

## 19. Lasers

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The goal of these workshops was to help teachers understand the theory underpinning laser technology through projects such as making holograms; therefore, the teachers needed to be introduced to the basic concepts of optics and waves. The teachers had little idea of what was involved in successfully making holograms. However, all participants did have the necessary skills to make holograms and attempted three during the workshop. Every teacher successfully made at least two holograms. The teachers were also provided with equipment and materials for making holograms with their students. Participants included both middle and high school teachers from diverse backgrounds. Of those who were science teachers, very few participants had ever had a science course that dealt with optics, waves, or lasers.

### *Justification*

Working with lasers and holograms can expose students to scientific principles and concepts, as well as the application of mathematics and science; however, very few of the teachers in this initiative had any prior knowledge of optics and waves. During the first session of the workshop, participants were asked what they wanted to learn, and one of the most common responses was about the use of laser technology in particular careers. That response was addressed at the second session.

### *Assumptions and Changes*

We assumed that the teachers wanted to learn how to make holograms and would be able to apply what they had learned in their curriculum. As in most initiatives, there was a range of participant motivations, and although there was great interest in applying mathematics and science through laser technology, teachers were unsure about having access to appropriate facilities in their schools. We also assumed that all the teachers had access to the Internet, and we created a website for the workshop that included the material (with links) covered in the workshops, as well as a full list of resources and additional lesson ideas and other resources for them to access later.

Furthermore, once work began with the teachers, it was necessary to move more slowly when introducing new concepts. Also we found that teachers had little prior knowledge of the science and mathematics foundations to laser technology; therefore, we had to incorporate changes in the content and process. Because of this, we found we needed more time.

### *Workshops*

The content covered during the first session of the workshop was organized historically. Topics included the properties of light, reflection, refraction, diffraction, and interference. During the second session, time was spent on types of lasers, laser safety, holograms, and the process of

making a hologram. We devoted most of the second session to making holograms. The secondary science teachers had definite plans on how they would use lasers and holograms in their curricula.

Four of the state science goals were built into the workshop:

- State Standard 11a: Know and apply the concepts and principles of scientific inquiry.
- State Standard 12b: Know and apply concepts that describe how living things interact with each other and with their environment.
- 12c: Know and apply concepts that describe properties of matter and energy and the interaction between them.
- State Standard 13a: Know and apply concepts that describe the interaction between science, technology, and society.

We employed three different teaching strategies: directed instruction, activity-based learning, and cooperative learning.

Evaluations revealed that all the teachers increased their knowledge base while having fun during the workshops. This is an important result because science is often intimidating. The workshop did teach the participants some optics, and the fact that all the participants were able to successfully make a hologram also improved their confidence. Participants were asked to respond to five statements about the workshop, indicating whether they strongly agreed, agreed, had no opinion, somewhat disagreed or strongly disagreed with each statement. A point value from 5 (strongly agreed) to 1 (strongly disagreed) was assigned to the answers, and an average response was found. The statements and the average response are as follows:

- This activity increased my knowledge and skills in my areas of certification, endorsement, or teaching assignment. (4.83)
- The relevance of this activity to ISBE teaching standards was clear. (4.78)
- It was clear that the activity was presented by persons with education and experience in the subject matter. (5.0)
- The material was presented in an organized, easily understood manner. (4.94)
- This activity included discussion, critique, or application of what was presented, observed, learned, or demonstrated. (5.0)

### *Lessons Learned*

Teachers in the workshops seemed to be split between two levels of capability; therefore, some teachers needed more assistance on the side of mathematics and science foundations, while a few others could have handled a higher level. If we were to do this again, we would suggest that there be a level one and a level two, with the first level offering scientific and mathematical foundations and the second level incorporating more advanced theory. For teachers to teach mathematics and science through holography, they need to acquire a thorough understanding of the mathematical, scientific, and technological concepts.

A workshop on holography can be extremely valuable for attracting teachers (and students) and creating an interest in science. It would be especially appropriate when offered

initially as an introduction to optics and subsequently by working with teachers to gain the concepts and skills to actually teach holography and its underpinning mathematics, science, and technology theory. Finally important to note is the cost of making holograms. If it is not possible to afford within the formal science curricula, then it can be offered as a “special” activity for a science club, or teachers can seek external partners to help with the funding.

### *Bibliography*

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