

ELEMENTARY SCIENCE PROGRAM
MATH, SCIENCE & TECHNOLOGY EDUCATION

A Collection of Learning Experiences

MEASURING



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MEASURING

GRADE 2

Unit Overview

Students will use standard and non-standard units of measurement and measuring tools to compare various measurements of objects in terms of mass, length, capacity, and area.

Scheduling

This unit may take from five to nine weeks to complete depending upon the goals of the teacher and interests of the students. Use of the section included in this manual called More Ideas may extend the time span of this kit.

Materials to be obtained locally:

Please make **one** student activity book for **each** student.

pencils
chart paper
felt tip markers
notebooks
folders
scissors
crayons
various small objects from home or classroom
three dimensional objects
water
rice, peas, dried cereal, etc.
construction paper

Caution

Remind students to wash their hands after handling any of the materials in the kit.

About the Format

Each learning experience is numbered and titled. Under each title is the objective for the learning experience.

Each learning experience page has two columns. The column on the left side of the page lists materials, preparations, basic skill processes, evaluation strategy, and vocabulary. The evaluation strategy is for the teacher to use when judging the students' understanding of the learning experience.

The right column begins with a "Focus Question" which is typed in italicized print. The purpose of the "Focus Question" is to guide the teacher's instruction toward the main idea of the learning experience. The "Focus Question" is not to be answered by the students. The learning experience includes direction for students, illustrations, and discussion questions. These discussion questions can be used as a basis for class interaction. A **Student Assessment** has been included in the **Teacher's Manual** and the **Student Activity Manual**. If you do not want the students to have the assessment beforehand, remove it from the **Student Activity Manual** before printing a class set of the student manuals.

Background Information

Over the millennium, humankind has developed, modified, and sometimes abandoned hundreds of non-standard and standard measurements. The history of measurement is the history of human progress. The rate of progress has been closely related to developments in the technology (tools or techniques) of measurement. The history of measurement is linked to changes or differences in the culture using the measurements. Non-standard units of length such as the hand, span, palm, and digit were used from the earliest times. There is little evidence of any attempt to establish a permanent standard until the building of the great Khufu Pyramid in Egypt about 2900 B.C. Pharaoh Khufu was the first to decree that a standard unit of length was to be fixed as the Royal Egyptian Cubit. The Royal Cubit was used to design and construct the pyramids of Egypt. The cubit was derived from the length of the arm from the elbow to the outstretched fingertips. By 2500 B.C., this unit had been standardized in Egypt as the royal master cubit of about 52 cm. in length.

The Romans were also great builders and constructed vast networks of roads and aqueducts. Precise measurements were essential to allow construction to occur at different locations at the same time. This could only have been practical if there was an established standard measurement system for use by the various artisans who worked on construction projects. The Egyptians and Romans were, for a time, partially successful in establishing workable measurement systems and standards that were accepted and adhered to throughout their nations.

Humankind had barely started their technological evolution in measurement when the great empires crumbled. Barbaric tribes invaded Europe, an action which history would later show set development back centuries. Man's entrance into the Dark Ages stifled and destroyed existing measurement technology. Most measurement systems were forgotten, with the exception of a few attempts by reigning monarchs, to establish standards usually based on their body dimensions.

In early England, King Edgar designated, by decree, that the measurement the "yard" was the distance from the tip of the King's nose to the end of his outstretched arm. This yard became the official yard at the time. However, this yard was not a universal standard of length, but was used only as a measure of cloth. It became common that people began using fingers, hands and legs for other measurements. What is now called an inch originally was the width of a man's thumb. It also was the length of the forefinger from the tip to the first joint and the inch was commonly taken to be the length of three barleycorns. Twelve times that distance made a foot. The foot was also chosen to mean the length of a man's foot. The foot, however, varied in length, sometimes as much as 7 to 11 centimeters or about 3 or 4 inches. Three times the length of the foot was called the yard. Two yards equaled a fathom (a measurement of the depth of water), which was the distance across a man's outstretched arms. Half a yard was the 18-inch cubit, and half a cubit was called a span, which was the distance across the hand from the tip of the thumb to the tip of the little finger when the fingers were spread out as far as possible. A hand was half a span. Today, a hand is 4 inches or about 10 centimeters and is used to measure horses (from the ground to the horse's withers or shoulder).

Early science and industry needed measuring tools to explore their theories and to build better clocks, machines, and devices. Together the scientists, technologists and instrument makers developed increasingly better measuring systems and tools. Over time, it was decided to derive a standard unit of length from a dimension of the earth. The meter, originally developed in France, was to become the basic unit of length. The meter was equivalent to one ten-millionth of a quadrant of the earth's meridian. Since this distance was already known with some precision, a provisional unit was adopted almost at once.

Today the United States National Bureau of Standards maintains over 700 different standards for measurement in addition to conducting basic research in many important related fields. It took man 5,000 years to evolve from the Royal Egyptian Cubit to his first highly defined standard, the meter, which was adopted about 1900.

Measuring is an important technique common to mathematics, science, and technology. Students measure in a variety of situations. The more measurement they engage in, the more skill they develop. Students need to have opportunities to compare the size of various objects, to arrange them by size (serial order), and to measure using nonstandard units and standard units. Learning experiences in the following units allow students to build their understanding of measurement and measurement systems.

Metric units are used throughout these learning experiences. The basic unit of the metric system is the **meter**. The meter was defined as being equal to one ten-millionth of a meridian from the North Pole to the equator or one ten-millionth of a quadrant of the earth's meridian. A liter equals the volume of a cube with edges equal to one-tenth of a meter or ten centimeters. A gram equals the mass of a centimeter cube of pure water at the temperature of 3.98 degrees Celsius. The cube has edges equal to one-hundredth part of a meter or one centimeter. Therefore:

- 1 meter (m) = 100 centimeters (cm)
- 1 cubic centimeter (cc) = 1 milliliter (ml)
- 100 cubic centimeters (cc) = 1 liter
- 1000 milliliters = 1 liter (l)
- 1 milliliter of water = 1 gram at 3.98 degrees Celsius (C)

Under average conditions, or 3.98 degrees Celsius, the density of water is considered to be 1 gram per cubic centimeter. The density changes only a small amount at other temperatures above 3.98 degrees Celsius.

Linear Measurement

Learning experiences in Measuring allow students to investigate linear measurement. Students learn that nonstandard units can be used to measure somewhat accurately, but may yield different results. Students may discover that the size of the object dictates the size of the unit of measure to be used. Small objects are not easily measured with large units and small units make the measurement of large objects slow, cumbersome, and more likely to result in accumulated error.

Through the Measuring learning experiences, students may develop the ability to estimate how large an object is. This skill is important as a check for measurements as they are made. Students should know the difference between height, width, and depth

when taking linear measurements. Students should label the measurement answers with the measurement units used.

Area refers to the size of a surface of an object. In Measurement learning experiences, students will measure or approximate the size of surfaces in square units through the use of centimeter grid paper squares that are 10 x 10 centimeters. This size allows counting by 100 square centimeter units.

Temperature

Students naturally compare temperature by deciding their own perceived differences between things or conditions that are warmer or cooler. Often there can be differences between an individual's perceptions depending on an individual's sensitivity or surroundings. Thermometers provide a standard to compare temperature measurements. Students will discover that an average room temperature is about 21°C and that an average normal body temperature is about 37°C.

The average kinetic energy of the molecules of a substance is its **temperature**. The kinetic energy of a substance relates to how much heat the substance has. An object that has a high temperature has molecules with a high average of kinetic energy. If an object has a low temperature, its molecules have a lower average of kinetic energy. **Thermometers** are tools that help us measure temperature. Thermometers have a long, thin tube filled with a red liquid that detects changes in some property of matter as a result of internal energy. The liquid in the thermometer rises when the air around it gets warmer (expands). This liquid falls in the tube when the air around it gets colder (contracts). Alcohol is the liquid used in the thermometers in this kit because it expands and contracts at a uniform rate. Fahrenheit and Celsius are two different scales for measuring temperature. These two scales are named after the scientists who developed them, Gabriel Daniel Fahrenheit and Anders Celsius. On the Fahrenheit scale, the freezing point of water is 32°F and boiling point is 212°F. On the Celsius scale, 0°C is the freezing point of water and 100°C is the boiling point. In this unit, the Celsius scale is asked for in all responses from the students because it is the scientific scale for measuring temperature. The Fahrenheit scale is on the thermometers because we are aware that students will hear the Fahrenheit temperature in weather reports in the United States. Therefore, you are able to introduce students to both scales if you choose to do so. Remember that when measuring temperature using the Fahrenheit scale each line on the thermometer is equal to 2° degrees. On the Celsius scale, each line is equal to one degree.

Volume may refer to the size of an object's capacity or its external three dimensional size. Students explore capacity (how much something can hold) through comparing a variety of containers. Students may predict the capacities of several containers relative to one another. Student may test the accuracy of their predictions. Students will compare various containers with one liter containers to gain understanding of a standard unit of volume.

Gravity affects everything on earth. This includes bodies of air and water and the things in them. Gravity pulls the air or water and the things in them toward the center of the earth. Only the solid surface beneath the air or water prevents them from being drawn further toward the center of the earth. When a spring scale is used, the measurement represents the force of gravity on the object being weighed. When a

balance scale is used, the mass is being measured. Each side of the balance is being pulled by gravity and therefore the measurement is of the object's mass.

Mass is a measure of the amount of matter in an object, while the **weight** of an object is a measure of the gravitational pull on the object. It can confuse students using a spring scale because the spring scale is actually measuring the force of gravity on the object's mass. Weight is the result of the effect of gravity on the mass that stretches or compresses a spring. Mass is measured by comparing the gravitational pull on a standard mass. Therefore, some sort of a balance scale is needed to measure mass. Weight will vary with gravitational force, while the mass will remain constant. Therefore, if you measure an object's weight on earth and then measure it's weight on the moon, you would find a difference because the force of gravity is different on the moon.

Students will use a double pan balance to compare the mass of various objects. Gram centimeter cubes are provided as the standard unit of measure for these learning experiences.

Learning Experience 1: Getting Started

Objective: Students will discuss their background knowledge of measurement.

Materials:

- Chart paper*
- Felt tip markers*
- Notebooks*
- Folders*

*provided by teacher

Preparation:

Each student should maintain a folder to hold the activity sheets for this unit.

Basic Skills Development:

- Discussing
- Brainstorming

Evaluation Strategy:

Students will contribute ideas to make a KWHL chart.

Vocabulary:

- measurement
- observe
- strategy

What do we know about measurement?

Using the KWHL Strategy, help your students explore their knowledge about measurement and expand on it throughout the unit. Guide your students in brainstorming what they might **know** about measurement. Ask students to brainstorm words that come to mind when they say measurement. Record their ideas on a class-size KWHL chart paper. Ask students what they might like to know more about concerning measurement and record their ideas under the "**want to know**" column. You may also contribute to the list. Now that the students have listed what they might want to know, they need to think about "**how they might find out**" answers to the questions they have. After the hands-on activities, maintaining journals, and discussions, students can then record information in the "**what we learned and still want to know**" column. This process can also be done in cooperative groups where students gather information in small groups then share their ideas with the class.

KWHL Strategy			
What we know	What we want to know	How are we going to find out	What we learned and still want to learn

Learning Experience 2: Non-Standard Measuring

Objectives: Students will measure various objects with nonstandard units and compare their differences and similarities. Students will identify hand, hand span, cubit, and foot.

Materials:

For each pair of students:

2 Measuring Student Activity Books

Crayons*

Construction paper*

Scissors*

For the class:

Chart paper*

Felt tip markers*

*provided by teacher

Preparation:

Read background information on pages 4 and 5. Provide each pair of students with crayons, construction paper, and scissors. Have each student help his/her partner trace and cut out their own hand, handspan, cubit, and foot.

Basic Skills Development:

Predicting

Discussing

Replicating

Counting

Organizing & Gathering Data

Evaluation Strategy:

Students will measure with non-standard measurements specific objects around the classroom.

Vocabulary:

non-standard

height

width

cubit

hand span

What can we measure in the classroom using our traced hand, handspan, cubit, and foot?

Guide the students through the process of tracing the width and length of their hands (closed fingers), handspan (fingers spread), cubit (from the elbow to the tip of their fingers), and foot on construction paper. See Learning Experience #2 in the Measuring Student Activity Book.

These non-standard measurements are known as the hand, handspan, cubit, and foot. Students are to use their hand, handspan, cubit, or foot, to explore, through measurement, specific objects in the room. (e.g. desk, door filing cabinet, chalkboard/markerboard). The activity sheet lists four specific items for them to measure.

Make a class graph based upon the information from students' activity sheets for each of the specific items measured. See if there are any similarities or differences among the measurements students obtained using the hand, handspan, cubit, and foot.

Make sure students save their traced parts for Learning Experience #6.

Discussion Questions:

How many hands, handspans, cubits, and feet did it take to measure the length and width of the desk?

How many hands, handspans, cubits, and feet did it take to measure the length and width of the door?

Learning Experience 2 continued

Page 2

How many hands, handspans, cubits, and feet did it take to measure the length and width of the filing cabinets?

How many hands, handspans, cubits, and feet did it take to measure the length and width of the chalkboard/markerboard?

What are reasons for the measurements made by different students being similar or different?

Is there a better way to measure objects?

Extension:

Give students a “follow-up” assignment. Students will measure different objects at home (e.g. couch, chair, TV, bed, floor) using their own hand, handspan, cubit, and foot. Have students record their measurements on graph paper and have them share their results with the class.

Learning Experience 3: Measuring Length

Objective: Students will measure various objects and compare their differences with fixed units.

Materials:

For each pair of students:

2 Measuring Student Activity Books

20 2" large paper clips

15 tongue depressors

For the class:

Chart paper*

Felt tip markers*

*provided by teacher

Preparation:

Read background information on pages 4 and 5. Provide students with background knowledge on the early history of measurement.

Basic Skills Development:

Observing

Gathering & Organizing Data

Predicting

Discussing

Evaluation Strategy:

Students will apply their knowledge of measuring different lengths and widths of specific objects inside the classroom.

Vocabulary:

length

width

How might we measure the length and width of specific classroom objects using large paper clips and tongue depressors?

Have each pair of students measure the length and width of specific classroom objects using large paper clips and tongue depressors. Specific classroom objects include desk, door, filing cabinet, and chalkboard/markerboard.

Provide each student the activity sheet for Learning Experience #3 in the Measuring Student Activity Book.

Make a class graph using the information from their activity sheet. See if there are any similarities or differences among the measurements students obtained using large paper clips and tongue depressors. Discuss how this measurement differed from using their hands, handspans, cubit, and foot.

Discussion Questions:

What was the length and width of your desk in large paper clips and tongue depressors?

What was the length and width of the door in large paper clips and tongue depressors?

What was the length and width of the filing cabinet in large paper clips and tongue depressors?

What was the length and width of the chalkboard/markerboard in large paper clips and tongue depressors?

What was the length and width of the largest item measured? What was the smallest?

Are there better ways to measure objects?

Learning Experience 3 continued

Page 2

Extension:

Students may want to measure items outside the classroom. For example: playground equipment, tree, sidewalk, window, leaf, and rock. What was the length and width of the largest outside classroom object? What was the smallest?

Learning Experience 4: Comparing Width and Height

Objective: Students will measure themselves and compare their height and width.

Materials:

For each pair of students:

2 Measuring Student Activity Books
Paper clips or tongue depressors
Scissors*
Pencil*

For the class:

Roll paper tape
Chart paper*
Felt tip markers*

*provided by teacher

Preparation:

Read background information on pages 4 and 5. Provide students with information about length, height, and width. Length is usually used to describe how long an object is. Height is used to describe how tall an object is and the width is used to describe how thick or how wide an object is.

Basic Skills Development:

Measuring
Comparing
Discussing
Gathering & Organizing Data

Evaluation Strategy:

Each student will identify and compare their height and width of themselves.

Vocabulary:

serial order

Are you taller (higher) than you are wide?

Provide each student with the activity sheet for learning experience #4 in the Measuring Student Activity Book. Have each pair of students stand and stretch their arms out from their sides. Ask students to predict which is longer, the distance from their head to their toes or the distance from the tip of their longest finger of their left hand to the tip of the longest finger on their right hand. Provide students with paper tape to actually measure their height and width. Make sure each student has a partner to measure their height and width using the paper tape. Students are to use one of the nonstandard measurement units (paper clips, tongue depressors, etc.) to find the "length" of their paper tape and record their results on the activity sheet for Learning Experience #4 in the Measuring Student Activity Book. Cut and label each tape with the student's name and the measurement. Encourage students to take the paper tapes and compare their height and width with other students. Have students record on their activity sheet their measurements.

Make a class chart comparing all the students' heights and widths. This could be done by posting the paper tapes on the chalkboard in serial order (tallest student to shortest student). **Make sure each student saves their paper tapes for Learning Experience #5 and Learning Experience #6.**

Discussion Questions:

Which piece of paper tape is longer - the piece measured from your head to your toes or from the tip of the longest finger on your left hand to the tip of the longest finger on your right hand?

Learning Experience 4 continued

Page 2

Are you taller than you are wide?

Who had the tallest piece of paper tape? Who had the shortest piece of paper tape?

Who had the widest piece of paper tape? Whose paper tape was the least wide?

Learning Experience 5: Comparing Pace

Objective: Students will measure the length of their pace and double pace.
Students will measure and compare their double pace with the height and width of their body.

Materials:

For each pair of students:

2 Measuring Student Activity Books
Paper tape from Learning Experience #4
Paper clips or tongue depressors
Scissors*
Pencil*

For the class:

Roll paper tape
Chart paper*
Felt tip markers*
*provided by teacher

Preparation:

Read background information on pages 4 and 5. Provide students information about what a pace and a double pace is and how to measure their pace and double pace. Today a pace is the length of one step - 65 cm to 80 cm. The ancient Roman soldiers marched in paces, which were the length of a double pace today about 150 cm. The pace should be measured from the tip of the foot to the tip of the next foot when taking a normal step forward. The double pace is measured by taking one step forward with the right foot, then one with the left foot. The measurement is illustrated on the activity sheet for Learning Experience #5 in the Measuring Student Activity Book. Each pair of students should be provided a roll of paper tape and scissors.

Basic Skills Development:

Measuring
Gathering & Organizing Data

What is the length of your pace/double pace?

Are you taller (higher) than you are wide or than your double pace is long?

Provide students the activity sheet for Learning Experience #5 in the Measuring Student Activity Book. Have each pair of students stand and practice taking a normal pace step forward. Make sure each student has a partner to measure their pace using the paper tape and scissors. After each student is done with their measurement of a normal pace step, have them take a double pace step. Make sure that the double pace step is measured, also. Cut and label each tape with the student's name and their measurement. Encourage each student to take the paper tapes and compare the length of their pace and double pace with other students. Have students record their results on their activity sheet their measurements.

Make sure students have their paper tapes from Learning Experience #4. Have students compare the double pace paper tape measurements with the height and width of their body paper tape measurements. Have students determine which is longer - the length of their double pace or the height or width of their body. Have students record the measurements on their activity sheet.

Make a class chart comparing all the students' lengths of their paces and double paces. This should be done by posting the paper tapes on the

Learning Experience 5 continued

Page 2

Interpreting Data
Comparing

Evaluation Strategy:

Each student will identify and compare their pace and double pace. Students will compare if their double pace is longer or shorter in length than the height and width of their body.

Vocabulary:

pace
double pace

chalkboard in serial order (longest to shortest normal pace and longest to shortest double pace). Make sure each student saves their paper tapes for Learning Experience #6.

Discussion Questions:

Who had the longest normal pace step?
Who had the shortest pace step?
Who had the longest double pace step?
Who has the shortest double pace step?
Is your double pace longer than you are tall?
Is your double pace longer than you are wide?
Is there a better way to compare length?

Learning Experience 6: Introduction to Standard Measurement (Linear)

Objective: Students will measure objects in centimeters.

Materials:

For each pair of students:

2 Measuring Student Activity Books
Traced parts from Learning Experience #2
Paper tape from Learning Experiences #4 and #5
Plastic jar of (50) gram centimeter cubes
Centimeter measuring tape
Centimeter ruler

For the class:

Chart paper*
Felt tip markers*
Three dimensional objects*
*provided by teacher

Preparation:

Read background information on pages 5 and 6. Provide students with information about linear measurements.

Basic Skills Development:

Measuring
Gathering Data
Discussing

Evaluation Strategy:

Each student will identify and compare the length, width, and height of themselves and various dimensional objects in the classroom.

Vocabulary:

centimeter
dimensional

How can we measure length, width and height more accurately?

Session 1:

Provide each pair of students with a plastic jar of about (50) gram centimeter cubes. Have students examine a centimeter cube and note that each cube can be connected to another. Have students arrange the centimeter cubes in three rows of various lengths. Students should count the cubes to determine the length of each row. Have students record their measurements on page 1 of the activity sheet for Learning Experience #6 in the Measuring Student Activity Book. Challenge the students to find objects in their classroom that measure 1 - 5 centimeter cubes in length. Explain to students that the gram centimeter cubes can be used to measure various objects in the classroom. Record the names and sizes of the various classroom objects on chart paper.

Provide students their traced parts from Learning Experience #2. Have each pair of students measure with the centimeter cubes the length and width of their traced hand, handspan, cubit, and, and foot. Have students record their measurements on pages 1 and 2 on the activity sheet for Learning Experience #6 in the Measuring Student Activity Book.

Session 2:

Provide students their paper tapes from Learning Experiences #4 and #5.

Learning Experience 6 continued

Page 2

Have each pair of students measure the length of their paper tape with the centimeter measuring tape. Measure to the nearest centimeter. Have students record their measurements on page 3 of the activity sheet for Learning Experience #6 in the Measuring Student Activity Book.

Session 3:

Provide each pair students with a centimeter ruler. Have students measure to the nearest centimeter the objects drawn on pages 4 and 5 of the activity sheet for Learning Experience #6 in the Measuring Student Activity Book. Have students record their measurements on the activity sheet and discuss with the class the height, width, and length of the objects they measured.

Provide each pair of students with gram centimeter cubes, a centimeter ruler, and a centimeter measuring tape. Have students measure, to the nearest centimeter, the height, width, and length of any three dimensional objects in the classroom such as a box or a desk. Have students discuss with the class the height, width, and length of the objects they measured.

Session 4:

Provide each pair of students with gram centimeter cubes, a centimeter ruler, and centimeter measuring tape. Have students measure to the nearest centimeter, their height, width, and length, waist size, hand length, and head size. Have students discuss with the class the height, width, and length of the objects they measured.

Discussion Questions:

What three dimensional objects were measured in the classroom?

Were some objects larger in width than they were in length? What objects?

Were some objects larger in length than they were in width? What objects?

Are there better ways to compare an object's height, width and length?

Learning Experience 7: Linear Measurement (Meters and Centimeters)

Objective: Students will measure distances using meters and centimeters.

Materials:

For each pair of students:

2 Measuring Student Activity Books
Centimeter measuring tape

For the class:

Chart paper*
Felt tip markers*

*provided by teacher

Preparation:

Read background information on pages 5 and 6.

Basic Skills Development:

Measuring
Gathering Data
Discussing

Evaluation Strategy:

Each student will identify and compare the distances of various objects in the classroom.

Vocabulary:

meter
distance

How long is a meter?

Each pair of students should be provided with a centimeter tape measure. Demonstrate to students that the centimeter tape measure is written in centimeters and that 100 centimeters equals one meter. Encourage your students to measure three various objects or distances in the classroom that have dimensions of one meter (100 cm). Record the three items measured and their measurements on the activity sheet for Learning Experience #7 in the Measuring Student Activity Book.

Discussion Questions:

What objects or distances in the classroom measure about one meter in length?

Would a meter be a good unit for measuring a chalkboard, a room, or an athletic field? Why?

What objects would you recommend you would measure in meters? Why?

Make a chart with your students of things you would measure in meters.

Extension:

Students may want to measure items in meters outside the classroom. For example: playground equipment, tree, sidewalk, window, athletic field. Create a chart on the outside items measured.

Learning Experience 8: Temperatures of Water

Objective: Students will measure and record a variety of water temperatures.

Materials:

For each group of three students:

3 Measuring Student Activity Books
3 thermometers
3 9 oz. clear plastic tumblers with water at various temperatures (hot, warm/tepid, ice cold)*

*provided by teacher

Preparation:

Read background information on page 6. Remind students that if the glass tube of their thermometer breaks or becomes detached, they are to notify you immediately.

Basic Skills Development:

Observing
Gathering Data
Discussing
Predicting

Evaluation Strategy:

Students will accurately read three different water temperatures on a thermometer.

Vocabulary:

temperature
thermometer

How can we read temperatures in water that is hot, warm, or ice cold?

Have each group of three students place one thermometer in each of the clear plastic tumblers with hot, warm/tepid and ice cold water. Each student should take a thermometer reading of each tumbler and record their reading on the student activity sheet for Learning Experience #8 in the Measuring Student Activity Book.

Discussion Questions:

What is the temperature of the hot water in the tumbler?

What is the temperature of the warm water in the tumbler?

What was is temperature of the cold water in the tumbler?

After students take temperature readings from each of the tumblers, ask students to predict what will happen to the liquid in the thermometer when you remove them from each tumbler. Have them take the thermometers out of the water and asks students to see if the height of the fluid in the thermometer moves up or down. Students can then determine what the new temperature will be for all three thermometers. Have students record the new temperature on the activity sheet for Learning Experience #8 in the Measuring Student Activity Book.

Discussion Questions:

What do you think will happen if you remove the thermometer from each tumbler? Why do you think so?

What happens to the height of the fluid in the thermometer when you remove the thermometer from hot water?

Learning Experience 8 continued

Page 2

What happens to the height of the fluid in the thermometer when you remove the thermometer from warm water?

What happens to the height of the fluid in the thermometer when you remove the thermometer from cold water?

Extension:

Have students find out the temperatures of different parts of their bodies (closed hand, armpit, chin, leg, etc.). Do not have students place the thermometers in their mouth. Normal body temperature inside the mouth is 37°C.

Learning Experience 9: Temperature Readings in the Classroom

Objective: Student will measure room temperatures in degrees centigrade.

Materials:

For each group of three students:

3 Measuring Student Activity Books
Thermometer

For the class:

Chart paper*
Felt tip markers*

*provided by teacher

Preparation:

Read background information on page 6.

Basic Skills Development:

Discussing
Measuring
Gathering & Organizing Data
Interpreting Data

Note:

Instruct student to never place thermometers in their mouths.

Evaluation Strategy:

Students will accurately read three different air temperatures on a thermometer.

Vocabulary:

temperature
thermometer
reading

Where is it the warmest in our classroom? Where is it the coldest?

Have students place their thermometer in various locations throughout the classroom. Each group of three students should take a thermometer reading early in the morning, at midday, and before going home. The location of the thermometer and its measurement should be recorded on the activity sheet for Learning Experience #9 in the Measuring Student Activity Book.

Make a class chart and write the locations of where the thermometers were located and time of day. Compare all the students' temperature readings from their activity sheets and classify them in serial order (coldest temperature to warmest temperature by location and time of day).

Discussion Questions:

What part of the room is the warmest in the morning?

What part is the coldest?

What part of the room is the warmest at midday? What part is the coldest?

What part of the room is the warmest just before we go home? What part is the coldest?

Why do you think those areas are the warmest? Coldest?

Learning Experience 10: Capacity - Fill It Up

Objective: Students will determine the relative capacity of a variety of containers and place the containers in serial order by capacity.

Materials:

For each group of three students:

3 Measuring Student Activity Books

Medicine cup

Portion cup

9 oz. clear plastic tumbler

Clear plastic jar

Clear rectangular jar

Water*

Rice, peas, dried cereal, etc
(optional)*

*provided by teacher

Preparation:

Read background information on page 6. Dry materials such as rice, peas, dried cereal, etc. may also be used instead of water.

Basic Skills Development:

Measuring

Discussing

Predicting

Gathering & Organizing Data

Comparing

Evaluation Strategy:

Students will explain how to find the capacity of a large container by using a small container and will determine the serial order of a variety of containers by capacity.

Vocabulary:

capacity

What is capacity?

Have each group of three students predict an arrangement of the empty containers in serial order from least capacity to greatest capacity. Students can order their prediction on the activity sheet for Learning Experience #10 in the Measuring Student Activity Book. Let students test their arrangements on their own. Have students explain what they could do to investigate to find out if they are correct.

Discussion Questions:

What container do you think has the smallest capacity?

What container do you think has the largest capacity?

What do you think you can do to make sure your arrangement of empty containers is the right serial arrangement?

Provide each group of three students with a medicine cup and a clear plastic jar. Tell students to find out how many medicine cups of water it will take to fill the clear plastic jar.

Have students repeat the activity using the following cups: a portion cup, a clear plastic tumbler, and a plastic rectangular jar.

Make a class chart using the information from their activity sheets. See if there are any similarities or differences among the measurements students obtained using the medicine cup to find the capacity of the clear plastic jar, portion cup, clear plastic tumbler, and the clear rectangular jar.

Learning Experience 10 continued

Page 2

Discussion Questions:

How many medicine cups full of water did the clear plastic jar, the portion cup, the clear plastic tumbler and the clear rectangular box hold?

Which container do you think has the largest capacity?

Have students rearrange their containers in a serial order now that they have measured each container with a medicine cup. Record results on the activity sheet.

Discussion Questions:

Did the order of your prediction change? Which container held the most water and which held the least?

Do tall containers always hold more than short containers?

How might we make more accurate predictions?

Learning Experience 11: Area

Objective: Students will measure area with 10 x 10 cm graph paper squares.

Materials:

For each student:

Measuring Student Activity Book
10 x 10 cm graph paper squares

Preparation:

Read background information on page 6. The 10 x 10 cm. graph paper squares equal 100 square centimeters in area. $10 \times 10 = 100$

Basic Skills Development:

Measuring
Discussing
Gathering and Organizing Data

Evaluation Strategy:

Students will accurately determine the area of their desk and of other surfaces in their classroom.

Vocabulary:

area

What is area?

How many paper squares (10 x 10 cm.) do you think it will take to cover the top of your desk?

Explain to students the length and width of each paper square (10 x 10 cm.) Have each student use as many paper squares (10 x 10 cm.) as needed to cover the whole area of their desk. When the students are finished, have them count the paper squares and record their answers on the activity sheet for Learning Experience #11 in the Measuring Student Activity Book.

Discussion Questions:

How many squares did you use to cover your desk?

What is the area of one paper square?
If the area of one paper square is (10 x 10 cm.) how can you determine the area of your desk?

Ask students to determine the area of other surfaces around the classroom (tables, an area of the floor, seat of chair, etc.) and record the results on the activity sheet.

Learning Experience 12: Boards and Fulcrums

Objective: Students will setup a simple balance beam and arrange in serial order blocks from the lightest to the heaviest.

Materials:

For each group of three students:

Balance board

Fulcrum

For the class:

Sponge block set

Set of weight scaled wooden blocks

Preparation:

Organize the wooden blocks set so that each group receives blocks of different sizes.

Basic Skills Development:

Measuring

Comparing

Observing

Communicating

Evaluation Strategy:

Students will demonstrate and explain how and why a balance board and fulcrum work. After students explain how a balance board and fulcrum work, they will arrange in serial order (lightest to heaviest) a set of wooden blocks.

Vocabulary:

balance

fulcrum

How can you make a simple balance?

How can you arrange objects from lightest to heaviest?

How can we adjust the fulcrum so the heaviest block and the lightest block balance?

Examine with students the balance board and fulcrum and discuss how they work. Question students on how the balance board and fulcrum work and why they need it to work properly.

Discussion Questions:

How do the balance board and fulcrum work?

In what location is the fulcrum located?

Why do we need the balance board and fulcrum to work properly?

What does the word balance mean?

As a teacher demonstration, arrange in serial order (lightest to heaviest) each of the sponge blocks. Discuss results with students throughout the demonstration. Balance two sponge blocks on the balance board. After balancing the sponge blocks, adjust the fulcrum so it is not in the middle of the balance board and try balancing the heaviest sponge block with the lightest sponge block. Compare the results.

Discussion Questions:

What sponge block is the heaviest?

What sponge block is the lightest?

What happens when you move the fulcrum away from the middle of the balance board? What happens to the weight of the sponge blocks?

Learning Experience 12 continued

Page 2

Give student groups a set of wooden blocks of different sizes. Ask students to arrange in serial order (lightest to heaviest) each of the wooden blocks using the balance board and fulcrum. Have each group of three students balance two wooden blocks on the balance board. After balancing those blocks, adjust the fulcrum so it is not in the middle of the balance board and try balancing the heaviest wooden block with the lightest wooden block. Have students compare the results. Student groups can then serial order the wooden blocks (lightest to heaviest) on their desks and prove for the class that their order is correct through a demonstration.

Discussion Questions:

What wooden block is the heaviest?

What wooden block is the lightest?

What happens when you move the fulcrum away from the middle of the balance board?

What happens to the weight of the wooden blocks?

Learning Experience 13: Assembling, Balancing, and Using a Double Pan Balance

Objective: Students will assemble, balance, and use a double pan balance beam to find the mass of various objects.

Materials:

For each group of three students:

3 Measuring Student Activity Books

Balance stand

Balance arm

Pin for balance

Balance base

2 baskets for balance

Modeling clay

Plastic jar of (50) gram centimeter cubes

5/16" washers

Various small objects from home or classroom (e.g. pencil, crayon, eraser, magnet, etc.) *

*provided by teacher/student

Preparation:

Provide students information on mass.

Each group of three students should be provided with a double pan balance, plasticine, gram centimeter cubes, and washers.

Basic Skills Development:

Measuring Comparing

Discussing

Evaluation Strategy:

A group of three students will assemble a double pan balance using the materials provided. After the group of students assembles the balance, they will level their double pan balance by using the modeling clay provided. After the double pan balance is level and ready for weighing, student will serial order (lightest to heaviest) the various objects provided in the kit and objects in the classroom/home.

Vocabulary:

balance

washers

level

mass

How is a double pan balance assembled? How can a double pan balance be made level? Can we determine the mass of an object?

Provide students the activity sheet for Learning Experience #13 in the Measuring Student Activity Book. The activity sheet illustrates to students how to assemble their double pan balance. After assembling the double pan balance, students may discover one side of the balance is higher than the other. Discuss with students that the balance must be level (calibrated) before it can be used to measure objects. Provide students with a piece of modeling clay to help level the double pan balance.

Discussion Questions:

What do you think the double pan balance is used for?

Why do you think that the double pan balance should be level?

What do you think the modeling clay will do to the unbalanced side of the double balance when it is added?

Provide students with the gram centimeter cubes, washers, and various small objects in the classroom. Have students determine the mass of different number of washers and the various objects in the classroom.

Name: _____

Date: _____

Measuring Student Assessment

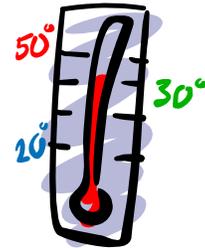
Directions: Read the question carefully and answer based on your knowledge about measuring. Circle the correct answer.

1.) If you and your mom were both going to measure the height of a milk carton, which unit of measure would you both use so that you each get the same answer.

- A.) Cubits
- B.) Hand spans
- C.) Hands
- D.) Centimeters

2.) This thermometer is showing a temperature of

- A.) 25°C
- B.) 30°C
- C.) 50°C
- D.) 10°C



3.) What would happen if you took a thermometer at room temperature and put into a cup of hot water?

- A.) The liquid inside the thermometer would go up.
- B.) The liquid inside the thermometer would go down.
- C.) The liquid inside the thermometer would not move.
- D.) The liquid inside the thermometer would leak.

4.) What would happen if you took a thermometer at room temperature and put it on top of a tray of ice cubes?

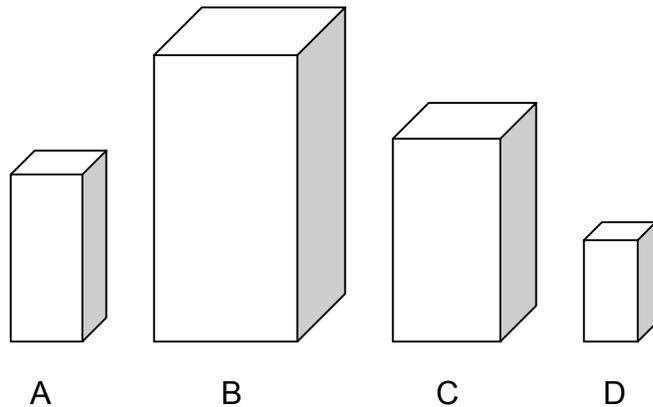
- A.) The liquid inside the thermometer would go up.
- B.) The liquid inside the thermometer would go down.
- C.) The liquid inside the thermometer would not move.
- D.) The liquid inside the thermometer would leak.

5.) There are _____ centimeters in 1 meter.

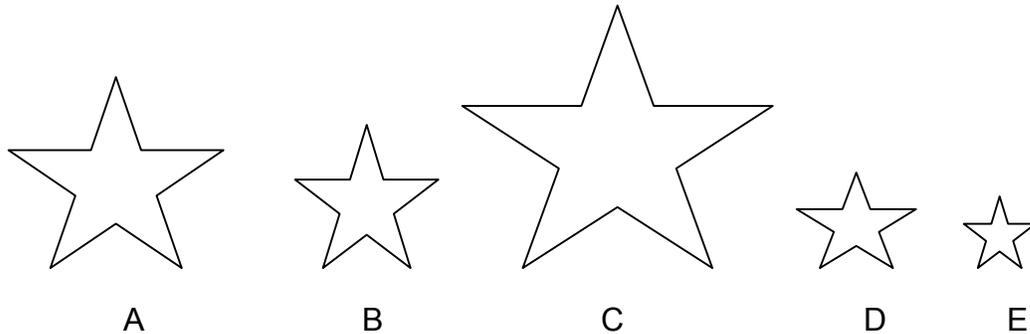
- A.) 20
- B.) 50
- C.) 100
- D.) 150

6.) What is the correct serial order of the blocks from widest to thinnest?

- A.) D, C, B, A
- B.) B, C, A, D
- C.) A, B, C, D
- D.) D, A, C, B



Use the stars to answer questions 7 and 8.



7.) What star would come first if you were putting these in serial order from tallest to shortest?

- A.) A
- B.) B
- C.) C
- D.) D

8.) Which star would come last if you were putting these in serial order from tallest to shortest.

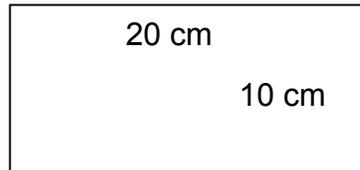
- A.) A
- B.) B
- C.) C
- D.) E

9.) Capacity is _____.

- A.) The amount of space that can be filled within an object.
- B.) The distance of 2 steps.
- C.) One-hundredth of a meter
- D.) The distance of 1 step.

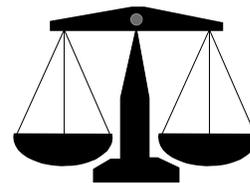
10.) What is the area of the rectangle below?

- A.) 200 square cm.
- B.) 300 square cm.
- C.) 400 square cm.
- D.) 500 square cm.

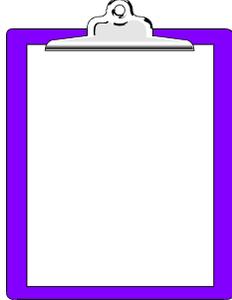
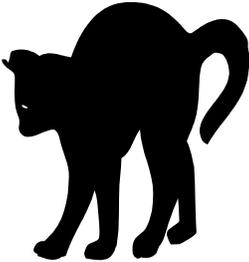


11.) Look at the balance. Pretend that there is one object in each basket. What do you know about the objects?

- A.) The objects have equal masses.
- B.) The object on side A has more mass.
- C.) The object on side B has more mass.
- D.) The object on side B has less mass.



12.) Measure the height and width of the following objects. Write your measurements in the correct spaces.

<p>A.</p>  <p>Height: _____ cm. Width: _____ cm.</p>	<p>B.</p>  <p>Height: _____ cm. Width: _____ cm.</p>
<p>C.</p>  <p>Height: _____ cm. Width: _____ cm.</p>	<p>D.</p>  <p>Height: _____ cm. Width: _____ cm.</p>

13.) Which object is the highest? _____

14.) Which object is the widest? _____

15.) Which object is as wide as it is high? _____

16.) Do any of the objects have greater height than width? _____
If yes, which ones? _____

Measuring Student Assessment Key

1. D
2. B
3. A
4. B
5. C
6. B
7. C
8. D
9. A
10. A
11. A
12. Answers will vary
13. |
14. |
15. ↓
16. ▼

MORE IDEAS

Language Arts

- ◆ Students could write a story about their body cutouts (see Art) that came to life and ran away. Where would they go? What would they do?
- ◆ Ask students to create a book about things that are tall, short, long or wide.
- ◆ Ask students to keep journals of their science experiences.
- ◆ Read the story *How Big Were the Dinosaurs?* By Bernard Most and ask student groups to use the variety of measuring tools in the kit to create an estimate of the size of the dinosaurs on the floor of the classroom or in the hallway.
- ◆ Students can create a book called “Measuring My Home” that includes distances around their house and objects in their house.

Book suggestions:

- Once I Was Very Small* by Elizabeth Ferber
- How Much Is A Million?* by David M. Schwartz
- How Big is a Foot?* by Rolf Myller
- The Biggest Boy* by Kevin Henkes
- The Biggest Fish* by Sheila Keenan
- Inch By Inch* by Leo Lionni
- Measuring Penny* by Loreen Leedy
- Take Off With Measuring* by Sally Hewitt
- Super Sand Castle Saturday* by Stuart Murphy

Art

- ◆ Students can create a body cutout by tracing their body on large pieces of white paper and create a collage on their cutouts with pictures of their favorite things.
- ◆ Look at clothing patterns and how they are used.

Social Studies

- ◆ Measure distances on a map using the key provided.
- ◆ Students can create a map of the school showing the distances between rooms.

Math

- ◆ Students may measure the height of faculty members and display the heights on a wall chart. Students may try to identify which teacher is which according to the measurements.
- ◆ Put a number of objects in a “junk bag”. Have students order, compare, and measure the length of these objects and then create a graph. They should label each strip on the graph with the name of the object. Use the graph to compare longer than or shorter than the tongue depressor. How many objects are longer than or shorter than the tongue depressor?
- ◆ Begin a height chart for each child and record his or her height throughout the year.
- ◆ Create a counting chart from 0 – 100 and practice counting by 10 by circling the numbers 10, 20, 30, ...90, 100 in red.

- ◆ Ask students to broad jump and measure the distance of their jumps.
- ◆ Ask students to find the perimeter of various objects.

Science

Plant fast growing seeds, such as lima bean seeds, and use the interlocking cubes to measure the height of the plant over time

INQUIRY AND PROCESS SKILLS

Classifying	Arranging or distributing objects, events, or information in classes according to some method or system.
Communication	Giving oral and written explanations or graphic representations of observations.
Creating Models	Displaying information by means of graphic illustrations or other multi-sensory representations.
Formulating Hypothesis	Constructing a proposition or assumption of what is thought likely to be true based on reasoning, which serves as a tentative testable theory.
Gathering & Organizing	Collecting information about objects and events which show a specific situation.
Generalizing	Drawing general conclusions from information.
Identifying Variables	Recognizing the characteristics of objects or events which are constant or change under different conditions.
Inferring	Making a statement or conclusion based on reasoning or prior experience to explain an observation.
Interpreting Data	Analyzing information that has been collected and organized by describing apparent patterns or relationships in the information.
Making Decisions	Choosing an alternative from among several and basing the judgment on defensible reasons.
Manipulating Materials	Handling or treating materials, equipment or procedures skillfully and effectively.
Measuring	Making quantitative observations by comparing to a standard.
Observing	Becoming aware of an object or even by using any of the senses to identify properties.
Predicting	Making a forecast or estimate of what future events or conditions may occur.

GLOSSARY

Area:	the total surface measured in square units.
Balance:	an instrument for determining mass by the equilibrium weights suspended from opposite ends of a horizontal bar.
Capacity:	the amount of space that can be filled.
Centimeter:	one hundredth of a meter.
Cubit:	an ancient linear unit usually from 17 to 21 inches measuring from the elbow to the tip of the middle finger.
Dimensional:	showing width, length, and thickness.
Distance:	the extent of space between two points.
Double pace:	the distance covered in two steps.
Fulcrum:	the support of point that a lever rests on when it is lifting something.
Hand span:	the distance between the thumb and fourth finger on a hand in which the fingers are spread apart.
Height:	the distance of the lowest point and the highest point of a person or object that is standing upright.
Length:	the linear extent of an object measured from end to end.
Level:	a horizontal position or condition.
Mass:	the amount of matter in an object.
Measurement:	the process of measuring or being measured.
Meter:	the basic unit of length in the metric system.
Non-standard:	a unit of measurement that is not a uniform scale.
Observe:	to become aware of an object or event by using any of the senses to identify properties.
Pace:	the distance covered in a step.
Reading:	to register or indicate, as in a thermometer
Serial order:	arranged in a series.

Strategy: a detailed plan for reaching a goal.

Tepid: moderately warm.

Temperature: measure of warmth or coldness of an object.

Thermometer: an instrument for measuring temperature.

Washer: a flat ring of metal used to hold a nut or bolt more tightly in place.

Width: measurement from side to side.

TEACHER REFERENCES

National Science Resource Center. Comparing and Measuring.
Hands-On Inc. Hands-On Measurement.
Ruth White and Marilyn Rehwald. Let's Measure. Rhythm Productions

Media Library

Call the media library to order media materials and to check on new materials that are available. The number to be reached is (716) 376-8212.

Web Sites

<http://www.quia.com/jg/2207.html>
<http://www.french-property.com/ref/convert.htm>
<http://www.aimsedu.org/>

Major Science Concepts To Be Addressed

Objects and events have distinctive properties.

The properties of an object are determined by its material and condition.

Some properties of an object are dependent upon the material from which the object is made.

Different kinds of materials have different properties.

For example:

Weight

Some properties of an object are determined by the place in space that it occupies.

For example:

Distance from other objects, such as between two desks, home, and school, or parked cars.

Location in reference to other objects

Position – (upside down, right side up, backward, forward)

Direction (in relation to another object – in front, behind, above, below, inside, outside).

The space occupied by an object is determined by the properties of the object.

For example:

Size such as a grain of sand, a toy ball, or the school building

Shape such as round (ball like), flat, box-like (cube)

The properties of an object can be changed by an event in which the object is involved.

Objects, which are not falling, are interacting with the object upon which they rest because they are being supported by it.

Objects on a uniform balance beam may or may not be in balance depending on rest because they are being supported by it.

When two objects of equal weight are balanced (on a uniform balance beam) they are the same distance from the balance point.

When two objects of unequal weight are balanced (on a uniform balance beam) the lighter weight object is farther from the balance point than the heavier weight object.

Energy and material have forms and properties.

Objects have properties determined by the forms, amounts, and properties of the materials of which they are made.

Some of the properties of an object may be determined by the amount of material in the object.

For example:

Volume & Weight