Demonstrate the apparent rotation of the sky with an astronomical umbrella

Using a simple model to show the difference in the appearance of the night sky seen from Earth or from space

Many textbooks explain the Earth motions (rotation, revolution, …) as seen from space. Also, the book pictures provide this kind of perspective, making it difficult for students to understand what they see from another point of view: the Earth's surface where they live.
This activity only needs a globe and an umbrella with a sketch of a celestial hemisphere drawn on the internal surface of the canopy. You can buy an astronomical umbrella or a plain umbrella (blue or black) where you – or your students - can draw with a white marker the main constellations of the Northern or Southern hemisphere, according to where you live. To do so, use the pictures on pages 3 and 4: the North (or South) celestial Pole will be at the crossing of the ribs. *Tip:* use the ribs as a reference to transfer the astronomical grid (meridians and parallels) on the umbrella canopy.

Astronomical umbrella
Image: public domain

Position the globe on a table at the centre of the classroom, with the North (or South) pole in the right direction with the help of a compass or of a smartphone with a compass app. Ask a student to position the astronomical umbrella over the globe: which direction will the umbrella tip be? (*northwards or southwards, depending on which hemisphere you have used for your model*).
What will be the angle between the umbrella shaft and the horizon - and the table, that is the local horizon? (*the shaft should be aligned with the globe axis).*
Ask another student to rotate the globe to simulate Earth rotation. Should it be eastwards or westwards? (*eastwards*).

The umbrella is positioned over the globe aligned to its axis
Photo: Giulia Realdon

How long will it take (approximately) for a complete rotation of the Earth? (*about 24 hours*).
Try this example to make the situation more familiar. Ask: imagine you are on a merry-go-round spinning in the middle of a town square, how would you see the square from your position? *(a probable answer will be "I would see the square landscape as if it were rotating in the opposite direction"*).
Ask a student to locate the school's country on the globe and position there a small piece of Plasticine™ as a signpost, then rotate the globe again.
If the umbrella is stationary, how will the sky be seen from the rotating point? (*anticlockwise or clockwise depending if you are looking northwards or southwards*).
For older students, ask: what is the relationship between the observer's latitude and the angle between the astronomical pole and the local horizon? (*they have the same value*).

Now, challenge the students with this task: how would you see the sky from your position? How would you simulate this with the astronomical umbrella? (*hint:* keep the globe still and think of the relative motion of the umbrella).
When students have correctly carried out this task, you can remove the globe and ask students to take the umbrella and to position and rotate it with respect to the local horizon, as if they were at the North Pole, in a location on the Equator, in a location at a medium latitude of the opposite hemisphere of their own, at the South Pole, etc.
In this way they can notice that not all the constellations are always visible from every observing site: according to our position on Earth, we will see some constellations rise and set during the night.

The back up

Title: Demonstrate the apparent rotation of the sky with an astronomical umbrella

Subtitle: Using a simple model to show the difference in the appearance of the night sky seen from Earth or from space

Topic: An “astronomical umbrella”, with the constellations of a celestial hemisphere drawn on the internal side of the canopy, and a globe are used to simulate the apparent motion of the sky as seen from the Earth’s surface.

Age range of pupils: 11-18 years

Time needed to complete activity: 40 minutes (plus the time needed to draw on the umbrella, if you make it yourself).

Pupil learning outcomes: Pupils can:
- realise that they are on a rotating planet even if they perceive that they are on a still surface;
- understand that the apparent motion of the night sky is due to the observer’s point of view on a rotating Earth;
- understand that the apparent motion of the sky is centred around a celestial pole and that it is seen anticlockwise if looking northwards and clockwise if looking southwards;
- understand and demonstrate the apparent motion of the sky as seen in different locations on the Earth.

Context: The simulation of the Earth’s rotation with a globe and the astronomical umbrella allows the students to see the same phenomenon from different points of view and facilitate the description of the apparent motion of the night sky.

Following up the activity: You can use a virtual planetarium program like Stellarium (https://stellarium.org/) to simulate the apparent motion of the sky, and to expand the simulation through the many available options (change point of view, time, speed, add equatorial or azimuthal grid, “erase” the atmosphere to see the stars during daytime, …).
You can also propose students a web quest on the evolution of the image of the sky and of the Solar System from antiquity to the Copernican revolution.

Underlying principles:
- The Earth rotates eastwards around an axis passing though the poles in approximately 24 hours.
- From the Earth’s surface this movement is perceived as an opposite (westward) rotation of the night sky and of the Sun’s daily path. A celestial pole (North or South) is seen at an angle equal to the North or South latitude of the observer.
- Constellations rotate on circles centred on the celestial pole (North or South) and, depending on the latitude of the observer, may either be visible for the entire rotation or rise and set below the horizon.

Thinking skill development: Through this activity students will improve their capacity to switch the point of view on the relative motions of the rotating Earth and the night sky. This switch presents students with a cognitive conflict that can be addressed through the use of a model of the Earth and of the celestial hemisphere. By manipulating the model and describing it from different points of view, students can bridge what they see in the classroom with the astronomical phenomena due to the Earth’s rotation.

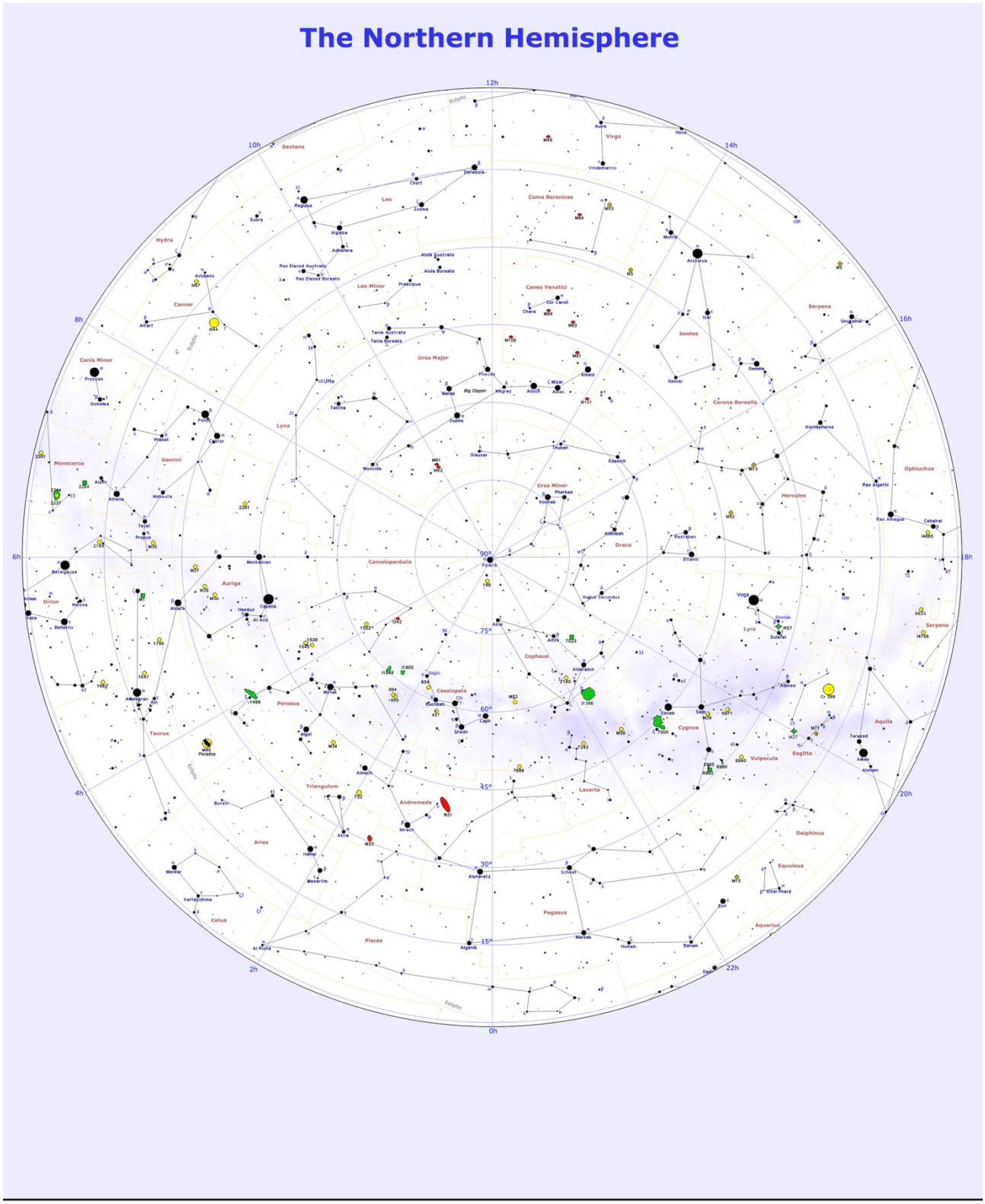
Resource list:
- an astronomical umbrella (bought from a science education provider or a normal umbrella prepared by the teacher or by the students. In this case a white marker and a celestial map, as at page 3 and 4, are needed)
- a globe
- a compass (or a compass app on the smartphone)
- a piece of Plasticine™

Useful links: Stellarium (https://stellarium.org/)

Source: Giulia Realdon, UNICAMearth workgroup, University of Camerino, Italy (https://geologia.unicam.it/). and Andrea Bernagozzi, UNICAMearth workgroup and Osservatorio Astronomico della Regione Autonoma della Valle d’Aosta (www.oavda.it), who also revised the activity.

Earthlearningidea team. The Earthlearningidea team seeks to produce a teaching idea regularly, at minimal cost, with minimal resources, for teacher educators and teachers of Earth science through school-level geography or science, with an online discussion around every idea in order to develop a global support network. 'Earthlearningidea' has little funding and is produced largely by voluntary effort.

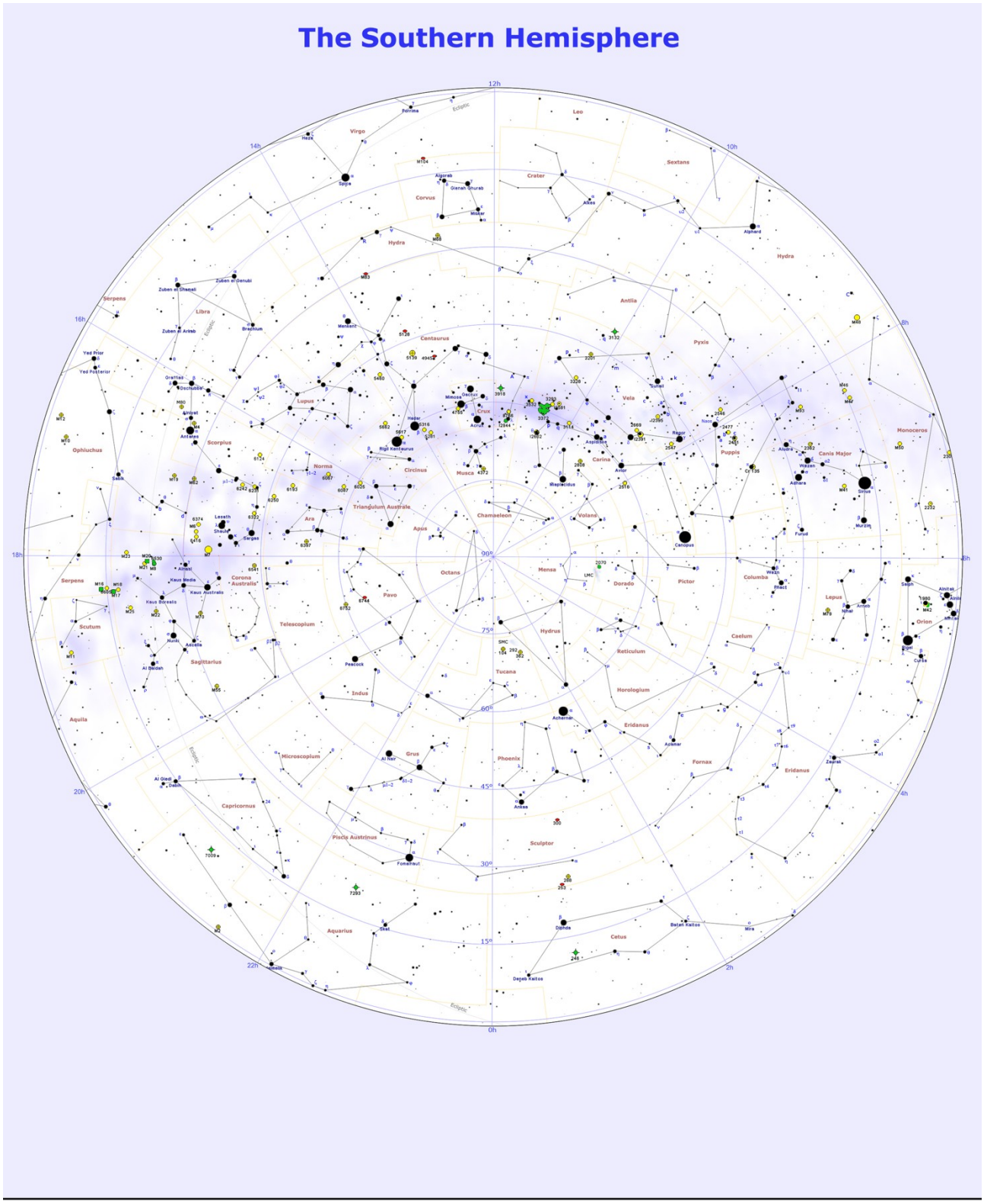
If you have any difficulty with the readability of these documents, please contact the Earthlearningidea team for further help.



LEGEND

STARS	OPEN CLUSTERS	GLOBULAR CLUSTERS	PLANETARY NEBULAE	BRIGHT NEBULAE	GALAXIES	MILKY WAY
Magn. -1 0 1 2 3 4 5 6	TO SCALE <20′	TO SCALE <20′	TO SCALE <20′	TO SCALE <20′	TO SCALE <20′	

Sky map of the Northern hemisphere
Image: Robero Mura, Wikipedia CC BY-SA



LEGEND

STARS	OPEN CLUSTERS	GLOBULAR CLUSTERS	PLANETARY NEBULAE	BRIGHT NEBULAE	GALAXIES	MILKY WAY
Magn. -1 0 1 2 3 4 5 6	TO SCALE <20'	TO SCALE <20'	TO SCALE <20'	TO SCALE <20'	TO SCALE <20'	

Sky map of the Southern hemisphere
Image: Robero Mura, Wikipedia CC BY-SA