Thinking About Metric Measures

About the Metic System
Just like our number system, the metric system ii based on the number 10. For example, there are 10 centimeters in a decimeter, and 10 millimeters in a centimeter. In the metric system, units relate to each other the same way that units in place value relate to each other. The 10-to-1 relationship and the use of powers of 10 are built into the metric system by design. To measure smaller amounts, divide the basic unit into parts of ten, a hundred, or a thousand, and so on. To measure larger amounts, multiply the basic unit by ten, a hundred, or a thousand, and so on.

Prefixes also help identify relationships: Cent (century – 100 years in a century) (cents 100 cents in a dollar) deci (decade – 10 years in a decade) (dime - 10 dimes in a dollar). Prefixes for all metric units change in the same way. Notice how "meter" serves as the anchor:

Kilo – kilometer – 1000 meters
Meter – standard length measure
Deci – 1/10 meter or 10 centimeters
Centi – 1/100 meter or 100 millimeters
Milli – 1/000 of a meter or 1000 millimeters

To change to a larger or smaller unit, you simply multiply or divide by a multiple of 10

The Metric System was developed by the French Academy of sciences in 1791. Thomas Jefferson tired to convince the United States Congress to adopt the Metric System. Today, the United States is the only major nation that has not adopted the metric system. The United States, Liberia, and South Yemen, are the only countries using the English or customary measurement system.

Importance of Benchmarks
Benchmarks are sometimes referred to as referent points because they provide individuals with a standard to refer to when thinking about measurement. It is important to have referents for measures, as referents provide us with benchmarks against which to test the reasonableness of our measures. For example, a centimeter is nearly the diameter of a dime, a little less than half an inch. A millimeter is about the thickness of a dime.

Personal benchmarks are essential tools for estimation and are developed and used throughout life. Benchmarks enhance the meaningfulness of standard units of measure (Bright 1976; Tierney 1998). They typically consist of nonstandard units and usually develop into mentally represented objects. When the standard tools for measuring with metric or customary units are not available, students must estimate measurements. Thus, through experiences, they develop and use personal benchmarks for the standard units. Identifying benchmarks and discussing them as a class supports students' familiarity with units, helps prevent errors in measurement, and allows meaningful use of measurement

Linear Measurements
Length is a measurement using one-dimensional units such as centimeters or meters, but area requires two-dimensional units such as square centimeters. Tiling is an example of units filling a space. For linear measuring, the measured distance is a count of linear units that begins at one

point and continues consistently to another point, focusing on the distance between the beginning and ending points. It is important that students keep the unit of measure constant. Often students will switch units when something doesn't fit. When measuring with paper, they might turn the paper different ways to make it fit.

Measurement tools for standard linear measurement include meter ruler (stick), meter tape, trundle wheel, centimeter ruler, and decimeter rods. These measuring tools iterate units and label the units so that each unit on the ruler is a linear distance. The number of subdivisions on a particular ruler affects its precision. A ruler has an origin or zero point that may not be on the edge (called a leading edge). However, students need to learn that any point on a ruler can be used as a starting point. When shown a ruler and asked, "Would you show me a inch or a centimeter," a child who does not yet see the marked interval of linear distance as the unit will simply point to the number 1 or to the line at that single point (Kamii, 1995). Students should be able to show you a centimeter or an inch anywhere on the ruler. Children tend to focus on the position of only one endpoint when measuring length (Clements & Battista, 1986). When presented with a broken ruler, many students look at the ending point and not the distance between the points. These children do not understand what constitutes a unit or how rulers are constructed.

Capacity and Volume

Objects having three dimensions have a measurable capacity. Volume and capacity both refer to measures of three-dimensional objects. Capacity refers to the amount a container will hold. The capacity of a container is the amount of space it has into which we can pour a liquid or any dry, pourable material. Because we usually measure liquids by pouring them into a container, we generally measure the amount of space that a liquid takes up with units of capacity. Metric units used to measure capacity are liters, milliliters and kiloliters which are used to measure liquids and also the containers that hold them.

Volume should be defined, in relationship to area, as the amount of space an object occupies in three dimensions. That is, the volume of a solid object is the amount of space that it occupies and is usually measured in cubic units. Metric units used to measure volume include cubic centimeters and cubic meters which are based on linear measure.

To know how much more one container holds than another, students usually begin measuring with nonstandard units such as marble, beans, sand, water or any other three-dimensional measurement medium that can be counted or measured out in uniform quantities.
One kilogram is about the mass of a liter of water. 20 drops of water is about 1 milliliter. A liter is "just a bunch" of milliliters put all together. If you have 1000 milliliters of water, then you will have a liter of water. Milk, soda and other drinks are often sold in liters.

Measuring Mass

Mass is the amount of matter in an object. Note that in upper grades in science the difference between mass and weight becomes important. Weight measures the pull of gravity on an object, while mass measures the amount of matter or "stuff" that makes up an object. On earth the measures of mass and weight are used interchangeably as our standards for mass are based on their weight on earth. This is not true on other planets or on the moon. The mass of objects stays the same on the moon but weight varies with gravity. An astronaut's mass remains the same on Earth as it does on the moon. However the astronaut's weight is different on the moon and on earth due to gravity.

In the metric system the basic unit of weight, the gram, is directly related to units used for volume and length. The inventors of the metric system began with a liter of water (one cubic decimeter) and decreed that the weight of that amount of water would be one thousand grams, or one kilogram. The gram, is one one-thousandth of the weight of a liter of water. A paperclip weighs about 1 gram. Hold one small paperclip in your hand. Does that weigh a lot? A gram is very light. That is why you often see things measured in hundreds of grams. Grams are often written as **g** (for short), so "300 g" means "300 grams." Balances are often used to determine mass as they allow comparison of objects with a standard unit. A paper clip is about 1 gram and a US nickel weighs 5 grams. One milliliter of water is approximately 1 gram, and one liter of water approximately is 1 kilogram.

Once you have 1,000 grams, you have 1 kilogram **(**1 kilogram = 1,000 grams). Kilograms are great for measuring things that can be lifted by people. Kilograms are often written as **kg** (that is a "k" for "kilo" and a "g" for "gram), so "10 kg" means "10 kilograms." To find your weight in metric units, you would use kilograms. A kilogram has a mass of about 2 pounds. How much do you weigh in kilograms? Compare your weight in kilograms to your weight in pounds? If you know your weight in pounds, is there a way you can think about your weight in kilograms?

Temperature in the Metric System

Temperature is expressed in degrees Celsius in the metric system. A thermometer is a device that measures the temperature of things. The name is made up of two smaller words: "Thermo" means heat and "meter" means to measure.

People in the United States usually measure temperature with a Fahrenheit scale. Weather reporters in our country use the Fahrenheit scale. Scientists use the Celsius scale for measuring temperature. Third graders might be introduced to the metric scale by giving them access to a large picture or models of thermometers with both the Fahrenheit and the Celsius scale. Students can see that the two sets of numbers on a thermometer measures in degrees (°) with both Celsius and Fahrenheit. When water freezes the thermometer shows 0 degrees Celsius on one side, but on the other side the scale shows 32 degrees Fahrenheit. We want students to notice each scale shows the same thing but with different numbers. A hot sunny day might have a temperature of 30 degrees Celsius but would be 86 degrees Fahrenheit.

The Celsius scale used to be called the "centigrade" scale. Centigrade means "divided into 100 degrees." Anders Celsius developed his scale in 1742. He started with the freezing point of water and said that was 0 degrees Celsius (C for short). At the point where water boils, he marked that at 100 degrees C. This scale is much more scientific because the measurement is broken down into an even 100 degrees.

Summarizing: Metric System

The metric system is based on powers of ten. Prefixes are used across measurement types to denote the magnitude, or power of ten, of the measurement in question.

The most common prefixes are kilo, centi, and milli. Kilo means a thousand, therefore, 1000 meters, therefore 1000 meters is a kilometer; Centi- means one-hundredth, so one hundredth of a meter is a centimeter. Milli- means one-thousandth; a millimeter is one-thousandth of a meter. At each end of the scale are mega-and micro, representing one million and one millionth, respectively. Other metric prefixes, such as deca-, dcci-, and hecta-, are less commonly used.

Attribute	Metric System	Benchmarks
length or distance	meter (abbreviated m) centimeter (0.01 meter) abbreviated cm kilometer (1000 meters) abbreviated km	meter is a little longer than a yard centimeter about the width of a paper clip meter about the length for the tip of your fingers to your opposite shoulder width of an average doorway
liquid volume (how much space a liquid occupies)	liter (abbreviated l) milliliter (00.001 liter)	millimeter is about the thickness of a dime or the wire on a paper clip liter is a little more than a quart
solid volume (how much space something takes up)	cubic centimeter (abbreviated cc) cubic meter (1,000,000 cc)	
weight	gram (abbreviated g) kilogram (1000 grams) metric ton (1000 kg)	gram is about the weight of two paper clips gram about the weight of a dime kilogram – about 2 pounds
temperature	0° Celsius (freezing) 100° C (boiling) 20°C (room temperature)	
In Science, the metric units *grams* and *kilograms* are measures of *mass*, or how much matter there is, where as the U.S. standard units *ounces* and *pounds* are measures of *weight*, which is the force of Earth's gravity on an object's mass. But in everyday usage and throughout this unit, we use both types of units as measures of *weight.*		