CosmoVerse Adventures:

Dark Energy

Lesson Plan

Grade/ Grade Band:	**Topic:** Dark Energy	**Lesson # _____ in a series of _____ lessons**

Brief Lesson Description: This lesson allows students to dive into the mysterious world of dark energy and its profound impact on the universe. Explore the cosmic forces at play, understand the nature of dark energy, and unravel how it influences the fate of the cosmos

Specific Learning Outcomes: By the end of the lesson, students will be able to:

(1) Grasp the fundamental idea of dark energy and its distinction from dark matter.
(2) Describe how dark energy contributes to the accelerating expansion of the universe.
(3) Gain insights into various theories about the universe's fate, such as the Big Freeze, Big Crunch, and Big Rip.
(4) Discuss how dark energy impacts the structure and future of the universe.

Narrative / Background Information

Prior Student Knowledge: Students should have a basic understanding of:

- Familiarity with fundamental concepts such as gravity, the solar system, and the structure of galaxies.
- Understanding the redshift of light from distant galaxies as evidence of an expanding universe.
- Basic knowledge of Newton's laws of gravity and Einstein's theory of general relativity.

Materials needed:

- Balloons
- Small round stickers
- Markers
- Ruler or tape measure
- Graph paper

LESSON PLAN – 5-E Model

ENGAGE: To pique students' curiosity about the concept of dark energy and its impact on the universe.
Activity: Start with tossing an apple in the air to discuss the concept of escape velocity.
Discussion:

(1) How does the concept of escape velocity relate to the expanding universe?
(2) Why might you have expected the universe's expansion to decelerate over time, and how does the discovery of dark energy challenge this expectation?
(3) What are the differences between dark matter and dark energy, especially in terms of their effects on the universe?

EXPLAIN: Students actively investigate the evidence supporting the existence of dark energy through 'Meet a scientist' with Stephen Hawking.
Activity: Share/Read out the conversation with Stephen Hawking.
Discussion:

(1) How does the concept of cosmological redshift provide evidence for the expanding universe?
(2) Why are standard candles, like Type Ia supernovae, crucial in measuring the distances of celestial objects?
(3) What was the significance of the discovery that distant supernovae appeared fainter than expected?

EXPLORE: Introduce hands-on learning with the Action Lab.
Activity: Conduct the " Expanding Universe " demonstration.
Discussion:

(1) How does the balloon model help us visualize the concept of the universe expanding due to dark energy?
(2) How does the concept of the cosmological constant relate to our current understanding of dark energy?

ELABORATE: Extend students' understanding of dark energy and its cosmic implications.
Discuss:

(1) How do these models predict the future of the universe?
(2) What might be the implications for our understanding of the universe if dark energy's nature is fully understood?

EVALUATE: Assess students' understanding and ability to apply the concept of dark energy.
Activity: A quiz or project where students explain the role of dark energy in cosmic scenarios, using both observational evidence and theoretical models.

Homework/Extension: For students keen on further exploring the enigmatic concept of dark energy, the "Cosmic Library" section offers a variety of resources for deeper investigation and learning:

- Online Simulations: Encourage students to interactively explore the concept of redshift and the expanding universe.
- If possible, organize a virtual or in-person talk with an astronomer or physicist specializing in dark energy and cosmology.