

Light Microscopy Outreach as an Introduction to Scientific Concepts for Students in Under-Resourced Schools Across the Globe

Sharyn A. Endow¹ and Umika S. Paul²

¹. Department of Cell Biology, Duke University, Durham, NC 27710 USA

². Pratt School of Engineering, Duke University, Durham, NC 27708 USA

Light microscopy provides a window into another world that is not visible to the unaided eye. Because of this and its importance in biological discoveries, the light microscope is an essential tool for scientific studies. It can also be used with a variety of easily obtained specimens to provide dramatic demonstrations of previously unknown features of common plants and animals. Thus, one way to interest young people in science is to start with an introduction to light microscopy. This is an especially effective strategy for individuals who attend less advantaged or under-resourced schools, as they may not have been previously exposed to scientific concepts in their classes. However, introducing light microscopy lessons in the classroom can be challenging because of the high cost of light microscopes, even those that are relatively basic, in addition to their usual large size.

Efforts are underway by our laboratory in collaboration with the Biophysical Society (BPS) to introduce young people to light microscopy using small, easy-to-assemble wooden microscopes developed by Echo Laboratories. The microscopes are available online as low-cost kits (\$10 each with shipping), each consisting of 19 parts printed onto an 8½ x 11 inch sheet of light-weight wood (Fig. 1). After punching out the pieces, they can be assembled into a microscope with a moveable stage and a low-power lens, also provided in the kit (Fig. 2). Photos taken with a cell phone through the microscope lens can give magnifications of ~16-18x, or higher. At these magnifications, features of specimens that are not visible to the unaided eye can be easily observed, e.g., small hairs on the margins of leaves or lichens [1]. As a member of the BPS Education Committee, one of us (SAE) wrote a *Lesson Plan on Light Microscopy* specifically for use with the wooden microscopes. SAE was also able to obtain a gift of 500 wooden microscope kits for the BPS from Echo Laboratories and Chroma Technology Corp in 2016. The wooden microscope kits, together with the lesson plan, have provided the materials for our present outreach efforts.

Rather than giving out the wooden microscope kits to individuals, the BPS asked the Education Committee to maximize the impact of the gift by distributing the microscopes with the *Lesson Plan on Light Microscopy* to teachers, e.g., through teachers' workshops or outreach sessions. This strategy was devised to enable the Society to reach a larger number of young people than by giving the microscopes to individuals.

The Education Committee first evaluated the microscopes as a tool to introduce students to scientific concepts by providing microscopes to a BPS member at the National University of Colombia who conducted a workshop on Sept 19-24, 2016 in Tumaco, Columbia. During the workshop, which involved 120 high school girls and 80 minority students, including Afro-Colombian and older students, the students built the wooden microscopes and examined specimens, and compared the microscopes to a conventional light microscope. Assembling the wooden microscopes was found to be a useful procedure that was similar to a scientific protocol, and encouraged young girls and older students to participate in science. This was especially promising in Colombia, where there are few women in science and little effort to increase

women in STEM fields.

Another area of outreach emerged recently when one of us, USP, an undergraduate student at Duke University, who was taught by SAE how to assemble the wooden microscopes and how to use the lesson plan, took three wooden microscopes on a visit to her family in Bangalore, India in summer 2018 [2]. There she organized and led three sessions in state run, under-resourced government schools, involving classes of ~25-40 students each. This was very successful – the students enjoyed learning about the microscopes and building them, and the science teachers were interested in expanding the sessions to other government schools. USP taught the teachers how to assemble and use the microscopes and gave the teachers the microscopes and lesson plan, which is also available to the public at the BPS web site. She also met with a founder of the organization, Whitefield Rising, which is working to improve teaching in government schools, and taught her and several volunteers how to assemble the microscopes and conduct the sessions. The Whitefield Rising members have been able to conduct nine further sessions in Bangalore over the past ~18 months (Fig. 3), using microscope kits provided to them by the BPS. USP has continued to work with members of the Whitefield Rising group during her summer and winter breaks on visits to Bangalore. Recently she has been working with another volunteer group that has expanded the outreach efforts to New Delhi.

The light microscopy outreach that our laboratory is conducting in India in collaboration with the BPS is having a positive impact because we have been able to develop a partnership with volunteers in Bangalore and New Delhi. The overall goal is to enhance science education globally, especially in less advantaged schools, by providing a low-cost microscope that can be used to introduce students to scientific concepts.

References:

- [1] SA Endow, “Lesson Plan on Light Microscopy”, *BASICS: Biophysics – A Step-by-step Introduction to Concepts for Students* (2016), <https://www.biophysics.org/biophysics-basics#/>
- [2] US Paul and SA Endow, BPS Bulletin, March 2020
- [3] This paper is part of Broader Impacts for research supported by the National Science Foundation under Grant Number CMMI 1660924 to SAE. Any opinions, findings, and conclusions or recommendations expressed in this lesson plan are those of the authors and do not necessarily reflect the views of the National Science Foundation.

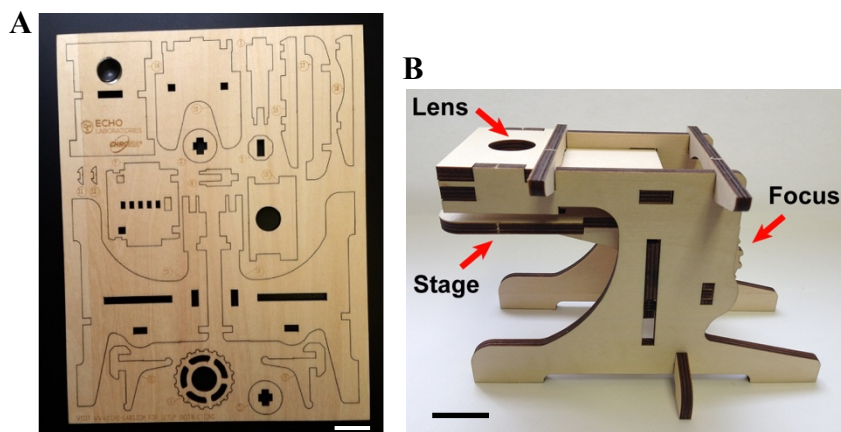


Figure 1. Small wooden microscope A) kit and B) assembled microscope. Bars, 1 inch.



Figure 2. Light microscopy outreach in Bangalore, India.