Optional session (Sequence 5)

To get one's bearings on the surface of the Earth

New step on Eratosthenes' course : once your first "serious" and accurate measures have been made, you will be able to compare your results with those of the partner schools. Before that, you'll have to get yourself familiar with geographical coordiantes that will help you localize the other schools ont the territory.

Duration : 2 sessions

Notions tackled : cartography, latitude and longitude, time zones.

Equipment :

For the class :

A map of France on the wall
A road map of your region
An A3 sheet
A transparent plastic sheet

For each group of 4 pupils :

A map of your territory (country, island) on an A4 sheet
A cross-ruled A4 sheet.
A spherical object (globe, tennis ball, orange,...)
An angular sector

Introduction

You can begin this session with a reminder of the principle of the operation. Nearly 150 classrooms (http://www.mapmonde.org/eratos/schools.php?lang=en), in 17 different countries are making the same measures you are making. With several angle measures and the distance between each of your partners, you are soon, like Eratosthenes, find the diameter of the Earth. This list of names are for the most part

unknown to you, so you are going to find where your partners are.

Summary of the sequence:

---

1) Locate yourself : your surroundings

Whole classroom

To get your pupils familiar with the notions of locating oneself, begin with the towns, cities, summits or monuments next to the school, places they know. Make a list and tell them to make a map of your surroundings (you could use a road map as a help, for example).

Put your school in the middle of an A3 sheet and tell them to put on this new map the elements of the list they have made. How can they draw a map as exact as possible?

Decide of a scale with them, ask them what it would be necessary to know about each place to put it on the map? What is the simplest and fastest way to put all these places on the new map?

They could give you two major strategies :

- For some of them, the distance between the points and the school will be a first step. They will then try to find their direction on the map
- Maybe some others will want to make a squaring and simply put the places just as pawns on a chessboard.

In groups of 4-5 pupils

You will then be able to divide your classroom in groups, each group trying his strategy.

- First strategy :

As they do not know all the distances, even if they have an idea of them because of their daily movements, you will use a local road map to help you and calculate with the scale the distances on your own sheet. It is not enough : you also need to know in which direction is the place. They will be able to use the 4 cardinal points, at first. Is a village to the north or the south is a first step. But how can they be more precise? Maybe some of them will remember the experiments with the angular sectors. They will cut a sector, one side of which will be the direction and the other the line that joins your school to one of the sites. With the road map, the pupils can now cut as many angular sectors as there are places on the list, chosing as reference one of the cardinal points (that could be different for each place if necessary). They will write down on each side of the sector the name of the site, its distance from your school and the direction chosen as reference. They will only need then to use these sectors on the sheet.

- Second strategy :

They will also need to decide two coordinates : not the distance and the direction, but two distances : one "horizontal" and the other "vertical", for the number of squares in both directions of their squaring. They will have to make two squarings : one on the road map and the other on their sheet with a scaling. They wil then be able to put the places chosen on their sheet, more or less precisely, depending upon the size of their squaring.

You can then reproduce, at your chosen scale, the surroundings of your school and even orientate this new map in your classroom with a compass!

Choice of the best method :

Ask them which is the best method for these maps, from the point of view of easiness and fastness. Let them talk about it. Ask them now to put themselves in their thoughts in one of the places they have put on your map (except your school). Tell one of them to explain to one of his comrades which way he should take on the map (and with his method) to go from that point to another place. Which is the best map now to find that way?

With the first strategy, they have to get through the process all over again : measure the distance between the two places and the direction . With the second strategy, they only need to give the number of squares to make horizontally and vertically, it is really much easier! They will soon be convinced of the efficiency of that coordinates syste, called "Cartesian" (the others are called "polar").

The country scale :

Put on the blackboard a wall map of your country or island and get a transparent plastic sheet (a cover for boks, for example, or flower paper,...) of the same size. Give each group an A4 sheet on which is drawn the outline of the territory.

Put the four cardinal points on the maps

With the wall map, make a list of the most well-known cities and put a coloured sticker on your own town or village.

Tell them to find an easy way to locate these cities on the map. How can they define their position? They will certainly choose the squaring method, and you will be able to use the game of naval battle as a way to learn (that is not so usual !!!). Each square will be located with a letter and a figure.

So, in the first time, you will draw a squaring you will superimpose to the wall map in order to locate the place of the major cities or mountains. They will wonder about the size of the squaring. They will decide for themselves the necessary parameters, and then make the squaring on the group sheet in order to put the points on the map as accurately as possible.

How many squares high? Wide? What size for a square?

Will they be square or rectangular? Which numbers will they use? In which way? What will be the point of origin? How can they make the two squarings coincide? Let them discuss along the problems met, the groups having opted for the first method will be at an advantage and will be able to help the others in their choice.

Notes : How do the lines cross each other in the squaring? In which directions?

2-Curved space : from the local to the global

In groups

During this second part, you are going to try to get progressively to the creation of a net of meridians and parallels that define the geographical coordinates used to locate oneself on the Earth.

How could you apply now to the globe what they have just used? Give them copies of the squaring you have prepared, and spherical objects : tennis ball, oranges,...
Tell them to apply the squaring upon the spheres. What is wrong?

How could they design a squaring adapted to this new geometry? Which shape take the lines of the plane squaring when they get rolled upon a ball?

Towards a new reference.

Each group is going to roll the cross-ruled paper around a sphere. First, they will make a cylinder, and they will see that the lines which were parallel become circles. To apply the wole squaring to the sphere, they'll have to fold the cylinder at the top and the bottom, like a sweet. They see then that the vertical lines are closing and all go towards to diametrically opposed points

As it is impossible to apply perfectly the surface of the sheet upon the sphere, they take another sphere upon which they are going to train to draw this strange network of lines, creating a brand new squaring they will try to make as regular as possible.

The network closes upon itself on the sphere. All the lines on the paper become circles, of various diameters, and parallel for the horizontal lines, cutting themselves on two points for the vertical lines. You can interpret with them this new drawing, and cut one of the spheres for example (very easy if you use fruits : an orange is perfect for that). You will cut in quarters for the circles with the same diameter, and in discs for the parallel ones.

Finally, you will give a number to the slices just as for the plane squaring, and they can now make a world-scale naval battle ! If the lack of Sun delayed you in the sequences, you can show them the network used for the Earth with a globe. The two points of convergence of the vertical lines are the north and south poles. Note that the squares on the globe are numbered by a scale in degrees (just like a protractor). Take care to make them see the new origins : the zero of the vertical scale on the equator and the one on the horizontal scale : a line called "Greenwich meridian, that goes through France near Paris.

You can explain the vocabulary linked to that new squaring as soon as these notions are clear enough for them : meridian, parallel, equator, longitude, latitude. In order to get more famoiliar with them, tell them to locate your school on a map, as well as your partner schools, with the latitude and longitude given in the table on the site La main a la pâte (new link : http://www. mapmonde.org/eratos/schools.php? lang=en).
This exercize applied to your country can be used in an infinite number of ways, it depends upon what you want and the time you have. For once, you don't need any sun for it !

You are now ready to get to compare your measures with the ones of your partners and at last measure the diameter of the Earth. If you hae more time, you can go further into these notions of latitude / longitude and think with your pupils about the idea of hour all around our planet.