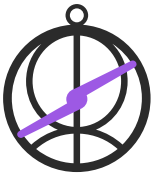
SPACE awareness

DISCOVERING THE SHAPE OF THE EARTH

How do we know the Earth is round?

Grom D.Matthies, Nuclio



Curriculumonderwerp
Geography

Grote idee van wetenschap

Trefwoorden
Islamic Heritage

Leeftijdsgroep
8 - 14

Onderwijsniveau
Primary School, Middle School

Tijd
1h30

Groepsgrootte
None

Toezicht voor de veiligheid
None

Kosten
Low (< ~5 EUR)

Locatie
None

Kernvaardigheden
Planning and carrying out investigations

Type leeractiviteit
Partial enquiry

KORTE BESCHRIJVING

By creating shadows with objects of different shapes and comparing them to the shadows seen in lunar eclipses, children will formulate a hypothesis for the most likely shape of the Earth, like Aristotle did in 400 BCE. This exercise sets the basis of knowledge that Eratosthenes and his contemporaries used 100 years later to measure the size of the Earth.



Fig. 11 Aristotle (Credits: shortbiography.org)

DOELEN

The children will use simple spatial geometry together with placing objects in space to discover how the shape of the Earth can be derived by observing lunar eclipses. The activity fosters the observational skills, hypothetical thinking and knowledge transfer from the observation of near objects to celestial bodies.

LEERDOELEN

After carrying out this activity, the children will be able to:

- explain how the shape of the Earth can be determined by observing lunar eclipses.
- name the ancient Greek philosopher who discovered the shape of the Earth.

EVALUATIE

- After having told the story of Aristotle and how he determined the shape of the Earth, the teacher or educator may ask the children to tell the same story in their own words.
- Ask the children how a lunar eclipse works.
- Ask the children, why the Moon becomes darker during an eclipse. Which celestial body casts the shadow?
- Ask the children, why the edge of the shadow cast on the Moon is curved. What can be derived about the shape of the celestial body that casts the shadow?

MATERIAAL

- A copy of images of a lunar eclipse (see figure 13)
- A strong lamp or a flashlight in a dimmed room
- 1 large sheet of paper (A3)
- Adhesive tape
- UNAWE Earthball or a globe
- 1 food plate, DVD or any other flat round object
- 1 box, book or any other rectangular object
- 1 tubular object (e.g. inner carton from toilet paper)
- Several other objects of different shapes



Fig. 12 (Credits: Grom Matthies)

ACHTERGRONDINFORMATIE

Lunar eclipses are the result of the shadow of the Earth being cast onto the Moon. Shadows have a shape and that shape depends on the shape of the object that casts it. By observing the shape of the Earth's shadow projected onto the Moon during a lunar eclipse, the philosopher Aristotle (living in Athens) inferred in 400 BCE the spherical shape of the Earth. Using this information, a Greek astronomer named Eratosthenes measured the size of the Earth, 100 years later.

VOLLEDIGE BESCHRIJVING VAN DE ACTIVITEIT

Draw a large circle on the A3 sheet of paper (about 29 cm diameter). This represents the Moon. With adhesive tape, fix this paper with the circle onto a wall. Dim the room. Place the lamp as far away as possible facing the page and shine onto the paper. Ensure focused bright light (spot light) so objects in the light path cast shadows with well-defined borders. To test, place your hand in the lightbeam and spread your fingers. Approach the circle at the wall until the shadow is dark and shows the shape of your fingers. Mark this as the primary position to create shadows with the other objects. Show the children the images of lunar eclipses below and explain that the moon gets dark because it enters into the shadow created by an object. What object could that be?



Fig. 13 Phases of a lunar eclipse showing the round shape of the Earth's shadow (Credits: wikipedia)

Ask the children in turn to choose and grab one of the designated objects and tell the others what shape the object has (round ball, rectangular box, triangular pyramid, circular plate…). Each student in turn moves the object into the beam of light until its shadow touches and enters the simulated moon circle.



Fig. 14 Projecting shadows on the moon model (Credits: Grom Matthies)

The student should then compare the shape of the shadow with the shape of shadows in lunar eclipses and decide if it is similar or not. Write or the shape of the object on the board and mark if the shadow is similar to the shadows seen in a lunar eclipse, or identify selectively only those that fit the eclipse shadow. Older children can make use of a table to write their results:

Object name	Shape name	Fits lunar eclipse? (Y/N)

With all objects and their shadows determined and compared to shadows in lunar eclipses, let students discuss and decide which shapes Earth most likely must have. Valid results must include:

- Any flat circular, elliptical or oval shaped object (e.g. round food plate, DVD, etc.)
- Any spherical, cylindrical or conical shaped object (e.g. ball, egg, rugby ball, etc.)

All considered Earth's shape must be round in some way. At the end of this short exercise, students should be aware and certain that:

Lunar eclipses are caused by the Moon entering the shadow of Earth, both are illuminated by the Sun. Earth's shadow is round, so Earth itself must also be round in some way.

This is the hypotheses Aristotle had in mind.

Note *Prevent emergence of wrong ideas right from the root and ensure to tell, that the phases of the moon are not caused by Earth's shadow! For this reason it is recommended to perform this activity after having carried out activity 3.1 (Lunar phases).*

CURRICULUM

Space Awareness curricula topics (EU and South Africa)

The journey of ideas, Geography

CONCLUSIE

In light of pseudoscientific beliefs like a flat Earth, this activity demonstrates that the actual shape of the Earth can be derived in a rather simple way, combined with a little bit of knowledge of geometry. The children follow up on the reasoning and observations of the ancient Greek philosopher Aristotle. The simple hands-on approach when simulating lunar eclipses with different shape models provides an intuitive understanding of the matter and makes it an interactive activity that can be included in STEM classes very easily.

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