Laser Applications in Science Education (LASE) Games

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ABSTRACT

Students love games! So why not teach electro-optics technology principles using games? While racing the clock and other teams, two to five member student teams are learning about laser applications, fiber optic principles, basic optics principles, interference filters, and other electro-optics phenomena.

Three laser light, "game oriented" activities, **Mirrors, The Right Image,** and **Light Links**, have proven to be a subtle and common-sense way of teaching students electro-optics technology principles by the direct experience of controlling a laser light beam, connecting fiber optics bundles, and manipulating combinations of convex and concave lenses. In the LASE Game **Mirrors,** student teams learn about reflection and the angles and locations involved in precisely directing a laser light to a targeted area. In **Light Links,** students experience the difficulty and the necessity for an "absolute" match in the precise coupling necessary in the connection of multiple fiber optics bundles. Using the lens set from the Optical Society of America's *Optics Discovery Kit*, students are individually challenged to use various combinations of lenses to "produce" **The Right Image**. Using these student centered activities, LASE Games has proven itself as an effective vehicle to teach students optically associated phenomena and simultaneously assist them to learn that teamwork is an essential ingredient in the completion of almost any multi-faceted task.

Keywords: optics education, fiber optics, fiber optics termination, interference filters, refractive index, educational games, reflection, refraction, electro-optics, optics principles, critical angle, HeNe lasers.

1. The LASE Project

The LASE Project[1], created by Gareth Williams, San Jose State University and Malcom Cornwall, Brighton Polytechnic University, utilizes a series of small-group activities, "LASE stations", wherein students observe and apply electro-optics properties and principles. The LASE stations stress qualitative exploration and analysis through hands-on activities, although quantitative analysis is an integral part of several of the stations. The principle educational objective of each station focuses on the usage of low-powered laser devices in which the laser beam is modulated and/or interrupted by mechanical and electro-optical devices. Students utilize the laser generated light to investigate electro-optical phenomena via a research centered, open ended approach using photosensitive devices, oscilloscopes, signal generators, and associated optics equipment. LASE activities are designed to promote student analysis of the processes, mechanisms, and outcomes of both teacher and self-directed investigations. Students don't just "do" experiments to obtain data that confirms already established concepts and principles, they are challenged to explore, modify, and extend the activities in a given set of LASE stations and present their "findings' in both oral and written form via student and teacher seminars and a *LASE Log*, a print format *publication*.

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Through this open-ended, ownership-oriented teaching methodology, students better understand and retain the fundamentals, and in many cases, the advanced concepts associated with modern electro-optical principles and phenomena. Since its inception in 1988, the LASE project has clearly impacted the teaching of optics in a positive manner. High school and middle school students involved in the LASE Project have encountered a multi-disciplinary (science, mathematics, computers, electronics technology) approach to their education. The industry oriented, project based method of task accomplishment is a mainstay philosophy of LASE and teacher and student participants have positively benefitted from the "what-if?" investigative aspect created by this research oriented exploration educational methodology.

2. Conceiving the Games

In late 1990, the author was awarded an Optical Society of America (OSA) Educator's Grant[2] to extend the LASE project into the middle (grades six to eight) school. Union Middle School, in San Jose, CA, was chosen for its proximity to the author's employment site and for the availability of a self-contained Special Education Program. Twenty-six Special Education and Resource Program students were selected for a specially tailored version of the LASE Project which was enhanced with supplemental explorations in basic optics principles using OSA's unique Optics Discovery Kit[3]. The author, along with a small number of his high school physical science students, made weekly visits to Union Middle School during the Spring of 1991.

Because of the unique nature of presenting technical material to Special Education students, the author end each session with some sort of "optical challenge" to the students. At first, these challenges were simply used to end the lesson on a positive note keeping within the philosophy of the "application oriented" objectives of the LASE activities and the optics principles lessons. Early on, it became quite obvious that all of the students enjoyed the "optics challenges" and asked for them at the start of each session. Also, a "lessons learned" period at the start of each session revealed that the students were learning and retaining a large portion of the optics embedded in the "challenges". The author realized that if more of the methodology of each session was based on this "challenge" principle, the students would be more attentive and at the same time, more receptive of the formal material being presented. What had started out as a "gimmick" to close a session became the mainstay of the presentation methodology! As much as possible, LASE stations and usage of the Optics Discovery Kit materials was restructured in a "games" format patterned after the ending session "challenges". Hence, the birth of the LASE Games scenarios.

3. Refining the games

Thrilled with the initial success of this games oriented technique of education, the author utilized the same format while conducting LASE activities with his high school physical science students. It was readily obvious that this "games" technique was equally popular with older students and where possible, games oriented activities with a "competitive component" were created for groups of three to five students. Often, classroom activities consisted entirely of "optics games" followed by discussion of the optics principles involved and possible extensions of the game to encompass other optical phenomena. A benefit of this methodology was that all of the LASE Games were based on group accomplishment, *any one group member* was always a "key" player! Often, students who had disowned themselves from the educational process became "active participants" and proponents of their own science education. Although many of the skills required of students were either existent or easily mastered, the participation of **every** member of the group was critical to the successful outcome! For some groups, "winning" became a continued goal, forcing **each** member to participate in a responsible and "involved" manner.

This demonstrated, highly desireable level of commitment to "group" goals was seldom witnessed in the myriad of small or large group activities that had been attempted by the author during the twenty five year span of his teaching career! It was obvious that the "games scenario" was a viable methodology in the presentation of both simplistic and complicated optics education objectives. The students enjoyed learning "optics" through the medium of healthy competition, group dynamics was positively reinforced, and students voluntarily enhanced and supplemented the game objectives thus applying creativity and ownership to their education. The uniqueness and mystique of HeNe and solid state lasers and the associated electro-optics technology, was also deemed to be a positive motivator of the high degree of student receptiveness of the LASE Games activities.

4. The Games

To date, three LASE Games have been formally developed: **Mirrors, The Right Image,** and **Light Links.** In the **Mirrors** game, teams or two to four students are challenged to intercept a low power (less than .5 mW) HeNe or solid state laser beam and direct it to a ten cm. circular target some five meters from their table site. Each team member uses 2.5 cm. circular interference filters which act as mirrors to the red colored laser beam. The arrangement and location of the hand-held filters is selected by the team so as to optimize the deflection and direction the beam while students race other teams to see who can maintain their beam "on target" for three seconds.

In **Light Links**, teams of four students are challenged to form a "continuous" light path made by linking 30cm. strands of fiber optic bundles. The winners are the first team that successfully link their strands so that laser light directed at the start of the fiber optic path exits from the end of the last fiber optic strand. More challenge is added when the teams are tasked to lengthen the light path to more than four fiber optic bundle strands by joining with other teams.

The Right Image utilizes OSA's Optics Discovery Kit plastic lens set, two different focal length double concave lenses and one double convex lens. Students are individually challenged to produce the "right' image of a particular object, usually the classroom clock by using a unique combination of one, two, or all three lenses. Either a predetermined or open-ended time period is selected depending on the "degree" of challenge desired and the skill level of the students. **The Right Image** can be used to acquaint students with the Optics Discovery Kit or used as a summary and/or assessment activity after conducting the optics investigations suggested in the Teacher's Guide.

5. Summary

LASE Games has proven to be an educationally sound methodology to introduce students to the arena of electro-optics technology. By utilizing the attractiveness of competition, student teams are challenged to investigate, create, and refine methods and mechanisms to quickly and efficiently accomplish one or more electro-optics associated tasks. Students who have manifested a "disinterest" in science, have been observed to enjoin in the "spirit"of the games, thus becoming *active players* in their education. The LASE Games seem to develop a sense of *ownership* promoting the interest of students who have then often *focused* and participated in follow-on science activities! LASE Games, can be used in conjunction with the LASE Project investigations and classroom usage of OSA's Optics Discovery Kit, but is can also function as an independent curriculum unit or as a supplement to an existing unit on optics phenomena. LASE Games is a particularly useful instruction for the Special Education and/or "At Risk" students who have short attention spans or reading difficulties. The author welcomes inquiries about particulars concerning the LASE Project, the Optics Discovery Kit, or LASE Games.

6. Acknowledgments

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7. References

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