dimensions, using non-standard units and standard units (i.e., centimetre, metre);
- providing opportunities to compare or order objects by area, mass, or capacity, using non-standard units;
- encouraging them to develop strategies for comparing and ordering objects according to a measurable attribute (e.g., "How could you determine which of these mats has the greatest area?");
- having them predict which of two containers has a greater capacity, or which of two surfaces has a greater area, and then verify their predictions by measuring;
- having them use different-sized non-standard units to measure area, and discussing why more small units than large units are needed (e.g., "It takes more square tiles than sticky notes to measure the area of the table, because square tiles are smaller than sticky notes");

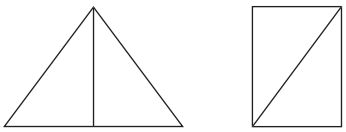
- providing opportunities to construct measurement tools (e.g., create paper rulers by gluing same-sized squares in a row on a strip of paper);
- having them use measurement tools (e.g., rulers, balances) to compare and order objects according to a measurable attribute;
- providing opportunities to investigate the relationship between centimetres and metres;
- providing opportunities to investigate the relationships between days and weeks and between months and years.

Grade 3

Characteristics of Student Learning

In general, students in Grade 3:

- compare and order objects according to measurable attributes (e.g., length, area, mass, capacity, temperature), and describe the objects, using mathematical language (e.g., *taller*, *heaviest*, *coldest*);
- compare and order objects by length, perimeter, mass, and/or capacity, using standard units (i.e., centimetre, metre, or kilometre for length and perimeter; kilogram for mass; litre for capacity);
- compare and order objects by area, using non-standard units (e.g., square tiles, cubes) and grid paper;
- recognize that different shapes can have the same area, and that different containers can have the same capacity (e.g., recognize that the following shapes have the same area);



- understand the relationship between the size of a unit of area and the number of units needed to cover a surface;
- understand the relationships between centimetres and metres and between metres and kilometres;
- measure and report length in terms of two standard units (e.g., "The width of the room is 4 m and 30 cm, or 430 cm");
- know the relationships between minutes and hours, hours and days, days and weeks, and weeks and years.

Instructional Strategies

Students in Grade 3 benefit from the following instructional strategies:

- providing opportunities to compare and order objects by length, perimeter, mass, and/or capacity, using standard units (i.e., centimetres and/or metres for length and perimeter; kilograms for mass; litres for capacity);
- encouraging them to develop strategies for comparing and ordering objects according to a measurable attribute (e.g., "How could you determine which of these pictures has the greatest perimeter?");
- having them predict which of two containers has a greater capacity, or which of two surfaces has a greater area, and then verify their predictions by measuring;
- having them compare and order various shapes by area, using non-standard units (e.g., square tiles, cubes) and grid paper;
- discussing the relationship between the size of a unit of area and the number of units needed to cover a surface (e.g., "It takes more square tiles than sticky notes to measure the area of the table, because square tiles are smaller than sticky notes");
- having them use measurement tools (e.g., rulers, balances) to compare and order objects according to a measurable attribute;
- providing opportunities to investigate the relationships between centimetres and metres and between metres and kilometres;
- having them measure and report length in terms of metres and centimetres (e.g., "The width of the room is 4 m and 30 cm, or 430 cm");
- providing opportunities to solve problems involving the relationships between minutes and hours, hours and days, days and weeks, and weeks and years.

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Learning Activities for Measurement

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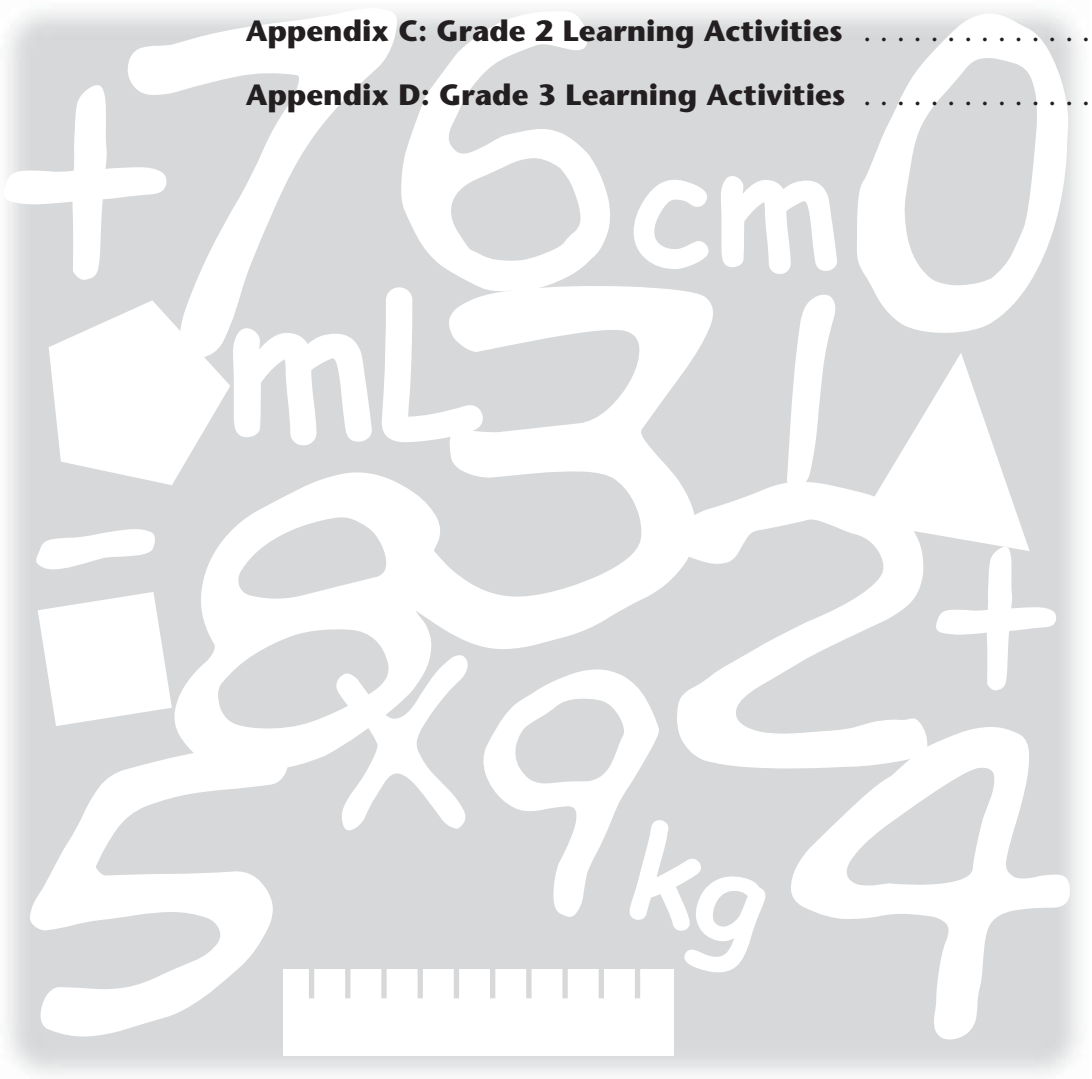

Introduction

The following four appendices (Appendices A to D) include learning activities that are practical applications of the big ideas in Measurement for Kindergarten through Grade 3, respectively. The three activities for each grade address different measurable attributes: length, area, and mass for Kindergarten; length, area, and capacity for Grade 1; length, area, and capacity for Grade 2; and perimeter, area, and mass for Grade 3. Each activity focuses on a big idea: on attributes, units, and measurement sense, or on measurement relationships.

These activities do not address all the key concepts for each big idea, since the big ideas cannot be fully addressed in one activity. The learning activities provide a starting point for classroom instruction related to the big ideas; however, students need multiple experiences throughout the school year to build an understanding of each big idea.

The learning activities are organized as follows:

- **CURRICULUM EXPECTATIONS:** The curriculum expectations are indicated for each learning activity.
- **MATERIALS:** A materials list is included for the main task in each learning activity. (The learning connections have their own materials lists.)
- **ABOUT THE MATH:** Background mathematical information that connects the learning activity to the big idea is provided. In some instances, reference is made to some of the important learning that should precede the activity.
- **GETTING STARTED:** This section provides the context for the learning activity, activates prior knowledge, and introduces the problem or task.
- **WORKING ON IT:** In this part, students work on a mathematical task, often in small groups or with a partner. The teacher interacts with students by providing prompts and asking questions.
- **REFLECTING AND CONNECTING:** This section usually includes a whole-class debriefing time that allows students to share strategies and the teacher to emphasize mathematical concepts.
- **ADAPTATIONS/EXTENSIONS:** These are suggestions for ways to meet the needs of all learners in the classroom.

- **MATH LANGUAGE:** Vocabulary that is important to the learning activity and to the concepts presented is included under this heading.
- **ASSESSMENT:** This section provides guidance to teachers on assessing students' understanding of mathematical concepts related to the big ideas.
- **HOME CONNECTION:** This section is addressed to parents or guardians and includes a task for students to do at home that is connected to the mathematical focus of the learning activity.
- **LEARNING CONNECTIONS:** These are suggestions for follow-up activities that either consolidate the mathematical focus of the main task or build on other key concepts for the big idea.
- **BLACKLINE MASTERS:** These pages are referred to and used throughout the activities.

The Mathematical Processes

The Ontario Curriculum, Grades 1–8: Mathematics, 2005 identifies seven mathematical processes through which students acquire and apply mathematical knowledge and skills. The mathematical processes that support effective learning in mathematics are as follows:

- problem solving
- reasoning and proving
- reflecting
- selecting tools and computational strategies
- connecting
- representing
- communicating

The learning activities in Appendices A–D demonstrate how the mathematical processes help students develop mathematical understanding. Opportunities to solve problems, to reason mathematically, to reflect on new ideas, and so on, make mathematics meaningful for students. The learning activities also demonstrate that the mathematical processes are interconnected – for example, problem-solving tasks encourage students to represent mathematical ideas, to select appropriate tools and strategies, to communicate and reflect on strategies and solutions, and to make connections between mathematical concepts.

Problem Solving: Each of the learning activities is structured around a problem or an inquiry. As students solve problems or conduct investigations, they make connections between new mathematical concepts and ideas that they already

understand. The focus on problem solving and inquiry in the learning activities also provides opportunities for students to:

- find enjoyment in mathematics;
- develop confidence in learning and using mathematics;
- work collaboratively and talk about mathematics;
- communicate ideas and strategies;
- reason and use critical thinking skills;
- develop processes for solving problems;
- develop a repertoire of problem-solving strategies;
- connect mathematical knowledge and skills with situations outside the classroom.

Reasoning and Proving: The learning activities described in this document provide opportunities for students to reason mathematically as they explore new concepts, develop ideas, make mathematical conjectures, and justify results. The learning activities include questions that teachers can use to encourage students to explain and justify their mathematical thinking, and to consider and evaluate the ideas proposed by others.

Reflecting: Throughout the learning activities, students are asked to think about, reflect on, and monitor their own thought processes. For example, questions posed by the teacher encourage students to think about the strategies they use to solve problems and to examine mathematical ideas that they are learning. In the Reflecting and Connecting part of each learning activity, students have an opportunity to discuss, reflect on, and evaluate their problem-solving strategies, solutions, and mathematical insights.

Selecting Tools and Computational Strategies: Mathematical tools, such as manipulatives, pictorial models, and computational strategies, allow students to represent and do mathematics. The learning activities in this guide provide opportunities for students to select tools (concrete, pictorial, and symbolic) that are personally meaningful, thereby allowing individual students to solve problems and to represent and communicate mathematical ideas at their own level of understanding.

Connecting: The learning activities are designed to allow students of all ability levels to connect new mathematical ideas to what they already understand. The learning activity descriptions provide guidance to teachers on ways to help students make connections among concrete, pictorial, and symbolic mathematical representations. Advice on helping students connect procedural knowledge and conceptual understanding is also provided. The problem-solving experience in

many of the learning activities allows students to connect mathematics to real-life situations and meaningful contexts.

Representing: The learning activities provide opportunities for students to represent mathematical ideas using concrete materials, pictures, diagrams, numbers, words, and symbols. Representing ideas in a variety of ways helps students to model and interpret problem situations, understand mathematical concepts, clarify and communicate their thinking, and make connections between related mathematical ideas. Students' own concrete and pictorial representations of mathematical ideas provide teachers with valuable assessment information about student understanding that cannot be assessed effectively using paper-and-pencil tests.

Communicating: Communication of mathematical ideas is an essential process in learning mathematics. Throughout the learning activities, students have opportunities to express mathematical ideas and understandings orally, visually, and in writing. Often, students are asked to work in pairs or in small groups, thereby providing learning situations in which students talk about the mathematics that they are doing, share mathematical ideas, and ask clarifying questions of their classmates. These oral experiences help students to organize their thinking before they are asked to communicate their ideas in written form.

Accommodations and Modifications

The learning activities in Appendices A–D have been designed for students with a range of learning needs. Instructional and assessment tasks are open-ended, allowing most students to participate fully in learning experiences. In some cases, individual students may require *accommodations* and/or *modifications*, in accordance with their Individual Education Plan (IEP), to support their participation in learning activities.

The term *accommodations* is used to refer to the special teaching and assessment strategies, human supports, and/or individualized equipment required to enable a student to learn and to demonstrate learning. Accommodations do not alter the provincial curriculum expectations for the grade.

Modifications are changes made in the age-appropriate grade-level expectations for a subject … in order to meet a student's learning needs. These changes may involve developing expectations that reflect knowledge and skills required in the curriculum for a different grade level and/or increasing or decreasing the number and/or complexity of the regular grade-level curriculum expectations.

(Ontario Ministry of Education, 2004, pp. 25 – 26)

Providing Accommodations

Students may require accommodations, including special strategies, support, and/or equipment to allow them to participate in learning activities. There are three types of accommodations:

- *Instructional accommodations* are adjustments in teaching strategies, including styles of presentation, methods of organization, or the use of technology or multimedia.
- *Environmental accommodations* are supports or changes that the student may require in the physical environment of the classroom and/or the school, such as preferential seating or special lighting.

- *Assessment accommodations* are adjustments in assessment activities and methods that enable the student to demonstrate learning, such as allowing additional time to complete tasks or permitting oral responses to test questions.

Some of the ways in which teachers can provide accommodations with respect to mathematics learning activities are listed in the following chart.

Instructional Accommodations

- Vary instructional strategies, using different manipulatives, examples, and visuals (e.g., concrete materials, pictures, diagrams) as necessary to aid understanding.
- Rephrase information and instructions to make them simpler and clearer.
- Use non-verbal signals and gesture cues to convey information.
- Teach mathematical vocabulary explicitly.
- Have students work with a peer.
- Structure activities by breaking them into smaller steps.
- Model concepts using concrete materials, and encourage students to use them when learning concepts or working on problems.
- Have students use calculators and/or addition and multiplication grids for computations.
- Format worksheets so that they are easy to understand (e.g., use large-size font; an uncluttered layout; spatial cues, such as arrows; colour cues).
- Encourage students to use graphic organizers and graph paper to organize ideas and written work.
- Provide augmentative and alternative communications systems.
- Provide assistive technology, such as text-to-speech software.
- Provide time-management aids (e.g., checklists).
- Encourage students to verbalize as they work on mathematics problems.
- Provide access to computers.
- Reduce the number of tasks to be completed.
- Provide extra time to complete tasks.

Environmental Accommodations

- Provide an alternative work space.
- Seat students strategically (e.g., near the front of the room; close to the teacher in group settings; with a classmate who can help them).
- Reduce visual distractions.
- Minimize background noise.
- Provide a quiet setting.
- Provide headphones to reduce audio distractions.
- Provide special lighting.
- Provide assistive devices or adaptive equipment.

continued

Assessment Accommodations

- Have students demonstrate understanding using concrete materials or orally rather than in written form.
- Have students record oral responses on audiotape.
- Have students' responses on written tasks recorded by a scribe.
- Provide assistive technology, such as speech-to-text software.
- Provide an alternative setting.
- Provide assistive devices or adaptive equipment.
- Provide augmentative and alternative communications systems.
- Format tests so that they are easy to understand (e.g., use large-size font; an uncluttered layout; spatial cues, such as arrows; colour cues).
- Provide access to computers.
- Provide access to calculators and/or addition and multiplication grids.
- Provide visual cues (e.g., posters).
- Provide extra time to complete problems or tasks or answer questions.
- Reduce the number of tasks used to assess a concept or skill.

Modifying Curriculum Expectations

Students who have an IEP may require modified expectations, which differ from the regular grade-level curriculum expectations. When developing modified expectations, teachers make important decisions regarding the concepts and skills that students need to learn.

Most of the learning activities in this document can be adapted for students who require modified expectations. The following chart provides examples of how a teacher could deliver learning activities that incorporate individual students' modified expectations.

Modified Program	What It Means	Example
Modified learning expectations, *same* activity, *same* materials	The student with modified expectations works on the same or a similar activity, using the same materials.	The learning activity involves reading time on an analogue clock to the nearest five minutes. Students with modified expectations read time to the quarter-hour.
Modified learning expectations, *same* activity, *different* materials	The student with modified expectations engages in the same activity, but uses different materials that enable him/her to remain an equal participant in the activity.	The activity involves ordering various shapes by area, using grid paper. Students with modified expectations may order the shapes by area, using square tiles.
Modified learning expectations, *different* activity, *different* materials	Students with modified expectations participate in different activities.	Students with modified expectations work on measurement activities that reflect their learning expectations, using a variety of concrete materials.

(Adapted from *Education for All: The Report of the Expert Panel on Literacy and Numeracy Instruction for Students With Special Education Needs, Kindergarten to Grade 6, 2005*, p. 119.)

It is important to note that some students may require both accommodations and modified expectations.

A Special Note About Kindergarten

The Kindergarten years represent a two-year continuum for those children who attend both Junior Kindergarten and Senior Kindergarten. In many classrooms, Junior Kindergarten and Senior Kindergarten students work together in multi-age groups. Therefore, it is important to assess and consider students' level of development of early mathematical understandings before planning any math activities. Many of the Measurement learning activities are multilevel and can be used with both age groups. In some cases, suggestions are made for adapting an activity for younger students.

Often, teachers in a multi-age classroom have the Senior Kindergarten students complete a small-group or independent follow-up activity after modelling or demonstration is done for the whole class. When invited, many Junior Kindergarten students will join in the activity, even though they are not required to participate. This willingness to learn can give teachers a greater understanding of students' level of mathematical knowledge and skills. Although teachers will have different expectations for younger students, sometimes the level of understanding that Junior Kindergarten students demonstrate surprises teachers. Providing instruction that meets the unique needs of each student helps to support further learning.

A. Kindergarten Learning Activities

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Measuring Up!

BIG IDEA **Attributes, Units, and Measurement Sense**

CURRICULUM EXPECTATIONS

Students will:

- compare and order two or more objects according to an appropriate measure *(e.g., length, mass, area, temperature, capacity)*, and use measurement terms *(e.g., hot/cold for temperature, small/medium/large for capacity, longer/shorter or thicker/thinner for length)*;
- demonstrate awareness of non-standard measuring devices *(e.g., feet, hand spans, string, or cubes to measure length; hand claps to measure time; scoops of water or sand to measure capacity)* and strategies for using them *(e.g., place common objects end to end; use cubes to plan the length of a road at the sand table or the block centre; measure the distance between the classroom and the water fountain in number of footsteps)*.

MATERIALS

- LengthK.BLM1: Ferris Wheels
- pieces of string, each piece measuring 1 m long (1 per group of three students)
- 3 cards, labelled "Taller", "Shorter", and "Same Height"
- LengthK.BLM2: Comparing Heights at Home (1 per student)

ABOUT THE MATH

Length is one of the first measurable attributes recognized by young students. In Kindergarten, most students have some concept of length, and are able to describe and compare objects by length (e.g., by using the words *short*, *long, longer*).

Height is an aspect of length that may be unfamiliar to Kindergarten students. It is important that they have opportunities to observe and describe objects by height, and to develop an understanding of associated vocabulary (e.g., *tall*, *short*).

In the following activity, students compare their body heights with the length of a piece of string. The activity helps students develop an awareness of height, and reinforces their understanding of comparative language (e.g., *taller than*, *shorter than*, and *same height as*).

GETTING STARTED

Set a context for the learning activity by discussing students' experiences with amusement park rides (e.g., Ferris wheels, merry-go-rounds, roller coasters).

Show students LengthK.BLM1: Ferris Wheels, and explain the following situation:

> "It is very important for people to be safe when they ride on a Ferris wheel. There are two Ferris wheels at a fair. The small Ferris wheel is safe for people who are shorter than the string, and the big Ferris wheel is safe for people who are the same height as, or taller than, the string."

Show students a piece of string that is one metre long. Have two students hold the ends of the string so that it extends vertically from the floor. Ask: "Do you think that you are taller than, shorter than, or the same height as this piece of string?" Have students point a finger:

- upward, if they think they are taller than the string;
- downward, if they think they are shorter than the string;
- forward, if they think they are the same height as the string.

Ask a student who thinks that he or she is taller than the string to stand in front of the class. Have two other students hold the string beside the student. Have students verify whether the student is taller than the string.

Have students compare a few classmates by height with the piece of string.

WORKING ON IT

Arrange students in groups of three. Provide each group with a piece of string that is one metre long. Explain that students need to work together to compare themselves by height with the piece of string. Explain that each student needs to find out whether he or she is taller than, shorter than, or the same height as the piece of string.

As students work on the task, ask the following questions:

- "What are you measuring?"
- "How are you using the piece of string to measure?"
- "Are you taller than, shorter than, or the same height as the string? How do you know?"
- "If you were at the fair, could you go on the small Ferris wheel or the big Ferris wheel? Why?"

REFLECTING AND CONNECTING

Gather students together. Ask a few students to explain how they determined whether they are taller than, shorter than, or the same height as the piece of string.

Show students three cards labelled "Taller", "Shorter", and "Same Height". Discuss the meaning of the word on each card. Place the cards on the floor, in a row. Ask each student to line up behind the card that describes his or her height in relation to the piece of string.

Explain that the class has created a people graph. Ask:

- "What does our people graph show?"
- "Which students would be able to go on the big Ferris wheel? How do you know?"
- "Which students would be able to go on the small Ferris wheel? How do you know?"
- "What do all the students in this line have in common?"
- "Why are these students in the "Taller" line?"
- "How many students are taller than the piece of string? Shorter than the piece of string? The same height as the piece of string?"
- "Which group has the most students? The fewest students?"
- "Are most students taller than, shorter than, or the same height as the string? How do you know?"

ADAPTATIONS/EXTENSIONS

The concept of height may be new to some students. Ask these students to compare themselves by height with classroom objects (e.g., door, chart stand, table), using language such as *taller than*, *shorter than*, and *the same height as*.

To help an individual student visualize his or her height in relation to an object, have the student stand beside the object. Then place a book on top of the student's head. Have the student step away from under the book and observe his or her height in comparison with the object.

Extend the activity by having students cut pieces of string that correspond in length with the heights of three or four classmates. Have students tape the ends of the strings to a wall, so that the strings extend vertically from the floor. Have them order the strings from least to greatest height.

MATH LANGUAGE

- tall, taller
- short, shorter
- height

ASSESSMENT

Observe students to assess how well they:

- use appropriate strategies to measure and compare objects by height (e.g., use a string to measure and compare objects by height);
- use mathematical language to describe and compare objects by height (e.g., *tall*, *taller*, *short*, *shorter*, *same height*);
- explain measurement concepts (e.g., the meaning of *height*, *tall*, and *short*).

HOME CONNECTION

Send home LengthK.BLM2: Comparing Heights at Home. This Home Connection activity provides students with an opportunity to compare themselves by height with objects at home.

LEARNING CONNECTION 1

Building Towers

Materials

- a variety of objects that stand upright (e.g., water bottle, candle, tin can)
- blocks

Gather a variety of objects that stand upright (e.g., water bottle, candle, tin can). Have students select an object, and then use blocks to build a tower that is shorter than the object, a tower that is taller than the object, and a tower that is the same height as the object. Have students count and compare the numbers of blocks in the towers.

LEARNING CONNECTION 2

Comparing Objects by Height

Materials

- pieces of string, each measuring 1 m long (1 per pair of students)
- LengthK.BLM3: Taller, Shorter, Same Height (1 per pair of students)

Provide each pair of students with a piece of string that is 1 m long and a copy of LengthK.BLM3: Taller, Shorter, Same Height. Have students find objects in the classroom that are taller than, shorter than, and the same height as the string. Ask students to record their findings by printing the names of objects or drawing pictures on their copy of LengthK.BLM3: Taller, Shorter, Same Height.

LEARNING CONNECTION 3

Growing Tall

Materials

- paper stems made by gluing together strips of green construction paper. Each stem should be approximately 5 cm wide. The length of the first stem should correspond with the height of the shortest student in the class, the length of the second stem should correspond with the height of the tallest student, and the length of the third stem should be midway between the two other stems.
- paper leaves cut from green construction paper (1 per student)
- tape

Tape the three stems onto the wall so that they extend vertically from the floor. Provide each student with a paper leaf, and have the student print (or print for the student) his or her name on the leaf.

Ask students to look at the stems and to estimate whether they are closest in height to the first, second, or third stem. Have each student place his or her leaf on the floor in front of the stem that the student thinks is closest to his or her own height.

Have each student, in turn, stand beside the stems, and have the class observe which stem is closest to the student's height. Determine whether the student estimated correctly when placing his or her leaf in front of a stem. Tape each student's leaf onto the stem that is closest to his or her height.

When all the leaves have been taped onto a stem, ask questions such as the following:

- "How can you tell by looking at the plants that Amir and Bianca are approximately the same height?"
- "How can you tell the Lou is taller than Gina?"
- "Is Fabien shorter than Martin? How can you tell?"

LEARNING CONNECTION 4

A Handy Ruler

Materials

- trays of tempera paint
- 6 in. x 24 in. pieces of construction paper (sheets of construction paper cut into thirds) (1 per student)
- scissors (1 per student)

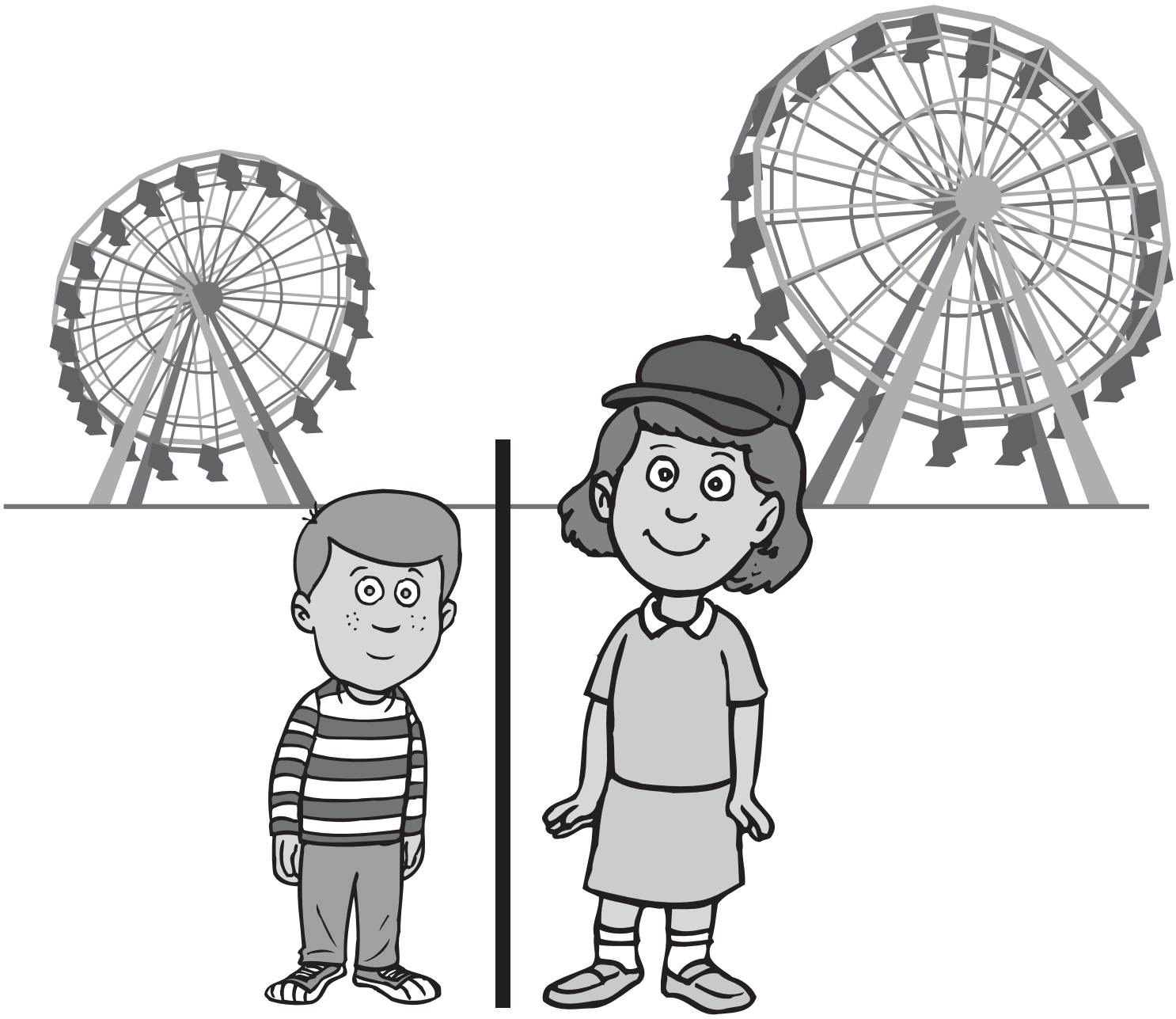
Have each student place a hand in a tray of tempura paint and stamp his or her handprint five times in a row, the prints side by side, on a sheet of paper. Guide students in placing the handprints without gaps and overlays. When the handprints are dry, have students cut off the ends of the paper that are not covered by handprints.

Have students find objects in the classroom that are taller than, shorter than, or the same height as their "handy ruler". Provide students with an opportunity to show classmates how they compared classroom objects by height with their handy ruler.

Note: Students can also use their rulers to measure the lengths of objects (e.g., objects that are 2 hands long/4 hands long/more than 5 hands long).

Ferris Wheels

LengthK.BLM1



Comparing Heights at Home

Dear Parent/Guardian:

In class, students completed a measurement activity in which they compared themselves by height with a piece of string. The activity helped students understand the meaning of measurement vocabulary, such as *taller*, *shorter*, and *same height*.

Review ideas about height with your child at home. Ask your child to compare himself or herself by height with a variety of objects in your home (e.g., refrigerator, chair, table, door). Encourage your child to use words such as *taller than*, *shorter than*, and *the same height as* to make the comparisons.

You might also ask your child to make a comparison between your height and the heights of different objects by asking him or her questions such as the following:

- "Am I shorter than the refrigerator?"
- "What objects in our home are taller than I am?"
- "What objects are about the same height as I am?"
- "What objects are shorter than I am, but taller than you are?

Thank you for helping your child review ideas about height.

Taller, Shorter, Same Height

Taller	Shorter	Same Height

Islands

BIG IDEA **Measurement Relationships**

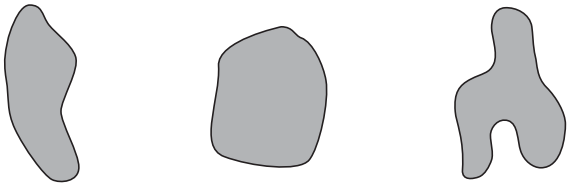
CURRICULUM EXPECTATIONS

Students will:

- compare and order two or more objects according to an appropriate measure *(e.g., length, mass, area, temperature, capacity)*, and use measurement terms *(e.g., hot/cold for temperature, small/medium/large for capacity, longer/shorter or thicker/thinner for length)*;
- demonstrate, through investigation, a beginning understanding of the use of non-standard units of the same size *(e.g. straws, paper clips)*.

MATERIALS

- 3 large paper islands. Create the islands by cutting out irregular shapes from large pieces of paper (e.g., mural paper, sheets of Bristol board taped together, sheets of newspaper taped together). Each paper island should be large enough that 5 to 8 students can stand on it. The paper islands should be different shapes, as illustrated below.



- paper plates (enough to cover all three paper islands)
- objects for covering the paper islands (e.g., index cards, bean bags, shoes)
- AreaK.BLM1: Whose Footprint Is Larger? (1 per student)

ABOUT THE MATH

Measuring area involves determining the number of units required to cover a surface. Concepts about area and about ways to measure area can be difficult for young children to grasp, and therefore should be developed gradually. Initially, students require experiences that help them develop an awareness of surface (e.g., covering shapes with objects). Once students have an understanding of surface, they are able to compare the areas of shapes through observation (e.g., "This picture looks bigger than that picture") or by placing one object on top of another to compare the areas directly. In the primary grades, students also learn to measure and compare objects according to area by covering surfaces with non-standard units (e.g., index cards, square tiles). In later grades, students are introduced to standard units (e.g., square centimetres, square metres).

The following learning activity provides students with an opportunity to focus on the surfaces of paper shapes that represent islands. Students informally compare the islands according to size by finding how many students can stand on the islands, and by covering the islands with objects (i.e., non-standard units). These experiences help students develop fundamental ideas about area and ways to measure area.

GETTING STARTED

Conduct the following activity in a large room (e.g., a gym) that has adequate floor space.

Activate students' knowledge about islands. For example, you might have students discuss the meaning of *island*, describe islands that they have visited, draw a picture of an island shape surrounded by water, identify island countries where they or their relatives were born, and/or find islands on a map or a globe.

Explain the following:

> "When people fly in an airplane over an ocean, they can sometimes see islands when they look out the airplane window. They know that they are looking at islands, because they see pieces of land that are surrounded by water. Sometimes they see big islands, and sometimes they see small islands. They also see that the islands are different shapes."

Place one of the large paper islands on the floor. Ask students to imagine that the piece of paper is an island that is surrounded by water. Ask: "How many students, do you think, could stand on this island, with both feet on land and not in the water?" Have a few students suggest the number of students that could stand on the island. Have students act out each suggestion, and discuss whether the island has enough space for the suggested number of students.

WORKING ON IT

Place the two other paper islands on the floor. Explain that the three paper shapes represent islands. Discuss the shapes of the three islands (e.g., one island is long and narrow; one island is round, like a circle; one island is an irregular shape). Ask: "Which island, do you think, is largest?"

Have a few students identify which of the three islands they think is largest, and ask them to explain why they think it is the largest island.

Ask: "How can we find out which island is largest?" Have students explain their ideas. For example, students might suggest laying the paper islands on top of each other in order to compare their sizes. (Because of the different island shapes, it may be difficult for students using this method to judge which island is largest.) Students might also suggest that classmates stand on the islands to determine which island holds the

greatest number of students. Have students try the various strategies, and discuss the results.

Show the students a large collection of paper plates. Ask: "How could we use paper plates to find which island is largest?" Discuss how students might cover the surfaces of the islands with the paper plates and then find the island that contains the greatest number of plates.

Have students cover the island shapes with paper plates. Encourage them to place the plates within the island boundaries ("to prevent the plates from getting wet"), and to set them close together in order to minimize overlaps and gaps. After all three islands have been covered with paper plates, have students count the plates on each island. Compare the numbers of plates, and discuss how the largest island contains the greatest number of plates.

Provide students with opportunities to cover the islands with other objects (e.g., index cards, bean bags, shoes), count the objects on each island, and compare the numbers of objects on all three islands.

REFLECTING AND CONNECTING

Review the activity with students by asking the following questions:

- "Which island is largest? How do you know that it is the largest island?"
- "Which island is smallest? How do you know that it is the smallest island?"
- "How did we use paper plates to find the largest island?"

Reinforce concepts about area by discussing the following questions:

- "Which island has the greatest area? How do you know?"
- "Which island has the smallest area? How do you know?"
- "How could we find the area of an island using sheets of paper? Using playing cards?"

ADAPTATIONS/EXTENSIONS

Students need to develop an awareness of surface before they are able to understand concepts about area. If students demonstrate a poor understanding of surface, provide for them opportunities to cover shapes with a variety of materials (e.g., pattern blocks, colour tiles, tangram pieces). Students might also spread glue over the surface of a paper shape and cover the surface with dried beans or pieces of pasta.

Extend the activity by having students compare by size three small paper islands (i.e., irregular shapes cut from 8½ in. × 11 in. sheets of paper). Have students cover the shapes with small objects of one kind (e.g., beans, colour tiles, cubes), count the number of objects covering each island, and then compare the islands by size.

MATH LANGUAGE

- shape
- cover
- surface
- large, larger, largest
- small, smaller, smallest
- more, most
- fewer, fewest
- area

ASSESSMENT

Observe students to assess how well they:

- demonstrate an understanding of surface;
- cover the surfaces of shapes with objects (e.g., minimize gaps and overlays);
- use appropriate language (e.g., *larger*, *smallest*) in comparing areas;
- demonstrate a beginning understanding of the use of non-standard units (e.g. paper plates, index cards) to measure area.

HOME CONNECTION

Send home AreaK.BLM1: Whose Footprint Is Larger? This Home Connection activity provides for students and their parents an opportunity to compare their footprints by area.

LEARNING CONNECTION 1

Comparing Mats

Materials

- 4 large rectangular sheets of paper of different sizes
- students' shoes

Show students four large rectangular sheets of paper of different sizes. Explain that people often place their wet shoes on mats when they enter their homes. Ask: "Which mat, do you think, is the largest? How can we determine which mat is largest?" Have students share their ideas. Discuss how students might determine which mat is largest by covering the mats with their shoes.

After students have covered the mats with shoes, count the shoes to find which mat holds the greatest number of shoes. Have students compare the mats by area (e.g., find greatest area, smallest area).

LEARNING CONNECTION 2

Covering Blobs

Materials

- 8½ in. x 11 in. sheets of paper (1 per student)
- crayons (1 per student)
- materials for covering a surface (e.g., square tiles, counters, pattern blocks)

Have each student use a crayon to draw a closed blob shape on a sheet of paper. Have the students use a variety of materials (e.g., square tiles, counters, pattern blocks) to cover their blobs. As the students cover their blobs, ask questions such as the following:

- "How many green triangle pattern blocks did you need to cover your blob? How can you check?"
- "How many square tiles do you think you will need to cover your blob? How can you check?"
- "Will you need more counters or more square tiles to cover your blob? Why do you think so?"

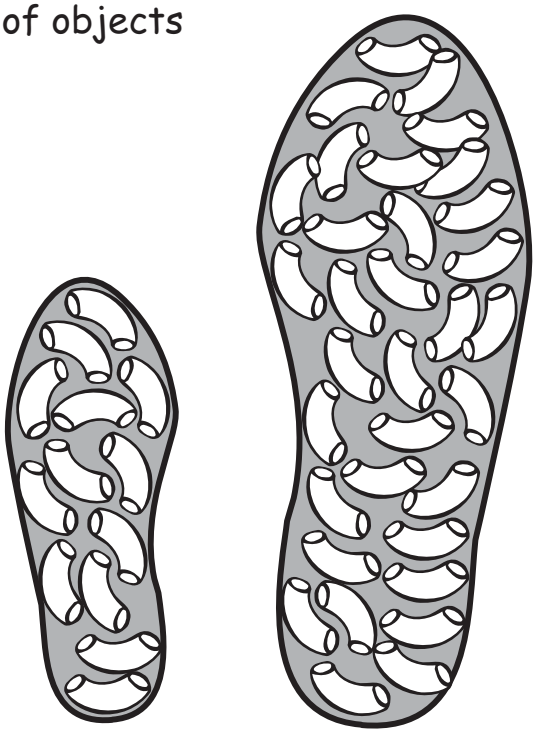
Whose Footprint Is Larger?

Dear Parent/Guardian:

Area is a measure of the amount of surface inside a shape. Our class has been learning about area by covering shapes with objects and then counting the numbers of objects that cover the shapes.

Here is an activity to do with your child:

- Help your child trace around his or her foot on a sheet of paper.
- Trace around your own foot on another sheet of paper.
- Cut out the footprints.
- Have your child compare the footprints. Ask: "Which footprint is bigger? How do you know? Which footprint is smaller? How do you know?"
- Next, ask your child to cover the footprint shapes with small objects of one kind (e.g., beans, small sticky notes, small pasta pieces, paper cut into small squares). Encourage your child to place the objects close together in order to avoid gaps and overlaps. Your child should also try to place the objects completely within the footprint shapes.
- Together with your child, count the number of objects that cover each footprint.
- Ask your child the following questions:
  - "Which footprint has the greater area? How do you know?"
  - "Which footprint has the smaller area? How do you know?"



Mass-ive Animals

BIG IDEA **Measurement Relationships**

CURRICULUM EXPECTATIONS

Students will:

- compare and order two or more objects according to an appropriate measure *(e.g., length, mass, area, temperature, capacity)*, and use measurement terms *(e.g., hot/cold for temperature, small/medium/large for capacity, longer/shorter or thicker/thinner for length)*;
- demonstrate, through investigation, an awareness of the use of different measuring tools for measuring different things *(e.g., a balance is used for measuring mass, a tape measure for measuring length, a sandglass for measuring time)*.

MATERIALS

- *The Grouchy Ladybug* by Eric Carle (New York: HarperCollins, 1977), if available
- 3 figures made of modelling clay: a small bug, a turtle, and a bird (The turtle and the bird should have approximately the same mass.)
- clumps of modelling clay (1 per student)
- balance
- MassK.BLM1: Which Object Is Heavier? (1 per student)

ABOUT THE MATH

Mass is the amount of matter in an object. Mass is an attribute of objects and is commonly referred to as *weight*. Scientifically, weight is a measure of the pull or force of gravity on an object. The weight of an object can vary, depending on its location in space, whereas the mass of the object remains constant. For example, the weight of an object is less on the moon than on the earth, while the mass of the object remains the same.

In the primary classroom, as in daily life, *mass* and *weight* are commonly used interchangeably. Teachers should model the term *mass* while accepting students' use of the word *weight*.

Young students often assume that the mass of an object is related to its size. They may find it difficult to understand that a small object can be heavier than a larger object. Opportunities to compare different objects by mass allow students to address misconceptions about relationships between mass and size.

In the following learning activity, students compare the masses of animal figures made of modelling clay by holding them in their hands and by using a balance. The activity provides students with an opportunity to develop vocabulary such as *heavier*, *lighter*, and *the same mass/weight*.

GETTING STARTED

Read aloud *The Grouchy Ladybug*, if the book is available. After reading the story, ask:

- "What did you notice about the size of each new animal that the ladybug meets?"
- "Do you think each new, bigger animal was heavier or lighter than the one before it? Why?"

Show the students the modelling-clay figures of the small bug and the turtle. Ask: "Which animal, do you think, is heavier: the bug or the turtle?" Invite the students to explain their thinking to a partner, and then ask a few students to share their thoughts with the class.

Ask a student to stand in front of the class and to extend both hands, palms up, in front of him or her. Have the student close his or her eyes. Place the bug in one hand and the turtle in the other hand. Ask the student to tell the class which animal feels heavier. Have the student open his or her eyes and identify which animal feels heavier.

Next, show the students the modelling-clay figures of the turtle and the bird. Invite another student to close his or her eyes, and place a figure in each of the student's hands. Ask the student: "Which animal is heavier?" Have the student explain his or her thinking. (The student might explain that the animals weigh about the same, or that one figure feels heavier than the other.) Ask a few other students to hold the figures in their hands and to judge which figure is heavier.

WORKING ON IT

Provide each student with a clump of modelling clay. Instruct the students to create an animal figure of any size. Discuss possible animals that students might create (e.g., small rabbit, big dog). Ask several students to show and identify their animals.

Arrange the students in pairs. Explain the activity:

- Partners examine their animals and estimate which animal is heavier.
- Partners take turns holding the animals in their hands and comparing the figures by mass (e.g., heavier, lighter, the same mass).

Provide students with opportunities to compare their animals by mass with other students' animals.

REFLECTING AND CONNECTING

Gather the students together. Ask two students to show their animal figures to the class. Ask: "Which animal, do you think, is heavier?" Have a few students compare the masses of the figures by holding the figures in their hands. Encourage the students to use vocabulary such as *heavier*, *lighter*, *the same mass*, to compare the masses of the animals.

Show the students a balance, and ask: "How can we use this balance to compare the masses of the two animals?" Place the animal figures on the balance, and discuss how the side of the balance with the heavier figure lowers.

Select other pairs of animal figures. Have students compare the masses of the animals by holding them in their hands and then by using the balance. Have the students observe that the sides of the balance are balanced when two figures have the same mass.

ADAPTATIONS/EXTENSIONS

Students require an understanding of vocabulary (*heavier*, *lighter*, and *the same mass*) to compare objects by mass. It may be necessary to provide students with opportunities to hold a variety of objects, and to describe and compare the objects by mass (e.g., "The box of cubes is heavy, but the box of building blocks is heavier").

As an extension, select a classroom object (e.g., book, paperweight), and challenge students to find objects that have a mass that is greater then, less than, or the same mass as the object. Have the students use a balance to compare the masses of the objects.

MATH LANGUAGE

- mass
- heavy, heavier
- light, lighter
- balance

ASSESSMENT

Observe students to assess how well they:

- compare the masses of objects (e.g., figures made with modelling clay);
- use mathematical language to describe and compare objects by mass (e.g., *heavier than*, *lighter than*, *the same mass as*).

HOME CONNECTION

Send home MassK.BLM1: Which Object Is Heavier?. In this Home Connection activity, students and their parents play a game in which they compare the masses of objects in their home.

LEARNING CONNECTION 1

How Does a Balance Work?

Materials

- a large quantity of cubes
- balances

Show students 2 cubes, and ask: "Do you think these cubes have the same mass? How can we use a balance to show that the cubes have the same mass?" Listen to students' responses and assess their understanding of how a balance works – for example: "If one cube is heavier than the other, the side of the balance holding the heavier cube will lower. If the cubes have the same mass, the sides of the balance will be balanced." Use a balance to demonstrate that the cubes have the same mass.

Show students 5 cubes, and count them together with the students. Place the cubes on one side of the balance, and ask the following questions:

- "How many cubes do I need to place on the other side to make both sides balance?"
- "How many cubes could I place on the other side to make this side go down?"
- "How many cubes could I place on the other side to make this side go up?"

Provide pairs of students with a balance and a collection of cubes. Explain the activity:

- One partner places a quantity of cubes on one side of the balance.
- The other partner places a quantity of cubes on the other side of the balance.
- The partners decide which side of the balance is heavier and which side is lighter.
- Together, the partners try to make both sides balance by adding cubes to, or removing cubes from, either side of the balance.
- Once the sides have been balanced, the students compare the numbers of cubes on the sides of the balance.

LEARNING CONNECTION 2

Whose Snowman Is Heavier?

Materials

- clumps of modelling clay (1 per student)
- balances

Have each student use modelling clay to make a small snowman.

Arrange the students in pairs. Ask the partners to estimate which of their snowmen is heavier. Have the students use a balance to verify their thinking.

Gather the students together, and ask pairs to share their findings. Prompt the students to use vocabulary such as *heavier*, *lighter*, and *the same mass* in comparing their snowmen.

LEARNING CONNECTION 3

Balancing Animals

Materials

- animal figure made with modelling clay
- clumps of modelling clay (1 per student)
- balance

Pass around an animal figure made of modelling clay, and allow students to feel its mass.

Provide each student with a clump of modelling clay. Challenge the students to create an animal figure that has the same mass as the one that was passed around.

Have the students, one at a time, show their animal figures to the class. Have each student use a balance to determine whether the mass of his or her own animal is the same as the mass of the original animal. Encourage the students to use vocabulary such as *heavier*, *lighter*, and *the same mass* to compare the animals.

Provide individual students with an opportunity to adjust their animal figures (by adding or removing amounts of modelling clay) so that each animal and the original animal have the same mass.

LEARNING CONNECTION 4

Small and Heavy, Large and Light

Materials

- an empty cottage cheese container filled with popcorn (or any light material, such as polystyrene packing chips)
- a small yogurt container filled with marbles (or any heavy material, such as metal washers)
- balance

Show students both containers, and have them compare the containers by size (e.g., larger, smaller).

Show students that the larger container is filled with popcorn and the smaller container is filled with marbles. Ask: "Which container, do you think, has the greater mass?" Have students explain their thinking. Listen for students who assume that the filled cottage cheese container has the greater mass because it is bigger.

Place the containers on a balance and discuss the results. Have students explain why the mass of the smaller container is greater than the mass of the larger container.

Have students find small heavy objects and large light objects in the classroom. Have students hold the objects or use a balance to show that small objects can have a greater mass than large objects.

Which Object Is Heavier?

Dear Parent/Guardian:

Our class has been learning to compare the masses of objects, using words such as *heavier*, *lighter*, and *the same mass*.

Play "Which Object Is Heavier?" with your child:

- Each player chooses an object (e.g., shoe, dish, fork) that he or she can hold comfortably.
- Each player estimates which object is heavier.
- The players verify their thinking by taking turns holding the objects in their hands in order to feel which of the two objects is heavier.
- Each player scores a point if he or she estimated correctly.
- The players repeat with other objects.
- The first player to score 10 points wins the game.

Remember to use words such as *heavier*, *lighter*, and *the same mass* in comparing the objects.

B. Grade 1 Learning Activities

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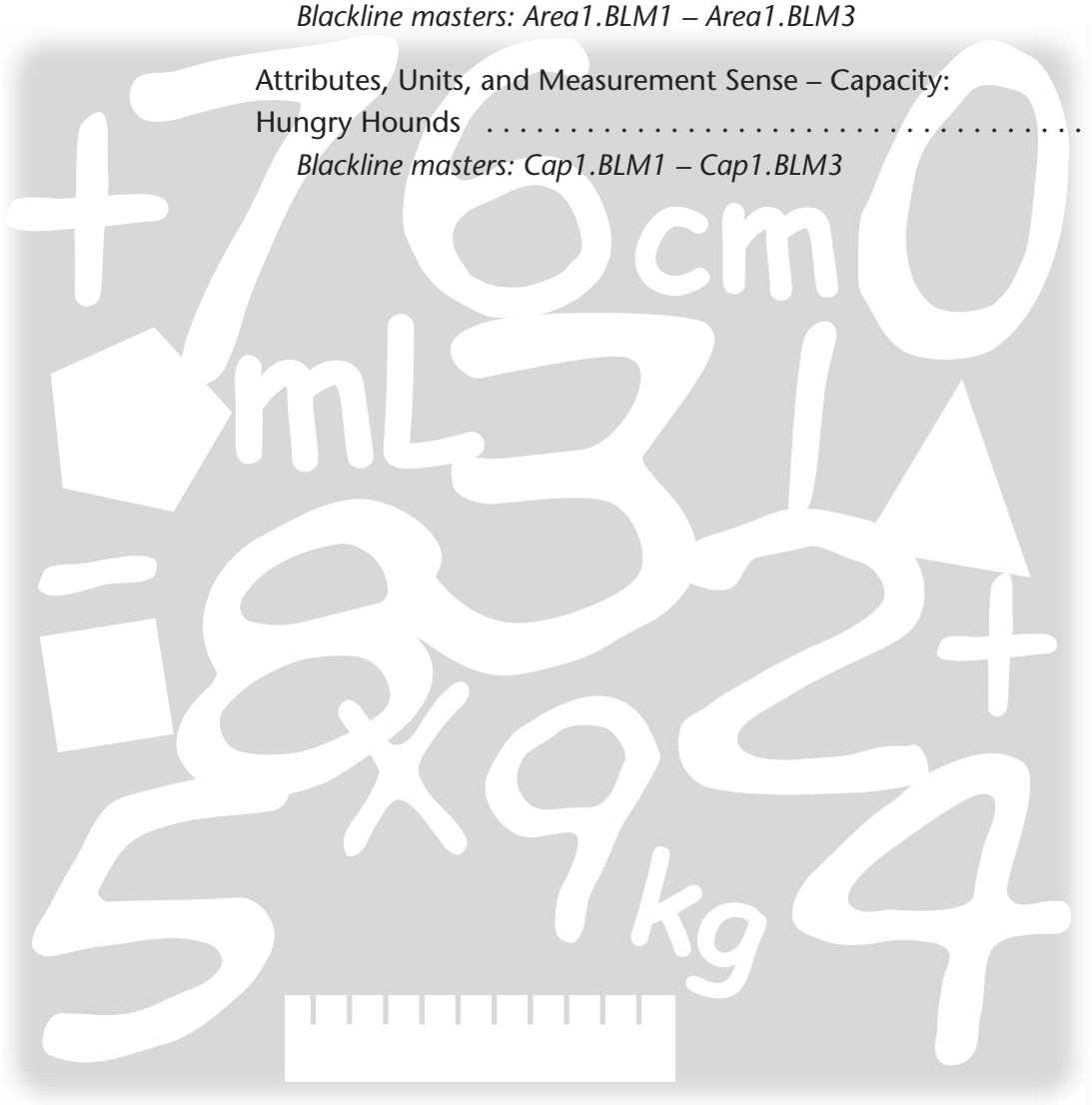


Measuring Snakes

BIG IDEA **Measurement Relationships**

CURRICULUM EXPECTATIONS

Students will:

- demonstrate an understanding of the use of non-standard units of the same size (e.g., straws, index cards) for measuring;
- estimate, measure (i.e., by placing non-standard units repeatedly, without overlaps or gaps), and record lengths, heights, and distances (e.g., a book is about 10 paper clips wide; a pencil is about 3 toothpicks long);
- compare two or three objects using measurable attributes (e.g., length, height, width, area, temperature, mass, capacity), and describe the objects using relative terms (e.g., *taller*, *heavier*, *faster*, *bigger*, *warmer*; "If I put an eraser, a pencil, and a metre stick beside each other, I can see that the eraser is shortest and the metre stick is longest.");
- compare and order objects by their linear measurements, using the same non-standard unit.

MATERIALS

- picture book about snakes – for example, *Snakes: Biggest! Littlest!* by Sandra Markle (Honnesdale, PA: Boyds Mills Press, 2005), if available
- 2 pieces of cord (rope, string, yarn), measuring 40 cm long and 30 cm long
- a variety of non-standard units for measuring length (e.g., toothpicks, straws, craft sticks, paper clips)
- Length1.BLM1a-c: Snakes (1 per group of three students)
- pieces of string, each measuring 2 m long (1 per group of three students)
- scissors (1 per group of three students)
- Length1.BLM2: Measuring and Comparing Lengths at Home (1 per student)

ABOUT THE MATH

Students learn that there are different ways of comparing objects by length. With direct comparison, students place objects side by side and observe which object is longer. When direct comparison is not possible, students make an indirect comparison. For example, to compare the length of a desk and the length of a table, students could cut a string to the length of the table and then the place the string along the length of

the desk to determine if the desk is longer than, shorter than, or the same length as the table.

Students learn that they can also use non-standard units (e.g., toothpicks, paper clips, craft sticks) to compare objects by length. They place the same non-standard units (e.g., paper clips) along the length of each object being measured, count the number of units along the length of each object, and then compare the numbers of units to see which object is longer.

In the following learning activity, students compare snakes (represented by cords and in pictures) by length, using different methods. They compare lengths by placing the snakes (cords) side by side and by using non-standard units to measure pictures of snakes.

The activity reinforces concepts about measuring length and about comparing objects by length:

- Length involves the distance between the two end points of an object.
- For the measuring of length, non-standard units must be placed end to end along the length of the object, without gaps and overlays.
- In order for two or more objects to be compared accurately by length, the same non-standard unit must be used in measuring them.
- A greater number of small non-standard units than of large units are needed to measure a specific length. For example, measuring the length of a table involves using more paper clips than craft sticks, because a paper clip is shorter than a craft stick.

GETTING STARTED

Set a context for the learning activity by reading aloud a picture book about snakes (e.g., *Snakes: Biggest! Littlest!* by Sandra Markle). Discuss the lengths of various snakes (e.g., short, long), and invite students to compare the snakes by length with various objects or with parts of their bodies (e.g., "I think this snake is about as long as my arm").

Next, have students sit in a circle. Place two pieces of cord on the floor — a cord that is 40 cm long, in a coiled position, and a cord that is 30 cm long, in a straightened position. Tell the students that the pieces of string represent snakes. Ask them to look at the snakes and estimate which snake is longer. Have the students explain their thinking.

Ask: "How could we find out which snake is longer?" Invite students to demonstrate their strategies for comparing the lengths of the snakes. Some students might compare the lengths directly, by extending both strings and placing them side by side. Discuss how both strings need to be straight and how they must have the same starting point.

Students might also use non-standard units (e.g., toothpicks, straws, craft sticks) to measure and compare the snakes. Discuss the importance of placing the units end to end, without gaps and overlays, along the lengths of the snakes.

WORKING ON IT

Show the students Length1.BLM1a–c: Snakes. Explain that the pictures represent snakes in a zoo. Explain the following:

> "A zookeeper was given instructions on how to feed the three snakes. He was told to feed the longest snake first and the shortest snake last. The zookeeper doesn't know which snake to feed first, second, or third."

Have students estimate which snake is the longest and which snake is the shortest. Have them explain their estimation strategies to the class.

Show a piece of string that is 2 m long. Explain that the zookeeper uses a piece of string to compare the lengths of the snakes. Divide the students into groups of three, and ask them to discuss how the zookeeper might have measured and compared the snakes. Have groups share their ideas with the class.

Provide each group of students with a string that is 2 m long and a pair of scissors. Tell students to imagine that they are the zookeeper and are to use their string to order the snakes from longest to shortest. For example, students might place the string on each snake, following the contours of the body, and then cut the string to the length of the snake. They might then place the strings side by side to order the snakes from longest to shortest.

Next, explain that the students must check their order by using non-standard units (e.g., paper clips, cubes, counters) of their choice. Provide a variety of non-standard units, and encourage groups to use different materials.

Observe students as they measure the snakes and order them from longest to shortest. Do students understand that the length involves the distance between both ends of a snake? Do they use string and non-standard units appropriately to measure the snakes? Do students use appropriate strategies for comparing lengths (e.g., place pieces of string side by side; count and compare the numbers of non-standard units that represent the lengths of the snakes)?

REFLECTING AND CONNECTING

Gather students together to review the activity. Have groups of students demonstrate how they used string to compare the lengths of the snakes, and how they ordered the snakes from longest to shortest. Discuss in which order the snakes should be fed.

Next, have groups explain how they used non-standard units to measure and compare the lengths of the snakes. Include groups that used different non-standard units. After groups have made their presentations, record their findings in a chart such as the one below.

Kind of Unit	Length of Snake A	Length of Snake B	Length of Snake C
paper clips	9 units	14 units	21 units
cubes	14 units	22 units	34 units
counters	17 units	26 units	39 units

Have students refer to information in the chart as they answer questions such as the following:

- "How do you know that the snakes are different lengths?"
- "Which snake is the longest? The next longest? The shortest? How do you know?"
- "Why are there different numbers of units for the length of Snake A? For example, why is the length of Snake A both 9 paper clips and 14 cubes?"
- "Why are there more counters than paper clips for Snake A? Why are there fewer paper clips than cubes for Snake B?"
- "Why is it important to use the same unit when comparing the lengths of different objects?"
- "What must you do to ensure that you measure accurately?"

ADAPTATIONS/EXTENSIONS

Some students may have difficulty measuring the lengths of the snakes illustrated in Length1.BLM1a–c: Snakes, because of the curved formations of the snakes' bodies. Provide these students with illustrations of snakes with straight bodies.

As an extension to the activity, ask students to draw a snake with a given length (e.g., draw a snake that is 6 toothpicks long). Students may draw a snake with a straight or curved body.

Another extension involves having students find a non-standard unit that produces a given measurement for one of the snakes. For example, pose the following problem: "Snake A on Length1.BLM1a is about 10 units long. What non-standard unit could it be?"

MATH LANGUAGE

- length
- long, longer, longest
- short, shorter, shortest
- unit

ASSESSMENT

Observe students to assess how well they:

- compare the lengths of objects directly (e.g., place two objects side by side to determine which is longer);
- use non-standard units to measure length;
- measure accurately (e.g., place non-standard units end to end, without gaps and overlays; count the units correctly);
- use non-standard units to compare the lengths of objects (e.g., recognize that an object that is 12 paper clips long is longer than an object that is 9 paper clips long);
- understand the relationship between the size of the unit and the number of units that are needed to measure a length (e.g., measuring the length of an object involves using more paper clips than craft sticks, because a paper clip is shorter than a craft stick).

HOME CONNECTION

Send home Length1.BLM2: Measuring and Comparing Lengths at Home. In this Home Connection activity, parents help their children use non-standard units to measure and compare objects at home.

LEARNING CONNECTION 1

A-Mazing Paths

Materials

- Length1.BLM3: A-Mazing Paths (1 per pair of students)
- a variety of non-standard units (e.g., small cubes, paper clips) for measuring length

Provide each pair of students with a copy of Length1.BLM3: A-Mazing Paths. Have students draw a line to show the path from Start to Finish in each maze.

Ask: "Which maze, do you think, has the shorter path?" Provide time for pairs to discuss how they could find the shorter path. Encourage them to think about how they might use non-standard units, such as small cubes and paper clips, to measure and compare the lengths of the paths. Have a few pairs share their ideas with the class.

Provide for pairs an opportunity to measure and compare the lengths of the paths. Have pairs of students explain their strategies and findings to the class.

LEARNING CONNECTION 2

Measuring Lines

Materials

- large sheets of paper (1 per student)
- markers or crayons (1 per student)
- a variety of non-standard units (e.g., cubes, paper clips) for measuring length

Provide each student with a large sheet of paper. Instruct the students to use a marker or crayon to draw a line. Tell the students that the line that each one draws may be straight, wavy, zigzag, or curved.

Next, ask the students to choose from a variety of non-standard units (e.g., cubes, paper clips) one unit with which to measure the length of the line. Instruct them to estimate the length of the line, and to record their estimate beside the line (e.g., Estimate – 25 cubes long). Next, have students use the chosen non-standard unit to measure the actual length of the line. Have them record the actual measurement (e.g., Actual – 23 cubes).

Provide students with opportunities to draw other lines, and to use a variety of non-standard units to estimate and measure the lengths of the lines.

LEARNING CONNECTION 3

Making Rulers

Materials

- a large collection of interlocking cubes
- sheets of paper

Before students use standard rulers to measure length, they should have experiences in using rulers that they construct from non-standard units. Such experiences help students focus on the linear units represented by a ruler.

Have the students create their own rulers by connecting up to 20 interlocking cubes in a row. Instruct the students to measure objects in the classroom, including objects that are longer than, shorter than, and the same length as their rulers. Give each student a sheet of paper on which to record the names and lengths of the objects that he or she measures (e.g., pencil – 8 cubes long).

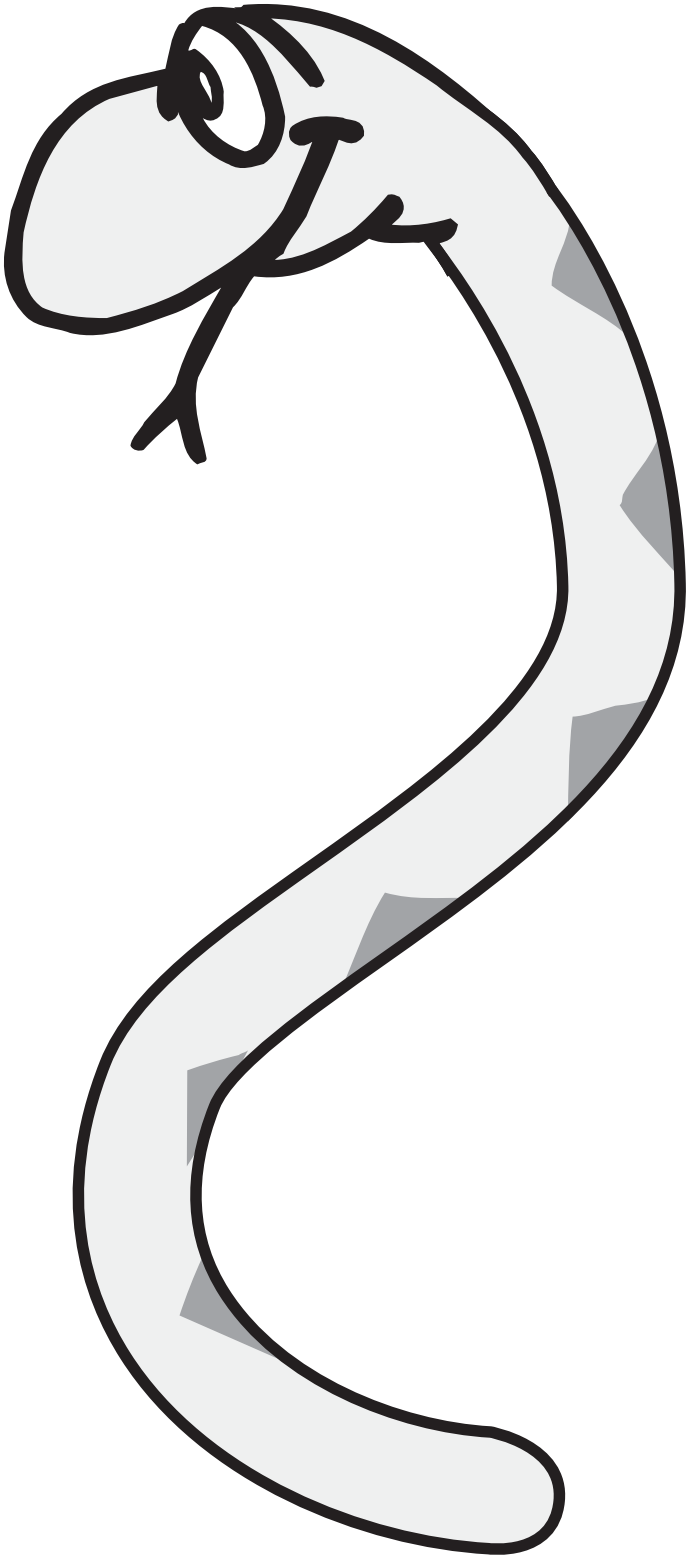
Invite a few students to share their findings with the class. Ask them to explain how they used their rulers to measure the objects.

Students could also use centimetre squares to construct rulers. Showing students that the length of each cube corresponds to the length of a space on a centimetre ruler helps them understand how standard rulers are constructed and how they are used to measure length.

Snakes

Length1.BLM1 (a)

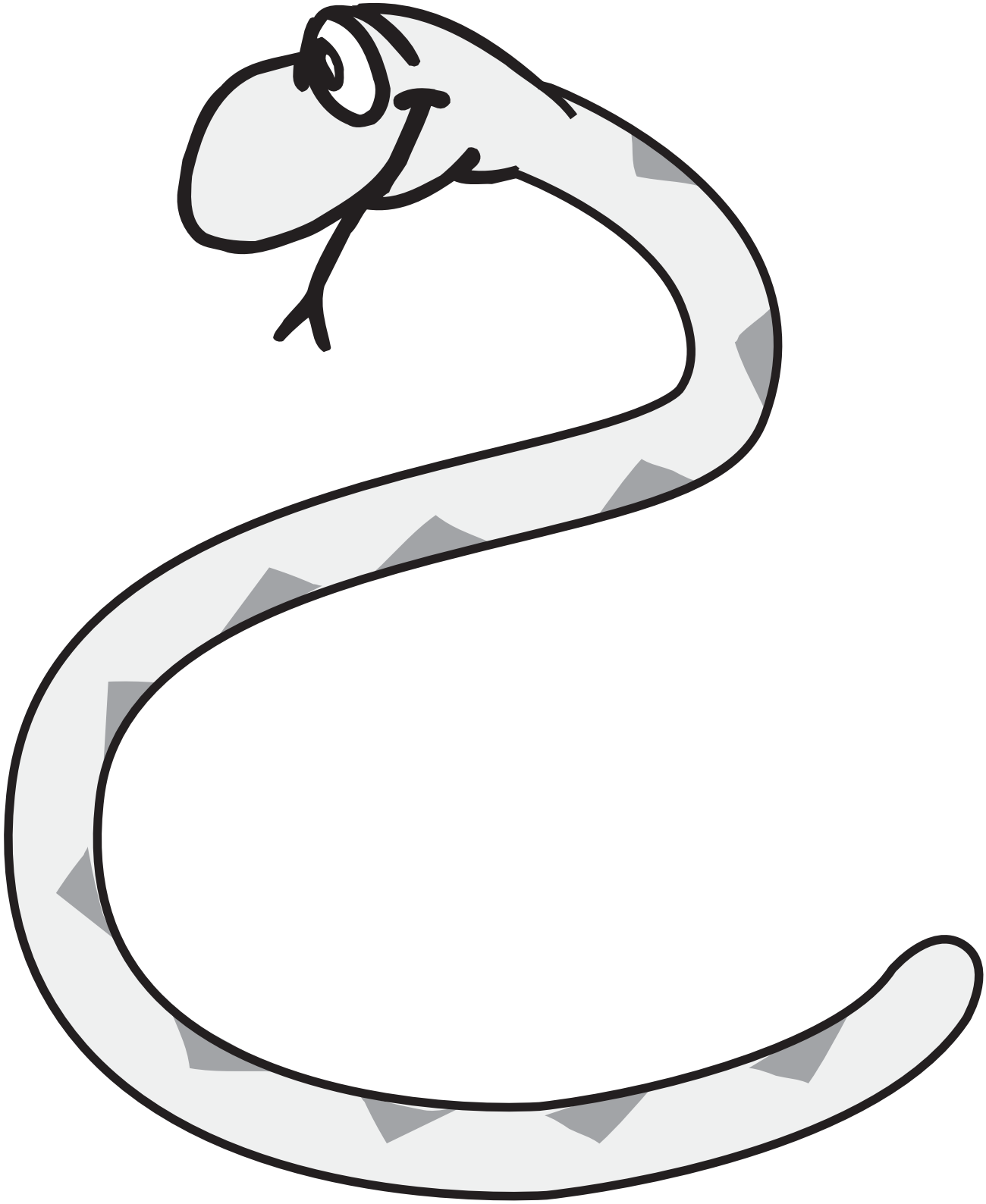
Snake A



Snakes

Length1.BLM1 (b)

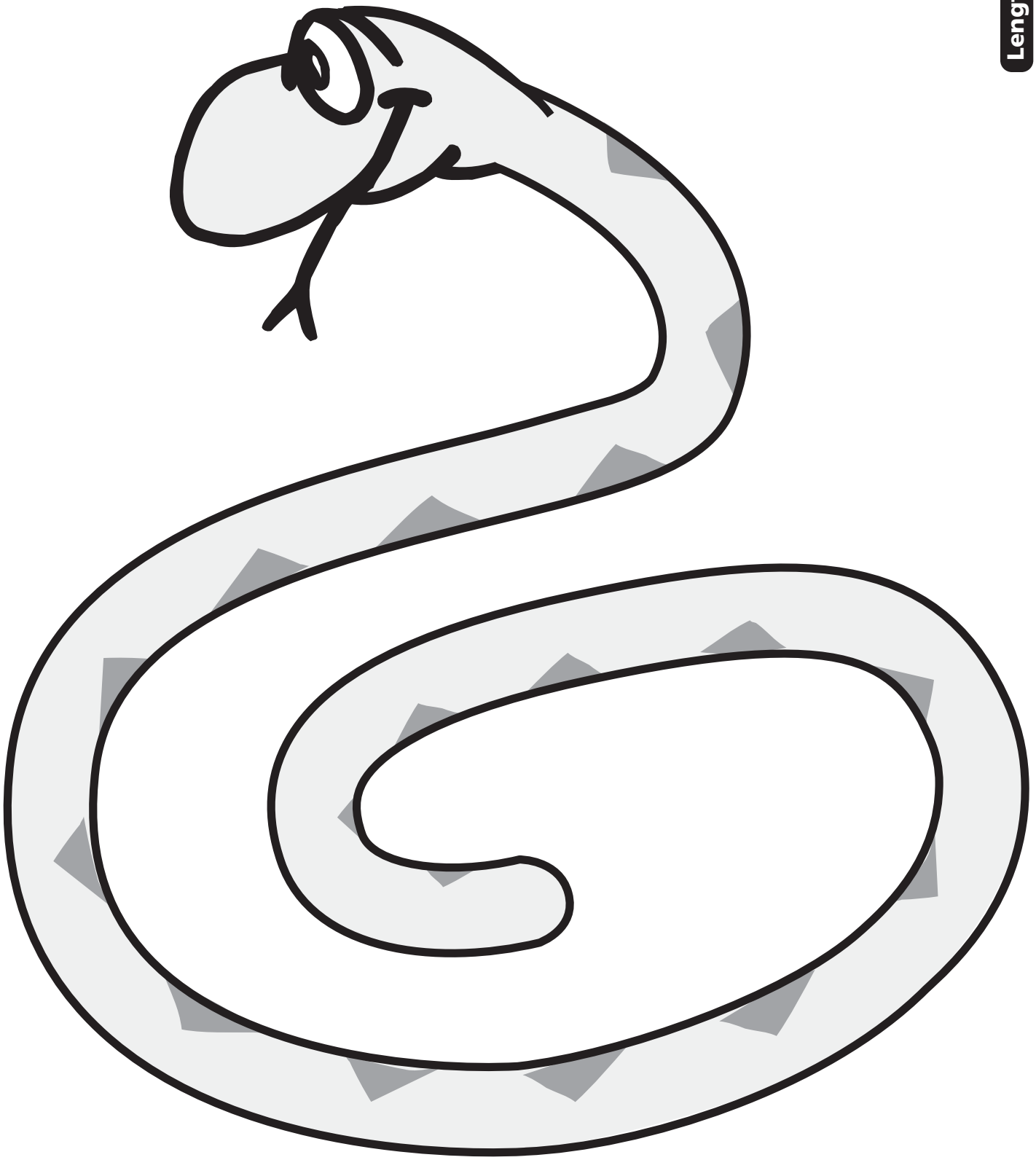
Snake B



Snakes

Length1.BLM1 (c)

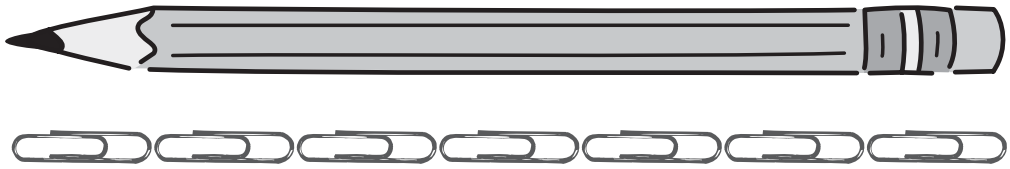
Snake C



Measuring and Comparing Lengths at Home

Dear Parent/Guardian:

Your child has been learning to measure and compare objects by length, using non-standard units (e.g., paper clips, toothpicks, small cubes). By placing the non-standard units beside objects, students can determine which object is longer.



Provide your child with an opportunity to measure and compare the lengths of objects at home. Find three objects (e.g., belt, shoelace, piece of string) to measure. Ask your child to use non-standard units (e.g., paper clips, toothpicks, spoons) to measure the length of each object.

Next, have your child compare the objects by referring to their lengths (e.g., "The belt is longer than the shoelace because the belt is 15 toothpicks long and the shoelace is 12 toothpicks long").

You might also have your child use non-standard units to measure and compare the widths of three objects (e.g., window, door, table).

Thank you for providing your child with opportunities to measure and compare the lengths of objects at home.

A-Mazing Paths

Start

Finish

Start

Finish

Newspaper Photographs

BIG IDEA **Measurement Relationships**

CURRICULUM EXPECTATIONS

Students will:

- demonstrate an understanding of the use of non-standard units of the same size (e.g., straws, index cards) for measuring;
- estimate, measure (i.e., by minimizing overlaps and gaps), and describe area, through investigation using non-standard units (e.g., "It took about 15 index cards to cover my desk, with only a little bit of space left over.");
- compare two or three objects using measurable attributes (e.g., length, height, width, area, temperature, mass, capacity), and describe the objects using relative terms (e.g., *taller*, *heavier*, *faster*, *bigger*, *warmer*; "If I put an eraser, a pencil, and a metre stick beside each other, I can see that the eraser is shortest and the metre stick is longest.").

MATERIALS

- newspaper page
- Area1.BLM1a–c: Newspaper Photographs (1 per pair of students)
- square tiles (approximately 30 tiles per pair of students)
- 11 in. x 17 in. sheets of paper (1 per pair of students)
- Area1.BLM2: Measuring Area at Home (1 per student)

ABOUT THE MATH

In the early primary grades, students develop concepts about area through opportunities to cover different surfaces with a variety of non-standard units (e.g., square tiles, pattern blocks, sheets of paper). Such experiences help students understand that area can be measured by counting the number of units that cover a surface.

In the following learning activity, students measure the areas of three rectangular photographs, using square tiles, and then order the photographs from least to greatest area. The activity helps students understand that a surface that appears to be larger than others (e.g., because it is taller) does not necessarily have a greater area.

GETTING STARTED

Show students a newspaper page. Refer to the page to show how newspaper reporters use text and photographs to communicate news.

Explain that page designers are responsible for planning every page in a newspaper. Discuss how the designers need to know how much area the text and photographs will cover, so that there will not be empty spaces on the page.

WORKING ON IT

Display Area1.BLM1a–c: Newspaper Photographs. Tell the students that a newspaper designer is preparing an article about the new play equipment in a park and wishes to use the three photographs on Area1.BLM1a–c: Newspaper Photographs. Explain that the designer needs to know which photograph has the greatest area, which photograph has the next greatest area, and which photograph has the least area.

Ask students to estimate which photograph has the greatest area and which photograph has the least area. Ask a few students to explain how they compared the areas of the photographs. (Some students may assume that the tallest photograph has the greatest area.)

Ask: "How can we compare the areas of the photographs?" Some students might suggest comparing the areas directly by placing the photographs on top of one another. Other students might suggest covering the photographs with small objects (i.e., non-standard units, such as square tiles or cubes) and comparing the numbers of objects needed to cover the photographs.

Show students a collection of square tiles, and ask: "How could you use square tiles to compare the areas of the photographs?"

Provide each pair of students with a copy of Area1.BLM1a-c: Newspaper Photographs. Ask the pairs to estimate the number of square tiles needed to cover the surface of Photograph A, and to record their estimate on the page. Ask the students to raise their hands if their estimate falls within a specific range that you announce aloud – for example, "Raise your hand if your estimate is from 5 to 10 square tiles (from 11 to 15 square tiles/from 16 to 20 square tiles/more than 20 square tiles)."

Provide each pair with a quantity of square tiles. Instruct the students to find the number of square tiles needed to cover the surface of Photograph A and then to record the actual measurement on the page.

Direct the students to estimate and measure the areas of Photograph B and Photograph C.

Have the students cut out the photographs and glue them on an 11 in. x 17 in. sheet of paper, arranging them from greatest to least area. Ask the students to record the area measurement directly below each photograph.

REFLECTING AND CONNECTING

Gather the students together to share the results of their investigation. Ask the following questions:

- "What strategy did you use to compare the areas of the photographs?"
- "How many square tiles did it take to cover Photograph A? Photograph B? Photograph C?"
- "How close were your estimates to the actual numbers of square tiles?"
- "How did you arrange the square tiles on the photographs to avoid a lot of gaps?"
- "How did you order the photographs from greatest to least area? How could you prove to someone that you ordered the photographs correctly?"

ADAPTATIONS/EXTENSIONS

Some students may have difficulty arranging the square tiles in arrays. Help these students complete the first row, showing them how to place the square tiles side by side along the top edge of the photograph. Next, have the student complete the remaining rows. Point out how the square tiles are arranged in rows and columns.

Assist students who need help in counting the square tiles correctly. Model a counting process in which you touch and move aside each square tile so that it receives one, and only one, count.

As an extension, provide students with other non-standard units (e.g., triangle pattern blocks, sticky notes), and have them estimate the number of units needed to cover each photograph. Have students use the non-standard units to measure the areas of the photographs.

Challenge students to use a single square tile to find the area of a photograph. This activity provides them with an opportunity to measure by moving one square tile repeatedly over the surface being measured (unit iteration). The activity can also prompt students to devise strategies for finding the total number of units needed to cover a surface (e.g., by finding the number of units in one row and then skip counting or using repeated addition to find the total number of units).

MATH LANGUAGE

- area
- estimate
- surface

ASSESSMENT

Observe students to assess how well they understand concepts about measuring area.

- Do students make reasonable estimates about the area of surfaces?
- How well do students understand that measuring area involves finding the number of units required to cover a surface?
- How well do students cover a surface with non-standard units, minimizing gaps and overlaps?
- Are students able to order surfaces from greatest to least area?
- How well do students describe the area of an object, using appropriate vocabulary (e.g., "It took 22 sticky notes to cover the book")?

HOME CONNECTION

Area1.BLM2: Measuring Area at Home describes to parents how they can help their child estimate and measure the area of surfaces at home.

LEARNING CONNECTION 1

Cover the Cover

Materials

- books (1 per student)
- sticky notes
- a variety of non-standard units for measuring area (e.g., playing cards, recipe cards, square tiles)

Show students a book with a sticky note on it. Ask: "How many sticky notes do you think it would take to cover this book?" Elicit a few estimates from students.

Next, arrange sticky notes along the top edge and the left-hand side of the book cover to show a row and a column. Have students count the number of sticky notes, and then ask if they would like to change their estimates. Ask a few students to tell how they revised their estimates, encouraging them to explain how they used the partially filled book cover to help them determine the total number of sticky notes needed to cover the book. Record students' estimates on the board or chart paper.

Ask students to explain how they could find the total area of the book. After students have suggested covering the surface of the book with sticky notes, begin to attach the notes, leaving gaps and overlays. Invite students to explain how the sticky notes should be arranged in rows and columns so that gaps and overlays are minimized.

Ask a student to cover the book by arranging sticky notes in rows and columns. Have students count the total number of sticky notes, and discuss the area of the book

(e.g., "The area of the book is about 25 sticky notes"). Compare the actual measurement with students' estimates.

Have each student choose a book and use non-standard units (e.g., sticky notes, playing cards, recipe cards, square tiles) to estimate and measure the area of the book.

LEARNING CONNECTION 2

A Stamping Good Time

Materials

- rubber stamps (2 identical stamps per pair of students)
- stamp pads (1 per pair of students)
- shapes cut from Bristol board (1 per student)

Provide each pair of student with two identical rubber stamps, a stamp pad, and two different shapes cut from Bristol board. Instruct each student to select a shape and to cover its surface with stamps. Encourage the students to avoid leaving gaps and overlays as they stamp. Have the students count the number of stamps on each shape in order to determine which shape has the greater area.

Students could complete this activity at a learning centre.

LEARNING CONNECTION 3

Same Shape, Different Units

Materials

- pattern blocks
- Area1.BLM3: Same Shape, Different Units (1 per student)

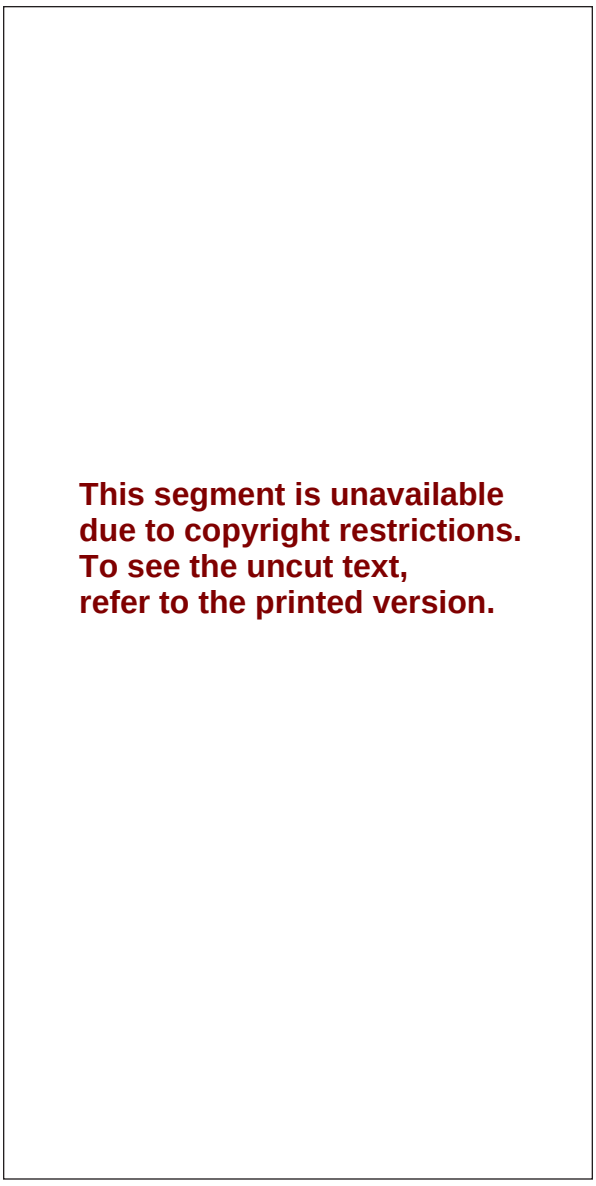
Provide each student with a copy of Area1.BLM3: Same Shape, Different Units. Instruct the students to cover the rectangle on the page three times, each time using only one kind of pattern block (hexagon, trapezoid, square).

Discuss students' discoveries by asking the following questions:

- "Which kind of pattern block best covered the rectangle? Why?"
- "How many yellow hexagons/red trapezoids/orange squares did you need to cover the rectangle?"
- "Why did you need a different number of pattern blocks each time?"
- "Did you need more yellow hexagons or red trapezoids? Why?"
- "Did you need more red trapezoids or orange squares? Why?"

Newspaper Photographs

Photograph A

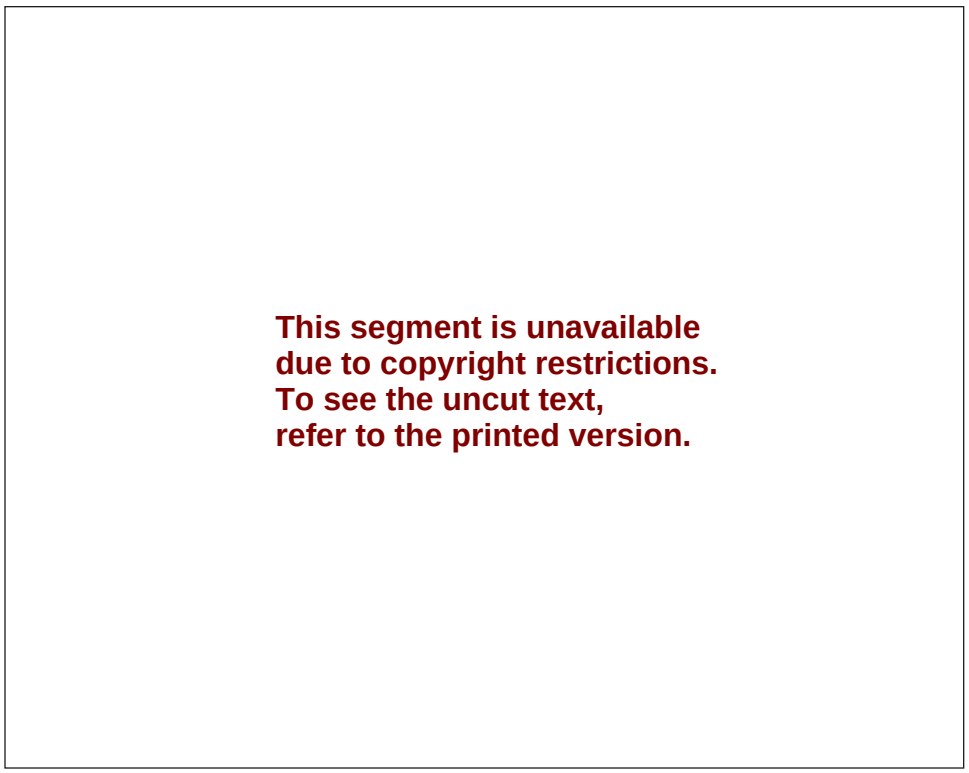


I estimated _____ square tiles.

I measured _____ square tiles.

Newspaper Photographs

Photograph B



I estimated _____ square tiles.

I measured _____ square tiles.

Newspaper Photographs

Photograph C

I estimated _____ square tiles.

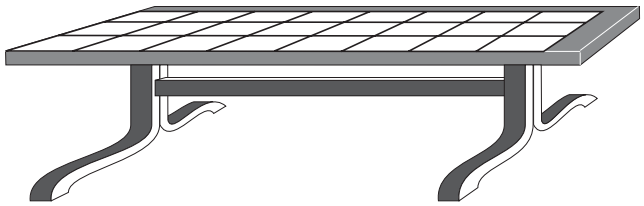
I measured _____ square tiles.

Measuring Area at Home

Dear Parent/Guardian:

Our class has been learning about measuring area. To measure area, the students cover a surface with objects (e.g., square tiles, cards, sheets of paper), and then count the number of objects needed to cover the surface. The objects that students use to cover a surface are referred to as non-standard units.

Help your child measure the area of a surface at home (e.g., table, bed, mat). Together with your child, choose non-standard units of one kind (e.g., recipe cards, playing cards, tissues, sheets of paper) that can be used to cover the surface. Have your child estimate the number of units that will be needed to cover the surface. Next, have your child cover the surface with the units and then count the number of units needed to cover the surface.



You may discover that the units do not fit exactly on the surface being measured. Point out that the measurement is approximate (e.g., "The area of the table is *about* 24 sheets of paper").

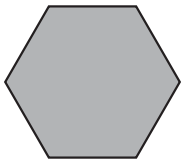
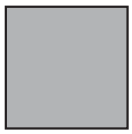
Have your child use different non-standard units to measure the area of other surfaces. Then discuss with your child how some non-standard units are more appropriate than others for measuring some surfaces. For example, playing cards are an appropriate non-standard unit for measuring the area of a small mat but are less appropriate for measuring the area of a large bed.

Thank you for helping your child measure area.

Same Shape, Different Units

Cover the rectangle with pattern blocks.

Use one type of block each time.

Pattern Block	Number of Pattern Blocks
Hexagon 	
Trapezoid 	
Square 	

Hungry Hounds

BIG IDEA **Attributes, Units, and Measurement Sense**

CURRICULUM EXPECTATIONS

Students will:

- demonstrate an understanding of the use of non-standard units of the same size (e.g., straws, index cards) for measuring;
- estimate, measure, and describe the capacity and/or mass of an object, through investigations using non-standard units (e.g., "My journal has the same mass as 13 pencils." "The juice can has the same capacity as 4 pop cans.");
- compare two or three objects using measurable attributes (e.g., length, height, width, area, temperature, mass, capacity), and describe the objects using relative terms (e.g., *taller*, *heavier*, *faster*, *bigger*, *warmer*; "If I put an eraser, a pencil, and a metre stick beside each other, I can see that the eraser is the shortest and the metre stick is longest.").

MATERIALS

- empty plastic containers (e.g., jars, cottage cheese containers, margarine tubs, juice bottles) and accompanying lids (1 container and lid per student)
- materials for making Hungry Hounds: plastic googly eyes; pompoms for noses; ears, tongues, and legs cut from construction paper or foam core; pipe cleaners or pieces of yarn for tails; glue; tape (enough materials for each student to make his or her own Hungry Hound)
- small scoops (e.g., coffee scoops, small plastic cups, caps from liquid laundry detergent bottles) (1 per student)
- containers of pourable materials (e.g., water, rice, or sand)
- a few plastic funnels (e.g., the top part of a plastic bottle cut in half)
- Cap1.BLM1: Hungry Hounds (1 per student)
- Cap1.BLM2: Measuring Capacity at Home (1 per student)

ABOUT THE MATH

Capacity refers to the maximum amount that a container can hold. In the early primary grades, students develop an understanding of capacity by filling a variety of containers with pourable materials (e.g., water, rice, sand), and by comparing the amounts that the different containers hold. They measure capacity by counting the number of units (e.g., scoops) that a container holds.

Young students often assume that tall, narrow containers have a greater capacity than short, wide containers, because tall containers "look bigger". Opportunities to estimate and measure the capacity of a variety of containers allow students to address their misconceptions about the relationships between the shapes and the capacities of containers.

As students develop an understanding of capacity, they develop language that allows them to compare containers by capacity. Initially, students make general comparisons (e.g., "The water jug is bigger than the baby food jar"). Later, they use more precise language – for example, "The juice bottle has a capacity of 15 scoops and the pop bottle has a capacity of 18 scoops. The pop bottle holds more than the juice bottle."

GETTING STARTED

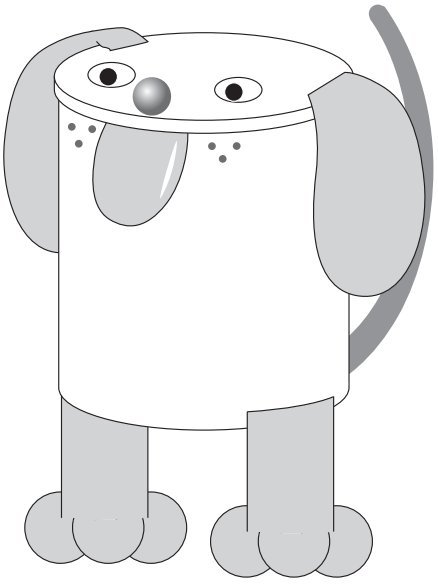
Prior to the activity, ask students to bring in empty plastic containers (e.g., jars, cottage cheese containers, margarine tubs, juice bottles) and accompanying lids.

Show students a model of a Hungry Hound that you made ahead of time. Explain the following:

> "Each of you will make a Hungry Hound. Once you have your own Hungry Hound, you will need to feed it. You will need to measure how many scoops of food your Hungry Hound can eat."

Provide each student with a plastic container and its lid, ensuring that the students have containers of various sizes. Have students create their hounds by:

- gluing plastic googly eyes, a pompom nose, paper or foam ears, and a paper or foam tongue to the lid. (Students can attach eyes, a nose, ears, and a tongue to a polystyrene ball if the lid is too small for the dog's head.);
- gluing paper or foam legs to the container;
- taping a tail (pipe cleaner or piece of yarn) to the back of the container.



Note: Having students make their own Hungry Hounds stimulates interest in the activity. However, if teachers wish to save time, they can have students create a simpler version of a hound by having them use a permanent marker to draw the hound's physical features directly on their containers.

After students have created their Hungry Hounds, explain that they will determine how much their hounds eat by counting the scoops of food it takes to fill them.

WORKING ON IT

Show students containers of pourable materials (e.g., water, rice, sand), and explain that the materials represent dog food. Tell the students that each one's task is to "feed" his or her Hungry Hound until it is full.

Provide each student with a small scoop and a copy of Cap1.BLM1: Hungry Hounds. Ask: "How many scoops of food do you think your Hungry Hound will eat?" Have the students record their estimates on their pages.

Observe the students as they fill their containers. (Provide plastic funnels for students who need them.) Emphasize the importance of filling the scoop to the same level each time. When the students have partially filled their containers, ask them to predict how many more scoops will be needed to fill the containers completely. Encourage the students to base their predictions on the numbers of scoops already poured into their containers. For example, knowing that 7 scoops filled half a container will help a student predict that 7 more scoops will be needed to fill the container. Students can also base their predictions on benchmark quantities (e.g., observing a quantity consisting of 2 scoops allows a student to predict the number of scoops that are needed to fill his or her container).

After the students have measured and recorded the capacities of their Hungry Hounds, ask them to compare their estimates with the actual measurements – for example, "My Hungry Hound has a smaller capacity than I thought. It took only 15 scoops to fill it, and I thought it would take 25 scoops."

Next, have the students empty their Hungry Hounds and exchange them with a partner. (Ensure that each student receives a container that is different from the one that he or she measured previously.) Have each student predict and record the number of scoops needed to fill the partner's Hungry Hound, encouraging the students to base their estimates on the measurements of their own containers (e.g., if the partner's container is smaller, fewer scoops will be needed to fill it). Have each student "feed" the partner's Hungry Hound with the same material that he or she used previously and record the capacity of the container on his or her copy of Cap1.BLM1: Hungry Hounds.

After each student has recorded the capacity of the partner's Hungry Hound, have the student compare the capacity of his or her own hound with the capacity of the partner's by completing the bottom section of Cap1.BLM1: Hungry Hounds.

REFLECTING AND CONNECTING

Gather the students together to review the activity. Ask a few students to show their Hungry Hounds and to tell the class their estimates and actual measurements of the capacities of their containers. Ask questions such as the following:

- "How did you estimate the number of scoops needed to feed your Hungry Hound?"
- "How did your estimate compare with your actual measurement?"
- "Whose Hungry Hound has a greater capacity, yours or your partner's? How do you know?"
- "What did you learn about measuring capacity?"

Show two Hungry Hounds that have approximately the same capacity but different shapes. Ask students to estimate which container has the greater capacity, and have students explain their estimation strategies. For example, the students might compare the sizes of the containers by observing which container is taller or wider. Have the owners of the Hungry Hounds reveal the actual capacity measurements of the containers. Discuss how different-shaped containers can have capacities that are approximately the same.

Conclude the activity by having students explain what they learned about measuring capacity. Record their ideas on chart paper. For example, students might explain the following ideas:

- Capacity is how much a container holds.
- Capacity can be measured with scoops.
- Containers can have different capacities.
- Containers can look different but have the same capacity.
- One way of comparing the capacities of containers is to count the number of scoops that each container holds, and then compare the numbers.

ADAPTATIONS/EXTENSIONS

In their enthusiasm to proceed with the activity, students might not fill their containers exactly, scooping too much or too little pourable material into their containers. Guide these students in working carefully as they scoop material into their containers. Help students understand that they need to fill the containers carefully in order to measure and compare accurately.

Some students may have difficulty making reasonable estimates about the capacities of different containers. Provide these students with opportunities to measure the capacities of a variety of containers by counting the numbers of scoops needed to fill them.

Extend the activity by having small groups of students order their Hungry Hounds from least to greatest capacity.

Students might also investigate the use of different-size scoops (e.g., whether more small scoops than big scoops are needed to fill a container).

MATH LANGUAGE

- capacity
- unit
- estimate
- great, greater
- few, fewer
- more, most
- less, least

ASSESSMENT

Observe students to assess how well they:

- explain the meaning of capacity (i.e., how much a container holds);
- make reasonable estimates about the capacity of a container (e.g., estimate the number of scoops a container will hold);
- explain their estimation strategies;
- measure accurately (e.g., by filling a measuring scoop to the same level each time and carefully counting the number of scoops needed to fill a container);
- compare the capacities of containers.

HOME CONNECTION

Send home Cap1.BLM2: Measuring Capacity at Home. In this Home Connection activity, students and their parents measure and compare the capacities of three containers in their home.

LEARNING CONNECTION 1

Loading Up on Laundry

Materials

- small scoop (e.g., cap from a liquid laundry detergent bottle)
- transparent plastic container (large enough to hold several scoopfuls)
- liquid or powder laundry detergent (or coloured water or sand)

Show the students a small scoop and explain that it is used to pour laundry detergent into a washing machine. Explain that one scoop of detergent is used for each load of laundry.

Next, show the students an empty transparent plastic container. Ask: "If this container were full of detergent, how many loads of laundry could be done?" Pour one scoop of detergent into the container, and ask the students to observe how much of the container is filled by one scoop. Then, have them estimate the number of scoops that will be needed to fill the container. Have students raise their hands if their estimate falls within a range you announce aloud (e.g., "Raise your hand if your estimate is from 1 to 3 scoops/from 4 to 6 scoops/from 7 to 10 scoops").

Continue to fill the container, having students count the scoops aloud. Have students compare their estimates with the actual number of scoops needed to fill the container. Discuss the number of loads of laundry that could be done with all the detergent in the full container.

LEARNING CONNECTION 2

Different Shapes, Same Capacity

Materials

- 500-g tubs (e.g., margarine tubs, sour cream containers) (1 per pair of students)
- 500-mL plastic water bottles (1 per pair of students)
- small scoops (e.g., coffee scoops, small plastic cups, caps from liquid laundry detergent bottles) (1 per pair of students)
- plastic funnel (e.g., top part of a plastic bottle cut in half) (1 per pair of students)
- containers of pourable materials, such as water, rice, sand (1 per pair of students)

Show students a 500-g tub and a 500-mL plastic water bottle. Compare the shapes of the two containers (e.g., the tub is short and wide, whereas the bottle is tall and narrow). Ask: "Do you think these two containers have the same capacity?" Have the students give a thumbs-up gesture if they think the containers have the same capacity and a thumbs-down gesture if they think the containers have different capacities.

Provide each pair of students with a 500-g tub, a 500-mL plastic water bottle, a small scoop, a plastic funnel, and a container of a pourable material. Have the students use the materials to determine whether both containers have the same capacity.

Gather the students to share their findings. Discuss how different-shaped containers can have the same capacity.

LEARNING CONNECTION 3

Comparing With a Star Container

Materials

- containers of different shapes and sizes (4 per group of three students)
- sticky notes (4 per group of three students)
- small scoops (e.g., coffee scoops, small plastic cups, caps from liquid laundry detergent bottles) (1 per group of three students)
- containers of pourable materials, such as water, rice, sand (1 per group of three students)
- Cap1.BLM3: Comparing With a Star Container (1 per group of three students)

Arrange the students in groups of three. Provide each group with four containers, four sticky notes, a small scoop, a container of a pourable material, and a copy of Cap1.BLM3: Comparing With a Star Container.

Instruct the groups to choose one of their containers as the Star Container, and to label it by drawing a star on a sticky note. Have students use a small scoop and a pourable material to measure the capacity of the Star Container. Have them record the information on their copy of Cap1.BLM3: Comparing With a Star Container.

Next, have students use sticky notes to label three other containers A, B, and C. Tell the students that they need to determine whether each container has a capacity that is greater than, less than, or the same as the capacity of the Star Container. Explain that the groups are to:

- estimate whether Container A has a capacity that is greater than, less than, or the same as the capacity of the Star Container;
- measure the capacity of Container A with a small scoop and a pourable material, and record the capacity of Container A on the page;
- determine whether the capacity is greater than, less than, or the same as the capacity of the Star Container, and circle the appropriate comparison on the page;
- repeat the process with Container B and Container C.

Gather students together after they have completed the activity. Ask the following questions:

- "Were your estimations correct?"
- "When was it easy to estimate correctly?"
- "When was it difficult to estimate correctly?"

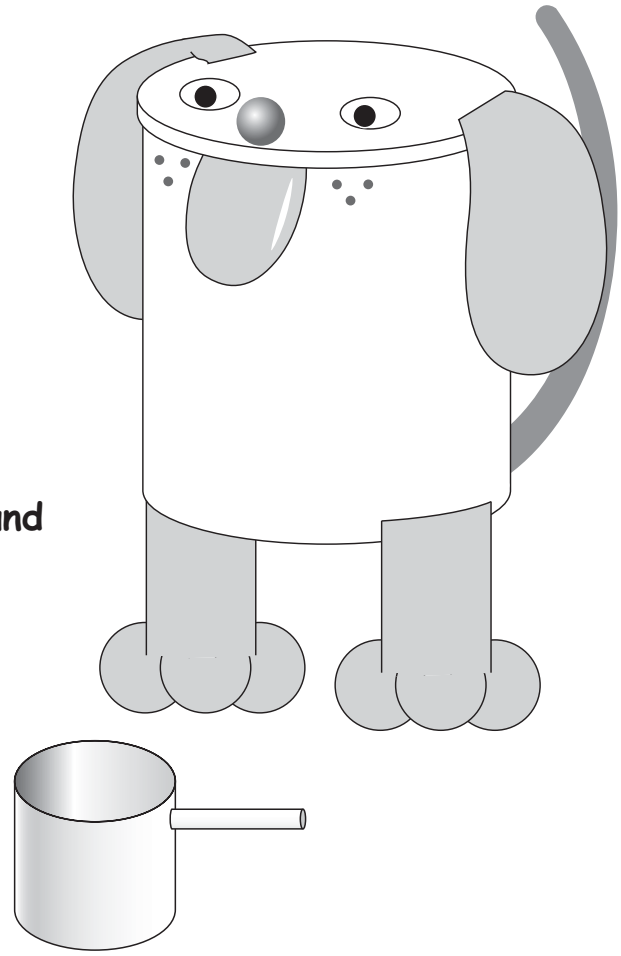
- "Is the capacity of your Container A greater than, less than, or the same as the capacity of your Star Container? How do you know?"
- "Which of your containers has the greatest capacity? How do you know?"
- "Which of your containers has the least capacity? How do you know?"

Hungry Hounds

Capacity of My Hungry Hound

I estimated _____ scoops.

I measured _____ scoops.



Capacity of My Partner's Hungry Hound

I estimated _____ scoops.

I measured _____ scoops.

Whose Hungry Hound has a greater capacity?

_____

I know this because_____

_____

_____.

Measuring Capacity at Home

Dear Parent/Guardian:

Our class is learning to measure capacity by exploring how much different containers hold. Here is an activity to do with your child:

- Find three containers (e.g., bottle, empty jar, glass). Try to find containers that have about the same capacity but are different shapes.
- Ask your child to estimate which container has the greatest capacity (i.e., which holds the most) and which container has the least capacity (i.e., which holds the least).
- Provide your child with a large spoon (or a small scoop), and a pourable material, such as rice, dried beans, or sand. Have your child count the number of spoonfuls (scoops) of material needed to fill each of the containers completely.
- Have your child compare the numbers of spoonfuls (scoops) needed to completely fill the containers. Ask him or her to identify the container with the greatest capacity and the container with the least capacity.

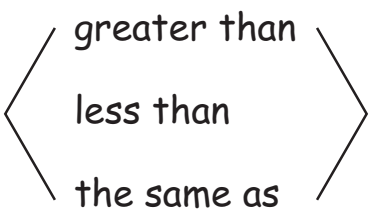
Thank you for helping your child measure and compare capacities at home.

Comparing With a Star Container

The capacity of the Star Container is _____ scoops.

Container A

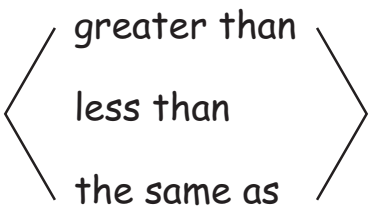
The capacity of Container A is _____ scoops.

The capacity of Container A is 

the capacity of the Star Container.

Container B

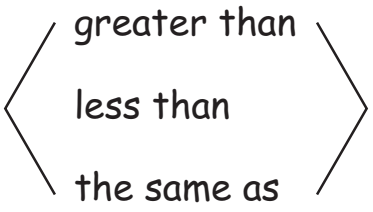
The capacity of Container B is _____ scoops.

The capacity of Container B is 

the capacity of the Star Container.

Container C

The capacity of Container C is _____ scoops.

The capacity of Container C is 

the capacity of the Star Container.

C. Grade 2 Learning Activities

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If the Shoe Fits …

BIG IDEA **Attributes, Units, and Measurement Sense**

CURRICULUM EXPECTATIONS

Students will:

- estimate and measure length, height, and distance, using standard units (i.e., centimetre, metre) and non-standard units;
- record and represent measurements of length, height, and distance in a variety of ways (e.g. written, pictorial, concrete).

MATERIALS

- 2 cm x 2 cm x 2 cm interlocking cubes
- 2 cm x 30 cm strips of tag board or Bristol board (1 per student)
- 2 cm x 2 cm squares of construction paper (5 red squares and 5 yellow squares per student)
- glue sticks
- Length2.BLM1: If the Shoe Fits ... (1 per student)
- Length2.BLM2: Measuring Shoes at Home (1 per student)

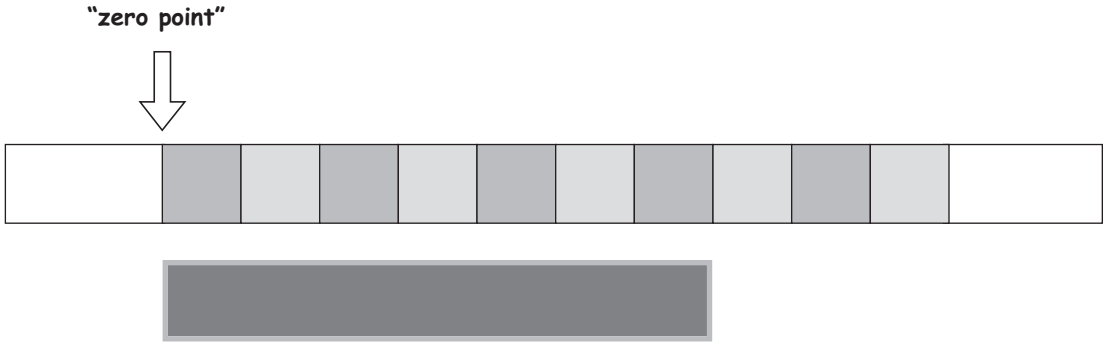
ABOUT THE MATH

Having students construct their own rulers helps them understand how a standard ruler is used to provide a measurement. Lacking such experiences, students learn to read numbers on a ruler without understanding that the numbers represent an accumulation of linear units (e.g., the number 5 on a centimetre ruler represents a length involving a total of 5 cm).

Students can construct simple rulers by joining interlocking cubes in a row. Measuring the lengths of objects with such rulers helps students understand that, in the measurement process, the end of the object must align with the outer edge of the first unit (i.e., cube), and that the length of the object can be found by counting the number of units.

The absence of printed numbers on student-made rulers helps build students' measurement sense, as the units, not the numbers, need to be considered. When students' first experiences in measuring length involve the use of a standard ruler, the focus on the printed numbers on the ruler can create misconceptions. For example, students might assume that measuring length involves counting the marks on a ruler, rather than the spaces between the marks.

In the following activity, students construct their own paper rulers by gluing paper squares in a row, along the length of a paper strip. This activity reinforces the idea that each unit (square) is exactly the same size – in this case, the same size as a face of an interlocking cube. Students are asked to leave an empty space (a section without squares) for holding the ruler at either end of the paper strip. This feature of the ruler helps students recognize that the end of the object being measured must align with the outer edge of the first unit (i.e., the "zero point") of the ruler.



Students' understanding of measurement can be further developed when the tools they use have inherent properties associated with important number and measurement concepts. For example, a paper strip ruler consisting of 10 units emphasizes counting by 10's as the ruler is repeatedly laid along the length of an object that is longer than the ruler. Unit iteration (the process of moving a ruler repeatedly along the object being measured) also reinforces the idea that length involves an accumulation of linear units.

GETTING STARTED

Measuring Length, Using Interlocking Cubes

Explain the following to the class:

> "My friend bought a pair of shoes that I really like. She said that I could borrow the shoes at any time. Yesterday, I wondered if my friend's shoes would fit me, so I called her to ask if her shoes were the same length as my shoes. To measure the length of a shoe, my friend connected some interlocking cubes in a row. Then she placed her shoe beside the row of cubes, and she counted the cubes that matched the length of her shoe. She said that her shoe is 13 cubes long."

Ask: "How can we find out if my friend's shoes are the same length as my shoes?" Invite students to explain how they might determine whether the shoes have the same length. Students might suggest making a row of interlocking cubes to measure the length of your shoe to determine if it is longer than, shorter than, or the same length as 13 cubes.

Show the students an interlocking cube (2 cm x 2 cm x 2 cm) and a shoe. Ask students to use cubes as units to estimate the length of the shoe. Connect several cubes in a row. Demonstrate how to align one end of the shoe with an end of the row of cubes. Together, with the class, count the number of cubes that match the length of the shoe. Compare the length of the shoe with students' estimates. Discuss whether your friend's shoe and your shoe are the same length.

Making a Ruler

Explain the following:

> "We will be doing measurement activities both in our classroom and at your homes. The activities involve using interlocking cubes to measure length. However, the interlocking cubes must stay in the classroom and are not to go to your homes. What measurement tool could we make that would allow us to measure both at school and at home?"

Have students share their ideas about measurement tools they could make. For example, students might suggest making paper rulers with units that are the same size as the face of an interlocking cube.

Show students a paper ruler that you made ahead of time. Demonstrate that each coloured square is the same size as the face of an interlocking cube. Explain that you made the ruler by gluing squares of coloured construction paper onto a strip of paper. Point out that you left space at either end of the ruler so that you can hold the ruler without covering the squares.

Provide each student with a strip of tag board or Bristol board, 5 red paper squares (2 cm x 2 cm), 5 yellow paper squares (2 cm x 2 cm), and a glue stick. Instruct the students to make their own rulers by gluing squares onto the paper strip in a red-yellow-red-yellow-red-yellow pattern. Stress the importance of gluing the squares close together, without gaps or overlays. Remind students to leave space for holding the ruler at either end of it.

After students have made their rulers, ask the following questions:

- "How is your paper ruler like the ruler made with interlocking cubes?"
- "How can you prove that each square is the same size as the face of an interlocking cube?"
- "How is your paper ruler different from the ruler made with interlocking cubes?"
- "How can you use the paper ruler to measure length?"

WORKING ON IT

Have students sit in a circle, with their legs extending towards the centre of the circle. Ask: "If you needed to borrow someone else's shoes, whose shoes would fit you?" Explain that the students will use their paper rulers to measure the length of classmates' shoes and find shoes that are longer than, shorter than, and the same length as their own. Invite the students to look at their classmates' shoes and to estimate whose shoes are longer than, shorter than, and the same length as their own.

Instruct the students to use their paper rulers to measure the length of one of their own shoes. Discuss how students will need to align an end of the shoe with the outer edge of the first square, and will then need to count the number of units (squares) that correspond to the length of the shoe. Explain that the length of the shoe might not match the units exactly, and that students should count the number of units that best match the length of the shoe.

Explain how the students will also need to estimate and measure the lengths of classmates' shoes in order to find shoes that are longer than, shorter than, and the same length as their own.

Provide each student with a copy of Length2.BLM1: If the Shoe Fits ..., and explain how the students are to record their findings on the page.

Provide the students with time to measure and record the lengths of their own and classmates' shoes. If necessary, guide students in following appropriate measurement procedures (e.g., align the end of a shoe with the outer edge of the first unit on the ruler; count the units accurately).

REFLECTING AND CONNECTING

Gather the students to review the activity. Ask the following questions:

- "Who has shoes that are longer than yours? How do you know?"
- "Who has shoes that are shorter than yours? How do you know?"
- "Who has shoes that are the same length as yours? How do you know?"
- "What was important to do when measuring with a paper ruler?"
- "How did you measure the lengths of shoes that are longer than your paper ruler?"
- "What other things could you measure with your paper ruler? How would you use your ruler to measure them?"

ADAPTATIONS/EXTENSIONS

Students whose fine motor control is not fully developed may have difficulty making their own rulers. Have these students work with a classmate who can help them construct their ruler.

If students are not developmentally ready to use a paper ruler to measure length, have them use a ruler made with interlocking cubes.

Extend the activity by having students use their paper rulers to measure a variety of objects in the classroom. Include objects that are longer than the paper ruler, thereby requiring students to move the ruler repeatedly along the length of the object (unit iteration).

MATH LANGUAGE

- length
- long, longer
- short, shorter
- estimate
- unit

ASSESSMENT

Observe students to assess their understanding of linear measurement.

- How well do students estimate the lengths of objects?
- How well do students use a paper ruler to measure length? For example: Do students align the end of the object being measured with the outer edge of the first unit on the ruler? Do students count units on the ruler correctly? Can students measure the length of objects that are longer than the ruler?
- Do students demonstrate an understanding that length is an accumulation of units (e.g., squares on a paper ruler)?

HOME CONNECTION

Send home Length2.BLM2: Measuring Shoes at Home. In this Home Connection activity, students use paper rulers to measure and compare the lengths of family members' shoes.

LEARNING CONNECTION 1

Estimating Strings That Are 100 Cubes Long

Materials

- interlocking cubes (at least 10 cubes per pair of students)
- pieces of string, each measuring 3 to 4 m in length (1 per pair of students)
- scissors (1 per pair of students)

Arrange students in pairs. Provide each pair with interlocking cubes, a piece of string, and scissors. Instruct the pairs to connect 10 cubes in a row. Next, have each pair cut a piece of string to match the length of its row of cubes. Have each pair demonstrate that its piece of string and row of cubes are the same length. Establish that the piece of string is 10 cubes long.

Ask: "How long would a piece of string be if it was 100 cubes long?" Tell students that they are to cut a piece of string that they estimate to be 100 cubes long. Encourage students to use their string that is 10 cubes long as a benchmark to help them determine the length of a string that is 100 cubes long. Have students use visualization to determine the length of the string, rather than use cubes or the shorter piece of string to physically measure the string.

After students have estimated and cut their pieces of string, tape the strings lengthwise onto the board, aligning the left ends of the strings. Record students' names below their strings.

Ask: "How can we find the length of a string that is 100 cubes long?" Discuss how connecting 10 rows of 10 cubes produces a row that is 100 cubes long. Have students create the 100-cube row, and then cut a piece of string that is 100 cubes long. Tape the string to the board, and label it "100 cubes long".

Ask students to examine the strings. Pose the following questions:

- "Whose string is longer than 100 cubes?"
- "Whose string is shorter than 100 cubes?"
- "Whose string is the same length as 100 cubes?"
- "Whose estimate was close to 100 cubes?"
- "How did knowing the length of 10 cubes help you estimate the length of 100 cubes?"

LEARNING CONNECTION 2

Measuring Classroom Objects

Materials

- paper rulers constructed during the main learning activity (1 per student)
- a classroom object that is shorter than a paper ruler (e.g., crayon, chalkboard brush)
- classroom objects that are longer than a paper ruler (e.g., skipping rope, broom)
- Length2.BLM3: Measuring Classroom Objects (1 per student)

Show students a paper ruler (constructed in the main learning activity) and an object that is shorter than the paper ruler. Have students demonstrate how to use the paper ruler to measure the length of the object. Emphasize the importance of aligning an end

of the object with the outer edge of the first unit (square), and then counting the units that correspond to the length of the object.

Next, show an object that is longer than the paper ruler. Ask students to demonstrate how they could use the ruler to measure the length of the object. Discuss how they need to move the ruler along the length of the object, each time placing the beginning of the first unit of the ruler at the end point of the previous position of the ruler. Remind students that the ruler consists of 10 units, and that they can count by 10's as they move the ruler along the length of the object.

Show students other objects that are longer than the ruler. Have them estimate the length of each object (e.g., "The broom is about 72 units long"), and then ask students to use the paper ruler to measure the length.

Provide each student with a copy of Length2.BLM3: Measuring Classroom Objects. Explain that students are to estimate and measure the lengths of the objects listed in the chart, as well as of two objects of their choice. Discuss the meaning of *height*, *length*, and *width* by having students show these dimensions on different objects.

After students have completed the page, discuss their findings.

LEARNING CONNECTION 3

Centimetre Hunt

Materials

- centimetre ruler
- sheets of paper

Show students a centimetre ruler, and explain that the distance between two marks represents a centimetre. Ask a student to place the tip of his or her little finger on the ruler to demonstrate that the width of the finger tip is about one centimetre.

Have students go on a centimetre hunt in the classroom. Suggest that they use the tips of their little fingers as a measuring tool to find objects that are approximately one centimetre long. Have students draw or record on a piece of paper the names of objects that they find. Have students share their findings with the class. Ask them to demonstrate how they determined that the objects are approximately one centimetre long.

Have students close their eyes and imagine the lengths of different objects that you announce aloud (e.g., the width of a small button, the length of a beach towel, the width of a small pebble, the width of a pencil). Ask them to raise their hands if an object that you announce has a length of about one centimetre.

LEARNING CONNNECTION 4

Looking for Metres

Materials

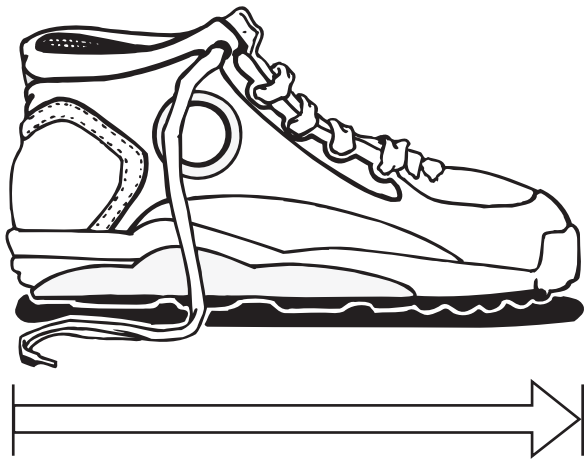
- metre stick

Show students a metre stick. Ask them to look around the classroom and identify objects that are about one metre long. Have students use the metre stick to determine whether the objects they identify are longer than, shorter than, or the same length as the metre stick.

Take the class for a walk around the school. Ask students to find objects that appear to be one metre in length. Have them measure the object, using a metre stick, to determine whether it is longer than, shorter than, or the same length as the metre stick.

After the walk, ask students to name objects that will help them think about the length of one metre. Discuss how thinking of objects that are one metre long helps in judging the lengths of other objects (e.g., since an adult-sized baseball bat is about one metre long, a skipping rope must be longer than one metre).

If the Shoe Fits ...



My shoe is _____ units long.

I think that _____'s shoe is **longer**.

I estimated _____ units.

I measured _____ units.

I think that _____'s shoe is **shorter**.

I estimated _____ units.

I measured _____ units.

I think that _____'s shoe is **the same length**.

I estimated _____ units.

I measured _____ units.

Measuring Shoes at Home

Dear Parent/Guardian:

The class has been learning to measure length. The students made their own rulers and then used the rulers to measure and compare the lengths of classmates' shoes.

Ask your child to show you a paper ruler that he or she made in class. Have your child explain how he or she made the ruler.

Allow your child to use the paper ruler to measure the lengths of different shoes in your home. Have your child record the measurements below.

_____'s shoe is _____ units.

_____'s shoe is _____ units.

_____'s shoe is _____ units.

Next, have your child compare the shoe lengths:

_____ has the longest shoe.

_____ has the shortest shoe.

Please have your child return the paper ruler to class.

Thank you!

Measuring Classroom Objects

Estimate, then measure, using your paper ruler.

Object	Estimate	Measure
Height of a bookshelf	___ units	___ units
Length of a book	___ units	___ units
Width of a desk	___ units	___ units
Length of the table	___ units	___ units
Width of a window	___ units	___ units
Width of a door	__ units	___ units
Height of a chair	___ units	___ units
_____	___ units	___ units
_____	___ units	___ units

Wet Paintings

BIG IDEA **Attributes, Units, and Measurement Sense**

CURRICULUM EXPECTATIONS

Students will:

- estimate, measure, and record area, through investigation using a variety of non-standard units (e.g., determine the number of yellow pattern blocks it takes to cover an outlined shape);
- describe, through investigation, the relationship between the size of a unit of area and the number of units needed to cover a surface.

MATERIALS

- 20 cm x 24 cm sheets of paper (10 sheets per group of three students)
- 12 cm x 20 cm sheets of paper (20 sheets per group of three students)
- double-pages of a newspaper (1 double-page per group of three students)
- Area2.BLM1: Wet Paintings (1 per group of three students)
- Area2.BLM2: A Cool Place to Measure (1 per student)

ABOUT THE MATH

In the primary grades, students explore area by covering surfaces with non-standard units (e.g., counters, pattern blocks). They discover that they can arrange rectangular units (e.g., playing cards, index cards, square tiles) in arrays, thereby minimizing gaps that might occur with other kinds of units.

In the following learning activity, students find the number of rectangular paintings that fit on a large sheet of newspaper, where the paintings can dry. In covering the newspaper with different-sized paintings, students have an opportunity to explore the relationship between the size of the unit of area and the number of units needed to cover a surface (i.e., a greater number of small paintings than large paintings fit on the newspaper).

GETTING STARTED

Display a 20 cm x 24 cm sheet of paper and a 12 cm x 20 cm sheet of paper. Explain that students in another class will paint pictures on the two different-sized sheets of paper. Next, show an unfolded double-page of a newspaper. Explain that the teacher of the class will place the wet paintings on the sheet of newspaper, where they can dry.

Explain the following:

> "The teacher needs your help in solving a problem. She would like to know how many small paintings fit on a sheet of newspaper. She would also like to know how many large paintings will fit on a sheet of newspaper. The teacher wants to place the paintings as close together as possible, and she knows that she cannot place any part of a painting on top of another one, because the paint is wet."

Ask: "How can the teacher arrange the paintings so that she can fit as many paintings as possible on the newspaper sheet?" Discuss how the paintings should be arranged in rows and columns, without gaps and overlays.

WORKING ON IT

Divide the students into groups of three. Tell the students that each group needs to estimate and then find the number of paintings that will fit on the newspaper sheet. Provide each group with a copy of Area2.BLM1: Wet Paintings and a double-page of a newspaper. Give half of the groups ten 20 cm × 24 cm sheets each, and give the other half of the group twenty 12 cm × 20 cm sheets of paper each. Tell the students to work together to complete Area2.BLM1.

Remind the students that they should try to fit as many sheets of paper on the newspaper as possible and should avoid gaps and overlays. As well, tell them that all sheets of paper must be placed entirely within the boundaries of the newspaper sheet. Suggest that the students try arranging the sheets of paper in different ways in order to determine whether some arrangements allow for more sheets of paper than others.

As students work on the task, ask the following questions:

- "How many paintings, do you think, will fit on the newspaper?"
- "How can you arrange the sheets of paper on the newspaper to avoid gaps?"
- "How can you find the number of paintings that will fit on the newspaper?"
- "If you had paintings that were smaller than these, would you be able to fit more or fewer paintings on the newspaper? Why?"

REFLECTING AND CONNECTING

Gather the students together to have groups present their findings to the class. Begin with groups of students who placed the large pictures on the newspaper, asking them to explain their estimates and the actual numbers of sheets they arranged on the newspaper. On the board, record the measurement results of the different groups, and discuss the reasons for any discrepancies (e.g., groups may have arranged pictures differently). Next, have groups who worked with small pictures report their findings, and record their measurement results on the board.

Ask the students to examine the results recorded on the board. Ask:

- "How many large pictures were most groups able to place on the newspaper?"
- "How many small pictures were most groups able to place on the newspaper?"
- "What size of picture does the newspaper hold more of – the large picture or the small picture?"
- "Why is it possible to place more small pictures than large pictures on the newspaper?"
- "Why is it possible to place fewer large pictures than small pictures on the newspaper?"
- "If we had pictures that were medium sized, about how many pictures could we place on the newspaper? Why?"

Note: Some students might observe that the number of small paintings is double the number of large paintings. Discuss the fact that the small paintings are half the area of the large paintings, so twice as many small paintings can fit on the newspaper.

Draw the students' attention to the surface of the sheet of newspaper, and ask students to describe its area. When students describe the sheet of newspaper as "big", ask, "How big is it?" Explain that the area of the newspaper can be described by stating the number of units that cover it. Show students a 12 cm x 20 cm sheet of paper, and ask: "If this is one unit, what is the area of the newspaper?"

ADAPTATIONS/EXTENSIONS

Students who experience difficulty in covering the double-page of a newspaper could use playing cards or index cards to measure the area of smaller sheets of paper.

As an extension of the activity, pose the following problem: How many double-sheets of newspaper will the teacher need if the students paint 25 small paintings (12 cm x 20 cm sheets of paper) and 25 large paintings (20 cm x 24 cm sheets of paper)?

MATH LANGUAGE

- row
- column
- estimate
- area
- unit

ASSESSMENT

Observe students to assess how well they:

- estimate the number of paintings that will fit on the large sheet of newspaper;
- arrange rectangular sheets of paper in an array without gaps and overlays;

- find the number of paintings that fit on the large sheet of newspaper (e.g., by counting, skip counting, using repeated addition);
- explain the relationship between the size of the unit and number of units needed to cover a surface.

HOME CONNECTION

The letter to parents on Area2.BLM2: *A Cool Place to Measure* describes an activity in which students measure area by finding the number of pieces of art that fit on a refrigerator door.

LEARNING CONNECTION 1

Measuring Handprints and Footprints

Materials

- large sheets of paper (1 per student)
- pencils (1 per pair of students)
- a variety of non-standard units for measuring area (e.g., cubes, counters, beans, square tiles, sticky notes)

Show students how to make a handprint and a footprint by tracing around a student's hand (fingers close together) and foot on a large sheet of paper.

Record the following statements on the board:

- My handprint has a greater area than my footprint.
- My footprint has a greater area than my handprint.
- My handprint and my footprint have the same area.

Read the sentences together, and ask each student to decide which sentence is true about his or her own handprint and footprint. Read each sentence aloud, and have students raise their hands if they think the statement is true. Beside each statement, record the number of students who raised their hands.

Arrange students in pairs, and provide them with two large sheets of paper and a pencil. Have each student help the other trace a handprint and a footprint on a sheet of paper.

Make available a variety of non-standard units for measuring area (e.g., cubes, counters, beans, square tiles, sticky notes). Instruct the students to measure the area of their handprints and their footprints with one kind of non-standard unit, and to record the measurements on their sheets of paper. After students have measured their handprints and footprints, have them determine which of the three statements on the board is true.

Gather the students together. Ask the following questions:

- "Which has a greater area – your handprint or your footprint? How do you know?"
- "Which kind of unit did you use for measuring? Did this unit work well for measuring area? Why or why not?"
- "Why is it important to use the same unit for measuring both your handprint and your footprint?"
- "If you measured your handprint and your footprint again, what unit would you choose? Why?"

LEARNING CONNECTION 2

Revising Estimates

Materials

- $8\frac{1}{2}$ in. x 11 in. sheet of paper
- sticky notes

Post an $8\frac{1}{2}$ in. x 11 in. sheet of paper on the board or on a chart stand. Tell the students that the paper represents the floor of a bedroom. Next, show a sticky note and explain that it represents a sheet of newspaper. Explain the following:

> "I want to paint the walls of the bedroom, but first I need to cover the floor with sheets of newspaper to avoid getting paint on the floor. I would like to use this miniature floor and this miniature sheet of newspaper to find out how many sheets of newspaper I need to cover the floor."

Place a sticky note in the top left corner of the sheet of paper. Ask students to estimate the number of sticky notes needed to cover the sheet of paper. Ask several students to explain how they arrived at their estimate. Record the students' names and their estimates on the board.

Cover the top half of the sheet of paper with sticky notes. Explain how you arrange the sticky notes in rows and columns, without gaps and overlays.

After covering half of the sheet of paper with sticky notes, ask the students if they would like to change their estimates. If they do, ask them to explain why. Discuss how, in real life, people often change an estimate if they get information that helps them make a better estimate.

Finish covering the sheet of paper with sticky notes. Have students compare the number of sticky notes with their estimates.

Conclude the activity by asking the following questions:

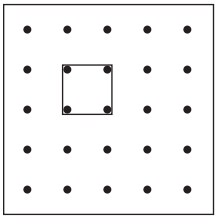
- "How many sheets of newspaper are needed to cover the floor?"
- "If a sheet of newspaper is a unit of area, what is the area of the floor?"
- "If we used sheets of construction paper rather than sheets of newspaper to cover the floor, would we need more or fewer sheets of construction paper? Why?"

LEARNING CONNECTION 3

Area on a Geoboard

Materials

- geoboards (1 per student)
- geobands (elastic bands) (1 per student)



Provide each student with a geoboard and a geoband. Ask students to use a geoband to show one small square on their geoboard. Explain that the square represents one unit of area.

Ask the students to create shapes such as the following:

- a rectangle that has an area of 2 units
- a rectangle that has an area of 6 units
- a square that has an area of 4 units
- a square that has an area of 9 units
- a shape that has an area of 5 units

After the students have created each shape, have them share their work with a partner.

LEARNING CONNECTION 4

Shaping Up With Tangrams

Materials

- sets of tangram pieces (1 set per student)

Provide each student with a set of tangram pieces. Have the students identify the shape that has the greatest area (i.e., the large triangle), and the shape that has the smallest area (i.e., the small triangle). Ask the students to explain how they were able to determine which shape has the greatest area and which has the smallest area.

Challenge the students to use their tangram pieces to create:

- a shape that has the same area as a large triangle;
- a shape that has the same area as the square;
- a shape that has the same area as the medium-sized triangle;
- a shape that has the same area as the two large triangles combined.

After the students have created each shape, have them share their findings with a partner. Ask the students to prove that the shape they created in response to a given challenge has an area that is equal to the area of the shape stated in that challenge.

Wet Paintings

We are covering the newspaper with

- ☐ large paintings.
- ☐ small paintings.

We estimate that _____ paintings will fit on the sheet of newspaper.

Our picture below shows how we arranged the paintings on the sheet of newspaper.

We found that _____ paintings fit on the sheet of newspaper.

A Cool Place to Measure

Dear Parent/Guardian:

In Grade 2, students learn about measuring area by covering surfaces with non-standard units (e.g., index cards, sheets of paper), and then counting the numbers of units. Ask your child to tell you about the learning activity in which the students covered a large sheet of newspaper with paintings.

Provide an opportunity to measure area in your home.

Explain to your child that some families cover the refrigerator door with pieces of art created by family members. Show your child a letter-sized sheet of paper and ask him or her to imagine that it is a piece of art. Ask: "If you had several pieces of art that are the same size as this piece of paper, how many pieces of art, do you think, would fit on the refrigerator door?"

After your child has explained an estimate, have him or her find the number of sheets of paper that fit on the refrigerator door. Your child might need to tape several sheets of paper to the door to find an answer. Encourage him or her to avoid gaps and overlays.

Extend the activity by showing your child a different-sized piece of paper and asking him or her to find the number of pieces of art of the same size that would fit on the refrigerator door.

Thank you for helping your child measure area in your home.

Sizing Up Containers

BIG IDEA **Measurement Relationships**

CURRICULUM EXPECTATIONS

Students will:

- estimate, measure, and record the capacity and/or mass of an object, using a variety of non-standard units (e.g., "I used the pan balance and found that the stapler has the same mass as my pencil case.");
- compare and order a collection of objects by mass and/or capacity, using non-standard units (e.g., "The coffee can holds more sand than the soup can, but the same amount as the small pail.").

MATERIALS

- a variety of empty plastic containers of various shapes and sizes (e.g., margarine tubs, cottage cheese containers, food storage containers) (4 containers per group of three students)
- containers of pourable materials, such as water, rice, or sand (1 per group of three students)
- small scoops (e.g., coffee scoops, small plastic cups, caps from liquid laundry detergent bottles) (1 per group of three students)
- sticky notes (4 per group of three students)
- Cap2.BLM1: Sizing Up Containers (1 per student)
- Cap2.BLM2: Exploring Capacity at Home (1 per student)

ABOUT THE MATH

Capacity refers to the maximum amount that a container can hold. In the early primary grades, students develop an understanding of capacity by filling a variety of containers with pourable materials (e.g., water, rice, sand), and by comparing the amounts that the different containers hold. They measure capacity by counting the number of units (e.g., scoops, cups) that a container holds.

Students need to realize that they must use consistent units (e.g., scoopfuls of the same size) in measurement activities in order to determine an accurate measure. Students should also learn that capacity refers to the maximum amount that a container can hold, and that they must take care not to underfill or overfill a container while measuring its capacity.

Having students use different-sized units (e.g., first using large scoops and then using small scoops to fill a container) helps them recognize the relationship between the size of units and the number of units. For example, fewer large scoops than small scoops are needed to fill a container.

In the following learning activity, students estimate and measure capacity by finding the number of scoops different containers hold. They then order the containers from least to greatest capacity.

GETTING STARTED

Show the students two different-sized containers (e.g., margarine tub, cottage cheese container, food storage container). Explain the following situation to the students:

> "I usually have soup for lunch. Today, I forgot to bring a soup bowl to school. I found these two containers that I could use instead. I want to use the container that will hold the most soup. Which container do you think has the greater capacity?"

Have students express their thoughts about which container has the greater capacity. Ask, "How could we find which container has the greater capacity?" Explain that capacity means the greatest amount that a container holds. Show a small scoop (e.g., coffee scoop, small plastic cup, cap from a liquid laundry detergent bottle), and ask students to explain how they might use the scoop to find which container has the greater capacity. For example, students might suggest using the scoop to fill both containers with a pourable material (e.g., water, rice, sand), and then comparing the numbers of scoops needed to fill the containers.

Have students estimate the number of scoops needed to fill each container, and record their estimates on chart paper or the board. Have the class watch as a student uses a scoop to fill the containers with a pourable material (e.g., water, rice, sand). Emphasize the importance of filling and levelling each scoopful in order to measure accurately. Have students compare the numbers of scoops needed to fill the containers and determine which container has the greater capacity.

WORKING ON IT

Organize the students into groups of three. Provide each group with a small scoop, a container of a pourable material (e.g., water, rice, sand), and four empty plastic containers. Have the groups use sticky notes to label the containers A, B, C, and D. Explain that the students are to:

- estimate the number of scoops that each container holds;
- use a scoop and a pourable material to measure the capacities of the containers;
- order the containers from least to greatest capacity.

Provide each student with a copy of Cap2.BLM1: Sizing Up Containers, and instruct the students to record their findings on the page.

As the students work on the activity, ask them the following questions:

- "What strategy did you use to estimate the capacity of each container?"
- "Which container, do you think, has the greatest capacity? Why?"
- "Is your estimate reasonable? Why do you think it is reasonable?"
- "How can you find the capacity of each container?"
- "How can you measure accurately?"
- "How can you order the containers from least to greatest capacity?"

After the students have ordered the containers from least to greatest capacity, have them record what they learned about measuring capacity on their copy of Cap2.BLM1.

REFLECTING AND CONNECTING

Gather the students together to review the activity. Have students explain how they estimated and measured the capacities of their containers, and how they ordered the containers from least to greatest capacity.

Ask students to explain what they learned about measuring capacity. For example, they might explain that capacity is the maximum amount that a container holds, that capacity can be measured with scoops, and that containers that look different can have the same capacity. Record students' ideas on chart paper. Conclude the discussion by reviewing students' ideas about capacity.

ADAPTATIONS/EXTENSIONS

Simplify the activity by having students compare the capacities of two containers, rather than order the capacities of four containers. It may be easier for some students to handle larger scoops (e.g., mugs, plastic tumblers) as they fill containers with a pourable material.

As an extension, provide students with a variety of containers of various sizes and shapes, and challenge them to find two containers such that the capacity of one container is double the capacity of the other container.

MATH LANGUAGE

- capacity
- estimate
- greater, greatest
- less, least

ASSESSMENT

Observe students to assess how well they:

- demonstrate an understanding that capacity is the maximum amount a container holds;
- make reasonable estimates about the capacities of containers;
- measure accurately;
- order containers from least to greatest capacity.

HOME CONNECTION

Send home Cap2.BLM2: Measuring Capacity at Home. In this Home Connection activity, students estimate, measure, and compare the capacities of containers at home.

LEARNING CONNECTION 1

Making a Measuring Cup

Materials

- a measuring cup (e.g., a 500-mL measuring cup for cooking)
- transparent plastic jars (1 per pair of students)
- markers (1 per student)
- containers of a pourable material, such as water, rice, or sand (1 per pair of students)
- small scoops (e.g., coffee scoops, small plastic cups, caps from liquid laundry detergent bottles) (1 per pair of students)
- a few large containers (e.g., sand pails, pots, bins)

Show students a measuring cup. Draw their attention to the marks on the cup. Explain that each mark indicates the quantity of units held by the cup when it is filled to the level of the mark. For example, a mark labelled "100" represents 100 units.

Have the students create their own measuring cups. Provide each pair of students with a transparent plastic jar, a marker, a scoop, and a pourable material. Instruct the students to put 10 scoops of the pourable material into the jar and then use a marker to draw a short line at the top level of the material. Have them label the line "10".

Next, have them put 10 more scoops into the jar, and mark and label the 20-scoop level. Have the students continue to indicate intervals of 10 scoops on the jar.

Provide students with an opportunity to use their measuring cups to measure the capacities of large containers (e.g., pails, pots, bins). Have them repeatedly fill their measuring cups to a mark with a pourable material, and then pour the material into the container being measured. Stress the importance of keeping track of the total number of units that are poured into the large container.

Sizing Up Containers

Estimate and measure the capacity of each container.

Container	Estimate	Measure
A	_____ scoops	_____ scoops
B	_____ scoops	_____ scoops
C	_____ scoops	_____ scoops
D	_____ scoops	_____ scoops

Order the containers from least to greatest capacity:

_____ _____ _____ _____

What did you learn about measuring the capacity of a container?

Exploring Capacity at Home

Dear Parent/Guardian:

Capacity refers to the maximum amount that a container holds. Our class has been exploring the capacities of a variety of containers by filling the containers with scoops of a material such as rice or sand. Students measure the capacities of the containers by counting the number of scoops needed to fill the containers.

Provide your child with an opportunity to measure the capacities of containers (e.g., bowls, cups, jars, bottles) in your home. Find two different containers that are about the same size, a small scoop (e.g., a coffee scoop, the cap of a liquid laundry detergent bottle, a small measuring cup), and a pourable material (e.g., water, rice).

Ask your child to estimate the capacity of each container by predicting the number of scoops that will be needed to fill it. Then have him or her fill the container with scoops of the pourable material and count the number of scoops needed to fill it. Have your child compare the results with his or her estimates. Discuss which container has the greater capacity.

Provide your child with an opportunity to estimate and compare other containers by capacity.

Thank you for exploring ideas about capacity with your child.

D. Grade 3 Learning Activities

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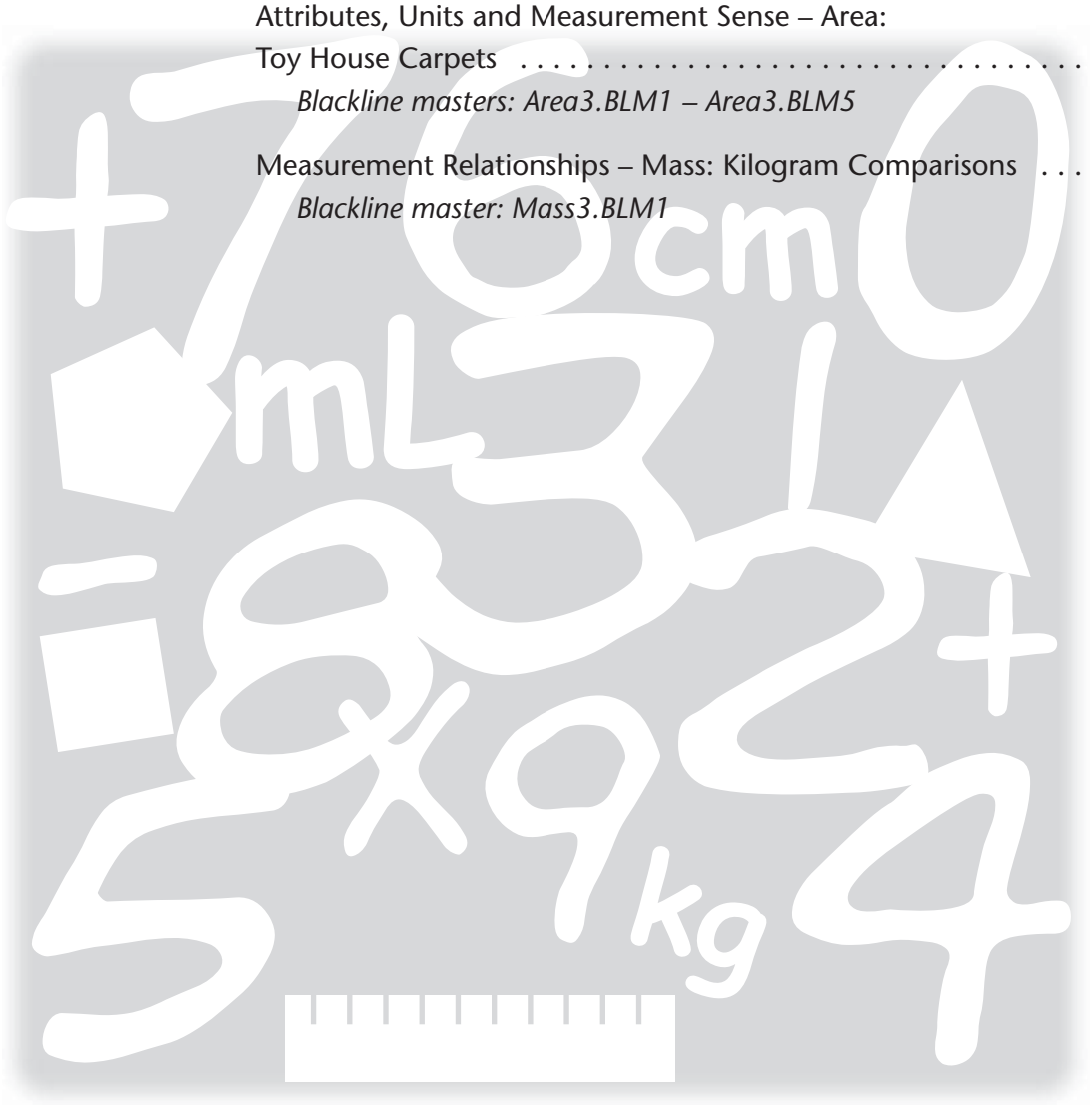
Blackline master: Mass3.BLM1



A Geometry Mobile

BIG IDEA **Attributes, Units, and Measurement Sense**

CURRICULUM EXPECTATIONS

Students will:

- estimate, measure, and record the perimeter of two-dimensional shapes, through investigation using standard units.

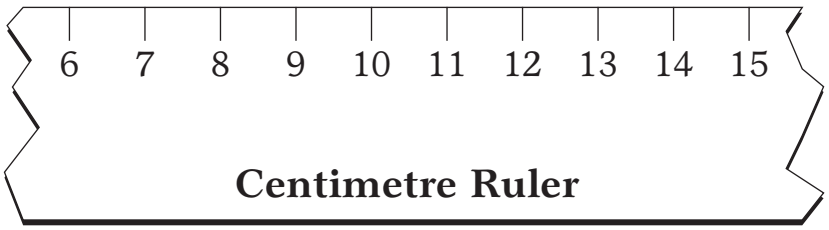
MATERIALS

- Per3.BLM1: Shapes for a Geometry Mobile (1 per pair of students)
- diagrams of broken rulers from Per3.BLM2: Broken Rulers (1 broken ruler per pair of students)
- scissors (1 per pair of students)
- math journals
- Per3.BLM3: Measuring Perimeter (1 per student)

ABOUT THE MATH

By Grade 3, most students understand the processes involved in using a ruler to measure length – they align the ruler beside the object being measured and note the number on the ruler that indicates the length of the object. Knowing how to use a ruler to measure length also allows students to measure perimeter, the distance around a shape.

In the following learning activity, students are challenged to use a broken centimetre ruler – a ruler with units missing at both ends – to measure the perimeter of shapes.



Measuring with a broken ruler reinforces students' understanding of how a ruler works. In using a broken ruler, students cannot simply read the numbers on the ruler to obtain a measurement; instead, they need to count the spaces (centimetre units) that correspond to the length of the object being measured.

GETTING STARTED

Provide each student with a copy of Per3.BLM1: Shapes for a Geometry Mobile. Explain the following situation:

> "In math, Frances is learning about two-dimensional shapes. For a project, Frances wishes to create a geometry mobile, using a variety of shapes. She plans to glue a piece of string around the border of each shape in the mobile."

Explain that the page shows two-dimensional shapes that Frances plans to use in her mobile. Have students identify the shapes (e.g., triangle, quadrilateral or rectangle, pentagon). Discuss how Frances will need to measure the perimeter of each shape in order to determine the length of string for the shape. Ask: "How long do you think the string for Shape A will need to be?" Remind students to include a unit (centimetre) in their estimates.

Ask a few students to share their estimates with the class, and have them explain their estimation strategies. For example, students might estimate the lengths of the sides by using a personal referent (e.g., the width of the tips of the little fingers is approximately one centimetre), or they might refer to previous measurement experiences to judge the lengths of the sides (e.g., "The length of this side looks to be about 10 cm"), and then add the estimated side lengths together.

Arrange students in pairs. Provide partners with an opportunity to estimate the perimeters of Shapes B and C. Have students explain how they estimated the perimeters.

WORKING ON IT

Show students a broken ruler cut from Per3.BLM2: Broken Rulers. Explain the following:

> "Frances wishes to measure the perimeter of each shape but can find only a centimetre ruler with the ends broken off. How can Frances use a broken ruler to measure the perimeters of the shapes?"

Provide each pair of students with a pair of scissors and a diagram of a broken ruler from Per3.BLM2: Broken Rulers. Instruct the students to cut out the broken ruler. Challenge the pairs to use the broken ruler to measure the perimeter of each shape on the Per3.BLM1: Shapes for a Geometry Mobile.

Observe the strategies used by the students. Some students might place the broken ruler beside each side of a shape, count the number of centimetres along each side, and then add the side length measurements together. Other students might count the number of centimetres along one side, and then continue to count on from this amount

as they measure the other sides of the shape. As students work on the activity, ask them the following questions:

- "What strategy are you using to measure the perimeters of the shapes?"
- "How is using a broken ruler like using a regular ruler? How is it different?"
- "How could you measure the perimeters of the shapes in a different way?"

Watch for students who demonstrate misconceptions about measuring length with a broken ruler. For example, students might incorrectly assume that the number indicated by the ruler represents the length of a side, disregarding the fact that the left-most mark on the ruler indicates 6 cm and not 0 cm. Other students might place the ruler against a side and count the marks on the ruler, including the mark at the beginning of the line segment. By counting marks, rather than spaces, students will incorrectly include one unit too many in their measurement. Provide assistance to students who demonstrate misconceptions by showing them that each side length can be found by counting the number of centimetres (i.e., spaces on the ruler).

REFLECTING AND CONNECTING

Provide an opportunity for pairs of students to demonstrate their measurement strategies to the class. Select pairs who used different strategies, so that students can observe various approaches to measuring perimeter with a broken ruler.

Review the activity and emphasize concepts about perimeter by asking the following questions:

- "What is the meaning of *perimeter*?"
- "How could you use a regular ruler to measure the perimeter of a shape?"
- "How could you use a broken ruler to measure the perimeter of a shape?"
- "What advice would you give someone who needs to use a broken ruler to measure the perimeter of a shape?"

Ask students to respond to the following question in their math journals: "How do you measure the perimeter of a shape?"

ADAPTATIONS/EXTENSIONS

Some students may not have a strong understanding of perimeter. Provide these students with opportunities to trace a finger around the perimeter of a variety of shapes. These students might also place a piece of string along the sides of a shape, cut the string to the length of the perimeter, and then measure the string, using a ruler.

Using a broken ruler to measure perimeter may be difficult for some students. Allow these students to create a concrete ruler by connecting centimetre cubes in a row and to measure perimeter by counting the number of cubes along each side of a shape.

To extend the activity, have students draw shapes with a given perimeter (e.g., "Draw different shapes that have a perimeter of 24 cm"). Challenge students to use a broken ruler from Per3.BLM2: Broken Rulers, rather than a regular ruler, to construct the shapes.

MATH LANGUAGE

- two-dimensional shape
- triangle
- quadrilateral
- rectangle
- pentagon
- side
- perimeter
- length
- unit
- centimetre

ASSESSMENT

Observe students as they find the perimeters of the shapes on Per3.BLM1.

- How well do students explain the meaning of *perimeter*?
- Do students apply an appropriate strategy for finding the perimeter of a shape?
- How accurately do students measure perimeter?
- How well do students explain strategies for using a broken ruler to measure perimeter?

HOME CONNECTION

Send home Per3.BLM3: Measuring Perimeter. In this Home Connection activity, students find the perimeter of a shape, using a broken ruler. They then explain their measurement strategies to a parent.

LEARNING CONNECTION 1

Different Shapes With the Same Perimeter

Materials

- Per3.BLM4: Centimetre Grid Paper (1 per student)
- centimetre ruler (1 per student)

Provide each student with a copy of Per3.BLM4: Centimetre Grid Paper and a centimetre ruler. Have the students measure the sides of a small grid square, and establish that the length of each small line segment is 1 cm.

Instruct the students to draw a closed shape that has a perimeter of 24 cm by tracing on the grid lines. Advise the students to trace lightly, since they may have to erase lines as they revise their shapes. Watch for students who create shapes with an area of 24 spaces rather than with a perimeter of 24 cm.

After the students have created a shape with a perimeter of 24 cm, have them exchange their pages with a partner. Have the partners compare their shapes (e.g., the shapes look different, the shapes have the same perimeter).

Challenge students to create on their page other shapes with a perimeter of 24 cm. Have students compare their shapes with a partner.

LEARNING CONNECTION 2

Exploring Perimeter Using Cubes

Materials

- 2 cm x 2 cm x 2 cm interlocking cubes (8 per student)
- sheets of paper (1 per student)
- pencils (1 per student)

Provide each student with 6 interlocking cubes (2 cm x 2 cm x 2 cm). Instruct each student to connect all the cubes to create a figure with one layer and then use a pencil to trace around the outside of the figure on a sheet of paper. Next, have the student use a centimetre ruler to find the perimeter of the shape. Have students share their findings with the class. Discuss how the students' shapes can have different perimeters.

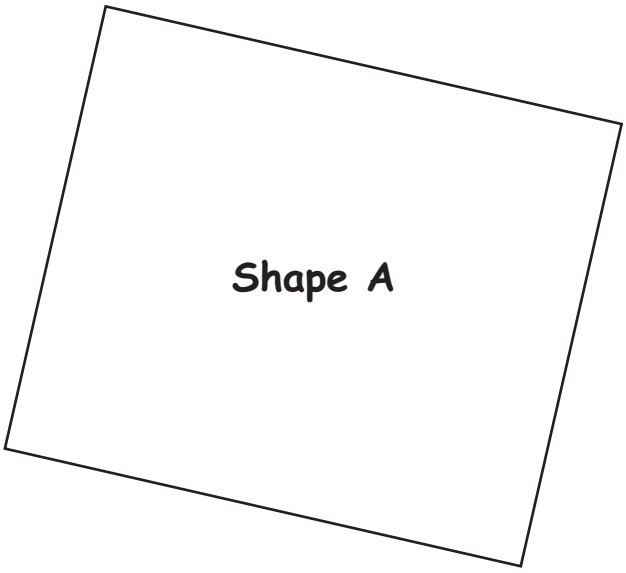
Challenge each student to rearrange the cubes to create a shape that has a different perimeter from the one that he or she obtained the first time.

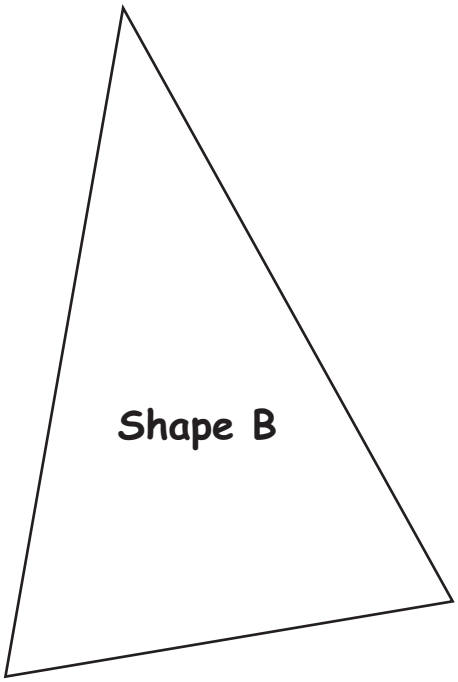
Next, provide each student with 8 interlocking cubes. Challenge the students to create and measure the following shapes, using all 8 cubes for each shape:

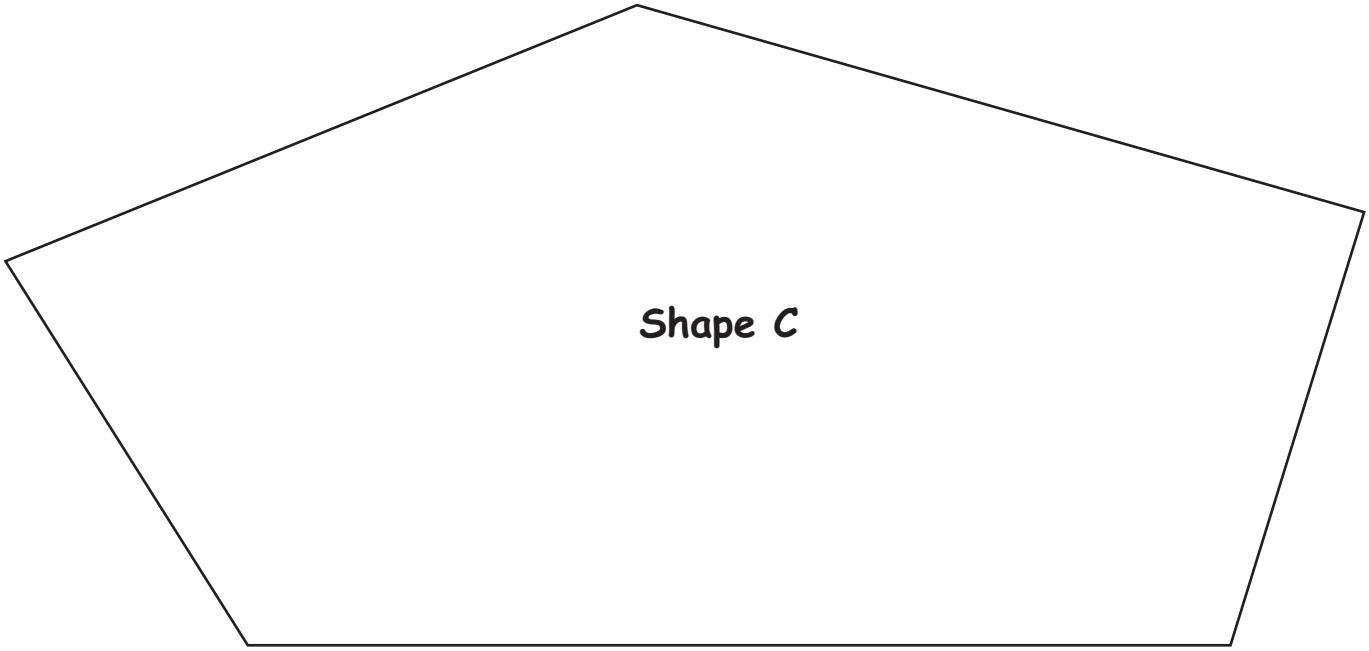
- the shape that has the greatest possible perimeter
- the shape that has the least possible perimeter
- two different shapes that have the same perimeter
- two different rectangles that have different perimeters

Shapes for a Geometry Mobile

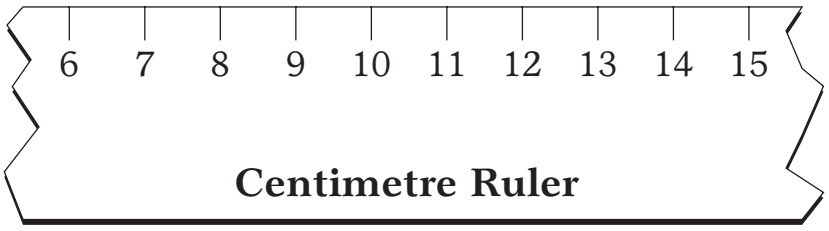
Per3.BLM1

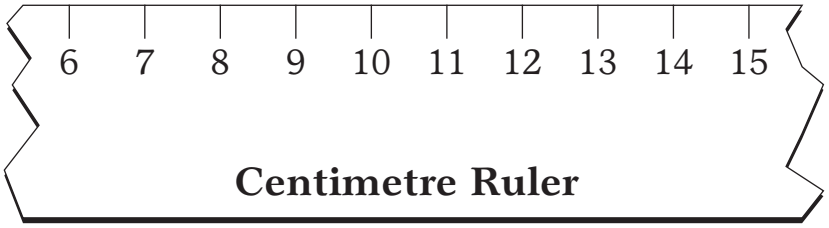


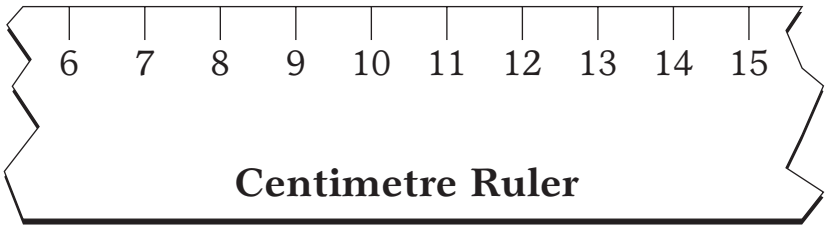


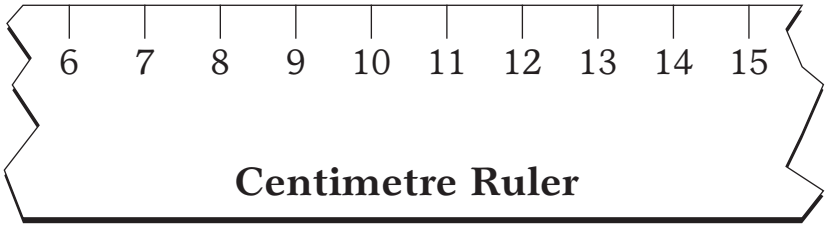


Broken Rulers









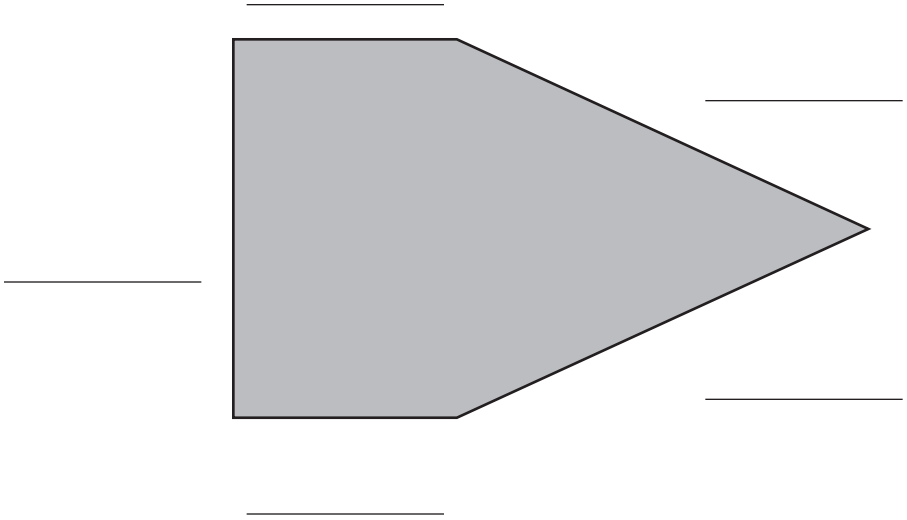
Measuring Perimeter

Dear Parent/Guardian:

In math, the class has learned that perimeter is the distance around a shape. Here is an activity that will help your child review ideas about measuring perimeter:

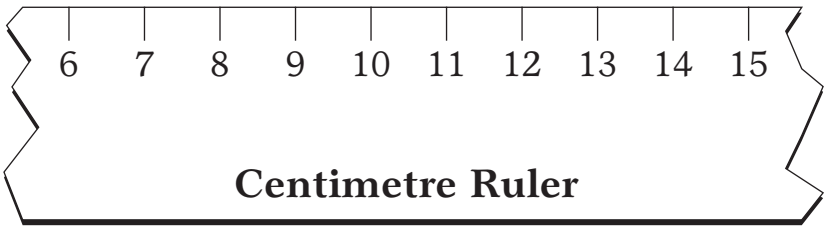
Have your child cut out the ruler piece at the bottom of this page. Challenge your child to use the "broken" ruler to measure the length of each side of the following shape. Next, have him or her find the perimeter of the shape.

Record the length of each side.

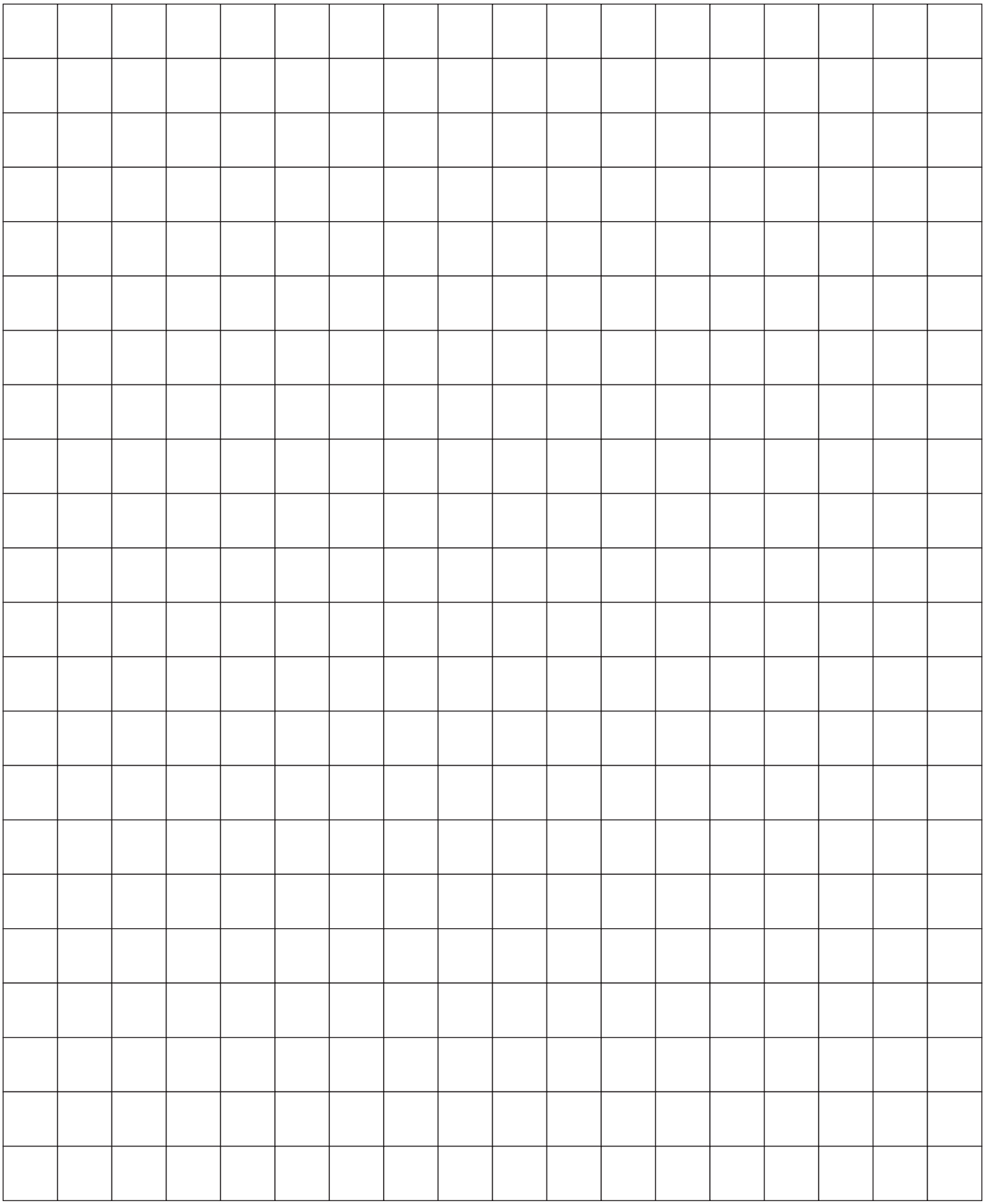


The perimeter of the shape is _____.

Ask your child to explain how he or she used the broken ruler to find the perimeter of the shape.



Centimetre Grid Paper



Toy House Carpets

BIG IDEA **Attributes, Units, and Measurement Sense**

CURRICULUM EXPECTATIONS

Students will:

- estimate, measure (i.e., using centimetre grid paper, arrays), and record area (e.g., if a row of 10 connecting cubes is approximately the width of a book, skip counting down the cover of the book with the row of cubes [i.e., counting 10, 20, 30, . . .] is one way to determine the area of the book cover);
- compare and order various shapes by area, using congruent shapes (e.g., from a set of pattern blocks or Power Polygons) and grid paper for measuring.

MATERIALS

- Area3.BLM1: Toy House Carpet
- Area3.BLM2: Centimetre Grid Paper (several copies for the class)
- transparencies of Area3.BLM2: Centimetre Grid Paper (several copies for the class)
- Area3.BLM3: Carpet Outlines (1 per student)
- a large quantity of centimetre cubes
- half sheets of chart paper, or large sheets of newsprint (1 per pair of students)
- markers of different colours (a few per pair of students)
- Area3.BLM4: Measuring Area at Home (1 per student)

ABOUT THE MATH

Area is the amount of surface of a shape. In the early primary grades, students develop concepts about area by covering surfaces with non-standard units (e.g., counters, pattern blocks, playing cards) and then counting the numbers of units that cover the surfaces. Students also learn that square units (e.g., square tiles) provide a convenient tool for measuring area. Unlike some other non-standard units, squares can be arranged in an array (arrangement of rows and columns) that covers a surface, without gaps and overlays.

After students have had experiences in covering surfaces with square units, they can be introduced to the square centimetre as a standard unit of measure. Students can measure area in square centimetres by finding the number of centimetre cubes that are needed to cover a surface. They can also use centimetre grid paper as a tool for measuring the area of a surface in square centimetres.

In the following learning activity, students investigate ways to find the number of centimetre square pieces of cloth that are needed to make four rectangular carpets for a toy house. The activity provides an opportunity to introduce students to the square centimetre as a unit for measuring area.

The activity also helps students make connections between arrays, concepts about area, and multiplication. It allows them to see that the area of a rectangle can be measured by covering the shape with squares (e.g., centimetre cubes, squares on grid paper) arranged in an array. Initially, students may count all the squares in the array, before they begin to understand that the total number of squares can be found by multiplying the number of squares in a row by the number of squares in a column.

GETTING STARTED

Show Area3.BLM1: Toy House Carpet to the class, and explain the following:

> "Last weekend, my friend attended a craft show. She told me about a crafter who constructs toy houses and then decorates the houses with miniature furniture. My friend was particularly impressed with the small carpets that the crafter makes for the toy houses. She explained that the crafter created the carpets by sewing together small square pieces of cloth."

Discuss how the squares in the carpet illustrated on Area3.BLM1: Toy House Carpet are arranged in rows and columns to form an array. Use a ruler to show that each side of a small square is one centimetre long, and explain that the area of each small square is one square centimetre.

Place a centimetre cube on a square in the diagram, and discuss how each face of the cube also has an area of one square centimetre. Next, overlay the diagram of the carpet with a transparency of Area3.BLM2: Centimetre Grid Paper in order to demonstrate that each square in the grid paper is also one square centimetre.

Provide each student with a copy of Area3.BLM3: Carpet Outlines. Ask: "How many square centimetres of cloth do you think the crafter needs to make Carpet A?" Have the students work with a partner to arrive at an estimate. Ask students to share their estimates with the class and to explain their estimation strategies. Encourage the students to express their estimates in terms of a number of square centimetres (e.g., "I think the crafter needs 24 square centimetres of cloth to make Carpet A").

Discuss the problems presented in Area3.BLM3: Carpet Outlines with the class. Explain that each student will work with a partner to find the number of square centimetres of cloth that the crafter needs to make each carpet. Instruct the students to make

decisions about the room in which each carpet will be placed, according to the directions of the page. Remind students that they will work with a partner but that each student is responsible for completing his or her own worksheet.

WORKING ON IT

Arrange the students in pairs. Make available centimetre cubes, copies of Area3.BLM2: Centimetre Grid Paper, and overhead transparencies of Area3.BLM2: Centimetre Gid Paper. Encourage the students to use materials that will help them find the number of square centimetres of cloth needed for each carpet. Explain that the students may cut out the carpet shapes if they wish.

Instruct the students to record the number of square centimetres on each carpet shape and to indicate in which room each carpet should be placed. Explain that each student should be prepared to tell the class how he or she found the number of square centimetres of cloth needed for each carpet.

Observe the different strategies used by the students. For example, the students might:

- cover the entire surface of a carpet with centimetre cubes and then count the cubes;
- arrange centimetre cubes along both the length and width of a carpet and then use skip counting, repeated addition, or multiplication to find the number of cubes needed to cover the shape;
- place a transparency of Area3.BLM2: Centimetre Grid Paper on the carpet and then find the number of squares by counting, using repeated addition, or using multiplication;
- cut out a carpet shape, trace around it on centimetre grid paper, and then find the number of cubes by counting, using repeated addition, or using multiplication.

If students choose to use centimetre cubes, it may be necessary to help them arrange the cubes in an array. Assist students in placing the cubes in straight rows and columns in order to cover the rectangles completely.

Note: The ways in which students find the number of square units depends on their understanding of the array (i.e., the arrangement of squares in rows and columns). Some students may need to count all the squares (e.g., centimetre cubes, grid paper squares) that cover the carpet shape. Other students may count the number of squares in one row, and then repeatedly add this number to find the total number of squares. Other students may understand that the total number of squares in an array can be found by multiplying the number of squares in a row by the number of squares in a column.

As the students work on the task, ask questions such as the following:

- "What strategy are you using to find the area of each carpet?"
- "How could you measure the area of the carpet in a different way?"
- "What is the area of this carpet in square centimetres? How do you know that the area of this carpet is this many square centimetres?"
- "How can you record the area of the carpet?"
- "Which carpet has the greatest area? How do you know?"

After the students have completed the worksheet, provide them with a half sheet of chart paper, or a large sheet of newsprint, and markers. Ask them to record an explanation of how they found the number of square centimetres for Carpet D. Encourage the students to use words and diagrams, so that their explanation can be easily understood by others.

REFLECTING AND CONNECTING

Provide pairs of students with an opportunity to present their solutions and to describe how they found the number of square centimetres for Carpet D. Select pairs who used different strategies, so that other students can observe various approaches to finding the area of a rectangle. Try to order the presentations so that students observe less-efficient strategies (e.g., counting every square unit, using repeated addition) first and more efficient methods (e.g., using multiplication) afterwards. Ask students to use materials and their recorded explanations to demonstrate how they found the number of centimetre squares in each carpet. Following each presentation, post the students' explanations.

Review the different strategies used by the students. Ask the students to consider the efficiency of the various strategies. Ask the following questions:

- "Which strategy, in your opinion, is an efficient way to find the areas of the carpets? Why?"
- "How would you explain this strategy to someone who has never used it?"
- "How can you find the area of a rectangle without counting every square centimetre?"
- "Which strategy would you use if you solved a problem like this again?"
- "How would you change any of the strategies that were presented? Why?"

Refer to students' work in order to highlight ideas about finding the area of a rectangle:

- The surface of a rectangle can be covered by square units that are arranged in an array.
- The total number of square units can be found by counting every square, by skip counting, by using repeated addition, or by using multiplication.
- Skip counting, using repeated addition, and using multiplication are more efficient strategies than counting every square.

ADAPTATIONS/EXTENSIONS

The students must understand that the area of a surface can be measured by finding the number of units that are needed to cover the surface. If this concept is poorly understood by students, provide them with opportunities to cover a variety of shapes with square units (e.g., square tiles, square cards). Demonstrate that square units can be arranged in an array in order to cover a shape, without gaps and overlays. Have students find the number of square units by counting, using repeated addition, or using multiplication.

In constructing arrays, some students may need to use concrete materials (e.g., cubes, square tiles) before using more abstract materials (e.g., centimetre grid paper) to measure area.

To extend this activity, have students draw the following rectangular carpet outlines on a copy of Area3.BLM2: Centimetre Grid Paper. (Students will need to refer to their completed work on Area3.BLM3: Carpet Outlines.)

- A carpet with an area that is less than the area of Carpet B.
- A carpet with an area that is greater than the area of Carpet C but less than the area of Carpet D.
- A carpet with an area that is twice the area of Carpet B.

Have the students compare their carpet outlines with classmates.

MATH LANGUAGE

- array
- area
- square centimetre
- estimate

ASSESSMENT

Observe students to assess how well they:

- demonstrate an understanding that area is measured by finding the number of square units that cover a surface;
- use appropriate strategies for measuring area (e.g., arrange centimetre cubes in arrays, use centimetre grid paper);
- find the number of square units in an array (e.g., using repeated addition, using skip counting, using multiplication);
- order and compare surfaces by area.

HOME CONNECTION

Send home Area3.BLM4: Measuring Area at Home, along with a copy of Area2.BLM2: Centimetre Grid Paper. In this Home Connection activity, students measure the areas of rectangular shapes found in their home.

LEARNING CONNECTION 1

Measuring the Area of Footprints

Materials

- Area3.BLM2: Centimetre Grid Paper (1 per student)
- pencils

Provide each student with a copy of Area3.BLM2: Centimetre Grid Paper. Have each student, with the help of a partner, trace an outline of the sole of one shoe on the grid paper. Ask the student to estimate the area of his or her footprint, in square centimetres, and to record the estimate on the page.

Next, have each student find the area of his or her footprint. Watch to see whether the students find partial squares that have a combined area of approximately one square centimetre (e.g., two half-squares have an area of one square centimetre). As well, observe the strategies that they use to find the total number of square centimetres. For example, students might:

- count all the squares individually;
- draw and find the area of a rectangle that includes most of the squares, and then add on squares outside the rectangle;
- divide the area of the footprint into arrays, find the number of squares in each array, and then add the areas of the arrays.

Discuss the strategies that students used to find the areas of their footprints.

LEARNING CONNECTION 2

Finding the Area of Rooms

Materials

- Area3.BLM5: Finding the Area of Rooms (1 per student)

Provide each student with a copy of Area3.BLM5: Finding the Area of Rooms. Explain that the diagrams show floor plans of rooms. Point out that the floors of the rooms are covered with square tiles and that furniture covers parts of the floors.

Ask the students to find the area of each room and to record on their page how they found each area.

Have the students share their findings with a partner. Provide the students with an opportunity to explain to the class how they found the areas of the rooms.

Toy House Carpet

Area3.BLM1

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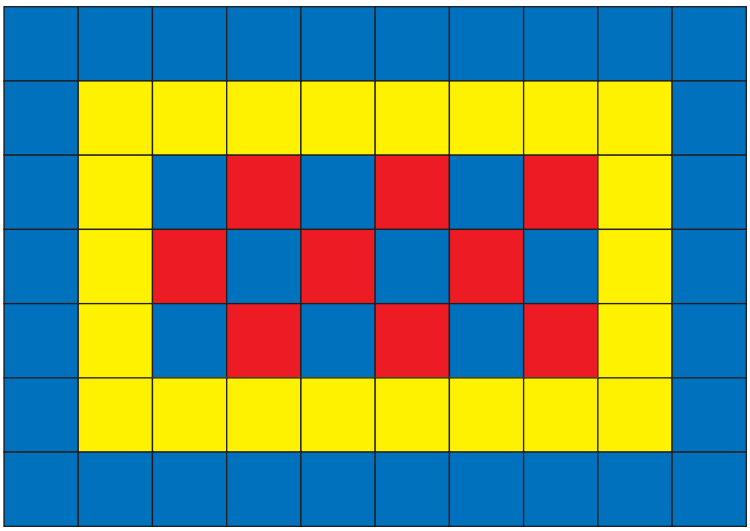
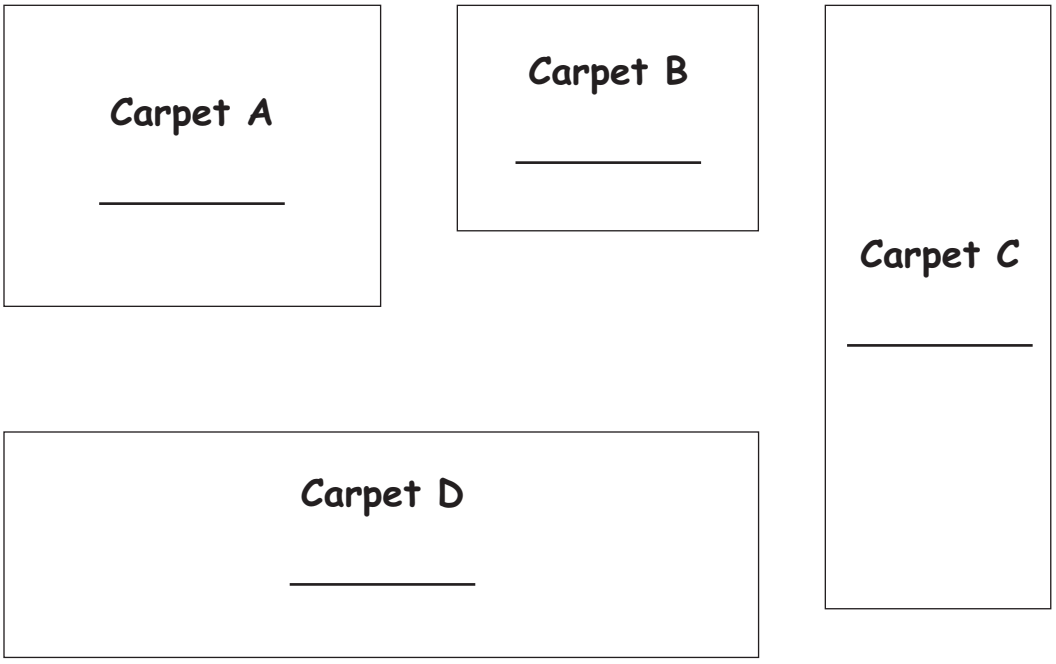


Centimetre Grid Paper

Carpet Outlines

How many square centimetres of cloth would the crafter need to make each carpet?



The crafter wishes to place the carpet with the greatest area in the living room, the carpet with the smallest area in the kitchen, and the two other carpets in bedrooms.

Which carpet should be placed in the living room? _____

Which carpet should be placed in the kitchen? _____

Which carpets should be placed in the bedrooms? _____

_____

Measuring Area at Home

Dear Parent/Guardian:

In math, students are learning to measure the areas of rectangles, using centimetre grid paper.

Provide your child with an opportunity to measure the areas of rectangular surfaces in your home.

Together with your child, find four small rectangular objects (e.g., an envelope, a postage stamp, a greeting card, a recipe card). Ask your child to trace around each rectangular object on the attached centimetre grid paper. Then have your child measure the area of each rectangle by determining the number of square centimetres within the rectangle. In some cases, the rectangle might not fit exactly on the lines of the grid paper, and your child will need to find an approximate measurement. Ask your child to record the measurements in the following chart.

Object	**Measurement**
Example: recipe card	about 92 square cm

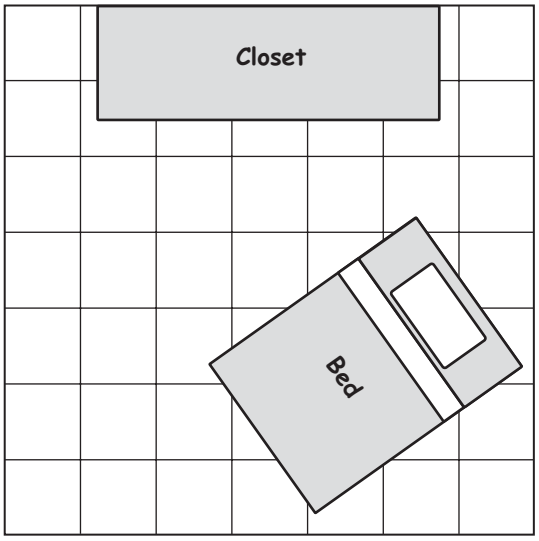
Have your child identify which rectangle has the largest area and which rectangle has the smallest area.

Thank you for helping your child measure area in your home.

Finding the Area of Rooms

The floors of a bedroom and a living room are covered with square tiles. Find the areas of the rooms in square tiles.

Bedroom

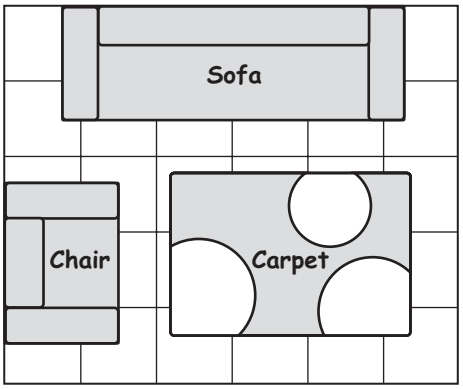


The area of the bedroom is

_____ square tiles.

I know this because

Living Room



The area of the living room is

_____ square tiles.

I know this because

Kilogram Comparisons

BIG IDEA **Measurement Relationships**

CURRICULUM EXPECTATIONS

Students will:

- choose benchmarks for a kilogram and a litre to help them perform measurement tasks;
- estimate, measure, and record the mass of objects (e.g., can of apple juice, bag of oranges, bag of sand), using the standard unit of the kilogram or parts of a kilogram (e.g., half, quarter);
- compare and order a collection of objects, using standard units of mass (i.e., kilogram) and/or capacity (i.e., litre).

MATERIALS

- one-kilogram mass (1 or more for the class)
- large resealable plastic bags (1 per group of three students)
- containers of different kinds of material (e.g., interlocking cubes, pattern blocks, base ten blocks, marbles, metal bolts, metal washers, small stones, gravel)
- balance
- familiar objects that have a mass of approximately one kilogram (e.g., one-litre bottle of water, one-litre carton of milk, box of salt, bag of sugar)
- Mass3.BLM1: Kilogram Search (1 per student)

ABOUT THE MATH

Mass refers to the amount of matter in an object. Standard units of mass include the kilogram and the gram.

Mass is an attribute of objects and is commonly referred to as *weight*. Scientifically, weight is a measure of the pull or force of gravity on an object. The weight of an object can vary, depending on its location in space, whereas the mass of the object remains constant. For example, the weight of an object is less on the moon than on the earth, while the mass of the object remains the same.

In the primary classroom, as in daily life, *mass* and *weight* are commonly used interchangeably. Teachers should model the term *mass* while accepting students' use of the word *weight*.

In the early primary grades, students develop concepts about mass by estimating, measuring, and comparing the masses of objects, using a variety of non-standard units

(e.g., interlocking cubes, metal washers, marbles). For example, they might use a balance to find the number of non-standard units that have the same mass as the object being measured, or to compare the masses of two objects.

In Grade 3, students are introduced to the kilogram as a standard unit of mass. The following activity allows students to develop a sense of the mass represented by a kilogram and to compare the masses of quantities of materials with a kilogram mass. The activity also provides students with an opportunity to develop benchmarks for a kilogram by identifying familiar objects that have a mass of one kilogram.

GETTING STARTED

Pass around a one-kilogram mass so that all the students are able to hold it and gain a sense of its mass. Explain that a kilogram is a standard unit for measuring mass, and provide a few real-life examples of how objects are measured by mass in kilograms (e.g., a person's body mass, produce in a grocery store).

Show a few classroom objects (e.g., a marker, a bottle of water, a book) and ask students to estimate whether each object is heavier or lighter than one kilogram. For each object, have a student hold the kilogram mass in one hand and the object in the other hand, and ask him or her to describe which item feels heavier. Finally, place the kilogram mass and the classroom object on a balance to verify which item has a greater mass.

WORKING ON IT

Organize the students in groups of three. Provide each group with a large resealable plastic bag and a container holding some kind of material (e.g., interlocking cubes, pattern blocks, base ten blocks, marbles, metal bolts, metal washers, small stones, gravel). Explain that each group is to fill its plastic bag with what group members estimate to be one kilogram of material. Tell the students that each group may borrow the one-kilogram mass to help determine whether the contents of its bag have a mass of one kilogram but that the group may not use a balance to check the mass of its bag.

As the students work, ask the following question:

- "How does your group decide how much material to put into your bag?"
- "How can you use the one-kilogram mass to help you decide how much material to put into the bag?"
- "Why do some groups' bags seem to have more materials in them than other bags?"
- "Which group's bag has a lot of materials in it? Why?"
- "Which group's bag has few materials in it? Why?"

Gather the students together after the groups have filled their plastic bags with what they estimate to be one kilogram of materials. Ask a group to show its bag of materials to the class. Have a few students hold the one-kilogram mass and the bag to estimate whether the contents of the bag have a mass of one kilogram. Next, place the one-kilogram mass and the bag on either side of a balance to determine whether the contents of the bag have a mass that is more than, less than, or equal to one kilogram. If the contents of the bag have a mass that is more or less than one kilogram, allow the group to adjust the mass of the bag by adding or removing materials.

Have other groups show their bags of materials to the class, and provide students with an opportunity to estimate whether the contents of each bag have a mass of one kilogram. Check the masses of the bags, using a balance.

REFLECTING AND CONNECTING

Review the activity by asking the following questions:

- "Which groups have bags of materials that are less than one kilogram? More than one kilogram? Exactly one kilogram?"
- "Was it easy for your group to estimate a mass of one kilogram? Why or why not?"
- "Why do some bags appear be fuller than others?"
- "What classroom objects, do you estimate, have a mass of one kilogram?"
- "How could you use a balance to check whether the objects have a mass of one kilogram?"

Help the students establish benchmarks for a kilogram by showing them familiar objects that have a mass of one kilogram (e.g., one-litre bottle of water, one-litre carton of milk, box of salt, bag of sugar). Ask: "Which of these objects, do you think, have a mass of one kilogram?". After the students have shared their thoughts, use a balance to verify that each object has a mass of one kilogram. Have students explain how they could use the objects as benchmarks to judge the mass of other objects (e.g., estimate whether a bag of oranges has a mass that is more than, less than, or equal to one kilogram by judging whether it is heavier than, lighter than, or the same mass as a one-litre bottle of water).

ADAPTATIONS/EXTENSIONS

Some students might have difficulty determining whether the contents of their bags have a mass of one kilogram. Allow these students to use a balance and a one-kilogram mass to measure the contents of the bag. Discuss how a balance works, so that students understand whether the bag contains too much or too little material.

Extend the activity by having students fill plastic bags with materials that they estimate to be half a kilogram (i.e., 500-g mass) or a quarter of a kilogram (i.e., 250-g mass). Have students use a balance to check their estimates.

MATH LANGUAGE

- mass
- kilogram
- standard unit
- heavy, heavier
- light, lighter

ASSESSMENT

Observe students to see how well they:

- estimate quantities of materials that have a mass of one kilogram;
- identify objects that have a mass of approximately one kilogram;
- use a balance to compare masses;
- use mathematical language in comparing objects by mass (e.g., *heavier*, *lighter*, *about the same mass as one kilogram*);
- identify benchmarks for a kilogram (e.g., familiar objects, such as a one-litre bottle of water, that have a mass of one kilogram) and explain how benchmarks can be used to judge the mass of other objects.

HOME CONNECTION

Send home Mass3.BLM1: Kilogram Search. This Home Connection activity provides students with an opportunity to find items at home that have a mass that is less than, greater than, or about one kilogram.

LEARNING CONNECTION 1

Comparing the Masses of Objects With a Kilogram

Materials

- sheets of paper (1 per pair of students)
- pencils (1 per pair of students)
- balances (a few for the class)
- one-kilogram masses (a few for the class)

Provide each pair of students with a sheet of paper and a pencil. Have the pairs create a chart with three columns entitled "Lighter than One Kilogram", "About One Kilogram", and "Heavier than One Kilogram". Instruct the students to find objects in the classroom whose mass they estimate to be less then, greater than, or about one kilogram. Have them record the items in their charts.

After students have recorded several items in their charts, have them use balances and one-kilogram masses to verify that they recorded objects in the appropriate columns.

LEARNING CONNECTION 2

Shopping for a Kilogram

Materials

- one-kilogram masses (or plastic bags containing materials that have a mass of one kilogram, from the main learning activity) (1 per pair of students)
- paper or plastic grocery bags (1 per pair of students)

Provide each pair of students with a one-kilogram mass (or a plastic bag containing materials that have a mass of one kilogram) and a paper or plastic grocery bag. Have the pairs "go on a shopping trip" by finding objects in the classroom whose combined mass is estimated by the students to be one kilogram. Have the students put the objects into their grocery bag.

Gather the students together after the pairs have gathered objects whose estimated mass is one kilogram. Use a balance to determine whether each pair's "shopping items" have a mass that is less than, greater than, or about one kilogram.

LEARNING CONNECTION 3

I've Got a Feeling!

Materials

- 1-kg mass, 500-g mass, 250-g mass
- 3 small paper bags
- balance

Show students a 1-kg mass, a 500-g mass, and a 250-g mass. Explain that the masses represent one kilogram, half a kilogram, and a quarter of a kilogram.

Without students' looking, place each of the masses in a small paper bag. Ask a few students, one at a time, to hold one of the bags and to estimate whether the mass of the bag is one kilogram, half a kilogram, or a quarter of a kilogram. Have each of the participating students reveal the mass in the bag to verify his or her estimation.

Next, have students find objects in the classroom whose mass they estimate to be one kilogram, half a kilogram, or a quarter of a kilogram. Use a balance to compare the masses of the objects with a mass of one kilogram, of half a kilogram, or of a quarter of a kilogram.

Kilogram Search

Dear Parent/Guardian:

In math class, students have been learning about the kilogram as a unit for measuring mass.

Provide for your child an opportunity to find items in your home that have a mass of one kilogram. For example, your child might be able to find food packages that are labelled "1 kg" or "1000 g". A litre of milk, water, or juice also has a mass of one kilogram.

After your child has found items that have a mass of one kilogram, have him or her find items that have a mass that is less than, greater than, or about one kilogram.

Have your child record the items in the following chart.

Less Than One Kilogram	About One Kilogram	Greater Than One Kilogram

Thank you for helping your child explore the kilogram at home.

E. Correspondence of the Big Ideas and the Curriculum Expectations in Measurement

Appendix Contents

Overall Expectations 143
Specific Expectations 143

Overall Expectations

KINDERGARTEN	GRADE ONE	GRADE TWO	GRADE THREE
Students will:			
• measure and compare length, mass, capacity, area, temperature of objects/ materials, and the passage of time, using non-standard units, through free exploration, focused exploration, and guided activity.	• estimate, measure, and describe length, area, mass, capacity, time, and temperature, using non-standard units of the same size; • compare, describe, and order objects, using attributes measured in non-standard units.	• estimate, measure, and record length, perimeter, area, mass, capacity, time, and temperature, using non-standard units and standard units; • compare, describe, and order objects, using attributes measured in non-standard units and standard units.	• estimate, measure, and record length, perimeter, area, mass, capacity, time, and temperature, using standard units; • compare, describe, and order objects, using attributes measured in standard units.

Specific Expectations in Relation to the Big Ideas

KINDERGARTEN	GRADE ONE	GRADE TWO	GRADE THREE
Big Idea: Attributes, Units, and Measurement Sense **Students will:**			
– demonstrate, through investigation, an awareness of the use of different measurement tools for measuring different things *(e.g., a balance is used for measuring mass, a tape measure for measuring length, a sandglass for measuring time)*; – demonstrate awareness of non-standard measuring devices *(e.g., feet, hand spans, string, or cubes to measure length; hand claps to measure time; scoops of water or sand to measure capacity)* and strategies for using them *(e.g., place common objects end to end; use cubes to plan the length of a road at the sand table or the block centre; measure the distance between the classroom and the water fountain in number of footsteps)*; – demonstrate, through investigation, a beginning understanding of the use of non-standard units of the same size *(e.g., straws, paper clips)*.	– demonstrate an understanding of the use of non-standard units of the same size (e.g., straws, index cards) for measuring; – estimate, measure (i.e., by placing non-standard units repeatedly, without overlaps or gaps), and record lengths, heights, and distances (e.g., a book is about 10 paper clips wide; a pencil is about 3 toothpicks long); – construct, using a variety of strategies, tools for measuring lengths, heights, and distances in non-standard units (e.g., footprints on cash register tape or on connecting cubes); – estimate, measure (i.e., by minimizing overlaps and gaps), and describe area, through investigation using non-standard units (e.g., "It took about 15 index cards to cover my desk, with only a little bit of space left over."); – estimate, measure, and describe the capacity and/or mass of an object, through investigation using	– choose benchmarks – in this case, personal referents – for a centimetre and a metre (e.g., "My little finger is about as wide as one centimetre. A really big step is about one metre.") to help them perform measurement tasks; – estimate and measure length, height, and distance, using standard units (i.e., centimetre, metre) and non-standard units; – record and represent measurements of length, height, and distance in a variety of ways (e.g., written, pictorial, concrete); – select and justify the choice of a standard unit (i.e., centimetre or metre) or a non-standard unit to measure length (e.g., "I needed a fast way to check that the two teams would race the same distance, so I used paces."); – estimate, measure, and record the distance around objects, using non-standard units;	– estimate, measure, and record length, height, and distance, using standard units (i.e., centimetre, metre, kilometre); – draw items using a ruler, given specific lengths in centimetres; – read time using analogue clocks, to the nearest five minutes, and using digital clocks (e.g., 1:23 means twenty-three minutes after one o'clock), and represent time in 12-hour notation; – estimate, read (i.e., using a thermometer), and record positive temperatures to the nearest degree Celsius (i.e., using a number line; using appropriate notation); – identify benchmarks for freezing, cold, cool, warm, hot, and boiling temperatures as they relate to water and for cold, cool, warm, and hot temperatures as they relate to air (e.g., water freezes at 0°C; the air temperature on a warm day is about 20°C, but water at 20°C feels cool);

KINDERGARTEN	GRADE ONE	GRADE TWO	GRADE THREE
Big Idea: Attributes, Units, and Measurement Sense (*cont.*) **Students will:**			
	non-standard units (e.g., "My journal has the same mass as 13 pencils." "The juice can has the same capacity as 4 pop cans."); – estimate, measure, and describe the passage of time, through investigation using non-standard units (e.g., number of sleeps; number of claps; number of flips of a sand timer); – read demonstration digital and analogue clocks, and use them to identify benchmark times (e.g., times for breakfast, lunch, dinner; the start and end of school; bedtime) and to tell and write time to the hour and half-hour in everyday settings; – name the months of the year in order, and read the date on a calendar; – relate temperature to experiences of the seasons (e.g., "In winter, we can skate because it's cold enough for there to be ice.").	– estimate, measure, and record area, through investigation using a variety of non-standard units (e.g., determine the number of yellow pattern blocks it takes to cover an outlined shape); – estimate, measure, and record the capacity and/or mass of an object, using a variety of non-standard units (e.g., "I used the pan balance and found that the stapler has the same mass as my pencil case."); – tell and write time to the quarter-hour, using demonstration digital and analogue clocks (e.g., "My clock shows the time recess will start [10:00], and my friend's clock shows the time recess will end [10:15]."); – construct tools for measuring time intervals in non-standard units (e.g., a particular bottle of water takes about five seconds to empty); – describe how changes in temperature affect everyday experiences (e.g., the choice of clothing to wear); – use a standard thermometer to determine whether temperature is rising or falling (e.g., the temperature of water, air).	– estimate, measure, and record the perimeter of two-dimensional shapes, through investigation using standard units; – estimate, measure (i.e., using centimetre grid paper, arrays), and record area (e.g., if a row of 10 connecting cubes is approximately the width of a book, skip counting down the cover of the book with the row of cubes [i.e., counting 10, 20, 30, . . .] is one way to determine the area of the book cover); – choose benchmarks for a kilogram and a litre to help them perform measurement tasks; – estimate, measure, and record the mass of objects (e.g., can of apple juice, bag of oranges, bag of sand), using the standard unit of the kilogram or parts of a kilogram (e.g., half, quarter); – estimate, measure, and record the capacity of containers (e.g., juice can, milk bag), using the standard unit of the litre or parts of a litre (e.g., half, quarter).

KINDERGARTEN	GRADE ONE	GRADE TWO	GRADE THREE
Big Idea: Measurement Relationships **Students will:**			
– compare and order two or more objects according to an appropriate measure *(e.g., length, mass, area, temperature, capacity)*, and use measurement terms *(e.g., hot/cold for temperature, small/medium/large for capacity, longer/shorter or thicker/thinner for length)*.	– compare two or three objects using measurable attributes (e.g., length, height, width, area, temperature, mass, capacity), and describe the objects using relative terms (e.g., *taller*, *heavier*, *faster*, *bigger*, *warmer*; "If I put an eraser, a pencil, and a metre stick beside each other, I can see that the eraser is shortest and the metre stick is longest."); – compare and order objects by their linear measurements, using the same non-standard unit; – use the metre as a benchmark for measuring length, and compare the metre with non-standard units; – describe, through investigation using concrete materials, the relationship between the size of a unit and the number of units needed to measure length.	– describe, through investigation, the relationship between the size of a unit of area and the number of units needed to cover a surface; – compare and order a collection of objects by mass and/or capacity, using non-standard units (e.g., "The coffee can holds more sand than the soup can, but the same amount as the small pail."); – determine, through investigation, the relationship between days and weeks and between months and years.	– compare standard units of length (i.e., centimetre, metre, kilometre) (e.g., centimetres are smaller than metres), and select and justify the most appropriate standard unit to measure length; – compare and order objects on the basis of linear measurements in centimetres and/or metres (e.g., compare a 3 cm object with a 5 cm object; compare a 50 cm object with a 1 m object) in problem-solving contexts; – compare and order various shapes by area, using congruent shapes (e.g., from a set of pattern blocks or Power Polygons) and grid paper for measuring; – describe, through investigation using grid paper, the relationship between the size of a unit of area and the number of units needed to cover a surface; – compare and order a collection of objects, using standard units of mass (i.e., kilogram) and/or capacity (i.e., litre); – solve problems involving the relationships between minutes and hours, hours and days, days and weeks, and weeks and years, using a variety of tools (e.g., clocks, calendars, calculators).

Glossary

Note: Words and phrases printed in boldface italics in the following definitions are also defined in this glossary.

analogue clock. A timepiece that measures the time through the position of its hands.

area. The amount of surface within a closed shape, measured in square ***units***, such as square centimetres and square metres. In the primary grades, students investigate area by covering surfaces with ***non-standard units***, such as ***pattern blocks*** and square tiles.

array. A rectangular arrangement of objects into rows and columns.

assessment. The ongoing, systematic gathering, recording, and analysis of information about a student's achievement, using a variety of strategies and tools. Its intent is to provide the teacher (and the student, where appropriate) with feedback that can be used to improve programming.

attribute. A quantitative or qualitative characteristic of an object or an event (e.g., colour, size, thickness, number of sides). Measurable (quantitative) attributes include ***length***, ***area***, ***mass***, ***capacity***, temperature, and time.

balance. A device consisting of two pans, buckets, or platforms supported at opposite ends of a balance beam. A balance is used to compare and measure ***masses*** of objects.

benchmark. A number or measurement that is internalized and used as a reference to help judge other numbers or measurements. For example, the ***length*** of a baseball bat is a benchmark for a metre. *See also* **estimation strategies** and **personal referent**.

big ideas. In mathematics, the important concepts or major underlying principles. For example, the big ideas for Kindergarten to Grade 3 in the Measurement strand of the Ontario curriculum are: ***attributes***, ***units***, and ***measurement sense***, and measurement ***relationships***.

capacity. The greatest amount that a container can hold; usually measured in litres or millilitres. In the primary grades, students investigate capacity by filling containers with scoops, cups, or handfuls of a pourable material.

centimetre cubes. Commercially produced cubes that help students learn measurement concepts. Each face of a cube has an ***area*** of one square centimetre.

chunking. *See under* **estimation strategies**.

concept. *See* **mathematical concept**.

concrete materials. *See* **manipulatives**.

context. The environment, situation, or setting in which an event or activity takes place. Real-life settings often help students make sense of mathematics.

Cuisenaire rods. Commercially produced manipulatives consisting of a set of rectangular rods of different lengths, in which each length is a different colour.

depth. The ***distance*** from the top of an object to its bottom, from front to back, or from the outside in.

direct comparison. A process of comparing objects (e.g., to determine which is longer, has a greater ***area***, or has a greater ***mass***) through observation, without the use of a measurement tool. For example, two objects can be compared directly by placing them side by side and observing which is longer. *See also* **indirect comparison**.

distance. The amount of space between two points.

estimation strategies. Mental mathematics strategies used to obtain an approximate answer. Some strategies for estimating measurements are:

- **using benchmarks**. A process of using a ***benchmark*** to estimate a measurement. For example, knowing that the ***length*** of a baseball bat is approximately one metre allows a person to estimate the ***length*** of a board.
- **using personal referents.** A process of using one's own body measurements, such as ***height***, ***mass***, ***length*** of hand span, or ***length*** of arm, to estimate other measurements. For example, knowing that the ***length*** of one's hand span is approximately 20 cm allows a person to estimate the ***length*** of a table.
- **chunking.** A process of visually breaking an object into parts and then estimating the measure of each part. For example, a person could estimate the ***length*** of a room by breaking the ***length*** into parts, estimating the ***length*** of each part, and then adding the estimates of the parts together.

expectations. The knowledge and skills that students are expected to learn and to demonstrate by the end of every grade or course, as outlined in the Ontario curriculum documents for the various subject areas.

extension. A learning activity that is related to a previous one. An extension can involve a task that reinforces, builds on, or requires application of newly learned material.

fine motor control. (Also known as *small muscle control*.) Control over the muscles that regulate the small, or fine, movements of the fingers, hands, and wrists.

height. The ***distance*** from the lowest point to the highest point of an object or a person.

indirect comparison. A process of comparing objects (e.g., to determine which is longer, has a greater ***area***, or has a greater ***mass***) by using a measurement tool. For example, a string can be used to compare the ***lengths*** of two objects. *See also* **direct comparison**.

investigation. An instructional activity in which students pursue a problem or an exploration. Investigations help students develop problem-solving skills, learn new concepts, and apply and deepen their understanding of previously learned concepts and skills.

iteration. *See* **unit iteration**.

learning styles. Different ways of learning and processing information. For instance, visual learners need to see visual representations of concepts. Auditory learners learn best through verbal instructions and discussions, and by talking things through and listening to what others have to say. Tactile/kinaesthetic learners learn best through a hands-on approach, and by exploring the physical world around them.

length. The ***distance*** along an object from end to end.

linear dimension. The measurement of one linear ***attribute;*** that is, ***distance***, ***length***, ***width***, ***height***, or ***depth***.

manipulatives. (Also called "concrete materials".) Objects that students handle and use in constructing or demonstrating their understanding of ***mathematical concepts*** and skills. Some examples of manipulatives are counters, interlocking cubes, and colour tiles.

mass. The amount of matter in an object; usually measured in grams and kilograms. In the primary grades, students use ***balances*** and ***non-standard units***, such as metal washers and marbles, to investigate mass.

mathematical concept. A fundamental understanding about mathematics that a student develops within problem-solving ***contexts***.

measurement sense. An understanding of measurement concepts and procedures. Measurement sense involves an understanding of appropriate measurement ***units*** in various situations, of the "howmuchness" of measurement ***units***, of measurement processes, of the use of measurement tools, and of estimation in measurement.

non-standard units. Measurement units used in the early development of measurement concepts – for example, paper clips, cubes, hand spans, and so on.

partitioning. The concept of dividing into parts. An understanding of partitioning allows students to comprehend how measurement tools (e.g., rulers, graduated containers, thermometers, clocks) are divided into equal parts that represent measurement units.

pattern blocks. Commercially produced learning tools consisting of green triangles, orange squares, tan rhombuses and larger blue rhombuses, red trapezoids, and yellow hexagons.

perimeter. The ***length*** of the boundary of a shape, or the ***distance*** around a shape.

personal referent. A knowledge of one's own body measurements (e.g., ***height***, ***mass***, ***length*** of hand span, or ***length*** of arm) that is used to estimate other measurements. For example, knowing that the ***length*** of one's hand span is approximately 20 cm provides a personal referent for estimating other ***lengths***. *See also* **estimation strategies** and **benchmark**.

problem solving. Engaging in a task for which the solution is not obvious or known in advance. To solve the problem, students must draw on their previous knowledge, try different strategies, make connections, and reach conclusions. Learning to solve problems by inquiry or ***investigation*** is very natural for young students.

referent. *See* **personal referent**.

relationship. In mathematics, a connection between ***mathematical concepts***, or between a ***mathematical concept*** and an idea in another subject or in real life. As students connect ideas they already understand with new experiences and ideas, their understanding of mathematical relationships develops.

representation. The use of ***manipulatives***, diagrams, pictures, or symbols to model a ***mathematical concept*** or a real-world ***context*** or situation.

side. An outer boundary (a straight or curved line) of a two-dimensional shape.

standard unit. A conventional measurement ***unit***. Standard units include: centimetre, metre, and kilometre for ***length***; gram and kilogram for ***mass***; millilitre and litre for ***capacity***; degree Celsius for temperature. *See also* ***non-standard unit***.

strand. A major area of knowledge and skills. In the Ontario mathematics curriculum for Grades 1–8, there are five strands: Number Sense and Numeration, Measurement, Geometry and Spatial Sense, Patterning and Algebra, and Data Management and Probability.

tile. Cover a surface completely, using repeated shapes. For example, students can tile a surface, using square tiles or ***pattern blocks***.

transitivity. The process used to compare two objects by considering their ***relationship*** to a third object (e.g., if a red bench is longer than a string, and a yellow bench is shorter than the same string, then the red bench is longer than the yellow bench).

unit. A fixed quantity used as a basis for measurement. Units may be ***non-standard*** or ***standard***.

unit iteration. The process of using one unit repeatedly to measure (e.g., using a metre stick by repeatedly moving it along the ***length*** being measured).

unitizing. The idea that, in measurement, a group of individual ***units*** can be combined to create a new ***unit***. For example, a metre stick represents a unit (1 m) that comprises 100 cm.

volume. The amount of space occupied by an object; measured in cubic units, such as cubic centimetres.

width. The ***distance*** from one side of an object to the other side.