Time goes by

Summary

Age category
9 - 12 years
Topic
Algebra
Total duration
585 minutes

Students explore how to determine the time from shadows. They reflect on how it tilts and rotates and they reflect on their own position on Earth. They design and construct a sundial.

Problem to be tackled:

Students are challenged to build their own sundials with recycled materials.

Real context

Real world motivation

We know that the Earth is nearly spherical and that it rotates and tilts. We also know that day and night are results of the Earth's rotation, while the seasons are explained by the Earth's tilt. Both movements make us aware of a dimension that we call time, which, unlike depth, height or width, cannot be measured in centimetres. Linking to the Social Science Curriculum and the study of our history, we introduce historic time and show how, for most of our existence, time has only been measured in an approximate way.

Goals

Skills

Domain-general:

- Collecting and managing data (e.g. using spreadsheets as a resource for managing and storing data and performing calculations).

Mathematics:

- Measuring the time using the position of the sun through an object's projected shadow.
- Using a compass to locate the four cardinal directions.
- Measuring lengths within appropriate levels of accuracy.
- Using protractors to transfer angle measurements.
- Locating real positions in maps using coordinates
- Using spreadsheets for repeated calculations and to manage and store numerical information.

Technology - Engineering:

- Building 3D models with recycled materials.
- Tackling the technical difficulties of working in 3 dimensions (gluing, sticking, weight balancing, etc.)

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Knowledge

Mathematics:

- Compass. Protractor
- Proportions and scales affect the lengths but not the angles.
- Scaling.
- Data management. Calculations. Spreadsheets.

Science:

- Earth’s main movements with respect to the sun: rotation and tilt.
- Position of the sun to estimate the time of the day.
- 8 main directions in a wind rose.
- Maps and coordinate systems.

Methodology

Part	Description	Timing
1	**Social and historic introduction to time measurement: Teacher's introduction** Teacher’s introduction (*see worksheets for students: Engage*) The information you can find here may be a starting point.	45'
2	**Research on different types of sundials: groupwork** Online research and literature review (*see worksheets for students: investigate, plan)* The task about finding reusable materials should be sent as homework, at least one week before to gather all the materials.	45'
3	**a scaled map of the playground or space chosen for the children: groupwork** **Draw a scaled map of the playground or space chosen for the children** to make the measurements. This should be south-oriented (in the northern hemisphere) or north-oriented (in the southern hemisphere).	45'
4	**Assign each sundial on the map: group discussion** On the map, **assign each sundial location** where the students will have to take their measurements.	45'
5	**Research how to build a sundial with recycled materials: group discussion** Analyze different options and bring the chosen materials to school.	45'

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6	**Build a sundial with the chosen materials: group work** Build the sundial (Remind the students not to make the hour marks yet!)	90'
7	**Take measurements** Take measurements (length and angle) on several consecutive days, at different times of the day. Children should do this 3 times a day for a week: before starting school, before or after breaks at noon and at the end of the school-day. Be aware that some lessons might start later than scheduled or should finish ahead of time in order to allow students to perform their measurements. On the worksheets for children (*investigate*), children can do excersies about exploring latitude and longitude with shadows.	45'
8	**Transfer the shadows to the map: group work** **Transfer the shadows to the map, scaling** their length and keeping their angles.	45'
9	**Transfer all measurements** Transfer all measurements to the spreadsheet. Learn how to calculate an average, and make two plots: length versus time and angle versus time.	45'
10	**Coordinate a teleconference with another school in Europe** This is optional. Teleconference or chat with another European School and compare your measurements and analysis.	45'
11	**Prepare a short video (2 min) with the conclusions: group work** Share the video, and watch all of the other teams' videos: What have you learned? Why is it important? What else would you like to learn about this topic? Elaborate conclusions, record short videos, watch and discuss	90'

Organization

Materials

- Recyclables for the models.
- Protractors, rulers, and stationery.
- Wall to keep the map hanged for several days.
- A3/A4 strong paper for constructing the map.
- Internet access for one session

- Access to a spreadsheet software

Grouping

Children should work in groups of 3 to 4 students. Abilities such as spatial orientation, fine motor skills, creativity, fluency with ICT and verbal skills should be present in all groups.

Coaching

Useful questions

We recommend having a model of the Earth and a torch to hand to allow children to reflect on the following questions.

- Was it dark when you woke up for school? And when you go home in the afternoon?
- Why do people say that the sun moves in the sky? Is it correct?
- If you were on the surface of the sun, how would the Earth look (with the north pole on top) [1]? What part of Europe would you see first as it spins? What part would be the last hiding? (Since the Cardinal points are mere conventions, this question should allow their introduction).
- When we are having dinner, what do you think that people are doing in North America? And in India?
- If you were on the surface of the sun, would your classmates see you at all times? When would they see you for the first time? When would you be hiding? (Changing the reference viewpoint to the Earth may be challenging for some children and sticking a pin on the Earth's surface should help). ...

[1] You can use the terrain view at https://www.echalk.co.uk/Science/physics/solarSystem/InteractiveEarth/interactiveEarth.html

Adaptations

- For younger children (9-10), depending on their ICT skills, the spreadsheet activity could be limited to making graphs for some given measurements.
- Children with difficulties may be in charge of length (and not angle) measurements, and be guided through the process with manipulatives. A model of the Earth and the sun (if possible, with light) should be to hand for them at all times.
- Enrichment for this activity is easy to find and to encourage, such as having some copies of "Around the world in 80 days" and allowing them to research other kinds of clock like clepsydras.

Assessment

Teacher's assessment:

A 5-level rubric for self-assessment should include

- Planning: All groups have been able to finish their project on time
- Planning: Initial grouping was adequate and there were no problems in or within groups
- Coaching: Students have been motivated and engaged in all sessions
- Coaching: Group members have respected and valued each other's skills and abilities
- Coaching: Questions have been posed to a much higher degree than answers have been given.

Student's assessment:

A 5-level rubric for student assessment should include if children can:

- Understand that we can estimate the time of day by looking at a shadow's angle with respect to the north

- Understand the need for time-zones
- Use a compass to point to the 8 main directions of the wind rose
- Measure angles and lengths
- Transfer scaled measurements
- Locate positions on a map using coordinates
- Use a spreadsheet to store numerical data and make simple calculations