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A hands-on approach to physics in the classroom

An EU-funded project is bringing 'inquiry-based learning' (IBL) to the physics classroom.

 [1]

Remember high school physics class? Trawling through text books, grappling with complex theories and little, if any, hands-on experimentation. Many students across Europe could be forgiven for describing physics as a boring subject. But that is now set to change thanks to an EU-funded project that is bringing 'inquiry-based learning' (IBL) to the physics classroom.

Developed by a team of photonics researchers, teachers and experts in pedagogy from 11 EU countries, a new educational kit, filled with equipment for fun and interesting classroom experiments is being distributed free to schools across Europe. By 2015, its developers hope, the Photonics Explorer kit will be used by 2.5 million European high school students to conduct practical experiments in photonics - a key area of modern physics and technology - and raise their interest in physics and science in general. That, in turn, should encourage more young people to focus on careers in the sciences, helping Europe overcome a shortage of skilled workers in high-tech industries.

'Photonics deals with the science of light and light technologies. It is an integral part of almost every technology in this digital age - from communication to healthcare - and it plays a key role in everyday technologies familiar to students such as the internet, mobile phones etc.,' explains Hugo Thienpont of Vrije Universiteit Brussel, who has over 20 years' experience in the field. 'Moreover it is very visually appealing, and experiments with light can effectively engage students, excite them and raise their interest and curiosity.'

Prof. Thienpont oversaw development of the Photonics Explorer kit and accompanying teacher training materials as coordinator of the 'Photonics Explorer: developing a photonics educational kit for Europe's secondary schools' (Expekt [2]) project, which was supported by EUR 550 000 in funding from the European Commission. With the support of EU governments and industry, the team subsequently set up 'EYESTvzw', a non-profit organisation that will manage the large-scale distribution of the kit from now on.

Over time, the effect on physics teaching could be significant across Europe, encouraging the adoption of more widespread inquiry-based learning instead of less effective and less engaging theoretical approaches.

'Low interest in science and technology is closely related to the quality of science education which often dissuades students from choosing scientific subjects and careers, especially physics. Students seldom experience real scientific methods and inquiring activities in their regular lessons, although experiments are an essential part of scientific work. The rather theoretical nature of presenting the content, as well as seemingly outdated equipment and references, very often contribute to the negative image of physics as being boring and unattractive - and many students therefore drop it as early as possible,' Prof. Thienpont notes.

In contrast, inquiry-based techniques have been found to greatly promote students' interest and motivation, although they have seldom been adopted due to time and curriculum constraints.

The Expekt team therefore sought to find a simple, easy and effective method to introduce inquiry-based learning into the classroom. Working closely with the educational community, they developed the Photonics Explorer kit and provided teachers with training on how to use it. Most importantly, the team ensured it can be integrated seamlessly into school curricula and different teaching cultures across Europe without requiring additional time or effort on the part of the teacher or students.

Learning with lasers at school

Each kit contains a set of versatile experimental components like lasers, polarisers, LEDs and mirrors, enabling a typical class of around 30 students to work in groups of two or three people to conduct hands-on experiments. Designed for students aged 12-14 and 16-18, topics include the basics of photonics and optics - from reflection and colours to diffraction and interference - areas that are covered by the curricula of all European countries.

Students can, for example, communicate a word using LED lights through an optical fibre, they can calculate the wavelengths of the colours in an energy-saving light bulb by building their own spectrometer or they can also build their own 'polarimeter' to measure the concentration of sugar in a solution by using the effect of polarisation.

'It is more than just components in a box,' Prof. Thienpont notes. 'Photonics Explorer equips teachers with a didactic framework which is a result of the voluntary efforts of over 35 teachers and science education professors. The Photonics Explorer is given to teachers completely free of charge but only in conjunction with teacher training courses. The didactic framework is modular in structure and therefore flexible and editable by teachers to fit into their own teaching style and classroom situation.'

The kit has so far been trialled with over 1500 students in Belgium, Bulgaria, France, Germany, Poland, Spain and the United Kingdom, while the teaching material has been translated into eight languages, with additional ones planned. Both students and teachers' assessments of using the kit

have been overwhelmingly positive, Prof. Thienpont says.

'Implementation of Photonics Explorer in the classroom shows significant positive short-term effects in terms of the improvement of self-efficacy and interest of students overall. The more IBL techniques the teacher uses in the classroom, the higher interest and self-efficacy of the students and the better their image of physics,' he points out. 'For the male students, their interest in physics rises after working with Photonics Explorer while girls feel more confident in their scientific ability and their self-efficacy rises.'

Notably, interest in physics also contributed to increasing interest in other scientific disciplines.

'Interviews with teachers and students showed that students enjoyed conducting hands-on experiments and teachers saw a significant change in the attitude of their students towards science in general,' Prof. Thienpont says.

So far, EYESTvzw has distributed 300 of the finalised Photonics Explorer kits and distribution is expanding to more EU countries, with the non-profit organisation seeking sponsorship from companies, governmental authorities, education ministries and foundations. The team plan to update the kit to keep pace with rapidly evolving technologies, and are also considering developing a similar kit for primary schools and universities.

By promoting inquiry-based learning in this way, Photonics Explorer will not only improve education in the sciences, but in the long-term give Europe a competitive boost, if, as expected, more students turn to scientific careers.

'Working with the kit encourages creativity, teamwork, problem solving and critical thinking - all essential skills required in the scientific workforce. Further, it gives students the opportunity to work as scientists and engineers while in school, thus equipping them for a career in science and technology,' Prof. Thienpont emphasises.

Expekt received research funding under the European Union's Seventh Framework Programme (FP7).

Link to project on CORDIS:

- FP7 on CORDIS [3]
- Expekt project factsheet on CORDIS [4]

Link to project's website:

- 'Photonics Explorer: Developing a photonics educational kit for Europe's secondary schools' project website [2]

Links to related videos/audios:

- Expekt project video [5]

Other links:

- European Commission's Digital Agenda website [6]

Information Source: Professor Hugo Thienpont, Vrije Universiteit Brussel, Belgium

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