Photonics Explorer: intra-curricular educational outreach

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INTRODUCTION

Enthusiastic, motivated and skilled scientists and engineers are needed to drive innovation and scientific excellence. However, there is an alarming lack of interest towards science amongst young people. It is said that based on the complexity of social, political and technological environment many people have increasing troubles in understanding their surrounding world[1]. This trend could soon result in a lack of skilled workforce for high-tech industries worldwide and become the primary limiting factor in the rapidly growing field of photonics, like all other scientific sectors. To avert this trend and encourage more young people to pursue scientific careers, the European Commission funded the ‘EXPEKT’ project in 2010, which resulted in the development of the ‘Photonics Explorer’ – a novel, intra-curricular, educational kit designed to *engage, excite and educate* students about the fascination of working with light and optics hands-on, within the classroom.

1 PHOTONICS EXPLORER KIT

Conventional outreach is typically based on demonstrations that use interesting visual and scientific effects to entertain students. They are generally presented by motivated and enthusiastic scientists but these efforts have local and rather limited impact. While such activities succeed in momentarily raising the interest and curiosity of young people, they have minimal impact on their future career choices or image of science as a whole. Therefore it is important that, complementary to such activities, students experience the fun and fascination of scientific discovery on a daily basis – with their own hands, in their own classrooms. We term this ‘educational outreach’ where rather than a demonstration, young people are encouraged to explore their own creativity through scientific experiments related to the curriculum.

The Photonics Explorer is an intra-curricular educational kit which has been specifically designed to integrate seamlessly into European secondary school science curricula to enhance and complement the teaching and learning of science within the classroom. The kit consists of a class set of experimental components based on light and photonics, provided within a supporting didactic framework based on guided Inquiry-Based Learning techniques. The content is designed for lower (12-14 years) and upper (16-18 years) secondary students.

The kit is a result of a pan-European collaboration of 35 teachers, experts in pedagogy, scientists at universities as well as support from industry and the extended European Photonics community.

1.1 Components and Didactic Framework

Each kit equips teachers with a class set of experimental components, sufficient for a class of 25-30 students to work in groups of 2-3 at a time. The components have been specifically designed to be safely used by students within the classroom. The components are robust, versatile and durable and can be used in a range of experiments.

Figure 1: The Photonics Explorer kit

The experimental components are provided within a didactic framework that is based on the proven principles of guided Inquiry Based Learning that emphasizes the importance of self-learning, critical thinking, teamwork and analysis. It has been designed with the input of an 'Educational Advisory Panel' consisting of 35 teachers and science education professors from 11 countries across Europe. The Rocard report[2], states that the EU needs a stronger emphasis on the use of inquiry-based learning (IBL) in its classrooms to achieve the goals of a knowledge based society and increase the scientific literacy of its citizens. The didactic content has also been developed to satisfy the diverse educational systems and teaching environments across Europe and to give students the opportunity to really work as scientists and engineers in the classroom. The content is laid out in a modular structure so that teachers can easily integrate it into their teaching styles and classroom situations.

They are encouraged to adapt the content to suit their needs and curriculum requirements.

The content consists of 8 stand-alone modules; 4 for lower secondary and 4 for upper secondary levels. The topics of the modules are as follows:

The modules for Lower secondary level (12-14 years)

- Light signals – the properties of light and its use in telecommunication
- Colours – colour perception, additive and subtractive colour mixing
- Lenses and telescopes – refraction and imaging
- Eye and vision – comparison between human eyes and digital cameras, accommodation in the eye

The modules for Upper secondary level (16-18 years)

- Making light – comparing different light sources, laser
- Polarisation – applications in displays and life sciences
- Diffraction and interference – diffraction on a slit, spectrometry
- A scientist's job – encouraging esp. young women to pursue careers in science and engineering

Each module consists of worksheets and factsheets for the students, a comprehensive teacher guide and, where relevant, supporting multimedia material, like pictures and videos that further help to illustrate the concepts. Each topic is always linked to current technologies that are familiar to the students and that they encounter in their daily lives.

2 FIELD TESTS AND SCIENTIFIC EVALUATION

The Photonics Explorer underwent extensive field testing in 7 EU countries from September – December 2011; Belgium, Bulgaria, France, Germany, Poland, Spain and UK. 50 kits were tested, with the content in the local language, with over 1500 students participating in these field tests. Each module was tested in at least 2 classrooms.

The field tests provided the basis for the short and long term scientific evaluation of the impact of the Photonics Explorer in the classroom. IPN in Keil, Germany was responsible for the scientific evaluation and extensive feedback was collected from all testing students and teachers. The feedback consisted of specially formulated questionnaires. The feedback was used to qualitatively and quantitatively evaluate the impact of the Photonics Explorer in terms of interest of students, self-awareness, image of science and learning progress.

The results of the impact study indicate that the Photonics Explorer indeed increased the self-efficiacy of students in those classrooms where initial IBL techniques were minimal to moderate. It also raised students' interest in Physics and, in particular, also for female students. It was seen that the kit worked especially well for lower secondary level, thus indicating that including such material to complement the curriculum can have an impact on students when they form their first impressions about science.

In addition to the evaluation study, the team responsible for the development of the kit (at the Vrije Universiteit Brussel), visited several testing classrooms to watch the performance of the kit in the class, interact with students and collect feedback. This feedback mainly concentrated on the content, structure, layout and usability from a student and teacher perspective. Teachers and students alike were extremely positive and teachers are eager to continue using and implementing the kit in their classrooms. The experimental components and content was greatly appreciated, in particular the detailed teacher-guide and examples of current technologies.

3 DISSEMINATION AND IMPACT

The Photonics Explorer kit is provided to secondary school teachers completely free-of-charge but only in conjunction with teacher training courses always conducted by local, professional teacher trainers. This ensures that the kit is correctly implemented to maximum advantage of students in the classroom. Further, the teacher training courses ensure that the principles of Inquiry Based Learning are explained and teachers are given the opportunity to test out the experimental material and gain an overview of the didactic content.

In order to ensure the long term sustainability of the Photonics Explorer kit, a non-profit organization EYESTvzw has been established. EYESTvzw [Excite Youth for Engineering Science and Technology] is responsible for the assembly and wide distribution of the Photonics Explorer kit [www.eyest.eu]. The kit is assembled in sheltered workplaces in Belgium.

Currently over 500 kits have been distributed in 10 EU countries reaching at least 25000 students every year. At present EYESTvzw is working with European industry, Photonics communities and ministries of education of raise funds to support the distribution of the kits throughout Europe. The successful field tests have already resulted in a demand of at least a hundred additional Photonics Explorer kits in every testing country. Additional countries such as Netherlands, Austria, Ireland, Italy, Sweden and the Czech Republic are mobilizing industry and governments to implement the kit in their classrooms.

4 REFERENCES

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