ELEMENTARY LASER OPTICS? YES!

Christina Wilder

In 1991, I knew no more about optics than any other person who wears contact lenses and has had frequent eye tests. Many science opportunities pushed me into Optics work: a workshop given by an S.F. Science Leadership Team colleague, using the 6th-8th grade **GEMS** guide: More Than Magnifiers. We made a pinhole camera, a simple telescope and a projector. I'd already used the **GEMS** guide: Color Analyzers for color filter work with 2nd and 3rd grade students, and I thought that More Than Magnifiers was possible with younger students.

In Spring, 1991, I met Dr. Gareth Williams, **LASE Project Director, NSF** (Lasers in Secondary Education) project at San Jose State. I spent two hours working with lasers, thought the activities were interesting as well as beautiful, and finally found a use for the mystifying trigonometry I'd taken back in 1961! Triangulation to measure height!

As a Science Leadership Team member in my school district, I went to a 3-week Exploratorium Light and Color workshop in July, 1991. I went to **NEWEST** at **NASA** Ames for two weeks, and in addition to exciting astronomical and aeronautical science information, learned about a simple Optics kit made from scrap plastics.

I was accepted in the 2 week summer **LASE** Institute and received warm encouragement from Dr. Williams and high school physics teachers, because of course I did not have the math background for the project, although, as it turned out, I certainly had the geometry background! The Optical Society of America (**OSA**) offered a grant program and organized an Educators' Day in San Jose in November, 1991. On November 4, 1991, I was given two lasers, as well as another which I had received through a local science grant, and optics equipment through the **OSA** grant and a grant from the Optical Society of Northern California.

Since then, I've purchased and been given a total of 8 lasers from various grants, continued to work with Light and Color with 3rd grade students each year, and have moved into astronomy through my **NASA, Harvard** and Astronomical Society of the Pacific (**ASP**) astronomy projects.

I organized Optics Kit I: the scrap plastics kit. It includes a sphere, cube, small hollow box (2 pieces), a cats' eye and two iridescent lenses, a small magnifying glass, and 5 "cuts" from long pieces of plastic: a solid and a hollow cylinder, a solid and a hollow rectangle and a half-cylinder, all cut in 4 inch pieces. We have 30 or more scrap kits, and I have demonstrated this kit at many local and State Science Conferences.

Description of the optical effects available through student experimentation with these varied lenses helped elementary students to develop optics vocabulary and concepts. We first worked on a classroom vocabulary for each lens so that we could have a common vocabulary for mutual discoveries and be able to share them orally and in writing.

Students work in cooperative groups or pairs and are required to draw, diagram and write about discoveries in their individual Science Journals, or on special worksheets which I share with Exploratorium colleagues in my Teacher Research Network group(**TRN**.) We use prisms, diffraction grating and glasses to study and diagram the spectrum. We use classroom surfaces to discover how light travels through and reflects from objects.

I purchased a classroom set of mirrors, an **OSA** classroom Optics Kit (Optics Kit 2) which has three concave and convex lenses, polarized filters, optical fibers, and sets of color filters: blue, red, green, cyan, magenta and yellow. A classroom set of flashlights were also available on-site due to a previous science grant. We discuss and diagram the effects of color filters on our observation of different objects (usually children's bright clothing.) I have led a workshop for 9 teachers and disseminated 6 similiar optics kits in the San Francisco Unified through an Exploratorium Lead Teacher Grant in 1993. I know that I can count on the Exploratorium staff and resources for my future projects.

We compare laser beams with the diffused light of our flashlights, and learn a little about refraction from observing laser light in air, water and prisms. We contrast the different effects of laser and white light with six color filters. I am still working out an appropriate way to use blacklight with my students; the equipment I have bought doesn't seem very sturdy.

Although elementary students lack the mathematics of optics, they can use optical studies for close observation and record, orally, in writing, pictures and diagrams, the principles of reflection, diffusion, diffraction, magnification and distortion caused by the bending of light. They understand the differences between a laser beam and the diffusion of most white light sources. They can understand the tricks their eyes play on them with optical illusions and even attempt to create some of their own. From observation, diagrams and dissection of cows' eyes at the Exploratorium, they can learn the structure and function of their own eyes.

Some students appeared to grasp some of the principles of refraction by using lasers. A few seem to understand rudiments of the electromagnetic spectrum from their study of color filters. More are starting to understand the spectrum now, in 1995, because of my increasing interest in spectroscopy and purchase of 10 spectroscopes.

Lasers are inherently exciting, and most students show healthy respect for laser use, due to years of sci-fi movies, perhaps. This year's students enjoy laser use, and are much more able to tell me about practical laser uses, particularly barcode scanning and alarms.

Although students do not have the math concepts, they have many of the geometrical concepts, and we are working successfully at 3rd grade level with protractors and angle measurement, aided by the **Sunburst Computer Program**, The Factory, an oldie, but goodie. Students have drawn and measured angles of incidence/reflection quite accurately; I am a little at a loss as to how to work with refraction successfully with such young students, without further materials development.

Laser use is an exciting and beautiful project - combining science, art, social science as we learned about Galileo and the history of the telescope through our related **SETI** Project pilot curriculum and Project **ARIES** (Harvard), which gave us 15 more **Project STAR** telescope. I subscribe to Astronomy, Sky and Telescope and **Mercury** (**ASP**) and see new discoveries every day in astronomy, mostly through spectroscopy at all spectrum levels and measurement through laser use. So much information is pouring in, so language can be everywhere - written, oral, individual and group projects. Mathematics is needed for timelines and geometrical drawings to show angles of traveling light. Science journals and pictures record our work and are shared at the Exploratorium and in conferences.

Since I learn every year along with the students: both new optical concepts and ways to "translate" secondary and college optical concepts into simpler terms, there have been many moments when we all stared at beautiful things which I had no idea how to explain, and yet students were able to find words and explanations which satisfied them.

I've taken 11 of my innercity SF students to the Optics Fairs at San Jose State in 1992 and 1993, the only elementary participants. Each had a poster and an experiment, and I received many compliments on their poise and knowledge, helped by the fact that there was a nearby fitness course which helped them to contain their energy throughout a long day. Unfortunately we've had schedule conflicts in 1994 and 1995, but I hope to give some of my students this experience in 1996, if possible.

I was able to share this project with many classes at my school, using my Optics kits and Light and Color Boxes from the Exploratorium. My future plans include:

1. Using blacklights with fluorescent rocks and art materials, thus giving us 3 types of light to contrast.

2. Writing more specific lesson plans for teachers without optics background - I have felt my way along and know elementary students can learn so much more about light! As a SFUSD Science Mentor, I am working on Light and Color Curriculum, which is not a part of our adopted materials.

3. Working with Dr. Williams and **SPIE** to develop more resources for laser-using educators at K-12 levels. I will be presenting at both the Fall **CSTA (San Jose)** and **NSTA (San Antonio)** conferences using light and color resources, including lasers and spectroscopy for elementary teachers. I am working with the California Dept. of Education offices to find funding sources for Light and Color Education, as **OSA** and **OSNC** no longer give grants.

4. As I mentioned above, we have been working on the geometry of angles of incidence and reflection, and I will present at next year's **NCTM** Conference in San Diego on the relationship between optics and geometry for elementary students.

I enjoy this project very much because I have found myself a student, learning along with my class, and also learning how to facilitate and organize optical concepts and understandings. In the second year, we worked more with polarization and refraction than we did before. Last year was more into color filter work and starting work with spectroscopy as a natural outgrowth of our associated astronomy projects. I hope to move up in grade level, which would help to facilitate the development of my related Light and Color and Astronomy Projects, and help me continue dissemination of the **LASE** Project, as well as associated astronomy studies, at the District, State and National Levels.

Thank you, Dr. Gareth Williams, for your continued support.