

The Making of Women in Optics

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ABSTRACT

Raffles Girls' Secondary School, Singapore has a Gifted Education Programme whereby bright young women are given the opportunity to fulfill their potential by taking up a project in a tertiary institution. Ning Hwee Tiang is one of the science teachers in the Programme who has seen the relevance of getting her students involved in optics and photonics. Basic optics is taught in Secondary 3 and this programme helps the students to enrich themselves with other related concepts in optics, and its application. It also helps build links between what is learnt in class and the real world. The ultimate aim is to get them interested enough to join in this area, thus increase the women representation in Optics. This paper aims to show how the Photonics Centre, NgeeAnn Polytechnic has participated in their Programme, the training methodology used to introduce difficult topics in optics and photonics, and the projects undertaken. Some of the projects include making transmission holograms, lasershow and sensor applications of the Michelson Interferometer.

Keywords: photonics, education, holography, optics

1. BACKGROUND

1.1 Photonics Center, NgeeAnn Polytechnic

NgeeAnn Polytechnic¹ is a tertiary institution in Singapore offering both business-related and technology-based diploma and advanced diploma programmes, ranging from engineering to business, maritime studies, biotechnology, mass communications, information technology, computing and e-commerce. In addition, the polytechnic also offers many short courses for working professionals. Students who gain entry at the age of 17, do a 3-year programme.

The Photonics Center² is one of the technology centers in the School of Engineering of NgeeAnn Polytechnic. It was established in 1995. The principal aim of the Photonics Center is to provide a broad-based and practice-oriented education and training in photonics and laser technology for our students and to promote Photonics and Laser Technology in Singapore.

Final-year students with electronics background but no photonics knowledge are taught the theory and applications of this technology. As such, the Photonics Center has been providing graduates with this additional skill since 1995 in preparation for this new technology that is beginning to emerge in Singapore.

As an effort to train our graduates to provide support in R&D in industry, our final-year project students do applied R&D projects. Today, the Photonics Center, NgeeAnn is a leader in training in this technology in Singapore. We have also developed expertise in holography, laser show animation, and fiber optic sensors.

The Photonics Centre is also devoted to bringing laser technology to secondary schools as a tool to enhance analytical and critical thinking. Annually, the Center takes in students from various schools in Singapore as part of its school outreach programme. One such school is Raffles Girls Secondary School.

1.2 Raffles Girls Secondary School (RGSS)

RGSS is one of the top ranking schools in Singapore. Like many top ranking schools, RGSS has its own mentor scheme. The scheme is started by matching the interests of the pupils with suggested topics. The project carries on for 5-6 months and culminates with a report and presentation in front of their peers. Outstanding projects receive

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recognition through the awarding of certificates of merit and prizes. The completion of the projects also gives the students a sense of satisfaction in knowledge gained.

The objectives of the Mentor Scheme are:

- 1) to provide enrichment that includes technological advances so as to enable participants to be at the cutting edge in the knowledge of science,
- 2) to enhance participants' understanding of major concepts and theories in science,
- 3) to develop skills for conducting investigations and inquiry in science,
- 4) to stimulate and nurture pupils' creativity in science,
- 5) to provide opportunities for pupils to interact with practising scientists for a better understanding of the activities, beliefs and traits of such professionals.

Ning Hwee Tiang is one of the science teachers in the school. She had an interest in photonics during her university days. Her interest resurfaced after attending a workshop held in the Photonics Center for schoolteachers. Now, it is her desire to instill this interest in her students. On her request, the Photonics Center agreed to participate in the RGSS Mentor Scheme.

1.3 Mentor Scheme between the Photonics Center and RGSS

As only basics optics is taught in sec 3, the girls are able to enrich themselves with other related concepts in optics and its application through the mentor scheme. Also, the scheme would help to build links between what is learnt in class, and the real world.

2. TRAINING METHODOLOGY

2.1 Fundamental Concepts

Annually, the Photonics Center takes in 2 girls from Raffles Girls Secondary School for a period of 4-6 months. They report to the Center once a week for 2 hours after their normal school hours. Initially, they are given brief lectures in the following topics:

1. Laser Safety – the human eye, irradiation effects on the eye and skin, laser classification, and laser safety measurements
2. Geometric optics – particle nature of light, Snell's Laws, reflection, refraction, dispersion of light, and lenses
3. Wave optics – wave nature of light, interference, diffraction, and polarisation
4. Basic Laser Operation – energy levels, spontaneous and stimulated emission, population inversion, and the operation of the Helium-Neon laser
5. Interferometry – optical path distance, Michelson interferometer, and Mach-Zehnder interferometer
6. Holography – transmission holograms and reflection holograms

As all these are very new for the girls, the lectures have to be pitched at the right level, using minimum mathematical concepts and everyday illustrations.

The lectures are further enforced with the following practical work:

1. Determination of Brewster angle for glass and Perspex
2. Using Malus Law to determine the quality of polarizers
3. Development of the Michelson Interferometer

The lab work provides the students the following skills:

- familiarization in handling optical components (mirrors, beamsplitters, polarizers, lasers, etc.)
- an understanding of concepts such as interference and polarization
- using MS Excel to plot graphs
- analyzing data and providing inferences
- confidence building

2.2 Making a Reflection Hologram

Once this has been completed, the girls advance to making their first reflection hologram. This exciting project allows the girls to explore their creative skills and at the same time understand the concept of interference of light. Here, the girls are trained on how to use the spatial filter, how to expose the holographic plate and how to develop the plate. The end result is a hologram for each of them to take home, giving them a sense of satisfaction and at the same time a better understanding of all the concepts they have learnt.



Fig.1 Students from RGSS using the spatial filter to align the beam.



Fig.2 The object is placed in front of the expanded beam.



Fig.3 Students in the developing room



Fig. 4 Reflection hologram of a toy car.

This project ends with a poster design of how to make a reflection hologram. This poster will be used by the girls for their presentation at school.

2.2 Final Project

Finally, the students are given one more project. This could be the development of a transmission hologram, or using the Michelson Interferometer set up to develop a holographic grating, or designing a laser show in the Laser Animation lab of the Photonics Centre. When all the projects are completed, the students are then trained on report writing skills.

3. CONCLUSION

The programme continues to evolve to make it more interesting for the girls of RGSS. The girls seem to be better in doing their lab work than their male counterparts from other schools. This is probably because the girls have more patience and are more meticulous in setting up their experiments. With the completion of their project work in the Photonics Center, the girls are in a better position to take on this new technology in future, thus increasing the women representation in Physics, especially in Photonics

REFERENCES

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