Science Tools Lesson: Social Applications for Power of Ten (P10)

**When**
Prior to the expedition

**Disciplines**
All Sciences, Mathematics

**Description**
In this lesson, students are asked to observe and record their observations of an object at a specific distance, either moving away from or toward at specific powers of ten intervals. Discussions of their observations may help students to see how detail changes with perspective, and how different jobs, including science, might require focus on different powers of ten.

**Learner outcomes**
The student will:
- Use their observation skills at different powers of ten to identify and draw characteristics of a teacher-chosen object
- Explore scientific and career uses of powers of ten.

**Materials**
- Small booklet with blank pages. The booklet needs to have enough pages to cover the number of powers you want your students to observe. From $10^{-2}$ to $10^2$ – or 1cm to 100m, would require a minimum of 5 drawing pages. One page is needed for each drawing, but the pages can be as small as from ½ sheet of 8½ x 11 up to a full sheet.
  - This is a prime opportunity to toss in a “quick bookmaking” lesson!
- Writing/drawing utensils
- A predetermined object located in a position that can be observed by multiple students from 5-6 powers of ten.
- Powers of Ten Background document for (teacher) reference

**Background**
This lesson provides students with an opportunity to apply their understanding of powers of ten and helps encourage the use of the vocabulary in other areas than science content. The activity can occur with any objects, in any space. Students observe objects from discreet, different distances ranging from nose distance away (or approximately 1 cm, or $10^{-2}$) to the distance of a football field (or approximately 100 meters or $10^2$). Discussions about their observations are geared to help students understand that individuals in a variety of careers look at objects from different powers of ten. The direction you choose for the activity – close to far or far to close – does not make a difference and may be selected based on your class management goals.
Suggested procedure

The teacher will:

1. Use the background information to lead a discussion on the concept of Powers of Ten. If this is a new concept for students, this lesson may take two periods. If it is review, 10-15 minutes of review would be appropriate. Although it is possible that students may have a little familiarity with exponents from math, do not assume that they will make the leap to connect exponents to P10. Sharing specific examples with students will be helpful in making this concept more concrete. You can do this by using the video links provided in the Powers of Ten Background Information.

2. Choose a location for the students to view a particular object in advance. The object needs to be on a vertical surface with enough space in front of it for students to stand up against the object and be able to stand a significant distance away from the object. It is best if you try this out yourself prior to the class period and think about how you will deal with behavior management issues. Ideas of possible objects include:
   - A brick wall
   - A painting or picture hanging on the wall
   - A sports field net
   - A tree

3. Making sure everyone has a drawing booklet and utensils and is prepared for the activity; take the student to the observation location. Tell the students to choose a spot directly in front of the object and stand “nose-to-nose” with the object. After giving them a minute or two to observe the object, have the students draw the spot in their booklet from this perspective. Encourage students to look for details! Talk about distance with the students. Share some of their drawings, and lead a discussion that helps students to understand this low power of ten. Help them to decide whether the distance to their nose is $10^{-3}$ (1mm) or $10^{-2}$ (1cm).

4. Next, have them step back one power of ten. If they have identified their first power to be $10^{-3}$, this will be a very small distance. If they have identified it as $10^{-2}$ they should be instructed to back up 10cm. Ask students to make more observations, drawings, and then share their observations from this distance.

5. Repeat this process until students cannot back up any further. It is appropriate and reasonable to estimate these distances. Have the students estimate a meter, then ten. It is also appropriate to use in between measurements, such as 50 meters, if the space does not allow for more. However, you need to be very explicit about this.
6. Conduct a whole group discussion with the students regarding their observations in relation to the powers of ten. This discussion can go in many directions. It can be focused simply on the student observations and how they changed with perspective, or it can lead into more global areas such as how individuals in different occupations view the same spot differently. For example, an exterminator will look at a brick wall very differently than an architect. Some sample questions for leading the discussions follow:

- What are some of your observations of your own observations?
- How did your observations change? (Details?)
- What stayed the same? (Colors? Light?)
- What are some occupations that require looking at low powers of ten? (Exterminators, inspectors, medical technicians)
- High ones? (Architects, highway construction, city planners)
- Can you think of jobs that might require both ends of the spectrum? (Structural engineers - understanding the properties at the micro level and how they react at the macro level can mean the difference between safe and unsafe structures)

Wrap up:
Create a cognitive link for students from the activity to science by asking:

- How might being able to look at and talk about the different powers of ten help scientists? (It gives them a common language to communicate about what they are observing, it can help frame the size of observations, studies, projects. Being able to look at some phenomenon broadly may give some very different findings than looking at it finely – neither is “correct” they are just different perspectives.)

Extensions:

- Write a story based on the perspective of a specific power of ten.
- Draw or take pictures of an item using a power of ten not typical for that object; for example, a water bottle would be measured in $10^{-2}$ (centimeters) or $10^{-1}$ (decimeters), but the drawing or picture could be done viewing this object at a different power, such as $10^1$ or $10^2$ (100 meters). Students can use these pictures to challenge each other to identify the item. Often student-developed Weekly Science magazines have photographs taken by electron microscopes of common objects, which are designed to give students a new and unusual perspective.

Additional Resources:
See resources listed in Powers of Ten Background section