THE EDGE

PLUTO AND BEYOND

EDUCATOR'S GUIDE

CLARK PLANETARIUM

SALT LAKE COUNTY

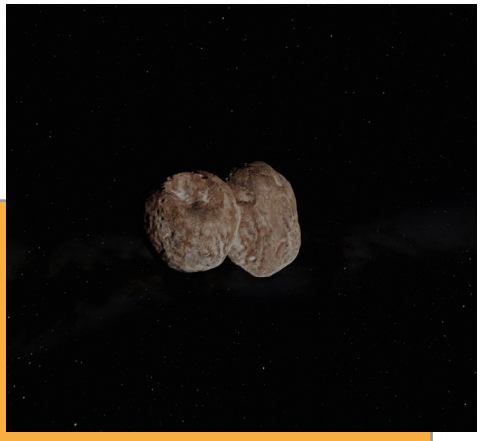
THE EDGE:
PLUTO AND BEYOND

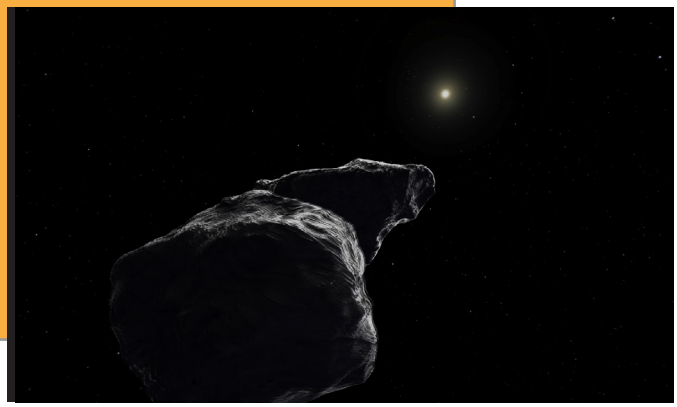
"The Edge: Pluto and Beyond" is a fulldome show from Clark Planetarium that explores the "third realm" of the Solar System, the immense region past the gas giants. The expanse at the edge of the Solar System is mostly unknown to scientists but it is believed to be occupied by hundreds of thousands of objects. With the help from missions like New Horizons, it is only in recent years that astronomers have been able to study this realm.

"The Edge: Pluto and Beyond" takes us from Clyde Tombaugh's discovery of Pluto to the recent discovery of the distant Kuiper Belt object Arrokoth and other objects beyond the planets in our Solar System.

Alignment to Next Generation Science Standards

"The Edge: Pluto and Beyond" models several Science and Engineering Practices, demonstrates numerous Crosscutting Concepts, and explores content associated with several Disciplinary Core Ideas.





Integration

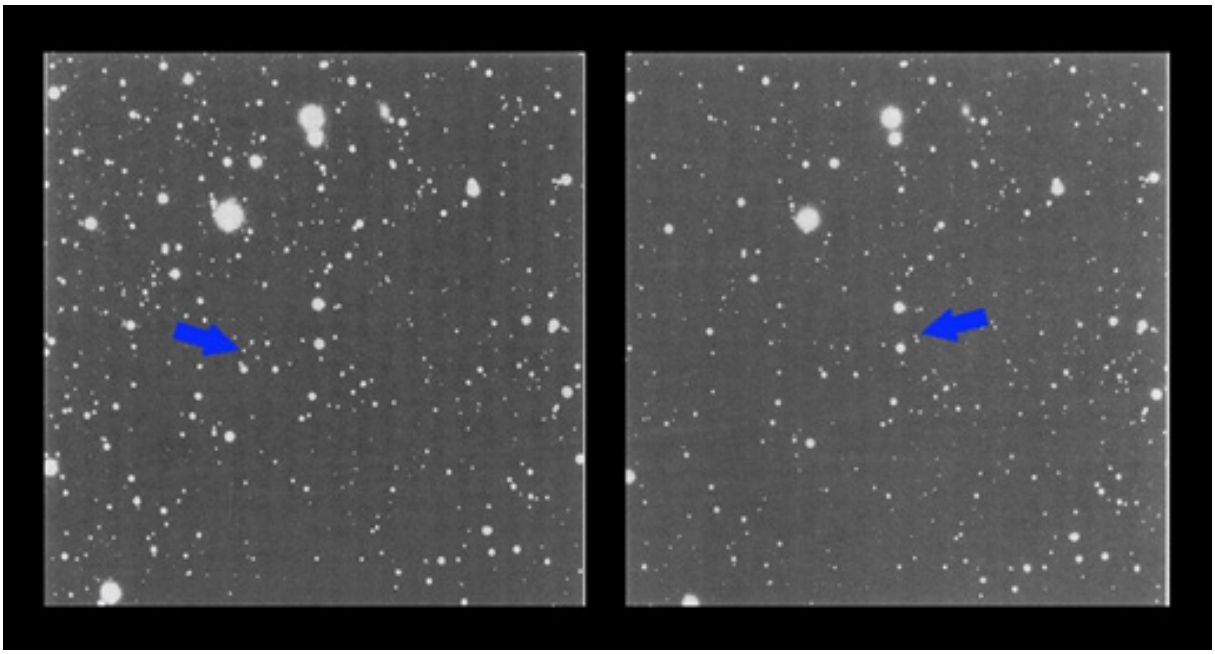
Science and Engineering Practices	Crosscutting Concepts	Disciplinary Core Ideas
Asking questions (for science) and defining problems (for engineering)	Patterns	Earth and Space Sciences 1: Earth's place in the universe
Planning and carrying out investigations	Scale, proportion, and quantity	Engineering, Technology, and Applications of Science 2: Links among engineering, technology, science, and society
Analyzing and interpreting data	Systems and system models	
Constructing explanations (for science) and designing solutions (for engineering)	Energy and matter: Flows, cycles, and conservation	
Obtaining, evaluating, and communicating information	Stability and change	

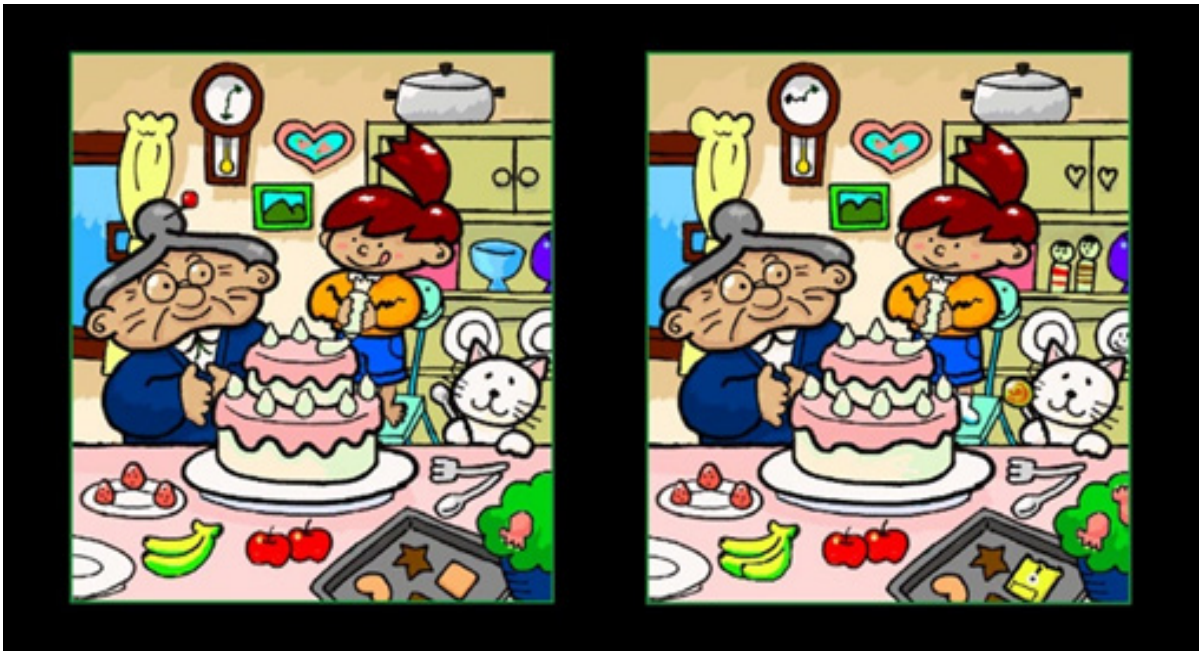
Lesson Overview

Overall Objectives	Student Objectives in the 5E Model	Student Objectives in This Lesson
Engage	Students build interest in phenomenon and access prior knowledge	Students observe two photos and try to identify Pluto
Explore	Students ask questions and gather information	Students compare two images to find differences, using two different methods
Explain	Students build an explanation of phenomenon	Students explain why one method is superior to another
Elaborate	Students deepen understanding by applying explanation to another version of the phenomenon	Students use blink comparator method to identify Pluto
Evaluate	Students demonstrate understanding of the phenomenon	Students demonstrate understanding by using blink comparator to identify Eris

Lesson Plan

Spot the Difference: Use the "blink comparator" method of spotting difference between images.





Preparation

Download the "Spot the Difference" Powerpoint from Clark Planetarium's website at: https://slco.org/clark-planetarium/education/for-educators/. Read through the lesson and test the "blink comparator" method of spotting differences between images.

For ease of use, the lesson notes below are also included in the Powerpoint file.

Engage: Can you spot the difference?

- Ask students to tell you what they know about Pluto.
- Ask students if they know how Pluto was first discovered.
- Tell students that Pluto was discovered in 1930 by a scientist named Clyde Tombaugh. Tombaugh was comparing two images of the night sky and found an object that appeared in different places at different times. In other words, the object was moving. There were no currently known planets or asteroids in that region of space, so Tombaugh had discovered something new.
- Show students the two images that Tombaugh used. Ask them if they can spot the difference? They will probably struggle to identify the difference quickly.

Explore: Can you spot the difference? pt. 2

- Tell students that they could use some practice finding differences in an easier image, then they can try to find Pluto again. Show students the simpler "find the difference" images.
- Give students several minutes to spot differences. Some may get spotted quickly and some may take more time.
- Stop students before they can fully finish and tell them that there is a simpler way to find the differences. When scientists are trying to answer a question, they want to find the simplest, most effective way to find the answer.
- Show students the first "find the difference" image that has been split. Then show students the second image.
- Quickly switch back to the first image. Then back to the second image. Repeat several times. As you flip back and forth, the differences in the images should become easier to observe.

Explain

- Ask students which method was more useful to spot differences: side by side or switching.
- Tell students that the switching back and forth technique is called a "blink comparator". The display "blinks" each image, allowing an observer to compare the differences.
- Ask students to explain how the blink comparator method works and why it is useful.

Elaborate

- Tell students that they can use this new technique with the photos that include Pluto.
- Blink back and forth between the two Pluto images, giving students time to find Pluto. Students may need to approach the projector screen to demonstrate what they see.
- Once Pluto has been identified, blink back and forth between the slides with the labelled arrows.
- Tell students that this method is much faster – but discovering Pluto in 1930 was still not easy!
    - Previous scientists had calculated where an unknown planet might be in the sky, but a large section of the sky had to be photographed. Each photograph required about an hour to develop, meaning only a few photographs could be obtained each night. And not all night have good conditions for stargazing – clouds, full moon, and the time of year can block parts of the sky.
    - Clyde Tombaugh had to "blink compare" hundreds of images to find Pluto. Early photographic techniques were not as easy as they are today. Each set of photographs were large 14" x 17" glass plates, unlike the digital photographs used today.

Evaluate

- Tell students you have one more astronomical object for them to identify using a blink comparator.
- Show students the next two slides, using the "blink comparator" method.
- Give students time to identify the moving object.

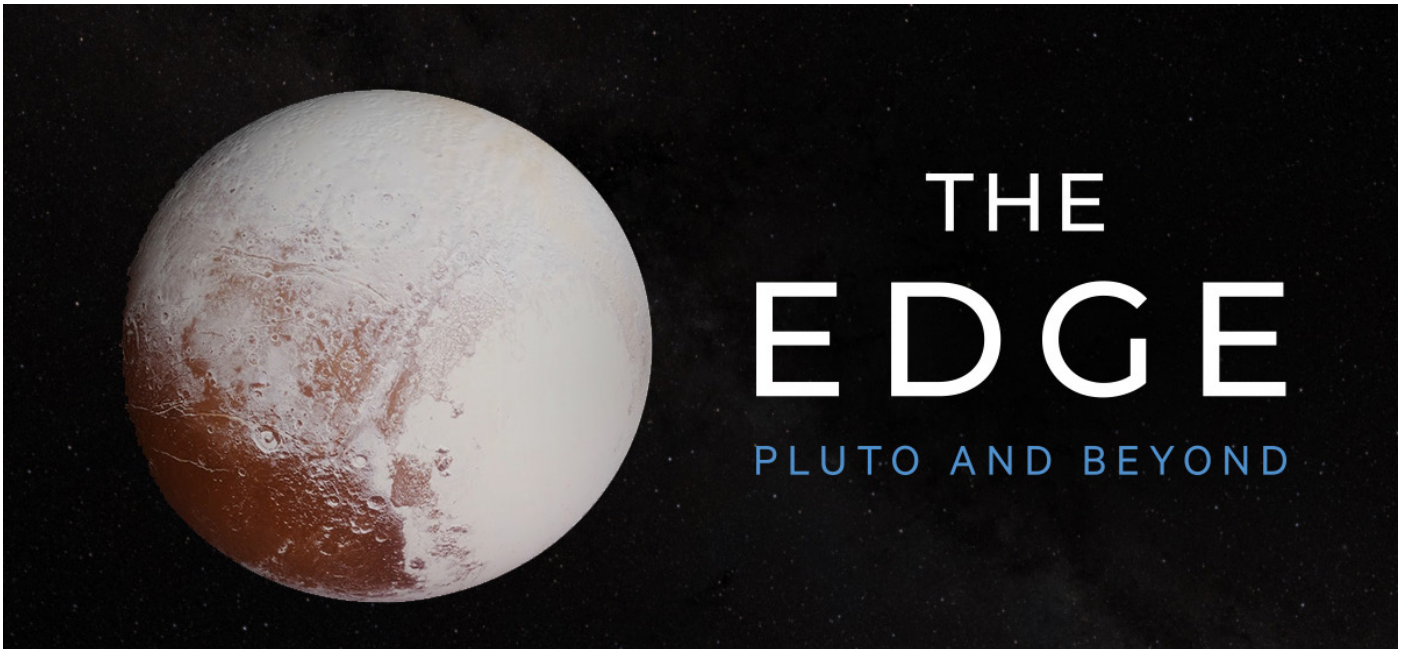
(cont).

- Ask students if there is anything different about this object. They may notice that it only moves a very small amount in the picture. This object is much farther away than Pluto – it is the dwarf planet Eris. In addition to being a slower moving object, these photos were taken closer together than the Pluto photos.
    - The discovery of Eris in the mid 2000's started the process that led Pluto to being reclassified as a dwarf planet. Eris was initially the "tenth planet", but additional similar objects were also discovered. A new classification system was developed that included a "dwarf planet" category, which includes Pluto, Eris, and several other objects.

Notes

Additional Resources:

- The discovery of Eris: http://web.gps.caltech.edu/~mbrown/planetlila/
- Pluto as a dwarf planet: https://www.iau.org/public/themes/pluto/
- The New Horizons NASA Mission page: http://pluto.jhuapl.edu/



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