NANOTECHNOLOGY LESSON PLAN

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Subject / Grade Level: Nanotechnology / Lower elementary

Materials:

- ruler (1 or class set)—printable available at printable-ruler.net
- nanometer ruler (1 or class set)—printable available at nanozone.org/nanoruler.pdf
- dime (1 or class set)
- paper clip (1 or class set)
- bottle cap (1 or class set)
- plastic bags
- LEGO bricks, or construction paper cut into different-size small pieces (for each student or pair)
- drawing paper
- crayons

NGSS Essential Standards and Clarifying Objectives:

- **2-PS1-3:** Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object. (Examples of pieces could include blocks, building bricks, or other assorted small objects.)
- **Disciplinary Core Ideas: PS1.A:** Structure and Properties of Matter
  - A great variety of objects can be built from a small set of pieces. **(2-PS1-3)**
- **Science and Engineering Practice:** Developing and Using Models
- **Crosscutting Concepts:** Scale, Proportion, and Quantity; Stability and Change

Lesson Objectives:

- Students will understand how and why scientists use the nanoscale.
- Students will measure various objects using a nanometer ruler in order to compare the macroscale and nanoscale.
- Students will create a larger structure from smaller building blocks and rearrange their materials to create something new. By using small LEGO bricks or tiny pieces of construction paper, students will model an application of nanotechnology.

Differentiation Strategies to Meet Diverse Learner Needs:

- Think-pair-share, for students who learn through engaging with others
- Multisensory learning, to accommodate students who are auditory learners and visual learners, and to encourage students to engage their senses in the learning process

ENGAGEMENT

- Ask students, “What are some of the smallest objects on Earth?”
- Chart students’ responses, if desired. You can provide students with the sentence frame: “A small object on Earth is _____.”
  - Possible student responses: pin, paper clip, staple, peanut, coin, etc.

Room to Read

EXPLORATION

Student Observations:

- Hold up and introduce the following objects for students to observe: a dime, a paper clip, a bottle cap, or any other small objects.

Student Predictions:

- Next, hold up a ruler with centimeters. Ask students, "How many centimeters do you think each object is?"
- Chart their predictions if desired. You can provide students with the sentence frame: "I think the _____ is _____ centimeters long."

Student Measurement Activity #1:

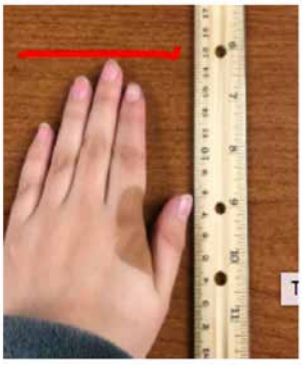
- Ask volunteers to come to the front of the class to measure one of the objects. They can measure under a projector so all students can see.
- If you printed and prepared a ruler for each student, and you have enough dimes, paper clips, or bottle caps, then all students can measure at the same time.

Student Predictions:

- Next, introduce a nanometer ruler. Inform students that for this lesson and activity, they will use a nanometer ruler.
- Explain that a nanometer ruler measures objects in nanometers, one of the smallest units.
- Explain that 1 centimeter is equal to 10,000,000 nanometers.
- Ask students, "How many nanometers do you think each object is?"
- Chart their predictions if desired. You can provide students with the sentence frame: "I think the _____ is _____ nanometers long."

Student Measurement Activity #2:

- Ask new volunteers to come to the front of the class to measure one of the objects in nanometers using the nanometer ruler. They can measure under a projector so all students can see.
- If you printed and prepared a nanometer ruler for each student, all students can measure at the same time.
- Encourage students to go around the classroom and measure other materials using a ruler and a nanometer ruler.



Student Discussion:

- To end this portion of the lesson, ask students, "How are a ruler and a nanometer ruler similar and different? How many nanometers are in a centimeter?" You can provide students with the following sentence frames: "They are similar/different because _____. There are _____ centimeters in a nanometer."

EXPLANATION

Student Discussion, Continued:

- Ask students, "Why is it important to look at small measurements? How do we use small measurements in our daily lives?"
- You can provide students with the following sentence frames: "Small measurements are important because _____. We use small measurements by _____."

Vocabulary:

- **macroscale:** describes the objects that can be seen with the human eye; measured in millimeters, centimeters, inches, feet, miles
- **matter:** material substance that occupies space, has mass, and is composed of atoms
- **microscale:** describes the objects that can be seen only with a light microscope; measured in nanometers
- **nanometer:** the units of measurement on a nanoscale
- **nanoscale:** a tool for measuring very small matter (solid, liquid, gas, or plasma)
- **nanotechnologist:** a person who studies nanotechnology using a special measurement tool called a nanoscale
- **nanotechnology:** the area of science that deals with matter at the nanoscale
- **structure:** how particles or parts are arranged in a substance
- Explain: When you break up the word "nanotechnology," you can uncover its meaning. "Nano" means "very small." "Tech" means "technology," requiring art and skill. "Ology" means "the study of a topic."
- Chart the three scales (macroscale, microscale, nanoscale) if desired.

ELABORATION

- Further explain: "Nanotechnologists can change matter on the nanoscale. They work with materials that are fewer than 100 nanometers in size. They study matter at the nanoscale and explore how they can design and create materials and technology that are new and improved. For example, nanotechnologists use different instruments and techniques to build very small materials and devices. It's like building with the world's tiniest LEGO bricks. They create new materials, like waterproof fabrics and sunscreen. They also build some of the world's smallest computers, like nanosensors."
- Present the Big Idea: **"Thousands of smaller pieces can make something larger."**
- Tell students that they will pretend to be nanotechnologists today by using small objects to create a larger structure.
- Point out that although they are working on the macroscale and can see the objects they are working with, nanotechnologists only create and rearrange nanomaterials. Nanomaterials are so small that nanotechnologists need special instruments, like microscopes, to see what they are creating. Nanotechnologists make nano creations.

Build a Structure:

- Distribute a plastic bag that contains LEGO bricks or construction paper shapes to each student. They can also work in pairs.
- Give students 5 to 10 minutes to create any structure using the small pieces. Students can use their imagination and be as creative as they would like to be. If they need more prompting, you can instruct them to make a building or a device, or even a new material.

- Next, pause the class and have students engage in a gallery walk—have them walk around the classroom to see what their peers have created.

Class Discussion:

- Bring the class back together for a brief discussion. Tell the students to think about their process. Ask students: "What did you make? How did you make your structure?" You can provide students with the sentence frame: "I made_____ by _____."

Rearrange a Structure:

- Send the students back to their seats and instruct them to put all their small pieces back in the plastic bags.
- Give the students another 5 to 10 minutes to create a new and different structure.
- Have students walk around the classroom again to see their peers' new structures.

Class Discussion:

- To end this portion of the lesson, ask students, "How can smaller pieces create larger structures? How can the same materials be used to create something new?" You can provide students with the following sentence frames: "Smaller pieces create something larger by _____. The same materials can create something new by _____."

EVALUATION

- Pass out paper and crayons to each student.
- Have students draw their first and second structures and explain to a partner or the class how the structures are different even though they use the same materials.
- To end the lesson, ask students, "What does a nanotechnologist do? How were you and your classmates nanotechnologists today?"
- Encourage students to refer to their experiences and drawings as evidence. You can provide students with the following sentence frames: "A nanotechnologist is someone who _____. I was a nanotechnologist today because I _____."