Young Astronomers

The sky above us

Classroom Activity – Before visiting the Observatory

Overview

Age Range:
7 – 10 years old, (optional extended tasks are aimed for older pupils.)

Prep. Time: 30 min – 1 hour

Lesson Time:
About 1-2 hours + a few separate moments for observing the direction of the Sun in the course of a day (+ optional extended task Analemma: several observations in the course of a year).

Cost per activity: Low

Includes the use of:
Pen, paper (size A3), toy figure (e.g. a favorite toy from home, max about 3 cm), ruler, compass (e.g. smartphone), sunny day, free Stellarium software or online version

Outline

The rotation of the Earth is investigated by observing the length of a toy figure's shadow in the course of a day. As an introduction, the pupils can spin around themselves like the planet Earth to reveal the daily motion of our planet, and they can try to create different kinds of shadows with a torch.

As an extended task, you can use the Stellarium software to investigate how the Sun seems to move across the sky in the course of a day and how this movement changes in the course of a year. Alternatively, the students can make real observations of the position of the Sun in the sky in the course of a year (the analemma pattern).

Pupils will Learn:

- The Sun seems to move in the sky during the day, but actually our planet Earth is rotating around itself.
- The elevation of the Sun in the sky changes in the course of a year.

The online observatory collaboration consists of the following partners:
Baldone Observatory, Brorfelde Observatory, Cardiff University, Harestua Solar Observatory, Helsinki Observatory

Lesson Plan:

Description	Time	Notes
Introduction to the subject	15 min	
Activity 1: Moving shadows and rotating Earth Spin like a planet Moving shadow Follow the Sun	15 min 15 min (1 day)	See the example files: TheSkyAboveUs StudentExample.pptx, TheSkyAboveUs TeacherExample.pptx At least one observation in the morning, at noon and in the afternoon/evening.
Assessment	10 min	
Activity 2 (optional extended): The path of the Sun in one year A) Stellarium **OR** B) Analemma	30 min (1 year)	https://stellarium.org/fi/ or online version https://stellarium-web.org/ Requires observations e.g. once a month in the course of one year.
Assessment	10 min	

Introduction to the subject:

The Earth rotates around itself like a spinning top causing the sequence of day and night.

Activate and find out the level of your pupils' prior knowledge by discussing with them the following questions:

- How can you see the daily rotation of the Earth by observing the Sun in the sky or by observing the night sky?
  [The Sun and the stars seem to move clockwise in the sky. This is caused by the Earth rotating counterclockwise on its axis.]
- Have you noticed that the Sun casts shadows? Do shadows stay the same and point to the same direction at all times of the day?
  [An object lit by the Sun casts a shadow which falls opposite the direction of the Sun. Hence, as the Sun moves in the sky, also the shadow moves. The length of the shadow depends on the elevation of the Sun. In the winter time shadows are longer

compared to the summer time, and similarly, in the morning and in the evening they are longer compared to the the noon.]

- From which directions does the Sun shine during the day, for example from different windows in the school building or at home? In which direction does the Sun rise? [The Sun appears to rise in the east, it seems to travel to the south and finally set in the west.]

Star trails. Credit: Iztok Bončina/ESO

Activity 1: Moving shadows and rotating Earth

Pre-activity steps

- A spot with direct sunlight is required throughout the experiment (observations required throughout the day). Please note that, if needed the task can be divided to several days within a reasonable short period of time.

Spin like a planet

1. Take a lamp (floor or desk lamp, torch) and imagine it is the Sun. Stand so that you can see the lamp. You are the planet [your name]. Is it day or night on your nose mountain?
2. Now you can start spinning slowly around yourself (for example, it takes 24 hours for the Earth to spin once around itself)! Did you notice that the Sun disappears? The night has fallen on your nose.

3. When you continue spinning slowly you can notice that the Sun soon rises again and a new dawn breaks. This is the cycle of day and night.

Moving shadow

1. You will need a torch and a toy figure of your liking.
2. Place the toy figure on the table and illuminate it with the torch. What will happen to the toy figure's shadow if you illuminate the figure from different directions?
3. What if you place the torch at different heights? When is the shadow at its smallest?

Follow the Sun

1. Choose a spot where the Sun shines throughout the day.
2. Find south (for example using a compass). Mark in the upper corner of the paper the direction of the south with an arrow. Point the arrow towards the south.
3. Draw in the paper the objects (houses, trees etc.) that you can see on the horizon. The model picture will help you (TheSkyAboveUs StudentExample.pptx).
4. Draw a circle in the middle of the same paper. Place the toy figure in the circle.
5. Draw in the paper the position of the Sun at least once in the morning, at noon and in the afternoon/evening. Write down the time of the observation.
6. In addition, draw a straight line starting from the circle all the way to the end of the toy figure's shadow. Again, write down the time of the observation next to the line. See the model picture (TheSkyAboveUs TeacherExample.pptx).
7. Compare the shadows in your drawing! Ask questions that make the pupils understand how the direction of the Sun affects the direction of the shadow. Furthermore, does the direction of the Sun have an impact on the length of the shadow? When is the shadow at its shortest and why? Remember the previous section in this activity!

Assessment:

- Why does the Sun appear to move across the sky? Where does the Sun go at night?
- If the rotation of the Earth around its own axis stopped, what would happen to the Sun in the sky?
- Do you know of a type of clock that uses shadows to measure time?
- How does the sky move at night? Which objects do not follow the rotation of the Earth? [Hint: think about airplanes, shooting stars etc.]

Activity 2 (optional): The path of the Sun in one year

A) Stellarium

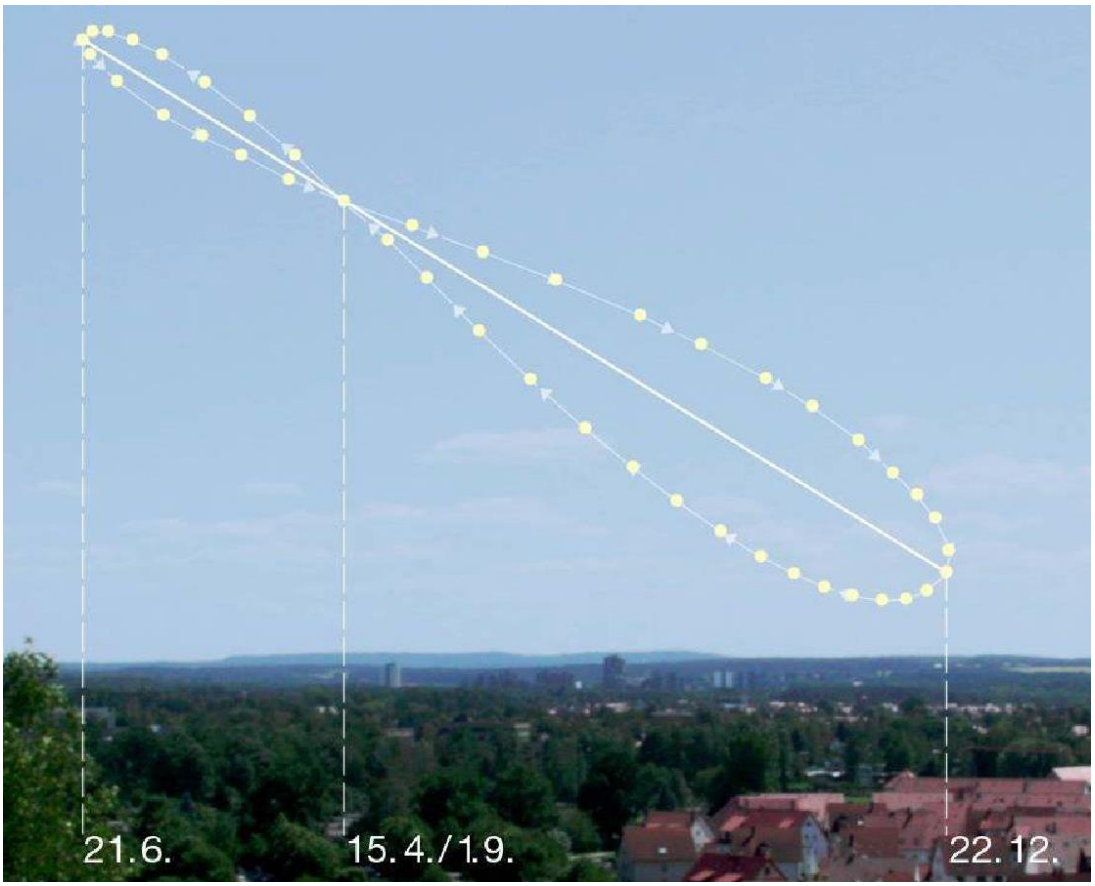
1. Download the free Stellarium software and investigate how the Sun seems to move across the sky in the course of a day (the same phenomenon as in the activity 1).

Open the Date/Time window to change the time. How fast does the Sun seem to move across the sky (from dawn to new dawn)?

2. Notice also how the objects seem to move during nighttime. Pay attention in which direction they rise and in which direction they set.
3. Open the Date/Time window to now change the month (keep the time fixed). Do you notice how the elevation of Sun (at noon) changes in the course of a year?

B) Analemma

1. Find a spot where you can see the Sun at least once a day (always at the same time, for example at noon) throughout the year.
2. Use a smartphone or camera to take a photo of the Sun. Make sure that there is also some landscape visible in the photo so that it is easier to see to which direction the photo is taken.
3. Once a month, exactly at the same time of the day, go to the same spot and repeat taking the photo of the Sun.
4. After a year you can compare the photos (or even combine them in the Photoshop) to see how the position of the Sun has changed in the course of a year. You should see the positions of the Sun forming an eight-shaped pattern called the analemma.



Analemma. Credit: Wikimedia Commons / user: jailbird/ CC BY-SA 2.0 DE

Assessment:

- **Stellarium:** How do the objects move during nighttime compared to the daytime? (Answer: The movement is similar, from east to west.)
- **Stellarium:** Can you figure out when the objects cast the shortest possible shadows (at noon)? (Answer: When the elevation of the Sun is at its largest, in other words in the summer time.)
- **Analemma:** Can you think what causes the eight-shaped analemma pattern? (Answer: The midday altitude of the Sun varies over the course of the year due to the tilt in the Earth's axis of rotation.)
- **Analemma:** What about the Sun's sideways movement in the analemma? Why is it not just a straight line instead of an eight-shaped pattern? (Answer: The Sun's sideways movement in the analemma is caused by the Earth's varying orbital velocity.)

Background Material/Knowledge:

- Cardinal directions (north, south, east, west)
- Knowledge of clock