Introduction 1

We aim to introduce the educational community to the use of microscopes as tools to advance hypothesis-driven science teaching at one level and to include them in a general science curriculum to help capture the imagination of the younger students. The SEM is an expensive microscope equipment, thus limits its purchase and use in the classroom. In addition, the SEM is often located in very small room limiting the size of classes that can visit the laboratory. With the Implementation of remote Scanning Electron Microscopy (rSEM), many of the problems faced by schools were addressed, specifically those wishing to use the SEM to integrate hypothesis-driven educational activities into their curriculum.

What remote Scanning Electron Microscopy (rSEM) does? 3

rSEM allows multiple users at locations around the world to remotely observe and control the SEM without having to travel to the SEM facility center. With the rSEM, the SEM is connected to the internet and is made more accessible to public school students. Establishment of virtual protocol network to setup the computer efficiently implement the rSEM for classrooms. Special software interfaces the rSEM to remote users and permits real time control on the microscope and allows classroom teachers and students worldwide to conduct research or scientific inquiry of their choice all from a personal computer over an internet connection.

What Scanning Electron Microscopy (SEM) does? 2

The SEM is an instrument that uses electrons instead of light to form a magnified image for seeing the unseen worlds of microscopy. The SEM is designed for direct studying of the surfaces of materials and biological samples. By scanning with an electron beam that has been generated and focused by the operation of the microscope, an image is formed on the screen. The SEM has many advantageous over traditional microscopes:
- Higher magnification ranging from 20X to approximately 30,000X
- Larger depth of focus to produce a three-dimensional sample
- Greater resolution to magnify specimens at higher levels
- Ease of sample observation with actual striking clear images

Hypothesis-Driven Science Lesson Plan 4

- Most sense organs of insects are microscopic in size like hairs and compound eyes. We cannot see them with our eyes, but we can see these organs with microscopes.
- Scanning electron microscopes (SEMs) do not use light waves; they use electrons (small particles within the atom) to magnify objects.
- The specimen is dried in a special manner and coated with a thin layer of metal, such as gold, to make it conduct electricity.
- The prepared specimen is ready and placed inside the microscope’s vacuum column through an air-tight door.
- The SEM is able to create a picture of the specimen based on the way the electrons bounce off it.
- The picture appears on a monitor.

Results: 5

1. Ant claw
2. Moth hair, eye, and antenna
3. Marbled cellar spider claw
4. Mosquito front claw

Discussion / Future Goals 6

- How might SEMs help diagnose and treat disease?
- Which images were most interesting and why?
- If you could look at something else under an SEM, what would it be? Why? What would you expect the magnified image to look like?

The long term goal of this project is to collaborate with multiple education levels to develop full curricula for rSEM use. Students start off by seeing and discussing the images produced by SEM. In the following year the students will have more responsibility in the project to control the SEM equipment once they get aware and feel comfortable with the manipulation of the equipment. Students design and conduct a group project using the rSEM and NASA resources which ultimately leads to a peer-reviewed scientific publication authored by all of the teachers and young students involved in the project.

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