Eyest vzw
Excite Youth for Engineering Science and Technology

Photonics explorer

Scientists and Engineers are needed for economic and social sustainability

Poor science aptitude worries leaders

Test from page A1

lagging behind 43 jurisdictions — 42 states and the Department of Defense schools — on the science test and in a dead heat for last with three others: Hawaii, Arizona and Mississippi.

Four states did not participate in the voluntary testing [illegible]

Youths lagging in science

Low proficiency seen as putting students, nation at risk

By Jill Tucker
CHRONICLE STAFF WRITER

Just 1 out of every 100 U.S. schoolchildren excels at science, while less than a third of their peers reach grade-level proficiency in the subject, according to the Nation's Report Card released Tuesday.

The scores are not nearly good enough given the demand for innovators, inventors and problem solvers required to keep the country on the cutting edge of industry and enterprise, education officials said.

2009 Nation's Report Card

Examples of the skills required for proficiency in science:

Grade 4	Grade 8	Grade 12
Recognize that gravitational force constantly affects an object.	Relate characteristics of air masses to global regions.	Evaluate two methods to help control an invasive species.

Source: National Assessment of Educational Progress

[illegible] ingly dependent on science, we are failing to educate our kids in science," said Tom Luce, CEO of the National Math and Science Initiative, a nonprofit that awards grants to improve [illegible]

at risk and putting our country at risk," he said in a statement.

California students fared worse than the national average on the standardized tests, with fourth-graders, for example [illegible]

Ingenieurstudies minder populair

- zondag 20 september 2009 Bron: belga

BRUSSEL - Het aantal studenten industrieel en burgerlijk ingenieur stijgt minder snel dan bij andere richtingen. Beide opleidingen zijn ook beduidend minder populair bij meisjes dan vorig jaar. De richting industrieel ingenieur telt zelfs 25 procent minder vrouwelijke studenten.

Dat blijkt uit een enquête van Agoria, de federatie van de technologische industrie.

Nog nooit schreven zoveel studenten zich in aan de universiteiten en hogescholen als dit jaar. Zo noteren al onze universiteiten een stijging van hun eerstejaarsstudenten met 10 tot 15 procent en bij enkele hogescholen loopt de stijging op tot 25 procent. 'Maar ingenieursopleidingen genieten niet genoeg mee van het succes van het hoger onderwijs', betreurt directeur-generaal Wilson De Pril van Agoria.

De stijging van studenten die zich voor de eerste maal inschrijven in het hoger onderwijs in de opleiding industrieel en burgerlijk ingenieur bedroeg respectievelijk met 3 en 3,6 procent. Het aantal vrouwelijke generatiestudenten in beide richtingen liep drastisch terug: -25 procent bij de industrieel ingenieurs in spe en -12 procent bij de richting burgerlijk ingenieur.

De Pril merkt nog op dat vrouwelijke studenten zowel aan hogescholen als universiteiten in de meerderheid zijn. Bij de ingenieursopleidingen is de verhouding daarentegen 16 procent vrouwen en [illegible]

Students are silent spectators

Nobody learns to ride a bike...

...by watching someone else

The Photonics Explorer: engage, excite, educate
A comprehensive , intra-curricular class kit

Photonics explorer

PHOTONICS21

Vrije Universiteit Brussel

B-PHOT BRUSSELS PHOTONICS TEAM

SEVENTH FRAMEWORK PROGRAMME

Photonics explorer kit =

Inquiry Based Learning with experiments about light and light technology

Central Aspects

Thinking: designing, planning, skills, motivation

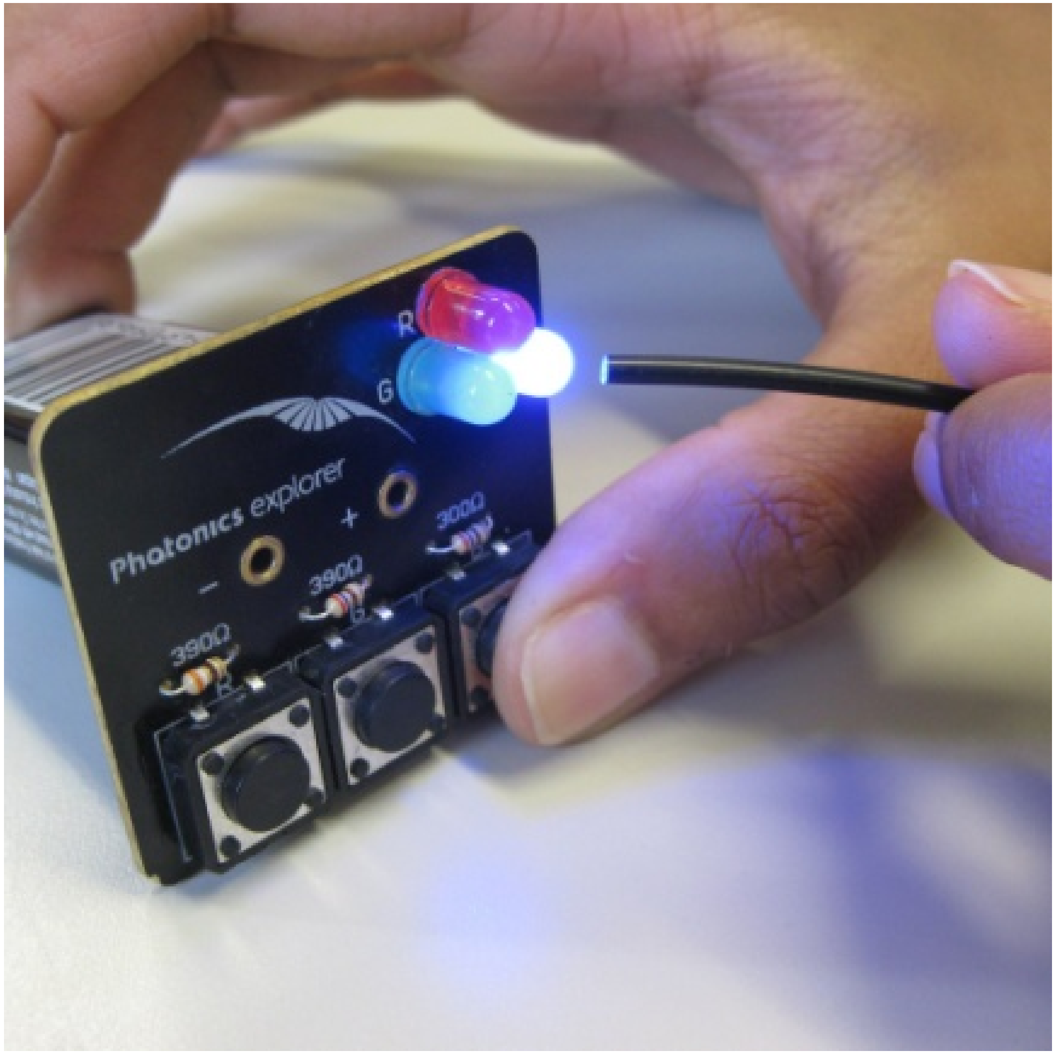
Doing: groupwork, discussions, relevant experiments

Learning: conclusions, 'Eureka!-moments'

Inquiry Based Learning Techniques

- hands-on experiments
- links to current technologies
- scientific and analytical skills
- teamwork
- problem-solving
- critical thinking
- working as scientists and engineers

experimental material for inquiry-based learning



- Simple
- Versatile
- Robust
- Safe

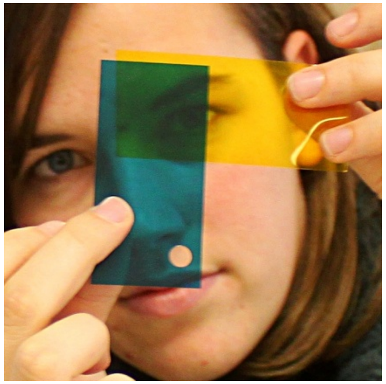
Class set of experimental material (for 10 groups)

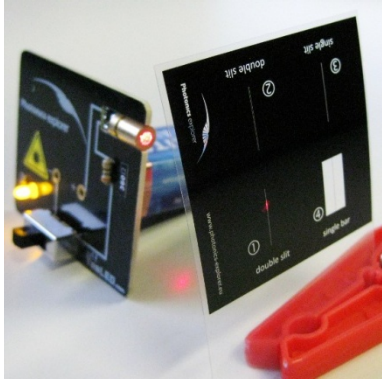
> 110 components

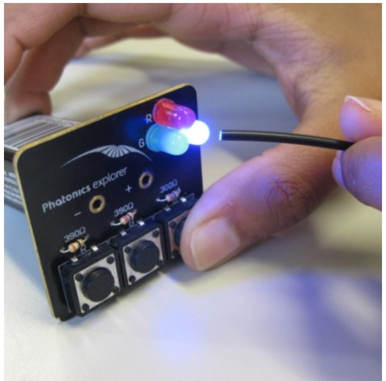
The Photonics Explorer: Experimental Components

Components in the kit

10 aluminium **mirrors** (7x7 cm)
20 **polarisers** (7x5 cm)
10 **colour filter** sets (7x4 cm) including red, green, blue, cyan, magenta and yellow
10 **LED modules** with red, green and blue LEDs
10 sets of robust plastic **lenses** with the focal lengths 30 mm, -30 mm, and 150 mm
10 foils with **slit and double slit** for optical diffraction experiments
10 **diffraction gratings**
5 m **polymer optical fibre**
10 eyesafe **Lasers**





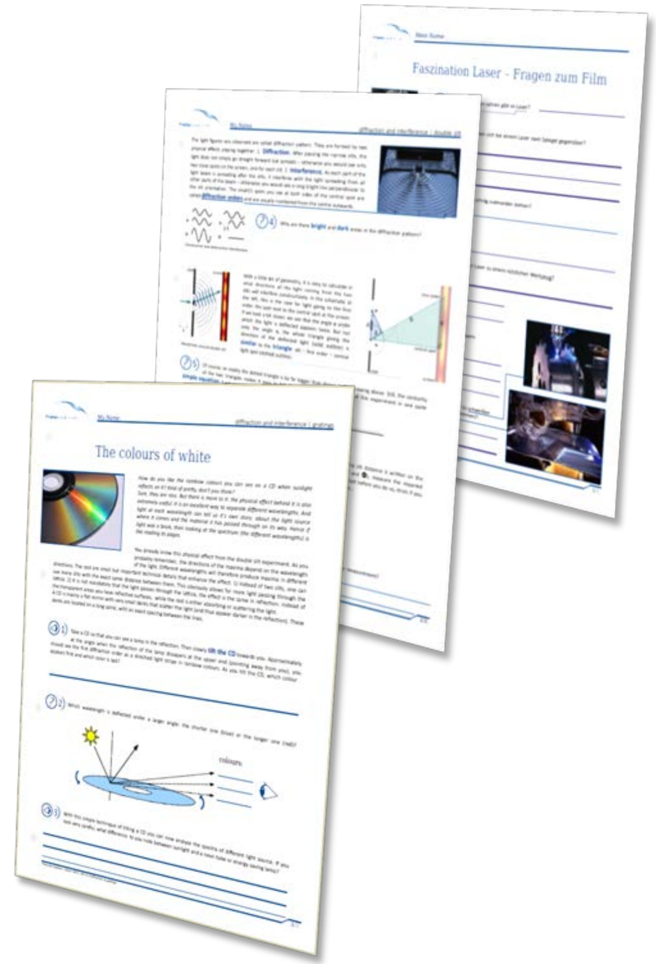


Didactive Framework

- **Didactic Framework (8 modules)**
  - Worksheets, Factsheets
  - Teacher-guides
  - Multimedia Material

  - Modular
  - Adaptable
  - Themes in concert with educational targets of the curricula
  - Available in 16 languages

(Bulgarian, Czech, Dutch, English, Finnish, French, Galician, German, Greek, Italian, Polish, Portuguese, Russian, Romanian, Swedish and Spanish)



The Educational Modules

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, learning about accommodation in the eye

Upper secondary level (16-18 years)

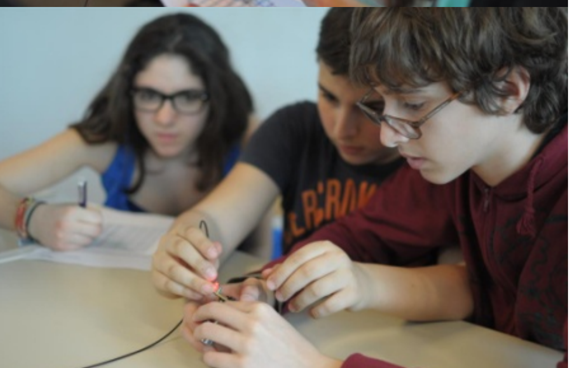
- **Making light** – comparing light sources for efficiency and sustainability
- **Diffraction and interference** – diffraction on a slit, spectrometry
- **Polarisation** – applications in displays and life sciences
- **A scientist's job** – encouraging esp. young women to pursue careers in science and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

Successful EU wide field tests

50 kits successfully tested with over 1500 students in 7 EU countries;

- Belgium
- Bulgaria
- France
- Germany
- Poland
- Spain
- UK

Impact scientifically evaluated

Scientific evaluation of impact

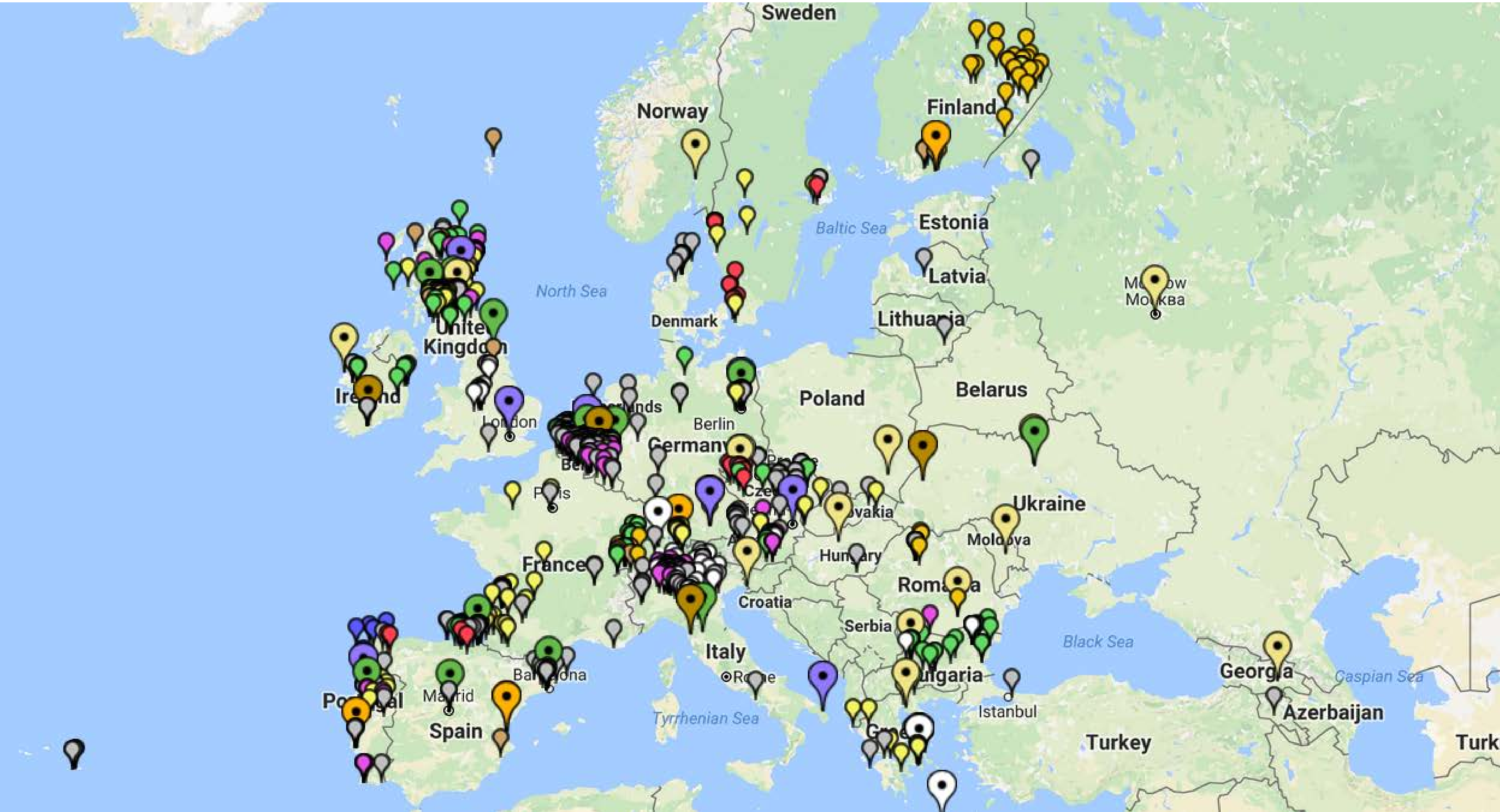
- **Improvement of self-efficacy and interest** of students overall
- **Girls feel more confident** in their scientific ability and their self-efficacy rises.
- **Interest of male students in physics rises**
- The Photonics Explorer works especially well with **lower secondary students.**

Feedback from teachers

- ‘It is a good concept, well designed with lots of **simple tools that can be easily used by students’**
- By doing the experiments it seems that the students **better understand the theory**
- Link to technological applications was well appreciated
- ‘Working with the Photonics Explorer triggered the students’ **interest.**
- Students were **more actively involved** in the lectures
- Students were triggered to raise much **more questions**

More than 3200 Photonics Explorer distributed

- Immediate overview of distribution: countries, schools and sponsors
- Scope of dissemination and impact
- Teachers know which neighbouring schools are using the kit for reference



Short movie about the Photonics Explorer

https://www.youtube.com/watch?v=zpSyZSdf6ig

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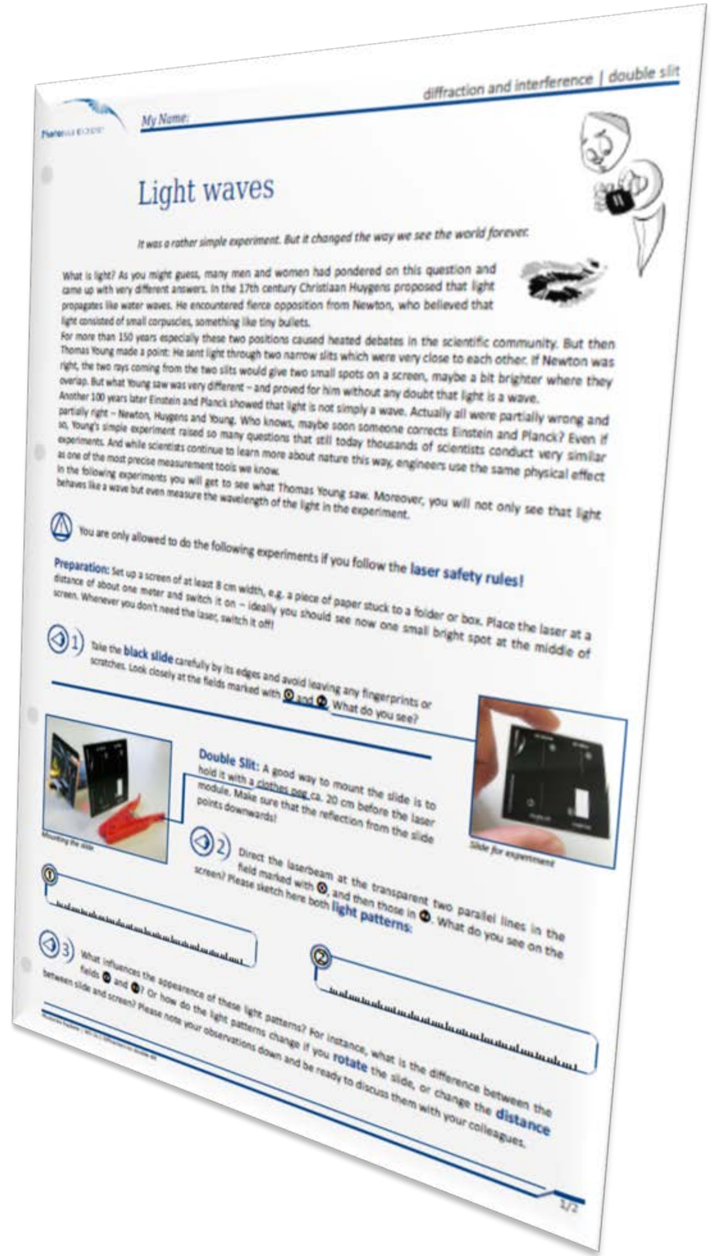
Worksheets

Factsheets

Notes for Teacher

Multimedia material

Inquiry Based Learning



diffraction and interference | double slit

My Name:

Light waves

It was a rather simple experiment. But it changed the way we see the world forever.

What is light? As you might guess, many men and women had pondered on this question and came up with very different answers. In the 17th century Christiaan Huygens proposed that light propagates like water waves. He encountered fierce opposition from Newton, who believed that light consisted of small corpuscles, something like tiny bullets.

For more than 150 years especially these two positions caused heated debates in the scientific community. But then Thomas Young made a point: He sent light through two narrow slits which were very close to each other. If Newton was right, the two rays coming from the two slits would give two small spots on a screen, maybe a bit brighter where they overlap. But what Young saw was very different – and proved for him without any doubt that light is a wave.

Another 100 years later Einstein and Planck showed that light is not simply a wave. Actually all were partially wrong and partially right – Newton, Huygens and Young. Who knows, maybe soon someone corrects Einstein and Planck? Even if so, Young's simple experiment raised so many questions that still today thousands of scientists conduct very similar experiments. And while scientists continue to learn more about nature this way, engineers use the same physical effect as one of the most precise measurement tools we know.

In the following experiments you will get to see what Thomas Young saw. Moreover, you will not only see that light behaves like a wave but even measure the wavelength of the light in the experiment.

You are only allowed to do the following experiments if you follow the **laser safety rules!**

Preparation: Set up a screen of at least 8 cm width, e.g. a piece of paper stuck to a folder or box. Place the laser at a distance of about one meter and switch it on – ideally you should see now one small bright spot at the middle of screen. Whenever you don't need the laser, switch it off!

1) Take the **black slide** carefully by its edges and avoid leaving any fingerprints or scratches. Look closely at the fields marked with ① and ②. What do you see?

Double Slit: A good way to mount the slide is to hold it with a clothes peg ca. 20 cm before the laser module. Make sure that the reflection from the slide points downwards!

Mounting the slide

Slide for experiment

2) Direct the laserbeam at the transparent two parallel lines in the field marked with ①, and then those in ②. What do you see on the screen? Please sketch here both **light patterns**:

①

②

3) What influences the appearance of these light patterns? For instance, what is the difference between the fields ① and ②? Or how do the light patterns change if you **rotate** the slide, or change the **distance** between slide and screen? Please note your observations down and be ready to discuss them with your colleagues.

1/2

Didactic Framework : Teacher Guide

- -Lesson overview
- Summary of module
- Age group
- Duration
- Prior knowledge
- What students will learn
- Description of suggested lesson
- Background information
- Suggested answers

Notes for teachers

on module 15:

Diffraction and Interference

Diffraction offers a variety of visually appealing experiments to demonstrate the wave character of light. But more than that, it gives students a unique opportunity to measure at a nanometre scale – with very simple means.

Summary: Students will generate diffraction patterns and use them for measurements.

The module is structured in 3 chapters:

- Diffraction on a double slit is used to measure the wavelength of the laser light.
- Diffraction on a single slit and bar are compared. Students then measure the thickness of a hair based on the diffraction pattern.
- Diffraction on a grating is demonstrated with a CD. Students then build their own spectrometer and measure the spectrum of a fluorescent light bulb.

Designed for: upper secondary level (age ca. 16 to 18)

Duration: Each chapter is designed for ca. 40 min;
in total 3 lessons or 120 min

What students should already know:

- constructive and destructive interference of waves, illustrated e.g. in a ripple tank or with sound waves
- light behaves as waves
- Huygens principle

What students will learn:

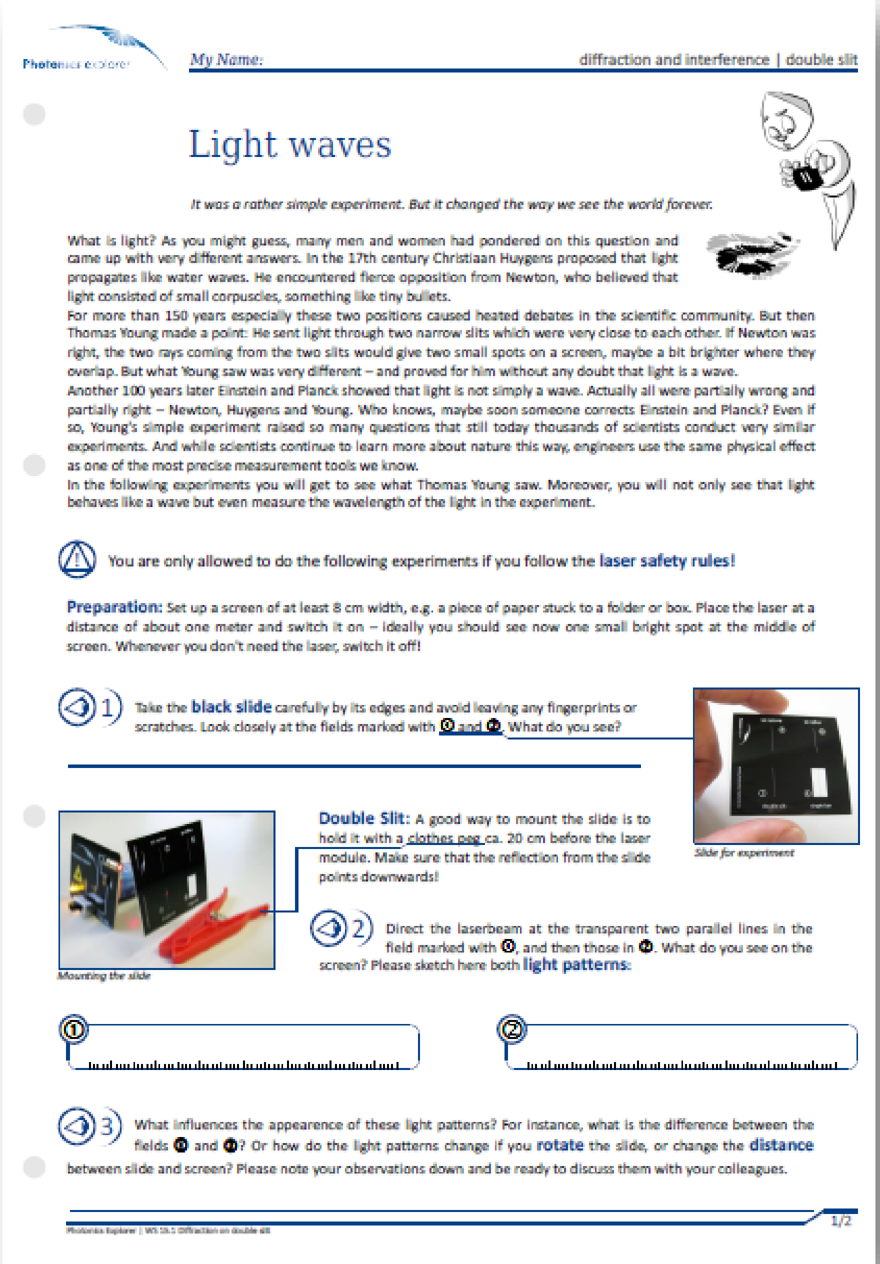
- The safe handling of lasers (Laser safety)
- To measure the wavelength of light with the double slit (Young) experiment.
- Diffraction on a single slit and Babinet's principle
- How to measure the width of a hair based on a diffraction pattern
- How the diffraction pattern of DNA lead to the discovery of its structure
- Diffraction on gratings in reflection and transmission
- How spectrometers work
- That the spectrum of energy saving light bulbs consists of discreet colours – in contrast to the continuous spectrum of sunlight.

This module includes:

- 3 worksheets
- 3 fact sheets

Didactic Framework : Worksheets

- Motivation/ background
- Experiments:
    - Setup
    - Observation
    - Discussions
    - Conclusions
- Guiding questions
- Do, Observe, Reason



Photonics explorer

My Name: diffraction and interference | double slit

Light waves

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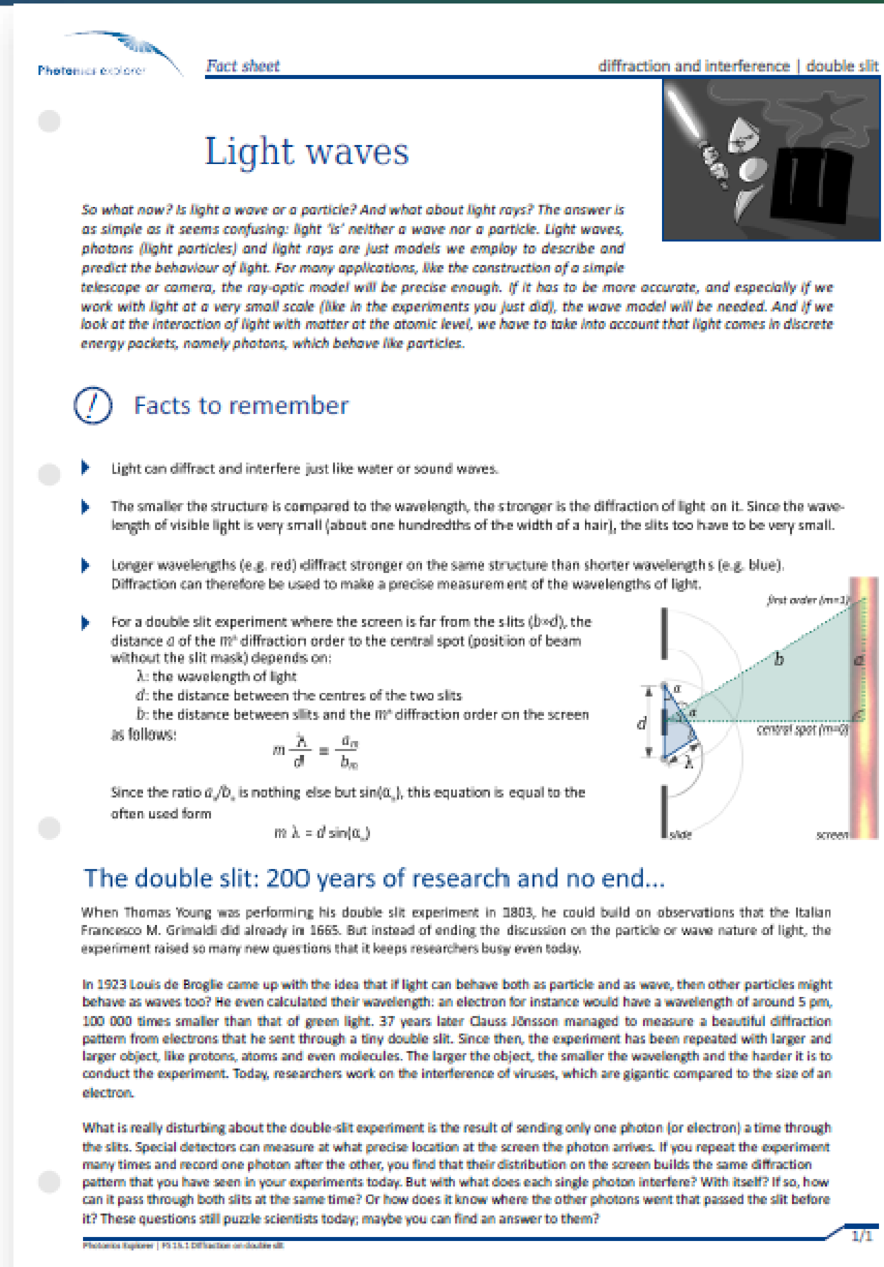
Photonics Explorer | WS 15.1 Diffraction on double slit 1/2

Didactic Framework : Fact Sheets

- given to take home at the end of lesson
- important facts to remember
- applications of the topic
- avoid incessant note taking



Light waves

So what now? Is light a wave or a particle? And what about light rays? The answer is as simple as it seems confusing: light 'is' neither a wave nor a particle. Light waves, photons (light particles) and light rays are just models we employ to describe and predict the behaviour of light. For many applications, like the construction of a simple telescope or camera, the ray-optic model will be precise enough. If it has to be more accurate, and especially if we work with light at a very small scale (like in the experiments you just did), the wave model will be needed. And if we look at the interaction of light with matter at the atomic level, we have to take into account that light comes in discrete energy packets, namely photons, which behave like particles.

Facts to remember

- Light can diffract and interfere just like water or sound waves.
- The smaller the structure is compared to the wavelength, the stronger is the diffraction of light on it. Since the wavelength of visible light is very small (about one hundredths of the width of a hair), the slits too have to be very small.
- Longer wavelengths (e.g. red) diffract stronger on the same structure than shorter wavelengths (e.g. blue). Diffraction can therefore be used to make a precise measurement of the wavelengths of light.
- For a double slit experiment where the screen is far from the slits (b»d), the distance a of the m^{th} diffraction order to the central spot (position of beam without the slit mask) depends on:
  - λ: the wavelength of light
  - d: the distance between the centres of the two slits
  - b: the distance between slits and the m^{th} diffraction order on the screen

  as follows:

  $$m \frac{\lambda}{d} = \frac{a_m}{b_m}$$

  Since the ratio a_m/b_m is nothing else but $\sin(\alpha_m)$, this equation is equal to the often used form

  $$m\,\lambda = d \sin(\alpha_m)$$

The double slit: 200 years of research and no end...

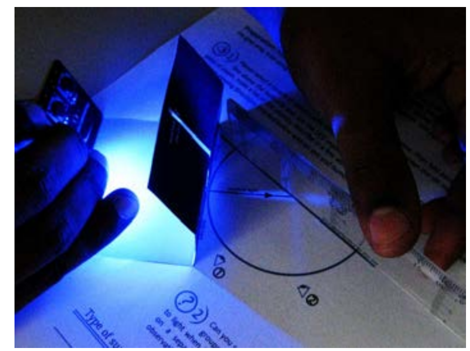
When Thomas Young was performing his double slit experiment in 1803, he could build on observations that the Italian Francesco M. Grimaldi did already in 1665. But instead of ending the discussion on the particle or wave nature of light, the experiment raised so many new questions that it keeps researchers busy even today.

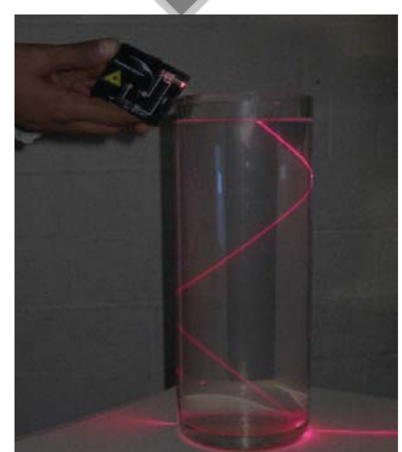
In 1923 Louis de Broglie came up with the idea that if light can behave both as particle and as wave, then other particles might behave as waves too? He even calculated their wavelength: an electron for instance would have a wavelength of around 5 pm, 100 000 times smaller than that of green light. 37 years later Clauss Jönsson managed to measure a beautiful diffraction pattern from electrons that he sent through a tiny double slit. Since then, the experiment has been repeated with larger and larger object, like protons, atoms and even molecules. The larger the object, the smaller the wavelength and the harder it is to conduct the experiment. Today, researchers work on the interference of viruses, which are gigantic compared to the size of an electron.

What is really disturbing about the double-slit experiment is the result of sending only one photon (or electron) a time through the slits. Special detectors can measure at what precise location at the screen the photon arrives. If you repeat the experiment many times and record one photon after the other, you find that their distribution on the screen builds the same diffraction pattern that you have seen in your experiments today. But with what does each single photon interfere? With itself? If so, how can it pass through both slits at the same time? Or how does it know where the other photons went that passed the slit before it? These questions still puzzle scientists today; maybe you can find an answer to them?

Module 1: Light Signals

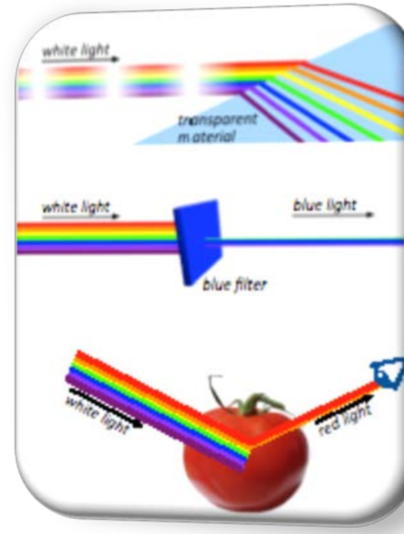
Communicating between 3 villages in a valley
Communicating with optical fibres

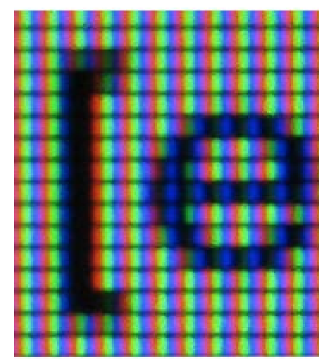


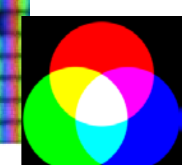


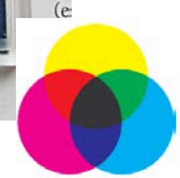
Module 2: Colours

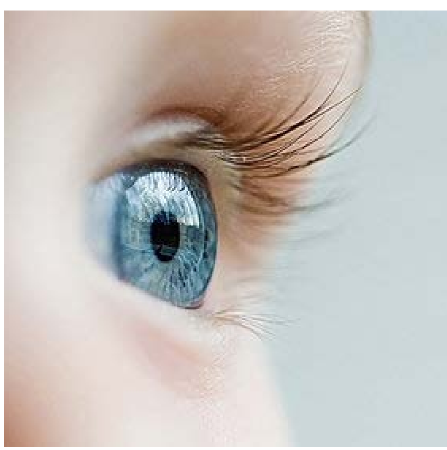
Colours of the rainbow
Colour Mixing



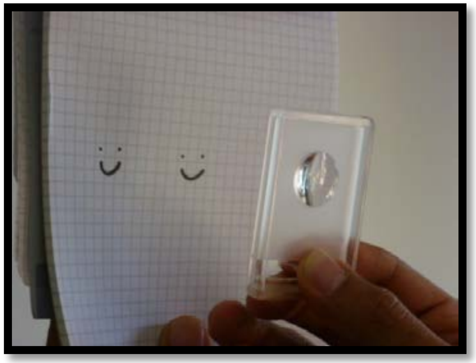


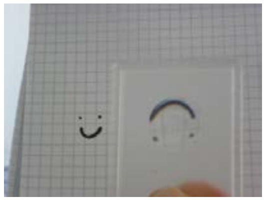




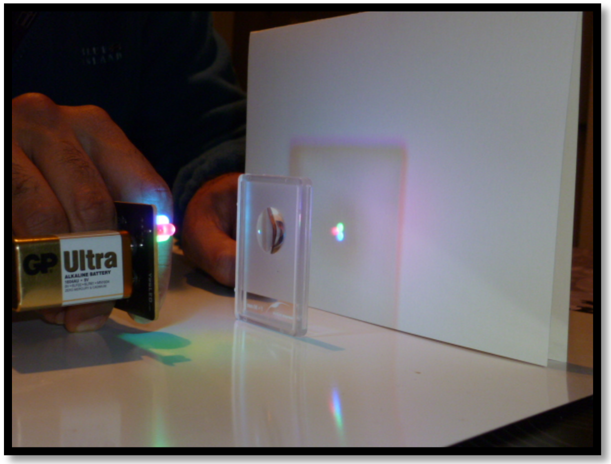


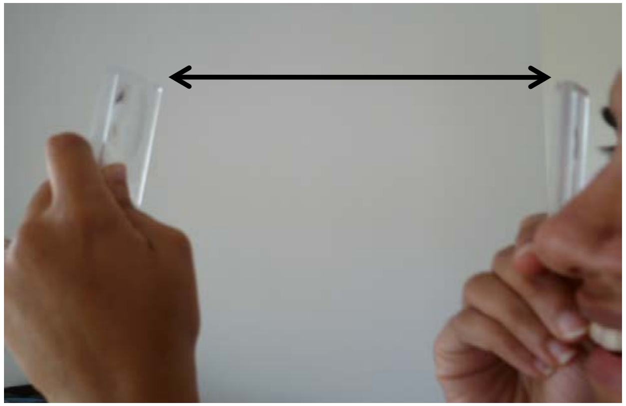
Refraction and imaging
Building Galilean and Kepler telescopes

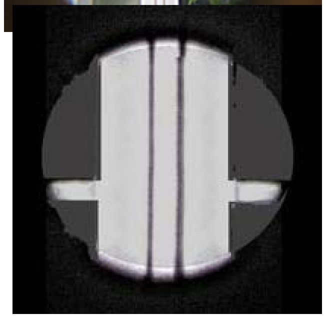




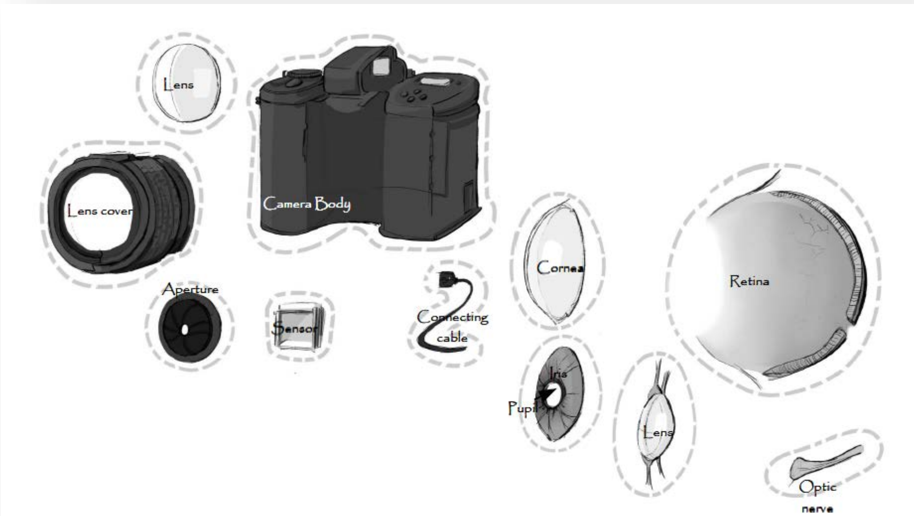
Type of lens	Focal length	Image distance	Image size	...
bi convex				
...				
...				



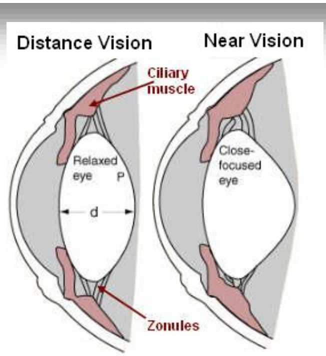




Comparing human eyes and digital cameras
Learning about accommodation in the eye

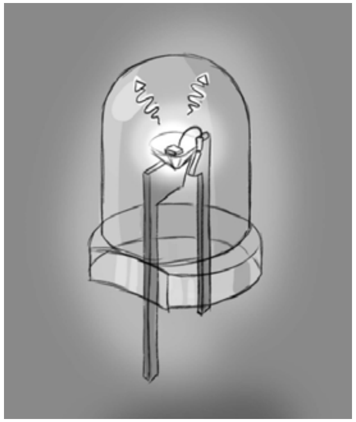


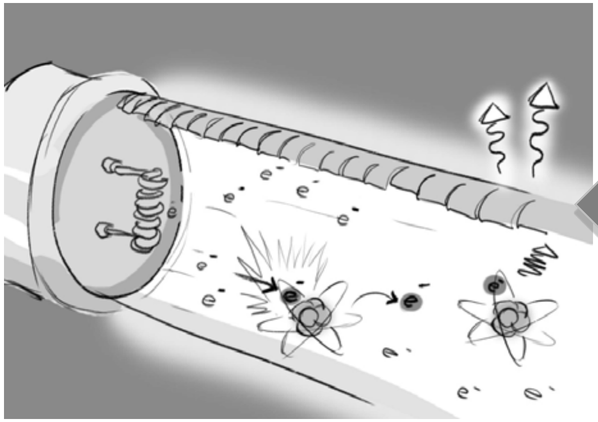
$$\frac{1}{\text{finger to eye } (S1)} + \frac{1}{\text{cornea to retina } (S2)} = \frac{1}{\text{focal length } (f)}$$



For near vision, the ciliary muscles contracts and the central lens thickness increases to increase its power.

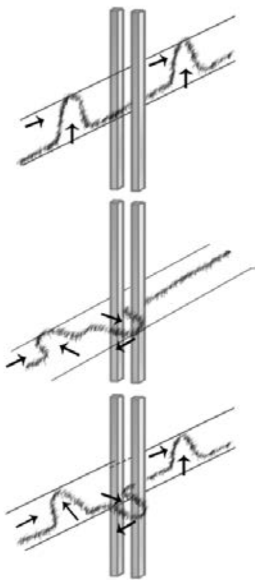
Analyzing the lighting situation in your school
Warm light and cold light (efficiency)

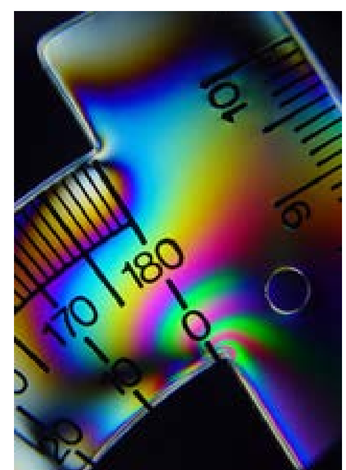


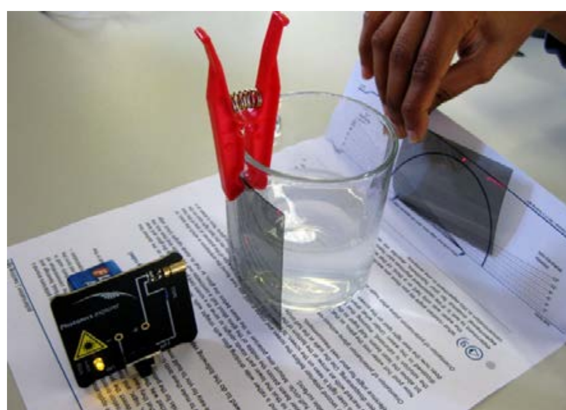


Module 6: Polarisation

Building a polarimeter to measure sugar concentration
Application and displays and life sciences

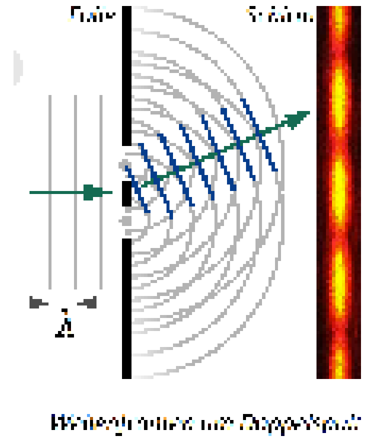


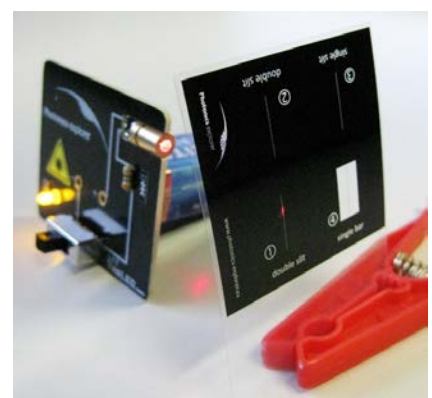




Module 7: Diffraction and Interference

1. Double slit and single slit diffraction
2. Building a spectrometer

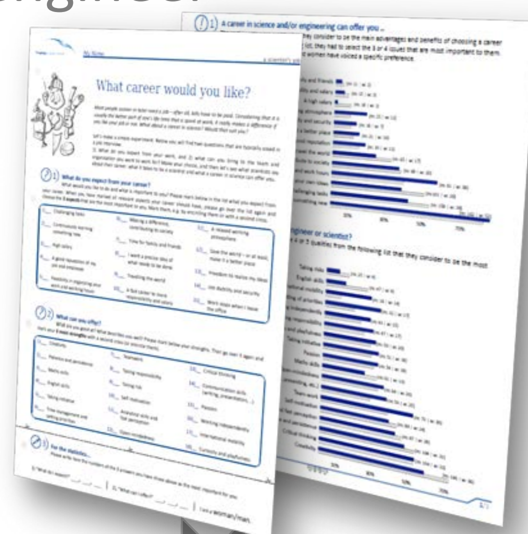




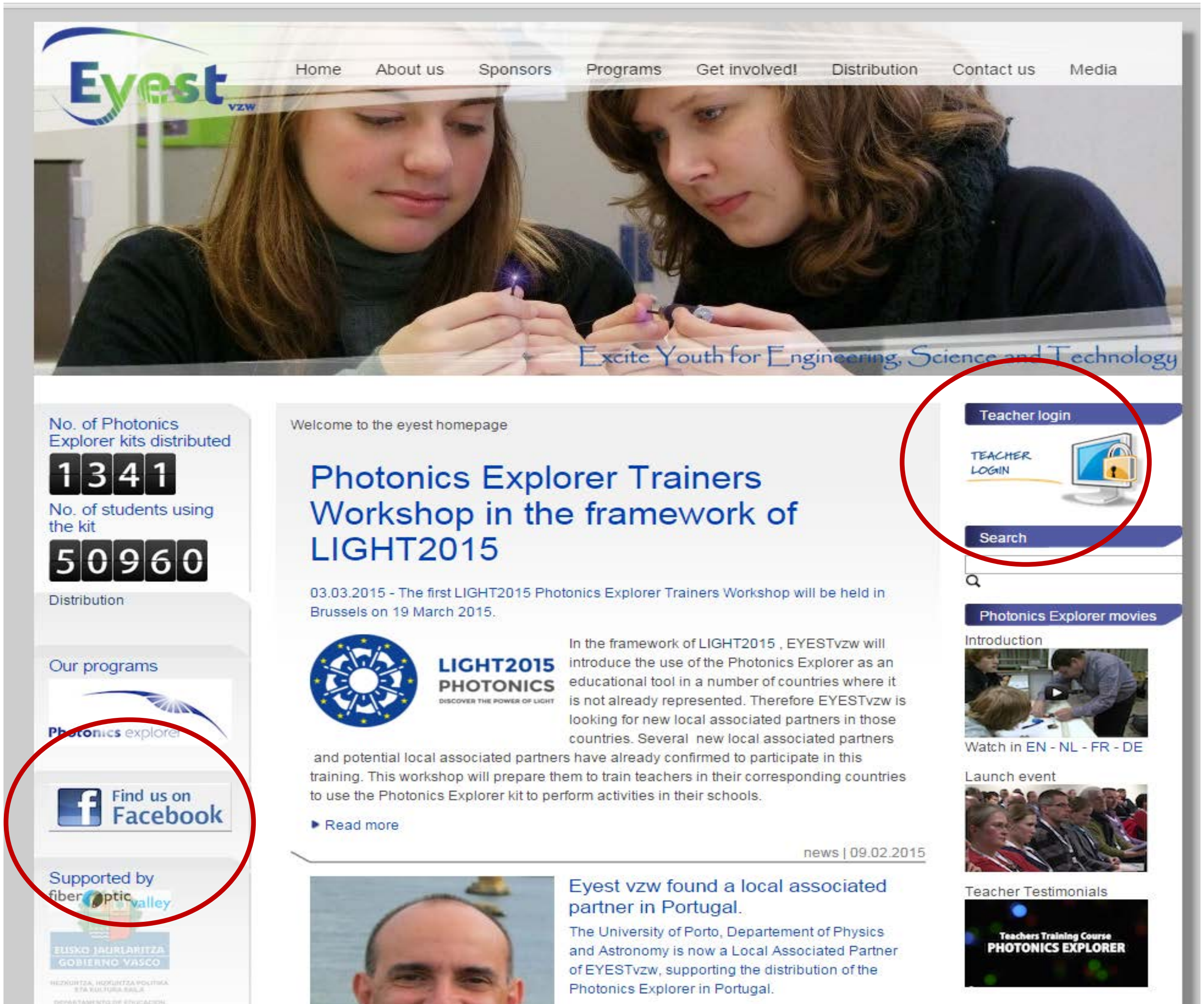
Breaking the stereotypes

Exploring what you want from a career

A day in the life of a scientist and engineer

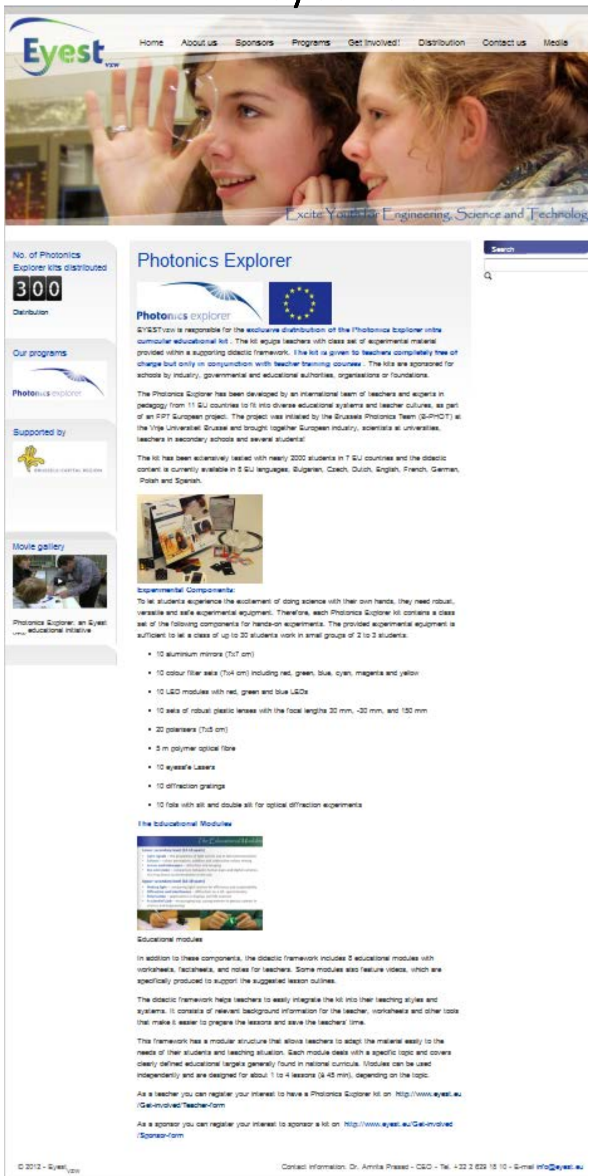


www.eyest.eu: Teacher login

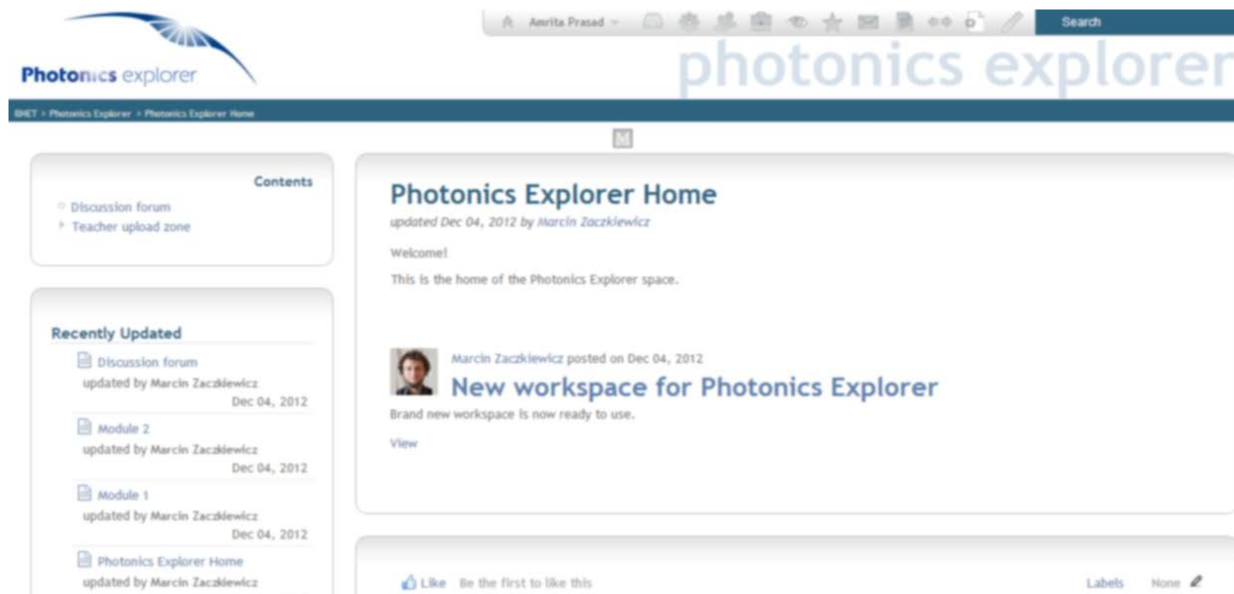


Online Platform

www.eyest.eu

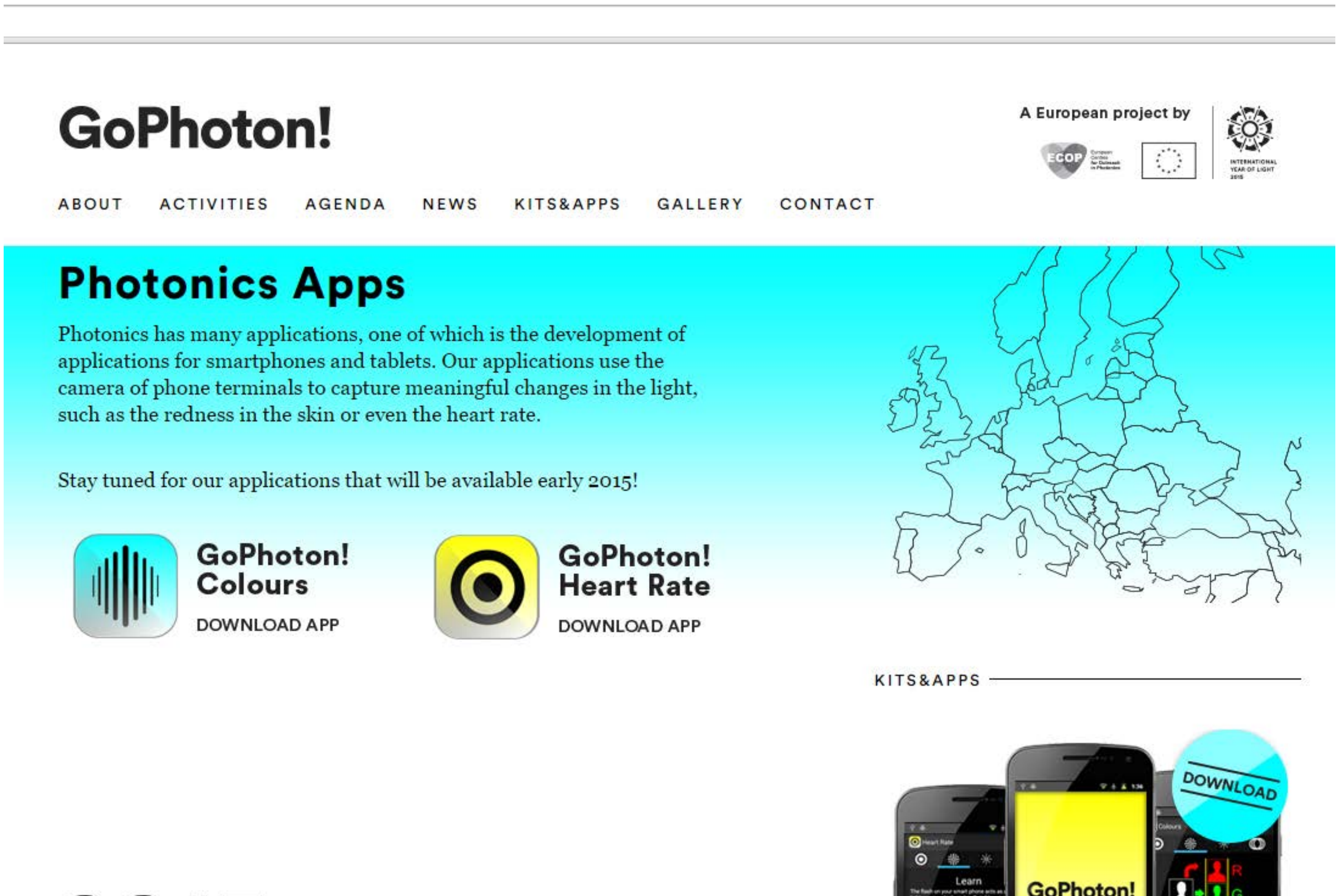


- Teachers receive an email to register with their details and serial number of their kit
- Online discussion forum in your language
- Updates (worksheets, videos etc.)
- Feedback
- Component replacements




c5eche7h

Thank you!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