



## Key Stage 2: Moon Zoo

### Teacher's Notes

#### **Curriculum Links: Sci3F – Light and Shadows, Sci5E – Earth, Sun and Moon**

This extension activity uses the Citizen Science project 'Moon Zoo' (<http://www.moonzoo.org>) to help astronomers identify boulders on the surface of the Moon.

**Equipment:** Computer with Internet access, Zooniverse username and password (see page 3, 'Getting Started'). Optional: demonstration computer connected to projector.

#### **Class discussion before the activity:**

How can we see the Moon? Does it produce its own light?

**Answer:** The Moon does not produce its own light. The sunlight from the Sun reflects off the Moon so that we can see it.

If the shadows cast by certain features on the Moon are long in an image, where do you think the Sun is – high or low relative to the surface of the Moon?

**Answer:** The higher the Sun is relative to the surface of the Moon, the shorter the shadow. The lower the Sun is relative to the surface, the longer the shadow.

How can you tell the difference between a mound and a boulder on the Moon from the Moon Zoo images using just light and shadow?

**Answer:** Shadows on the Moon are different for different types of features on the Moon. For instance, the shadows cast by crater walls have a generally smooth curve (with perhaps a few jagged shadows cast by mountains) while boulders have small irregular shadows. Also light reflects off some features on the Moon more than others. For example, boulders reflect more light than the lunar surface.

Why can we still see so many impacts on the Moon formed over billions of years and the same number are not visible here on Earth?

Hint: What are the differences between being on the Moon and being on Earth?

**Answer:** The Earth has an atmosphere and the Moon does not. Here on Earth we have the wind, rain and seas to erode or wear away features over time. Also, the atmosphere of the Earth can burn up material so that only bigger objects can make it to the Earth's surface. Finally the Earth is still a very active place – the rocks and land on our home planet are recycled over millions of years. Any older impacts are erased by this geological activity on Earth, while the Moon keeps its long visible history of impacts.

#### **Relevant background science**

All the images available on the Moon Zoo website are courtesy of the NASA Lunar Reconnaissance Orbiter (LRO) spacecraft. The LRO orbits the Moon taking high resolution images of the lunar surface from above. The images are so detailed that even objects only one metre long on the surface are distinctly recognisable. With

so many images being transmitted back to Earth on a daily basis, astronomers need all the help they can get to explore and analyse the detailed lunar landscape.

Computer programmes are often used in astronomy to number-crunch for large amounts of data, but there are still many things that humans do much more efficiently. In the case of the images from the LRO, the human eye can quickly pick out features such as craters and boulders on the surface of the Moon from photographs. By marking such features, astronomers can work out more about the history of our moon and the risk of impacts to both the Moon and Earth.

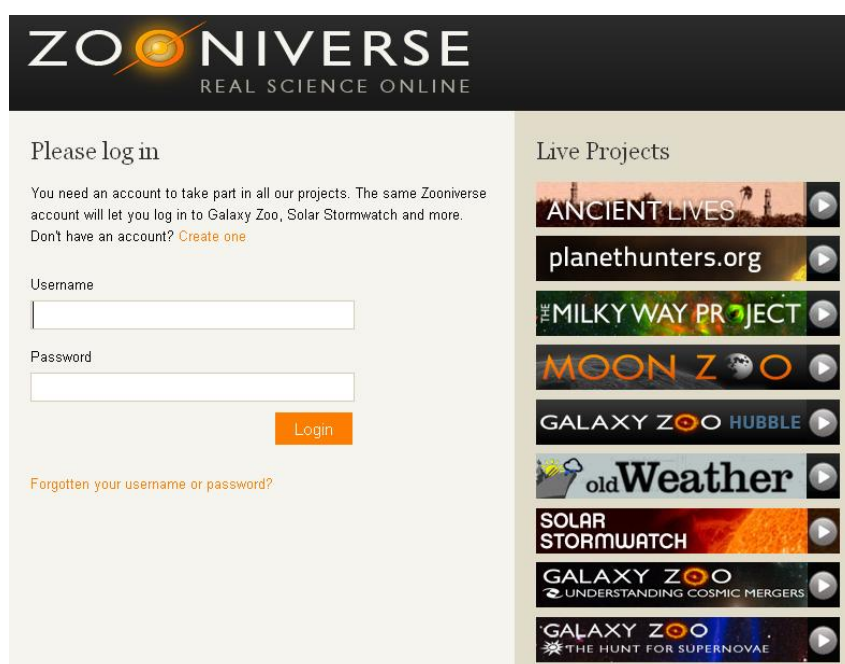
## Activity: ‘Boulder Wars’

There are two activities currently available on the Moon Zoo website: Crater Survey and Boulder Wars. Crater Survey requires much more time on each image and a more detailed marking method than Boulder Wars. Boulder Wars uses the concept of light and shadow to identify boulders by eye from the LRO images.

Locating regions with boulders present helps identify parts of the Moon that have suffered major impacts from comets or asteroids. In these cases the impacts have upturned the lunar soil or regolith. Studying these regions also helps identify how deep the lunar soil is for different areas on the Moon.

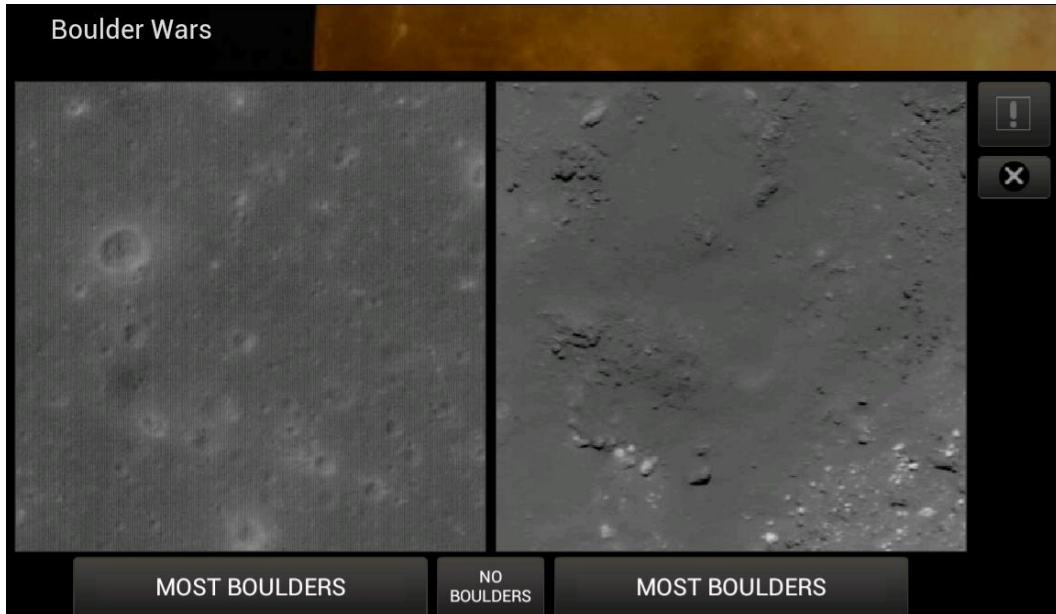
### Getting Started:

After using your internet browser to go to <http://www.moonzoo.org>, click the “EXPLORE THE MOON” in the bottom right corner. If you have an account with another Zooniverse project (like Solar Stormwatch or Galaxy Zoo), you can use the same Username and Password here. If not, click ‘Create one’. All students can log on using just one Username and password or individual logins could be created.



After logging into Moon Zoo, look to the top right of the screen and click on 'Boulder Wars' under the heading "Play".

You will be presented with a screen as seen below.



There are two images and three buttons to choose from. The objective is to click 'MOST BOULDERS' for the image with the most identifiable boulders and if both appear to have none then the 'NO BOULDERS' button can be clicked.

### **Class Setup:**

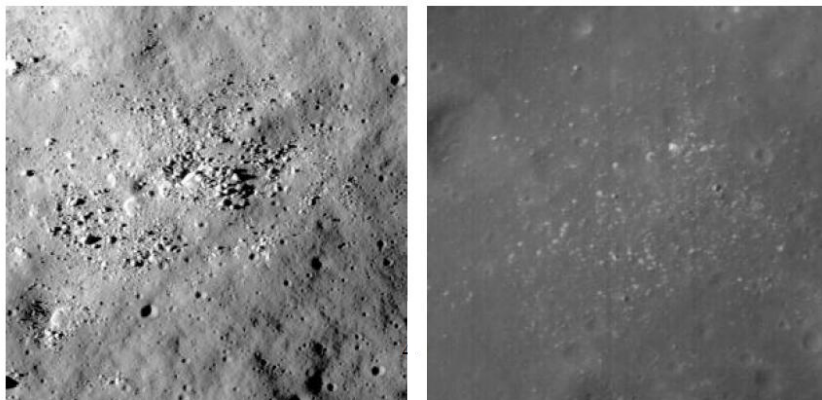
Two students per computer

The number of pairs of images submitted is flexible for the time allotted

The Interesting Features marker may be dropped or included depending on time and/ or ability.

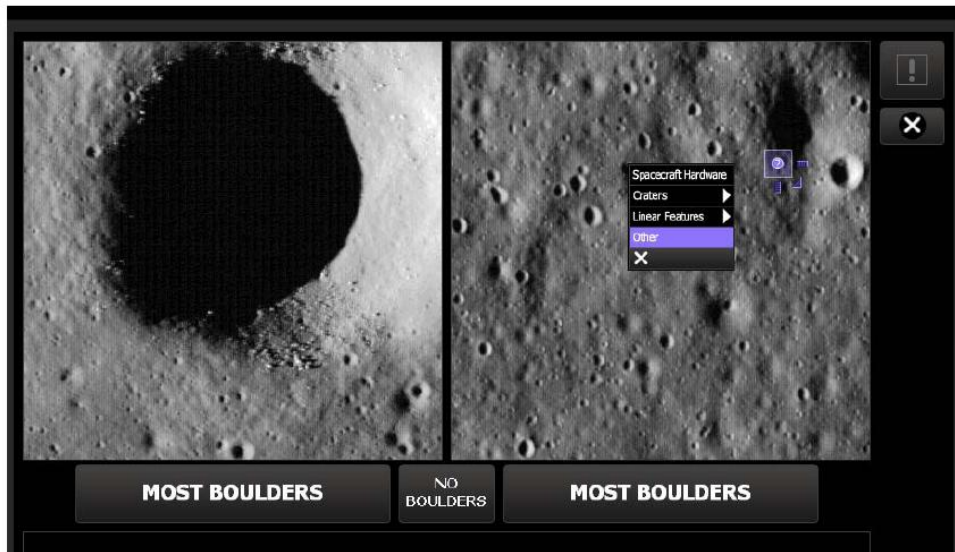
### **Identifying boulders and items of interest on an image:**

The key principle in finding boulders is the way light reflects off them and the shadows they cast. Sunlight reflects off the boulders and their shadows are irregular in shape as opposed to the round, smooth shadows cast by mounds and craters. Both of the images below contain boulders. Just as in the Shadows on the Moon workshop offered at the Royal Observatory Greenwich, the shadow length depends on the position of the Sun relative to the Moon.



Sometimes there are features on the Moon which look radically different from a standard boulder, mound or crater. In the event of a student finding an unusual feature, they can use the 'Mark interesting features' button (the exclamation mark button) to drag a rectangle around the unusual feature. Students can label the feature as one of the following:

- Spacecraft Hardware (such as the *Apollo* landing sites)
- Craters (with sub-menu of specific types)
- Linear Features (with sub-menu of specific types)
- Other (for anything else)



The rectangle can be resized or deleted with the X button if a mistake is made. For a full breakdown of the types of features including crater sub-categories and linear features, click 'How to Take Part' on the left-hand sidebar of the Moon Zoo website.