'Hoeked' on Science

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*****Note: Figures may be missing from this format of the document**

Sometimes a scientist's life is as interesting, if not more so, than the science with which he or she is credited. Such is the case with the life of Anton Von Leeuwenhoek.

Students at my school (a science and technology magnet school at which I am the science specialist) first encounter Anton Von Leeuwenhoek in the first half of fourth grade when we begin a major study of microscopy.

What follows is a description of some of my most successful microscope activities for students and a culminating celebration where students receive "A Leeuwenhoek License" certifying their proficiency with the microscope.

Leeuwenhoek's Life

Leeuwenhoek, a Dutchman, is credited with grinding and polishing lenses and using these lenses to make meticulous observations of many objects. (One may find "Leeuwenhoek" spelled in various ways, but this is the spelling that is used by the Library of Congress.) Leeuwenhoek is generally considered a founder of microbiology, though he also made contributions to crystallography and chemistry (Simmons 1996). Leeuwenhoek's fame rests upon the quality and extent of his observations, his technical excellence, and his intuitive grasp of scientific methodologies.

Leeuwenhoek was not initially considered learned enough for membership in the esteemed scientific organization the Royal Society because he did not speak and write Latin and therefore could not read the work of other scientists. Nonetheless. he was eventually granted membership in the Royal Society due to his earned reputation as a scientist and because of the urgings of Robert Hooke.

Hooke was the first person to report using a magnifying lens to systematically study the living world. In 1665' Hooke published a book of his many observations entitled *Descriptions of Minute Bodies Made by Magnifying Glasses with Observations and Inquiries Thereupon.* Hooke also coined the terns *cell* based on his observations of a thin slice of cork. As Hooke drew the cork's chambers he was reminded of monks' cubicles—otherwise known as *cells.* Thus, Hooke made the first documented microscopic observation of what we now know to be the basic structural unit of life—the cell (Hoagland, Dodson, and Hauck 2001; Ford 1985).

Hooke acknowledged Leeuwenhoek's outstanding accomplishments in science. According to Ford (1985), Leeuwenhoek was the more knowledgeable of the two when it came to microscopy. For example, Leeuwenhoek corrected three mistakes in Hooke's *Microphagia.* Consequently, Hooke, as curator of the Royal Society, clearly accepted the brilliance of Leeuwenhoek. Becoming a member of the Royal Society in 1680 was one of the highlights of Leeuwenhoek's life. This was illustrated when he bequeathed 26 of his microscopes to the Royal Society upon his death. Sadly, all have been lost. Only nine of his original microscopes remain today.

The Lessons

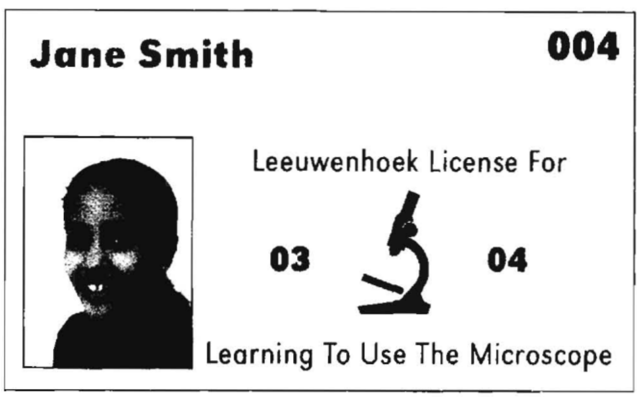
Before we begin our study of microscopes, I point out the difference between compound and single lens microscopes. Leeuwenhoek used a *simple* microscope, a microscope with a single lens. Even with this "simple" design. students of his work believe his microscopes could magnify objects up to 266 times their actual size.

The compound microscope, invented by Zacharias Janssen in the 1590s, uses two lenses instead of one. The lenses are arranged in a *body tube*, the part of the microscope that supports the eyepiece. For our study, I have a class set of 24 microscopes that have magnification ranges of 40x, 100x, and 400x. The eyepiece of the microscopes contains a 10x lens (magnifies objects 10 times their actual size) and, at the end of the body tube are objective lenses that magnify objects either 4, 10, or 40x. In these microscopes, the stage moves instead of the body tube, and the microscopes do not have a fine adjustment knob, but those are the major differences between them and the microscopes used in local high schools.

Microscopes can spread germs. Remind 7N students to never touch their eye to the microscope eyepiece. All microscopes should be cleaned with an alcohol wipe after use. (Be careful; a few very inexpensive microscopes have coating on the eyepiece that can be damaged with alcohol. Check the owner's manual of your microscopes for cleaning instructions.)

Figure 1.

A Leeuwenhoek License.



Lenses, Lenses, Lenses

We begin our study of the microscope by using "homemade' hand magnifiers. Students and I make them by taking the wire from bread ties, stripping the paper from the bread ties, making a loop with the wire and capturing a drop of water in the loop. (I strip the wire from the bread ties and students bend the wire to make the loop.) Students hold this loop over newspaper that has been covered with plastic wrap. The resulting magnification illustrates the use of a water lens.

Students then use a plastic commercial hand lens (3x, 6x). Hand lenses are used correctly by holding the lens close to the eye and then moving the specimen to be viewed back and forth until it is in focus. This is also what you do when you are using a compound microscope.

Next' students do the classic letter "e" experiment using microscopes. For this experiment, I use slides cut from poster board and clear tape to hold the specimens. This activity teaches students how to properly handle slides, which reduces the number of broken slides and helps to prevent damage to microscope lenses when students begin to use glass slides and cover slips later in the study. Many of the students want to keep their slides; this is another benefit of the poster board slides.

To make the paper slides, I cut the poster board to the size of a slide and then use a hole punch to make a hole in the slide. I cover this hole with tape on the bottom side to hold the letter "e" that was cut from a newspaper. After this initial experiment, students want to see everything and we look at whatever they can put on additional slides. For example' students look at a strand of their hair and other newspapers clippings, particularly if there is color on the newsprint. Warn students that focusing the sun through a hand lens may result in eye damage.

Figure 2.

The Microscope by Maxine Kumin.

Anton Leeuwenhoek was Dutch.
He sold pincushions, cloth, and such.
The waiting townsfolk fumed and fussed
As Anton's dry goods gathered dust.

He worked, instead of tending store,
At grinding special lenses for
A microscope. Some of the things
He looked at were:

mosquitoes' wings,
the hairs of sheep, the legs of lice,
the skin of people, dogs, and mice;
ox eyes, spiders' spinning gear,
fishes' scales, a little smear
of his own blood,
and best of all,
the unknown, busy, very small
bugs that swim and bump and hop
inside a simple water drop.

Impossible! Most Dutchmen said.
This Anton's crazy in the head.
We ought to ship him off to Spain.
He says he's seen a housefly's brain.
He says the water that we drink
Is full of bugs. He's mad, we think!

They called him dumkopf, which means dope.
That's how we got the microscope.

Onionskin v. Cheek

Our next lesson is a comparison of onionskin cells and cheek cells. This is the first time that students use glass slides and cover slips, so I give them cautionary instructions as well. I remind students that slides and cover slips are fragile and can break. so it is imperative that they treat the slides and cover slips carefully so they will not be hurt or cut. I also use "classroom helpers" for this activity because many students find it diffIcult to peel the onion to get a piece of the onionskin to observe, Usually' I choose one student at each table who can peel the onion and put it on the slide—they are the helpers.

After all the students obtain their onionskin' my assistant and I walk around the room and stain the onionskin samples using Lugol's Solution; you can obtain this from any chemical or science supply house or you can make it (students should *not* make Lugol's solution). To make Lugol's Solution, dissolve 10g of potassium iodide in 100 mL of distilled or tap water and then add 5 g of iodine crystals. When using chemicals in the classroom, always keep a Material Safety Data Sheet (MSDS) sheet on hand. We then place a cover slip over the onionskin to prepare it for viewing. For the cheek cell observation, we use commercially prepared slides.

With their slides prepared and our microscopes on a power of lox, students are able to see the nuclei of the onion and cheek cells. I bring up Robert Hooke's coinage of the word *cell* and encourage the students to begin to discern the differences between plant and animal cells. (Plant cells have a *cell wall* and animal cells have a *cell membrane.)* Then' I ask the students to draw what they see and, like Leeuwenhoek, take meticulous notes.

The drawings from Leeuwenhoek's specimens are amazing: We have a biography of him (Yount 1996) in our media center that has replicas of the drawings made from his observations, and I show these drawings to students at this time. I also introduce the words that Leeuwenhoek used to describe his initial observations of protozoa: *animalcules* and *wee beasties.*

Inside Pond Water

For the pond water lesson, we use well slides. *Well slides* are slides with an indentation in the glass that accommodates a drop of water so that water doesn't overflow the slide when it is covered with a cover slip. To begin the activity' we first watch Water *Circus* (see Resources), a video in which the movement of protists (protozoans, *slime molds, and algae)* is set to circus music. Next, students try their luck at finding some of the organisms from the videotape in drops of pond water.

Leeuwenhoek was interested in the fact that water contained material that could not be seen with the naked eye. I want my students to understand this as well, so I make a *hay infusion* by collecting pond water, adding a clump of grass (soil and all), and letting it sit in a jar in a window. After about a week' enough "wee beasties" are there for our observations and it,s time to make slides. In the interest of time and safety, my assistant and I prepare the slides. Depending on students, maturity, some teachers may allow students to prepare their own slides.

A commercially prepared hay infusion kit is also available from Carolina Biological (see Internet Resources). One thing to consider when using a hay infusion in the classroom is that in commercially prepared hay infusion kits the organisms that result are predetermined. If you collect pond water, whatever is in the pond will reproduce—and some of it may not be good.

Another thing to remember: Make sure students wash their hands with plenty of soap `**CAUTION** after handling slides. Though most microbes are harmless, some can he harmful to humans. Afterwards' my assistant and I also make sure all materials and work surfaces are disinfected.

As the students investigate their slides of the pond water' I tell them they are doing the same thing Leeuwenhoek did when he was looking at everything he could with his microscope. We then talk about single lens microscopes and I draw a picture of one of them on the dry erase board for the students to see.

A License to Learn

At the end of the lessons' students take a multiple- choice quiz on the parts of the microscope and complete a written assessment on the importance of the microscope to science knowledge. The two open- ended questions are 1) Why do you think the microscope is important to science' and 2) What have you learned about Anton Von Leeuwenhoek?

Due to the nature of the microscope activities' I am also able to use authentic assessment throughout this unit. For example, as the students are using the microscopes, I can tell if they are using them correctly and if they understand the function of each part, thereby providing instruction and modeling as needed, when students are confused. Of most importance' however, is the notion that students, by using the microscopes, actually learn how to use them and some of the history behind their invention.

Afterward' to mark the end of our microscope study' the students receive a Leeuwenhoek License—certifying their proficiency w the use of the microscope—at a special celebration (Figure 1, page 45). "Anton Von

Connecting to the Standards

This article relates to the following National Science Education Standards (NRC 1996):

Content Standards

Grades K-4
Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry **Standard C: Life Science**
- Characteristics of organisms
- Organisms and their environment

Standard E: Science and Technology

- Understanding about technological design **Standard G: History and Nature of Science**
- Science as a human endeavor

Leeuwenhoek" and "Robert Hooke" visit us—that is, two impersonators dressed in satins and lace. Hooke introduces Leeuwenhoek, who talks about how he became a successful scientist even though he did not speak Latin (much like the students). Leeuwenhoek explains a little about his life and his work. He was interested in everything, took meticulous notes, and learned from his mistakes.

Following the presentation, Leeuwenhoek answers questions from the students. Typically' students ask such questions as, "What did it feel like when you became a member of the Royal Society?" "Did people think you were strange when you looked at everything with your microscopes?" and "How exactly did you grind your lenses?"

Then, each student receives his or her Leeuwenhoek License (to keep and share with their teachers when they reach middle school) and ribbon- tied scroll with a poem about Leeuwenhoek (see Figure 2, page 45).

Finally, students view some of the marvels that have been invented since Leeuwenhoek first polished his pieces of glass. Corporate sponsors and/or area scientists attend the celebration to showcase their equipment and discuss the types of science they do. For example, one year Associated Microscope' a microscope distributor in our area, brought various microscopes to share with students. Each year I borrow a very old microscope with brass fittings from a retired science supervisor.

Throughout this study, from the introductory activities to its celebratory conclusion, I aim to foster in students an attitude shift—not just an ability to memorize or label a picture of a microscope but an understanding of what scientists do and how scientists build on previous discoveries. Great scientists were ordinary people—like themselves--who did extraordinary things. Hopefully students realize they, too, have the potential to build on scientific discoveries indeed a valuable lesson to learn.

Resources

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