Project Nano: Introducing K-12 Students to Nanoscale Phenomena

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Project Nano is a collaborative effort between university and high school faculty that was designed to increase K-12 students’ understanding of nanoscale phenomena through inquiry-based activities that use research-grade optical and electron microscopes as investigative tools. Project Nano’s lesson-plan format, designed and tested in 2009-2010 in chemistry classes at two high schools in the Portland area, provides students with (a) sufficient training to use the various microscopy tools, (b) an understanding as to how and why the tools work, (c) experience in using software programs to measure and analyze quantifiable aspects of nanoscale datasets, (d) experience in obtaining background research needed to interpret images, and (e) opportunities to prepare different types of samples for tool characterization. The multi-station lesson plan format, similar to that of the highly successful Project Micro (Bergman and Schooley, 2003), enables students to obtain the skills and understanding needed to conduct their own project-based hypothesis-driven projects.

The excitement generated by training K-12 teachers has led to an urgent need to expand our inventory of research-grade optical and electron microscopes at Portland State University. A Project Nano loaner tool set for local K-12 classrooms consists of a portable table-top SEM, a research-grade dissecting microscope, a phase contrast (i.e., for biology classes) or petrographic-grade (e.g., for chemistry, physics, earth, or environmental classes) compound optical microscope, and control and test specimens selected for the purpose of demonstrating the utility and limitations of the various types of microscopes. Project Nano optical microscopes are fitted with digital cameras that allow students to generate high-quality images for use in their oral and written reports. In some cases, Project Nano-trained teachers are able to access research-grade SEMs remotely via web-based portals. Portable research-grade optical and electron microscopes are ideal tools for motivating K-12 students to embrace scientific concepts and visualize nanoscale phenomena. The tools are easy to use and fun to operate, and they provide accessible datasets that can reinforce learning standards.

Our goal is to make Project Nano a sustainable model program in the greater Portland area that will increase student achievement in relevant STEM areas, as measured by state and national standards benchmarks. If successful, the program will be expanded nationwide. Project Nano provides a framework that allows high school and university faculty to work in collaboration and offer students inquiry-based learning experiences comparable to those encountered in college-level laboratory science courses.

The curricular focus of Project Nano is guided by learning strategies and objectives articulated in state and national standards. Progress and higher-level learning outcomes are measured by proficiency-based assessment of student work samples acquired throughout the academic year by faculty, teachers, and teacher educators who have met innovator reliability in terms of grading rubrics and evaluation criteria.
To date, Project Nano’s key achievements include the development and implication of:

(1) a self-sustaining program for training pre- and in-service teachers so that they can, in turn, train their students to use electron microscopy tools to answer hypothesis-driven questions,
(2) a classroom lesson-based format that can accommodate multi-disciplinary themes and allow several tens of students to work effectively in 1-4 person groups while mastering the skills and knowledge needed to use the various tools,
(3) a program that can grow locally, regionally, and nationally in ways that will allow private investors to meet their missions, and enable public school districts, magnet and private schools, local universities, and federal funding partners to collaborate in ways that support student’s achievements in STEM classwork,
(4) an innovative platform with which to engage faculty at university, high school, and non-traditional institutions (e.g., national laboratories, technology-based industries, small science-sector driven businesses) focused on improving students’ college readiness.

Project Nano teachers reported that learning how to use a portable table-top scanning electron microscope and advanced optical microscopy was a unique professional development experience with which they acquired a novel skill set useful for scaffolding STEM concepts for their students.

Figure 1. Images from a lesson plan designed by Project Nano teacher Jay Schauer, Wilsonville High School, Wilsonville, Oregon, titled “A Sense of Scale – Observing and Measuring with Technology.” Most mammals can be identified by the shape and size of the cuticular scales on their hairs. Jay’s students will use a Phenom™ table-top SEM to obtain high-resolution images of different types of hair samples like those shown above. Images of such “control” samples will then be compiled, catalogued, and used by the students to identify the prey upon which a predator feeds based on their SEM analysis of minute amounts of hair extracted from the predator’s scat.

References:
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