Earth's Radius (Eratosthenes' Method)

Author: Maria Guida, Palmira Ronchi.
Subject: Mathematics.
Country of creation: Italy.
Countries of testing: Belgium, Spain and Hungary.

Aims of the GP

Students learn to make practical estimations of the error in the measurement of physical quantities. They develop the capacity for abstraction, using geometry to solve a practical problem.

Teaching material

- IWB (or a computer lab and TeachNet or a PC and projector. This will allow you to show your students what you wish).
- Computer lab with Internet connection.
- GeoGebra software (free): http://www.geogebra.org
- GeoGebra drawing reconstructing the situation.
- Videos to introduce the story of Eratosthenes:
  http://www.youtube.com/watch?v=O6KOSvYHAmA
  http://www.youtube.com/watch?v=35UQVcY0_qw&feature=related

Age of the students

14

Preparation and teaching time

Preparation: 30 min (necessary to have basic knowledge of GeoGebra).
Class time: 2 x 90 min periods.

Lesson plan

1. The teacher shows on the IWB the main features of the Geogebra software then students have to draw an ellipse with GeoGebra using the Gardener's method (1 hour).
2. Place a stick in the garden. Students observe how the shadow of the stick changes at different hours. It is not really a measurement but just a qualitative observation to start studying something from the observation of real phenomena.

3. The teacher at the IWB tells the story of Eratosthenes and his idea about measuring the Earth, by means of multimedia (15 min).
4. Students in the lab: The teacher shows the picture reproducing a section of the Earth and Eratosthenes' problem and students have to draw it again by themselves with Geogebra.
5. The teacher gives the distance between Alexandria and Syene and asks for the indirect measurement of the Earth circumference using proportions. The students are supposed to write a report of the activities done up to this point (90 min).

Extract from the worksheet

Gardener's method to draw an ellipse.

Please refer, for example, to this link:
http://www.mathopenref.com/constellipse1.html

The measurement of the Earth's circumference

1. Search the Internet for current values of the measurement of the Earth's circumference in at least three sites. Write down the values and web addresses where you found them.
2. Calculate the difference between the measurement of Eratosthenes and the current calculated value.
3. Guess what is the cause of Eratosthenes' imprecision.

Questionnaire

The shadow of objects is proportional to their height

Yes / No

If the diameter is equal to 5 km then the length of the circumference is about

6.5 km
3.68 km
15.70 km
9.42 km

The Earth is divided into 24 time zones. About how wide is each time zone at the Equator?

166 km
166667 km
166.7 km

1667 km

On the day of the summer solstice Eratosthenes noticed that in Syene – now Aswan, Egypt – objects had no shadow at noon.

Yes / No

Eratosthenes used the cities of Syene and Alexandria to obtain the length of the Earth's circumference because he supposed them to be on the same meridian.

Yes / No

An angle of 7° 12', compared to a full circle, is equivalent to

1 / 25
1 / 30
1 / 5
1 / 50

Eratosthenes' measurements was not precise because he started from two mistaken assumptions; in fact, the Earth is not perfectly round and also Alexandria and Aswan are not exactly on the same meridian, the two longitudes differ by about 3°.

Yes / No

Eratosthenes knew precisely the distance between Syene and Alexandria, 5000 stadiums, which was about 890 km. What was the length of a stadium in meters?

17.8
178
1780
1.7

Teacher reviews

This GP was praised for its combination of hands-on experiments with the use of ICT and GeoGebra. In this respect, the Spanish teacher said that a mix of mathematics and a real experiment got him better results and motivation of his students. Furthermore he said that this GP also helped him to introduce GeoGebra and ICT in his maths classes. The Belgian teacher even said: "I persuaded other science colleagues and two students to do this real experiment during their trip to Rome. Students also started to work with GeoGebra to represent this problem. Since this experiment, some students

have been viewing mathematics in unconventional ways, generating new ways of thinking, and they are engaged in problem solving, communicating, reasoning and representing these problems using geometric models in real life situations."

In general, teacher implementers suggested the practice could be even more effective if the lesson started with the actual hands-on experiment and quantitative data is taken.

The SPICE project

SPICE was a two-year project (December 2009 – November 2011) carried out by **European Schoolnet** (http://europeanschoonet.org) together with **Direção Geral de Inovação e Desenvolvimento Curricular** (http://sitio.dgidc.min-edu.pt/Paginas/default.aspx) from Portugal and **Dum Zahranicnich Sluzeb MSMT** (http://www.dzs.cz/) from the Czech Republic.

The primary objective of the SPICE project was to collect, analyse, validate and share innovative pedagogical practices, particularly those using inquiry-based learning, whilst enhancing pupils' interest in the sciences. SPICE supported this objective by singling out, analysing and validating good practice pedagogies and practices in maths, science and technology (mostly ICT-based) and disseminating them across Europe. SPICE involved 24 teachers from 16 different educational systems (from 15 different countries). This teachers' panel helped the SPICE partners in defining good practices that were then tested in classes by 41 teachers during the school year 2010-2011.

For more information see: **http://spice.eun.org**

Education and Culture DG
Lifelong Learning Programme

Spice was funded with support from the European Commission.
This document reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.