

*"Study the science of art.  
Study the art of science."*

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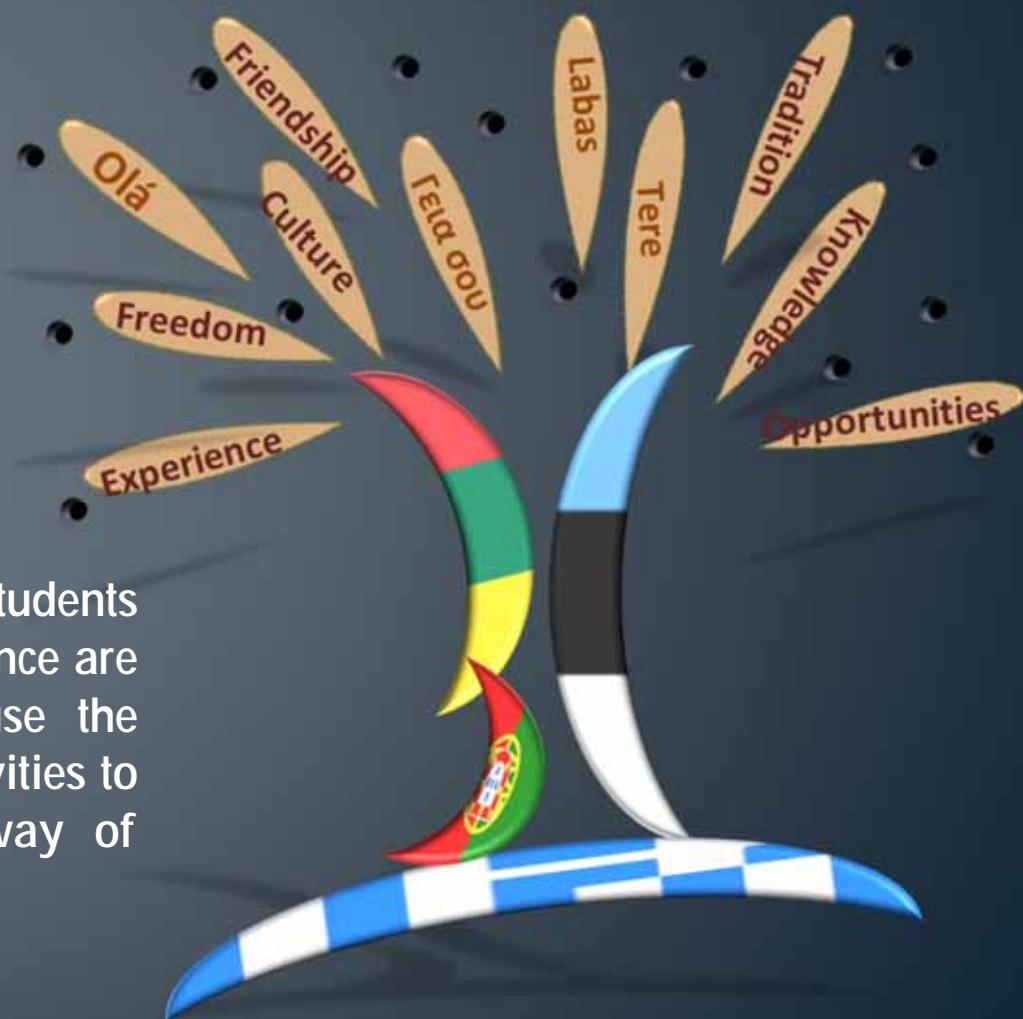
International Week - Baden  
May 28th to June 1st 2018

Students and teachers involved come from Estonia, Lithuania, Portugal and Greece.

Age of the students: 16-18

The basic idea of the project was to find new and different ways of teaching/studying art through gaining scientific knowledge and also studying science through artistic ways of thinking.

During the project we hoped that students would realize how closely art and science are connected and would be able to use the experience gained through project activities to practice new and much broader way of thinking in the future.



# PROPERTIES OF LIGHT

Look at the pictures. What do you see;



Purpose: Provoke curiosity.  
Recall former knowledge.

SET A QUESTION-PROBLEM

# Why use simulation?

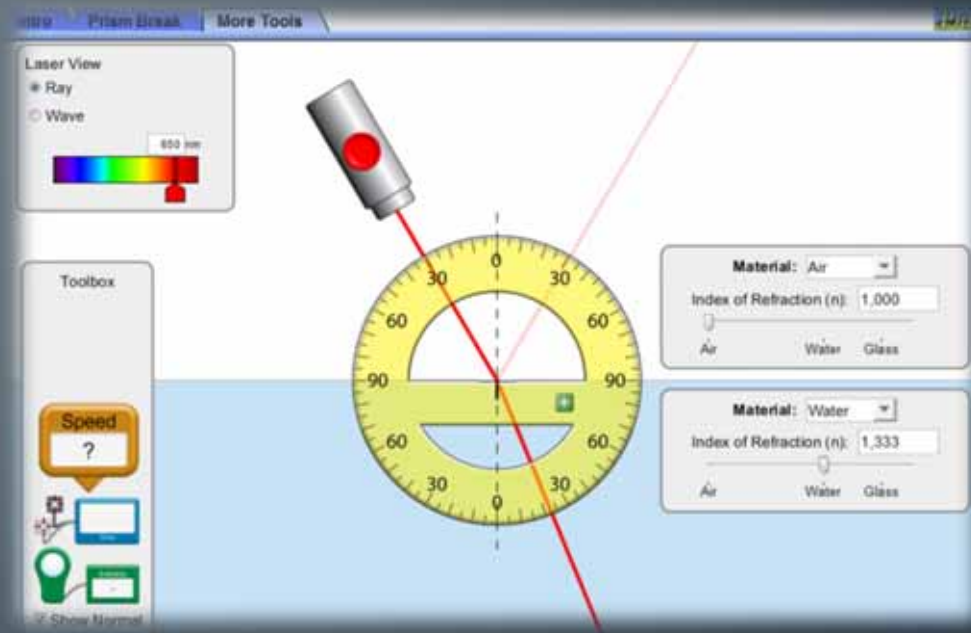
- Students are able to vary the parameters and see the effect of these variations.
- It gives them control when exploring scientific phenomena.
- Students can have access to equipment that are not commonly available in classroom.
- Students can work in groups to explain and describe their understandings to each other.



# PERFORMANCE OF SIMULATION

• Visit the web page of the University of Colorado: <http://phet.colorado.edu> and look for the simulation «Bending light»: <http://phet.colorado.edu/en/simulation/bending-light>.

Purpose: Students are trying to discover the properties of light (reflection, refraction).



# REFLECTION OF LIGHT

1. When a ray of light falls on the surface of a material it changes direction inside the propagation mean (air). This phenomenon is called **reflection**.
2. The incident angle ( $\pi$ ) is equal to the reflected angle ( $\alpha$ ):  
$$(\pi) = (\alpha)$$



# REFRACTION OF LIGHT

- The rays that penetrate the second propagation medium change direction. This phenomenon is called **Refraction**.
- Light refraction is due to the fact that the speed of light is different in every propagation medium.

The light is transmitted in the air with speed  $c_0 = 3 \times 10^8$  m/s. Inside another medium the light transmits with speed smaller than  $c_0$ . We use the refraction index  $n$  to be:

$$n = c_0 / C$$

Where  $C$  is the speed of light as it transmits inside a medium.

## EXPERIMENTAL ACTIVITY

### Instruments:

- Laser device
- Glass Prism
- Protractor

### Execution of the experiment

1. Put the protractor on a piece of paper and draw a circle.
2. Divide the circle every 10 degrees.
3. Put the prism on the paper in such a way that its plane face lean on the diameter of the circle
4. Use the laser to shoot a ray on the plane face of the prism.
5. Fill in the worksheet.



Lets make a kaleidoscope !!!





Kaleidoscope= kalos (beauty) + eidos (form) + scopeo (to look to, to examine)

# Planning of “kaleidoscope”

- Definitely use mirrors.
- Is it easy to form a cylinder with mirrors?
- Lets form a triangle with 3 mirrors.
- How do we keep them together ?
- How do we tap the 2 ends?
- Lets use cardboard and make a hole.
- Should we use cardboard at both ends?

# Materials

- 3 parallelogram shaped mirrors
- Beads of various shapes
- cardboard
- scissor
- tape
- jelly





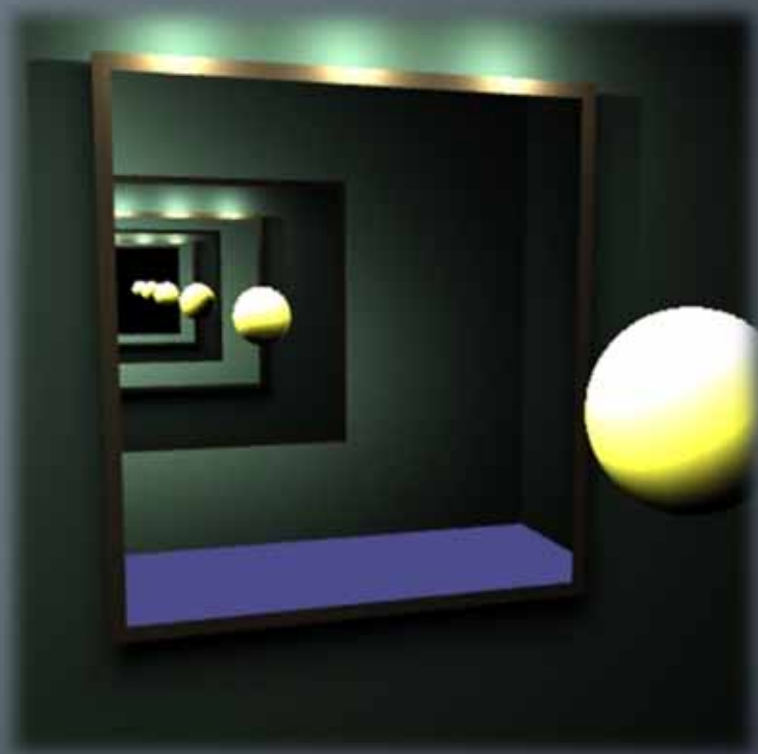
If we look into the hole, we'll see magic shapes created as we spin slowly our kaleidoscope.



But how are these magic shapes created?



In case of multiple mirrors, as in our kaleidoscope, we observe multiple reflections, creating thus multiple copies of our beads.



- Students watched pictures, in order to determine questions and problems.
- They were given the necessary tools (simulation), but they used their observations to develop relations among variables.
- Give answer to the problem.



## Inquiry - based method

- They used that knowledge to understand how certain devices work.
- They planed and constructed a kaleidoscope.
- Combination Science with Art.

# LIGHT AND SHADOW



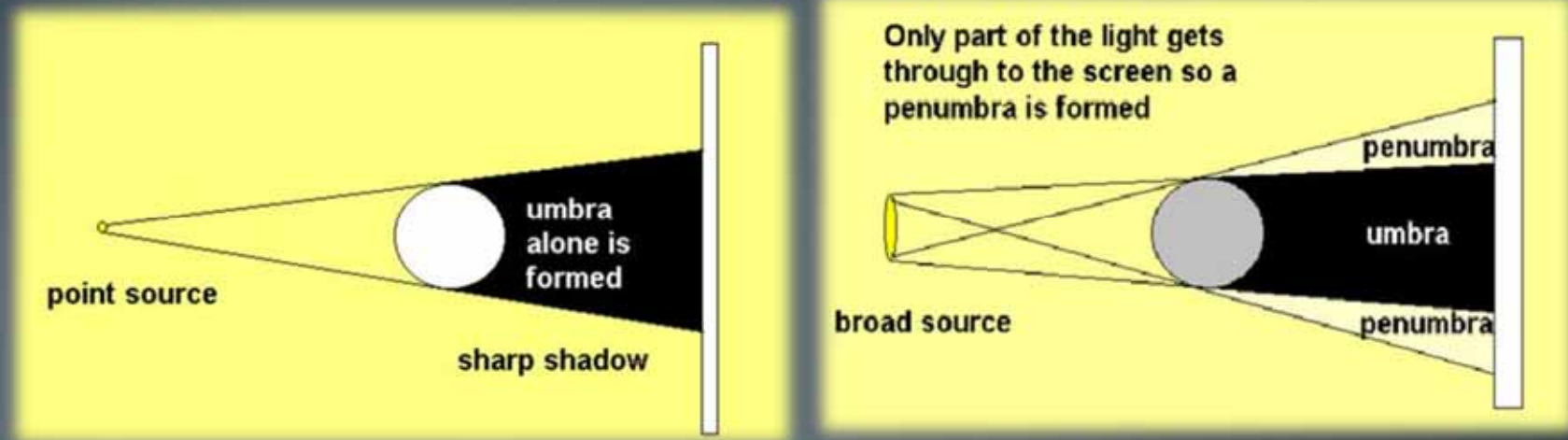
What do these pictures have in common?

# How shadow is formed ?

A shadow is formed where light is 'missing'.



# Shadow Formation



A dark shadow called umbra is formed where no light falls. A light shadow called penumbra is formed where some light falls, but some is blocked.

If the light source is very tiny and concentrated in one place only umbra is formed



## How light and shadow affected Leonardo Da Vinci ?



Kneeling Leda , 1508

The alteration between light and shadow gives the impression of depth and a sense of volume in modeling three-dimensional objects and figures.

# Using shadow for measuring tall objects



Identical triangles → Height of the lamp-post

# Measuring the perimeter of the Earth

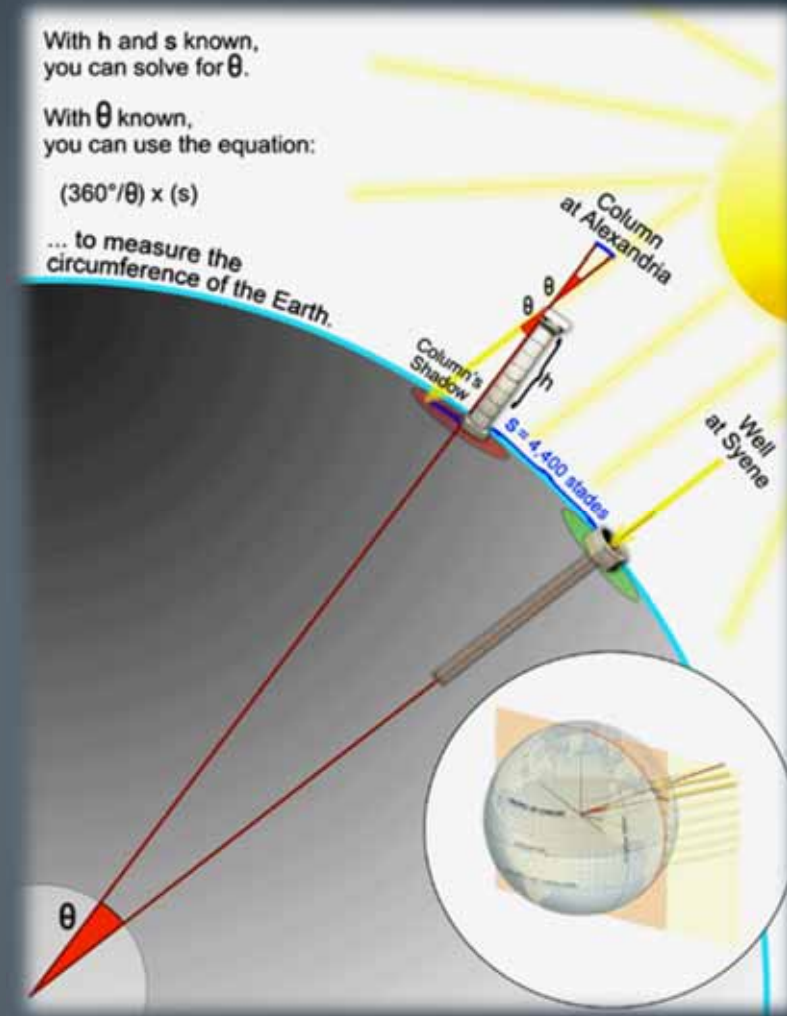


Eratosthenes was a Greek mathematician, geographer, poet, astronomer, and music theorist. He was a man of learning, becoming the chief librarian at the Library of Alexandria.

19<sup>th</sup> of June in 240 b.c

Eratosthenes measured the shadow angle of the great Obelisk in Alexandria the day the sun was directly above a well in Aswan.

He send a slave to measure in footsteps the distance from the well in Aswan to Alexandria.



Eratosthenes's only tools were sticks, eyes, feet and brains; plus a zest for experiment. With those tools he correctly deduced the circumference of the Earth, to high precision, with an error of only a few percent. That's pretty good figuring for 2200 years ago.

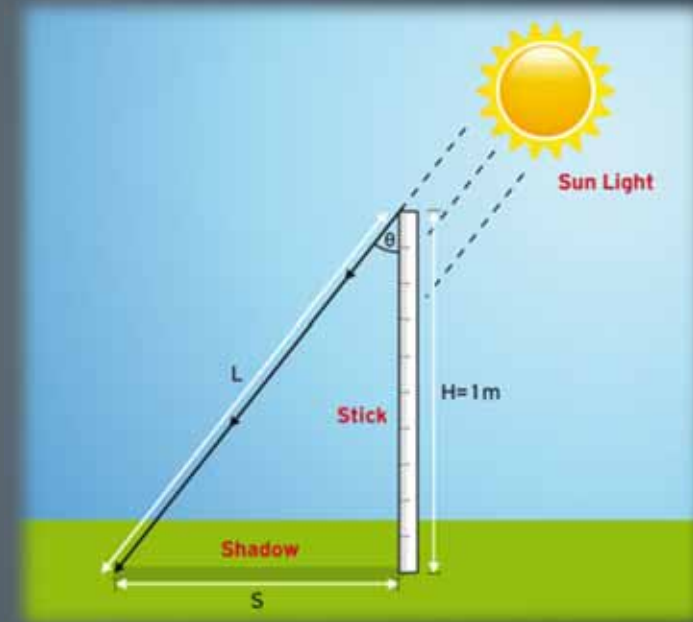
- Carl Sagan -



# Eratosthenes's Experiment at School

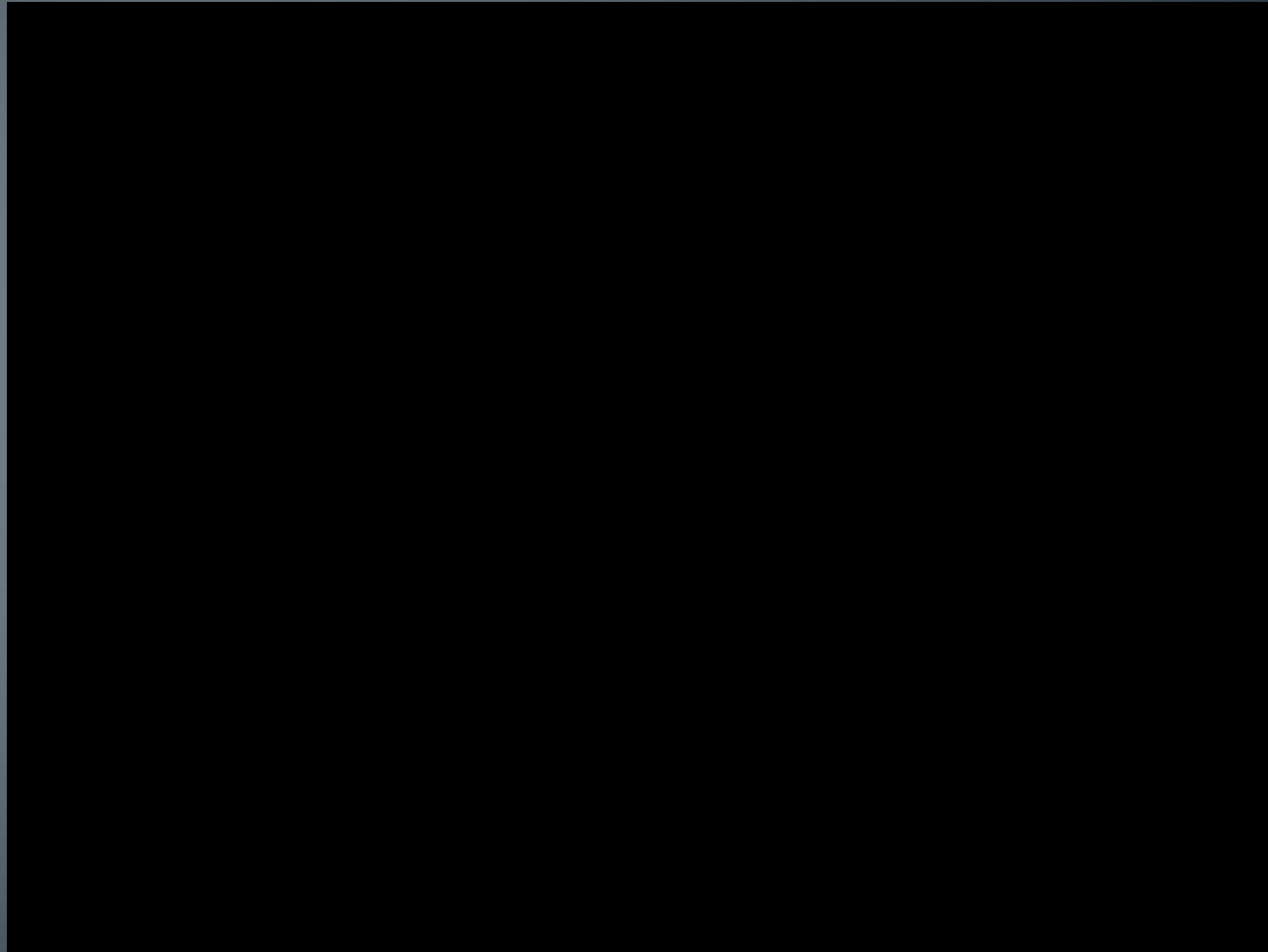
<http://eratosthenes.ea.gr/content/experiment>

1. Find the time of your local noon at your location. Please use the web-based NOAA Solar Calculator or Solar Calculator or the Stellarium software.
2. Take a one-meter stick ( $H= 1$  meter, see figure below) and place it vertically to the ground. Ask your students to measure the length of the stick to make sure it is one meter long. At the time scheduled to conduct the experiment, ask your students to measure the length of the stick's shadow (length  $S$  in the figure below). Repeat the measurement 5 times.
3. Calculate the distance using Google Maps between your school and the equator .





# LIGHT AND SHADOW



# Attending Science Classes



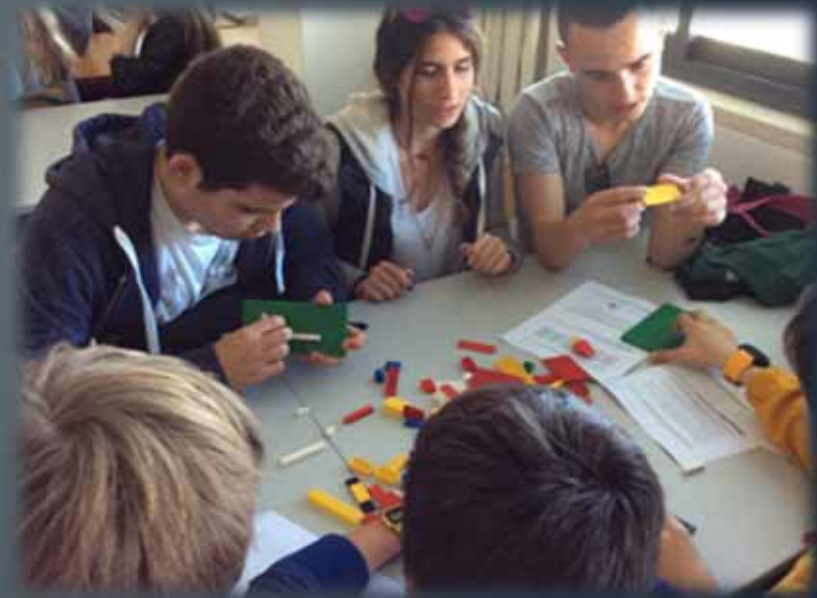
# Deciding on OUR logo...





# Visit to “ Departamento de Eng. Civil da Faculdade de Ciências e Tecnologia – Universidade Nova de Lisboa”

- Presentation
- Workshop - construction of building models and the test on shaking table





# “NUCLIO - Interactive Center for Astronomy”

- Sun observation with telescope



# Visit to “Museu Nacional do Azulejo”

- Exhibition
- Scientific Workshop



# Meeting with a professional photographer- Student workshop





# Playing Games-Quizzes





## CONCLUSIONS

- Promotes collaboration between schools, teachers and students.
- Introduces new educational philosophy.
- Supports interdisciplinary activities.
- Supports project methods, group working.
- Widens knowledge through traveling.
- Meet different cultures-develops intercultural philosophy.

"The world is a book  
and those who do  
not travel read only  
one page..."

*Augustine of  
Hippo*