**Long days of summer**

A teacher uses a spotlight and a globe to show why days are longer in summer and shorter in winter.



**To answer**

1. What makes the globe a good model for the Earth?
2. How can the spotlight and globe show days are longer in summer?
3. What needs to be changed to show how days are shorter in winter?
4. How is this change *similar* to what really happens?

How is it *different*?

*Physics > Big idea PES: Earth in space > Topic PES2: Earth and Sun > Key concept PES2.1: Days and seasons*

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| **Response activity** |
| **Long days of summer** |

**Overview**

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| Learning focus: | The temperature is higher in the summer because the tilt of the spinning Earth increases the length of a day and increases the heating effect of the Sun’s radiation. |
| Observable learning outcome: | Describe the apparent movement of the Sun during the day.  Describe the effect of seasons on temperature, day length and the apparent movement of the Sun.  Explain why days are longer in summer and shorter in winter. |
| Activity type: | Critiquing a representation |
| Key words: | Equator, season, spin, summer, winter |

This activity can help develop students’ understanding by addressing the sticking-points revealed by the following diagnostic questions:

* Diagnostic question: Changing Sun
* Diagnostic question: Changing seasons
* Diagnostic question: Summer days

**What does the research say?**

Students often learn about the cause of day and night in primary school at ages 9-11 (Department for Education, 2013) and it can be tempting to keep this work simple and descriptive when in fact it is conceptually demanding (Osborne, 2011). The scientific explanations for simple observations such as the Sun moving across the sky each day are not obvious and sometimes counter intuitive. The Sun’s ‘movement’ across the sky happens not because the Sun is moving, which is the most obvious explanation, but because the Earth is spinning on its axis.

At age 11-14 most students understand the Earth to be a sphere and describe the cause of day and night in terms of the movement of astronomical bodies (Driver et al., 1994; Baxter, 1989; Bakas and Mikropoulos, 2003; Brewer and Vosniadou, 1994; Sharp, 1996). Baxter (1989) found that the proportion of students’ holding the scientific understanding of the cause of day and night declines over time. Further studies (Sharp, 1996; Kikas, 1998) support this finding, which suggests many students learn this idea by rote without understanding, or that they are unable to integrate teaching with their earlier preconceptions. Typically after teaching, about 60% of 10- and 11-year-olds are able to explain night and day (Sharp, 1996; Kikas, 1998), but this ‘understanding’ can be short lived. In her study, Kikas found that after four years only 20% of the students from the original sample still maintained the correct scientific understanding.

In order to build and consolidate students’ understanding of day and night, the use of physical models has been shown to be an effective strategy (Bakas and Mikropoulos, 2003; Lelliott and Rollnick, 2009). Models can be used to explain day and night and why the tilt of the Earth alters the length of the day at different times of the year.

**Ways to use this activity**

This model can be demonstrated to students and the activity completed after the demonstration to help to consolidate understanding.

* In a semi-dark room hold the globe next to a bright light so that half of the globe is clearly lit up and the other half is in shadow.
* Show how the spin of the Earth causes day and night. A small piece of Blu-Tack fixed to your location helps illustrate this.
* Notice that the globe is on a tilt of 23.5o and explain this matches the tilt of the Earth.
* Elicit that there is no force to alter the tilt as the Earth orbits the Sun each year (ignoring a negligible gyroscopic force), which means sometimes it tilts towards the Sun and sometimes away.
* Recall the real scale of this situation – a globe of 25cm diameter means the Sun has a diameter of 2.73m and would be 2936m (nearly 2 miles) away. This is important in order to avoid the misunderstanding that the changing distance between the Sun and a point on the Earth’s surface is the cause of seasons.
* Show that for part of each year when it is summer, the Earth tilts towards the Sun (the hemisphere you are located on). Spinning the globe at a steady rate reveals the day to be longer than the night for your location. The reverse is true for places in the opposite hemisphere.
* Show that six months later after half an orbit the hemisphere you are located on is now tilted away from the Sun. The shorter days and longer nights of winter can be demonstrated.
* Ask how the heating of different parts of the Earth by the Sun changes between these two extremes. (The longer the day, the longer the Sun heats for.)

Students should now complete the activity in pairs or small groups, and the focus should be on the discussions. It is through the discussions that students can check their understanding and rehearse their explanations.

Philosophically science can be said to be a description of the ‘best model’ we have for the world. In this activity students should identify ways in which this particular model is a good representation of the real world, and ways in which it is not.

Students should work together to answer the questions on either the worksheet or the PowerPoint. Giving each group one worksheet to complete between them is helpful for encouraging discussion, but each member should be able to report back to the class. Listening in to the conversations of each group will often give you insights into how your students are thinking.

Ending with the students completing the worksheet or questions from the PowerPoint individually, might help them to consolidate their learning.

*Differentiation*

You may choose to use simplified worksheets for some students, for example with gaps to fill in so they can focus on the science. In some situations it may be more appropriate for a teaching assistant to read and/or scribe for one or two students.

**Equipment**

For the class:

* Globe
* Bright lamp

**Expected answers**

1. The globe is spherical, it spins and is tilted (at 23.5o).
2. When tilted towards the lamp, more than half of the top part of the globe is lit up. Spinning at a steady speed shows places in this part of the globe are lit up for longer than they are in shadow.
3. The globe needs to be tilted away from the lamp. It should be kept at the same angle and moved to the opposite side of the lamp. (The lamp may need to be turned round.) The force of the Sun on the Earth keeps it in orbit, but cannot change the tilt of the Earth. This means that to tilt away from the Sun the Earth must move around the Sun.
4. The Earth stays tilted at the same angle as it orbits the Sun so its tilt towards the Sun changes over a year.

It takes six months for the Earth to move half way around the Sun. The globe should be almost two miles from the lamp to match the true scale of the Sun and Earth system, and the lamp should be a 2.73m ball of plasma and hot gas that radiates in all directions.

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Developed by Peter Fairhurst (UYSEG).

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