Guided Poster Sessions: a way to introduce Optical Technology in a primary-secondary school

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ABSTRACT

There are few Optics contents along the primary and secondary studies in Spain. So, the relation between Optics and Technology is usually poorly known by the students. As a consequence, the number of students in Physics in general, and Optics in particular is low. In this paper we explain a project to show some topics in Optics Technology in a primary-secondary school. This project involves some Optics teachers in the Autonomous University of Barcelona (UAB) and a group of teachers and students of a primary-secondary school also in Barcelona (I.E.S. Costa i Llobera). Several Optics posters (made by the SPIE) were shown during one week. More than 200 students from 8 to 17 years old visited the Optics exhibition during this week. A group of 4 students (17 years old) were trained to show the posters to younger students. For this study we chose three age levels. For each level, a 50% of the students attended the exhibition and the rest didn't attend the poster session. So, it was possible to realize a survey to check whether some knowledge differences appeared between the two groups. A questionnaire was fulfilled by these groups. The results of this survey show that a significant new knowledge in Optics was learned by the students.

1. INTRODUCTION

The programs of Science (and in particular Physics) along the primary and secondary studies in Spain usually cover a small number of topics in Optics. In general, Mechanics and Electromagnetism are much better covered during these studies. Usually, some Optics contents are introduced in the two last years of the secondary school. Nevertheless, due to time restrictions, only general concepts about Waves, and also Geometrical Optics are treated. So, it is not strange that the relation between Optics and advanced Technology is unknown to the students, and as a consequence, few of them are motivated to study Optics in the future.

Fig. 1. View of the panels with the posters (left) and the audience (right).

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The Costa i Llobera school is a primary-secondary school (covering ages from 3 to 18 years) in Barcelona. It is celebrating its 50 anniversary this year. So, different activities were programmed. The Science department of the school decided to celebrate a “week of Science”. We choose to work on 4 topics (Water, the Antarctic continent, Darwin, Optics), creating a posters zone in the school (see Fig. 1). In the case of Optics, 12 SPIE Optics posters were used (these posters are freely distributed in http://spie.org/x31474.xml). In this work we explain a joint project between some Optics teachers (J.C Escalera, M.J. Yzuel) in the Autonomous University of Barcelona (UAB) and a group of teachers and students (J.C. Escalera and the other co-authors) of a the Costa i Llobera school (see Fig. 2 and 3). One of the members of the science department has a Ph.D. in Optics and is also a professor in the UAB. He trained 4 students to be capable of helping the students to understand the posters. The topics covered in the posters were very different: electromagnetic spectrum and its applications (x-rays, infrared commands, radio emissions, etc), optics devices and its applications (lasers, sensors, etc), biomedical optics and photonics. More than 200 students from 8 to 17 years old visited the Optics exhibition during this week. Usually, the groups were of about 15-30 students and they received information by one teacher or a trained student for a period of time between 20 and 60 minutes.

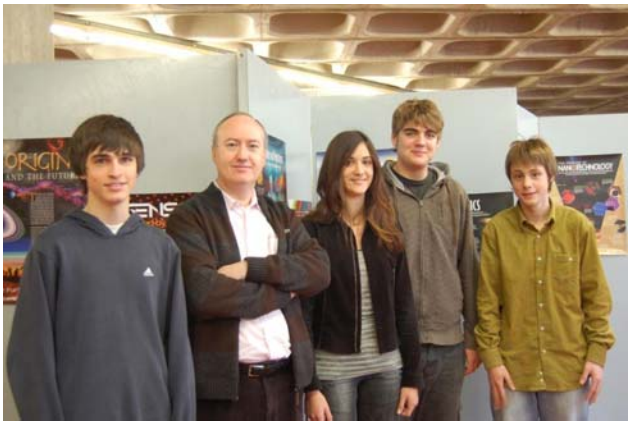

Fig. 2. The Costa i Llobera team (left to right): O. Ferreras, J. C. Escalera, C. Abelló, M. Torres and P. Matheu.

To analyze the usefulness of the method, a comprehension test was fulfilled by some groups. This questionnaire was designed by the four trained students. A comparative study was done to check whether there were real differences in the comprehension of Optics applications. In three levels (each with two groups of 20-30 students), we decided that one group would attend the poster session, and the other one wouldn’t attend it. The comprehension test was fulfilled by both groups, and we studied the differences between them.

Fig. 3. The Optics-UAB team (left to right): M.J. Yzuel, J. C. Escalera, J. Campos.

In sections 2-6 we show some of the posters that were shown and the questions related to these posters. In each section we will study the results of the answers of the students to the questionnaire. We will mainly analyze two parameters: age of the students and attendance to the poster session. Finally, in section 7 we summarize the work.

2. THE HIDDEN WORLD OF LIGHT

The first poster in the exhibition is "the hidden world of light" (see Fig. 4). It shows that other types of electromagnetic waves, apart from visible light, exist. It divides the spectrum in 7 parts, showing in each case one application (see table 1).

Light	Gamma Rays	X-Rays	Ultraviolet	visible	Infrared	microwave	radiowaves
Application	Detecting black-holes	X-ray medical photograph	Sunglasses	Colors	Infrared command	Mobile phone	Radio antenna

Table 1: topics studied in "the hidden world of light" poster.

The Question 1 was: "are there different types of lights (electromagnetic waves) apart from the visible light? Give some examples".

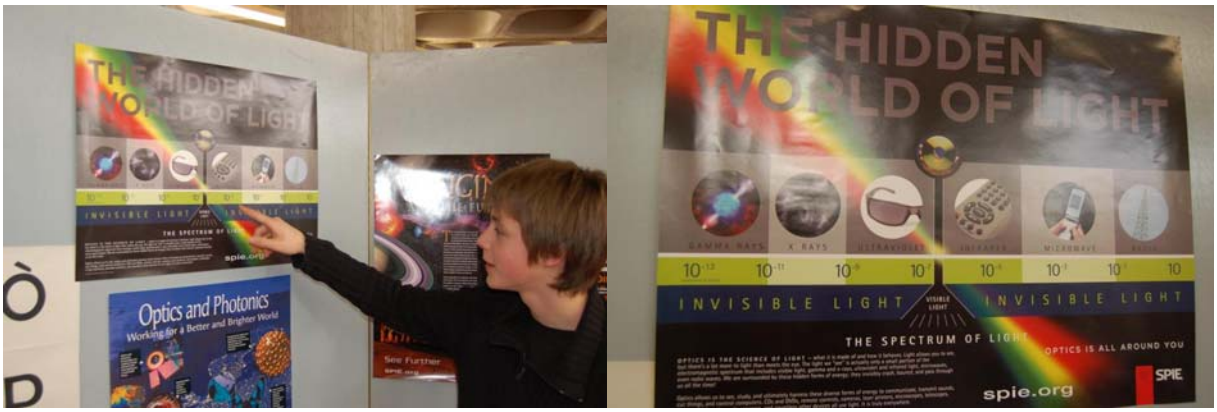

Fig. 4. "The hidden world of light" poster.

The results of the survey in the groups that didn't attend and attended the poster session are shown in tables 2 and 3 respectively.

Age group	1st most answered	2nd most answered	3rd most answered	Others	Wrong answers	Blank answers
9 years					(6)	(20)
12 years	Ultraviolet (1)	Infrared (1)	Gamma rays (1)			(21)
16 years	Ultraviolet (11)	Infrared (4)		(10)		(6)

Table 2: results of the survey (question 1) on the groups that didn't attend the poster session.

Age group	1st most answered	2nd most answered	3rd most answered	Others	Wrong answers	Blank answers
9 years	Ultraviolet (7)	Infrared (5)	TV-command(4)	(11)	(5)	(3)
12 years	Ultraviolet (7)	Infrared (4)	X-rays (1)	(2)	(3)	(8)
16 years	Ultraviolet (9)	X-rays (8)	Infrared (5)	(8)	(3)	(2)

Table 3: results of the survey (question 1) on the groups that attended the poster session.

On the groups that didn't attend the poster session, it can be seen (table 2) that there is a low knowledge of non-visible radiation. It changes with the age, and it becomes a little better for the 16 year group. In that case, the ultraviolet radiation is frequently mentioned, probably because of the advertising of solar protection creams.

On the contrary, the groups that attended the poster session (table 3) show a clear increase of correct answers in this topic. Interestingly, the results are very consistent with all the ages. In all the cases, several students can remember (after 3 weeks of the poster session) ultraviolet, infrared and x-ray radiations.
There were very nice discussions around this poster. Figure 5 shows one of these moments. One very young girl is asking whether the x-ray photograph can show a cut in the cheek. The x-ray photograph (head) in the poster clearly shows that only bones (and bones fractures) can be seen in that type of photograph.

Fig. 5. Some discussions with the students.

3. OPTICS AND MEDICINE

There were several posters related with applications of Optics in Medicine. We focused in three of them: "Optics and Photonics" (see Fig. 6) , "Optics, beyond eyeglasses…, way beyond eyeglasses!" (see Fig. 7) and "Biomedical Optics and Biophotonics, light for Health", "Biophotonics, Light for cancer" (see fig. 8). They treat very different aspects: using Optics to obtain biomedical information, applications in surgery, etc.

It also appears some interesting projects for the future, like the possibility of using nanostructures to medical applications (see fig. 6). Young students were enthusiastic about this project, and it provoked a lot of questions.

Fig. 6. “Optics and Photonics”.

The next three questions in our survey were the following:
Question 2: Can Optics help Medicine? How?

The results of the survey in the groups that didn’t attend and attended the poster session are shown in tables 4 and 5 respectively.

Age group	1st most answered	2nd most answered	3rd most answered	Others	Wrong answers	Blank answers
9 years	Glasses (6)	Electromagnetic waves (4)		(1)		(15)
12 years	X-Ray photographs (5)	See inside the body without surgery (2)	Glasses (1)	(1)		(13)
16 years	X-Ray photographs (5)	Laser surgery (5)	Yes (non specific answer) (5)	(5)		(7)

Table 4: results of the survey (question 2) on the groups that didn’t attend the poster session.

Age group	1st most answered	2nd most answered	3rd most answered	Others	Wrong answers	Blank answers
9 years	Laser surgery (3)	Devices for blind people (2)	X-Ray photographs (1)	(1)	(3)	(11)
12 years	Correcting myopia, etc (12)	Seeing inside of the body (9)	Laser surgery (2)	(4)		(9)
16 years	Seeing inside of the body (10)	Correcting myopia, etc (8)	Burning cancers (2)	(4)	(1)	(4)

Table 5: results of the survey (question 3) on the groups that attended the poster session.

Table 4 shows that students without specific training tended to focus the importance of Optics in Medicine in two aspects: X-Ray photographs and glasses. It is probably related to personal experiences. The number of blank answers is very high, but the knowledge is increasing with age. Table 5 shows that the poster session produces new answers, specifically “laser surgery” (including myopia laser correction), “seeing inside of the

body" (different techniques were mentioned in the poster talk), and "burning cancers". We can see that blank answers are reduced almost to a half, after the poster session.

Figure 7 shows some contents of the poster "Optics, beyond eyeglasses…" Most of the students were shocked when it was suggested that Optics may help in the future to enable blind people to see.

Fig. 7. "Optics, Beyond Eyeglasses…"

Question 3: Do you know some diseases that can be treated with the help of Optics?

The results of the survey in the groups that didn't attend and attended the poster session are shown in tables 6 and 7 respectively.

Age group	1st most answered	2nd most answered	3rd most answered	Others	Wrong answers	Blank answers
9 years	Cancer (1)	Eye cataracts (1)			(2)	(22)
12 years	Laser surgery (3)	myopia (1)	Eye cataracts (1)			(22)
16 years	Cancer (9)	myopia (2)	None (6)	(6)		(9)

Table 6: results of the survey (question 3) on the groups that didn't attend the poster session.

Age group	1st most answered	2nd most answered	3rd most answered	Others	Wrong answers	Blank answers
9 years	Eyes' problems (4)	Cancer (3)			(4)	(11)
12 years	Eyes' problems (10)	blindness (8)			(2)	(11)
16 years	Eyes' problems (13)	Cancer (6)		(1)		(6)

Table 7: results of the survey (question 3) on the groups that attended the poster session.

Table 6 shows that the use of Optics for treating diseases is poorly known in the 9 and 12 years group (22 blank answers). It is better in the 16 years group, where they relate the Optics applications in Medicine to cancer and myopia treatments. The groups that attended the poster sessions highly increase in their knowledge (11 blank answers). There is some concern about one aspect, maybe they thought that the cure for blindness was in a near future.

There were two very nice posters that explain applications of Optics in Medicine (see fig. 8). We focused in the importance of obtaining non invasive information (images) of the body. We also explained different laser techniques used in Medicine, in particular myopia correction. It is evident from table 7, that this possibility interested the audience.

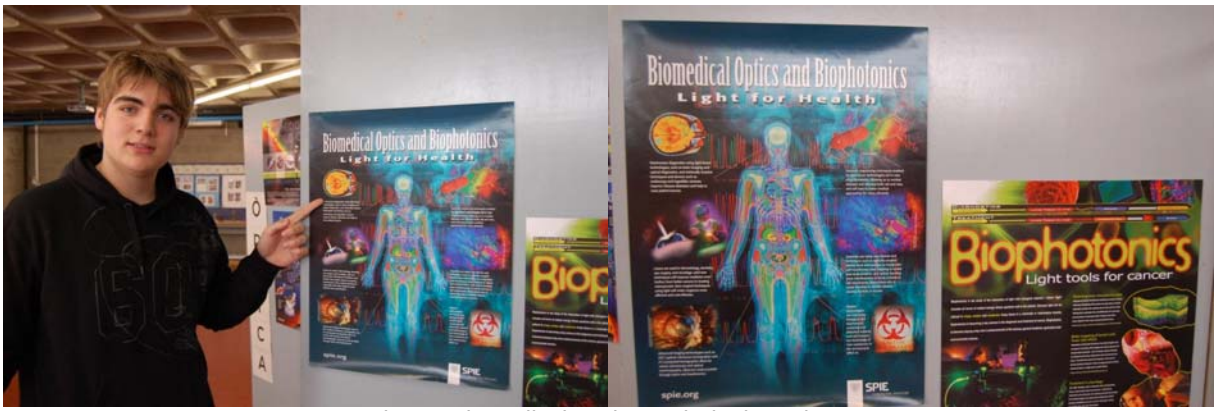

Fig. 8. “Biomedical Optics and Biophotonics”.

Question 4: Can we see inside the body by using light?

The results of the survey in the groups that didn’t attend and attended the poster session are shown in tables 8 and 9 respectively.

Age group	1st most answered	2nd most answered	3rd most answered	Others	Wrong answers	Blank answers
9 years	Yes, using X-rays (15)			(5)	(3)	(3)
12 years	Yes, using X-rays (19)	Yes (3)		(1)		(6)
16 years	Yes, using X-rays (18)	Yes (5)		(9)		(5)

Table 8: results of the survey (question 4) on the groups that didn’t attend the poster session.

Age group	1st most answered	2nd most answered	3rd most answered	Others	Wrong answers	Blank answers
9 years	Yes, using X-rays (2)	bones (2)	Cancer (1)	(2)	(5)	(7)
12 years	Yes, using X-rays (17)				(4)	(4)
16 years	Yes, using X-rays (8)	Seeing into your body with a video camera (6)	Detecting a contrast liquid in the veins with some method (2)	(1)	(2)	(1)

Table 9: results of the survey (question 4) on the groups that attended the poster session.

Table 8 shows that the use of X-ray photograph is very well known in all the ages. Interestingly, the 9 year group that attended the poster session seemed a little disoriented after the session (see table 9). Though there are more different answers, it also appears more wrong and blank answers. Maybe the explanation was not correctly prepared for that age. On the contrary, the older groups seemed to take more profit, specially the 16 years group. They consistently learned that it was possible to introduce a camera to film the digestive system and different techniques using contrasts and radioactive elements to obtain information of blood movement.

4. MACRO, MICRO, NANO

This poster shows the different scales that can be observed with different types of microscopes (see Fig. 9, 10)

Fig. 9. “Macro, Micro, Nano” and “Optics, way beyond eyeglasses”.

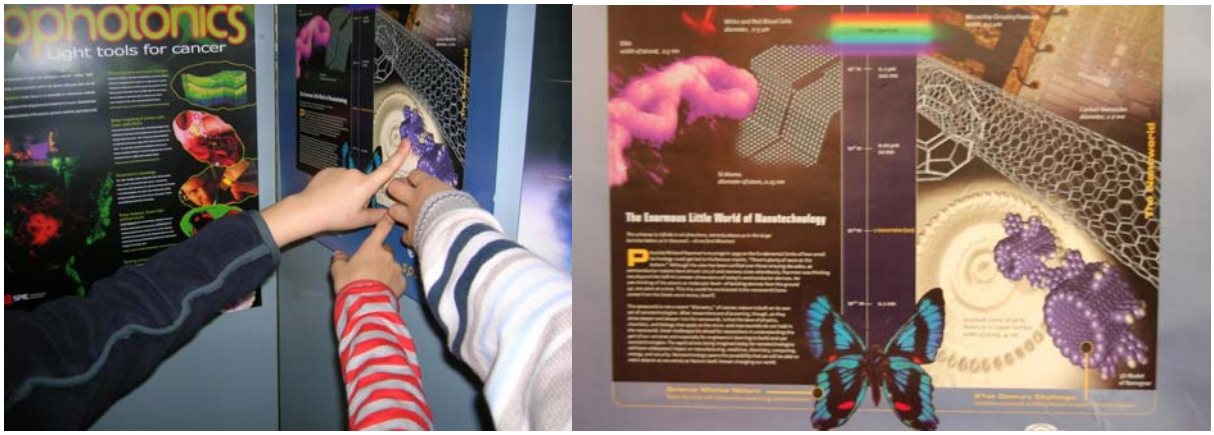

Fig. 10. “Macro, Micro, Nano”.

Question 5: Give some examples of small things that can be seen with the help of Optics but we cannot see with the naked eye.

Age group	1st most answered	2nd most answered	3rd most answered	Others	Wrong answers	Blank answers
9 years	Microorganisms (14)	Animals (5)			(2)	(5)
12 years	Microbial (14)	cells (7)	atoms (5)	(7)		(2)
16 years	cells (17)	Microorganisms (8)	Bacteria (7)	(13)		(1)

Table 10: results of the survey (question 5) on the groups that didn’t attend the poster session.

Age group	1st most answered	2nd most answered	3rd most answered	Others	Wrong answers	Blank answers
9 years	Microbial (7)	cells (2)	Fleas (2)		(7)	(8)
12 years	Molecular structures (15)	Microorganisms (13)	atoms (14)	(8)		(2)
16 years	Microorganisms (12)	cells (12)	Molecular structures (7)	(8)		

Table 11: results of the survey (question 5) on the groups that attended the poster session.

Table 10 shows that all the students that answered the quiz have previous knowledge of the use of microscopes to see microorganisms. It seems that the 12 years group had learned recently the concept of "atom". That knowledge is reinforced with the poster session, as table 11 shows. Some new answers (fleas, molecular structures) appear.

5. SATELLITES, TELESCOPES

Figure 11 shows several posters that were related with astronomy and remote sensing. Different types of telescopes (visible telescopes, radio-telescopes) were shown in the poster session.

Fig. 11. Telescopes and radio-telescopes.

Question 6: Give some examples of distant objects that can be seen with the help of Optics but we cannot see with the naked eye.

The results of the survey in the groups that didn't attend and attended the poster session are shown in tables 12 and 13 respectively.

Age group	1st most answered	2nd most answered	3rd most answered	Others	Wrong answers	Blank answers
9 years	Space (8)	Terrestial surface (5)			(2)	(11)
12 years	planets (18)	stars (18)	birds (7)	(4)		(6)
16 years	planets (22)	stars (17)		(7)		(5)

Table 12: results of the survey (question 6) on the groups that didn't attend the poster session.

Age group	1st most answered	2nd most answered	3rd most answered	Others	Wrong answers	Blank answers
9 years	planets (1)	stars (1)	Meteorites (1)		(2)	(16)
12 years	planets (13)	stars (13)	Distant objects (7)	(8)		(7)
16 years	planets (13)	galaxies (12)	Infrared (5)	(3)	(1)	(2)

Table 13: results of the survey (question 6) on the groups that attended the poster session.

Table 12 shows that the use of telescopes is well known, specially for older children. Table 13 shows that the 9 years group was a little disoriented by the information they received. The 12 and 16 year group reinforced their previous knowledge, with some new concepts (infrared telescopes, distant objects – probably galaxies).

6. WOMEN IN OPTICS

Figure 12 shows the posters about "Women in Optics". In general, the students didn't know that women have not been present in Science (and in Optics in particular) until quite recently.

Fig. 12. "Women in Optics".

Question 7: In the world of Optics, there are working:

a) More women than men.
b) More men than women.
c) Approximately the same number of men and women.

Age group	More women than men	More men than women	The same	Blank answers
9 years	14	6	5	1
12 years	14	5	10	0
16 years	12	8	9	0

Table 14: results of the survey (question 7) on the groups that didn't attend the poster session.

Age group	More women than men	More men than women	The same	Blank answers
9 years	5	6	6	3
12 years	9	5	15	0
16 years	4	16	2	0

Table 15: results of the survey (question 7) on the groups that attended the poster session.

Table 14 shows that in all the age groups that did not attend the posters, they think that there are more women than men working in Optics. They think that the field Optics is related with Optometry, and they usually find more women than men when they go to buy glasses or sunglasses. This opinion changes in the groups that attended the poster session. The 9 and 12 year groups tend to think that the presence of men and women in Optics is similar. Only the 16 year group changed their opinion in this subject, and they feel that it is more difficult for women to work in Optics Research and Technology.

7. SUMMARY

We have described a simple (and cheap) method to introduce Optics for young students. The SPIE posters are attractive and they not only show a relation between Science and Optics, but also very significant real world applications of Optics. The students involved in learning and teaching really enjoyed the process, and the knowledge in Optics increased for the students that attended the posters presentation.

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