Lesson Title: Transitioning Exoplanet Survey Satellite and Citizen Scientists

Grade Band: 10-12 Science Research

Length: 3- 42 minute lessons

Materials: Access to internet

NGSS Standards:

Disciplinary Core Ideas:

MS-ESS1.A.3

Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe.

HS-PS4.B.1

Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features.

HS-ESS1.A.3

The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.

Science and Engineering Practices:

SEP.6.d

Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

SEP.4.a

Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships.

SEP.4.g

Analyze and interpret data to determine similarities and differences in findings.

Crosscutting Concepts:

Scale, Proportion, and Quantity

It is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

My student population includes high school sophomores through seniors that are embarking upon independent research projects. I would like them to be involved with citizen science projects as an entry point to the scientific community. I located a NASA citizen science project, Planet Hunters, TESS, which I will support my students to participate in. The project will use data from the Transitioning Exoplanet Survey Satellite (TESS) to look for planets outside our solar system. The satellite will be surveying two-hundred-thousand bright nearby stars, measuring and recording their brightness every two minutes. The goal of this project is to potentially discover other planetary systems, and their development over time.

The need for citizen scientists arises because the computer based algorithms created to interpret satellite data may get confused by conflicting information. Humans can identify patterns that the computer may miss. Students will be partnered up to review lightcurves to identify drops in light due a potential transiting a planet. Leading up to their participation, students will learn about exoplanets and how to detect planets using the transit method. They will then be trained on how to interpret and identify different types of light curves, eventually training how to search for exoplanets in observations from NASA's TESS mission.

Engage: Can life exist outside of planet Earth?

- Students will line up along the classroom: Yes/No signs will be on opposite sides of the room and they will place themselves along the continuum. Teacher will ask for 2 volunteers from each student cluster to provide their reasoning.

- Working with a partner, students will use the QFT strategy to generate a list of scientific questions that they need answered in order to be able to answer the question more fully. Questions will be shared as a class. Students will look for patterns in the questions and sort class questions into groups based on these patterns

Explore:

- Students will act as “NOVA-nauts” through an online simulation to determine if exoplanets are habitable. They will analyze simulated data to support whether an exoplanet might be habitable for certain life-forms.

https://cptv.pbslearningmedia.org/resource/nvexl-sci-exoplanetlab-lessonplan/nova-exoplanet-lab-lesson-plan/
https://view.officeapps.live.com/op/view.aspx?src=https://static.pbslearningmedia.org/media/media_files/2c840887-e708-4c28-a0fc-4838f12dc9da/d66fb896-841a-4e20-b6a7-ae84be0c0cf7.docx

Explain:

- Students will revisit the class questions, and indicate which questions have now been answered and which still remain.
- Teacher will address any misconceptions with students and highlight the use of data to support claims, making the connection between simulated data and real data to transition to the Planet Hunters Citizen Science Project

Elaborate:

- Students will go to the following site to learn about exoplanets and use the training tools to learn how to interpret and identify different types of light curves, eventually training how to search for exoplanets in observations from NASA's TESS mission:

https://www.zooniverse.org/projects/nora-dot-eisner/planet-hunters-tess/about/research

- Once training is complete, students will review their ability to identify curves with teacher. If more training is needed, students will train. If successful, they will participate in the citizen science project, analyzing real data to classify exoplanets using the transit method.

Evaluate:

- Students will compare the transit data used in the simulation to the transit data in the citizen science project. Using the citizen science data transit data, they will calculate the volume of 3 planets using the methodology from the simulated lab data. Students will make a claim if they think the exoplanets they measured could support life given the patterns they observed in the simulated lab. Students will provide color coded peer feedback using the following rubric. Students will have a opportunity to modify their work based on feedback and then submit for teacher review.

Science Reasoning Rubric

		2 pts	1 pt	0 pt
Statement	**Claim** An assertion that something is true	Makes a claim that is sufficient to answer the question <u>and</u> is coherent.	Makes a claim that is sufficient to answer the question <u>or</u> is coherent.	Does not make a claim <u>or</u> makes an incoherent claim.
	or			
	Explanation Describes how and why a phenomenon occurs	Provides an explanation that addresses how <u>and</u> why a phenomenon occurs	Provides an explanation that addresses how <u>or</u> why a phenomenon occurs	Does not provide an explanation.
Argument	**Reasoning** Provides reasons the reader should accept your claim or explanation.	Includes <u>all</u> of the following: ❏ Cites sufficient and relevant evidence to support the claim/explanation. ❏ Describes how the cited evidence defends the claim/explanation. ❏ Reader feels compelled to accept your argument.	Includes <u>two</u> of the following: ❏ Cites sufficient and relevant evidence to support the claim/explanation. ❏ Describes how the cited evidence defends the claim/explanation. ❏ Reader feels compelled to accept your argument.	Includes <u>one or none</u> of the following: ❏ Cites sufficient and relevant evidence to support the claim/explanation. ❏ Describes how the cited evidence defends the claim/explanation. ❏ Reader feels compelled to accept your argument.

https://www.chemedx.org/blog/%E2%80%9Cscience-reasoning-rubric%E2%80%9D-support-argumentative-writing