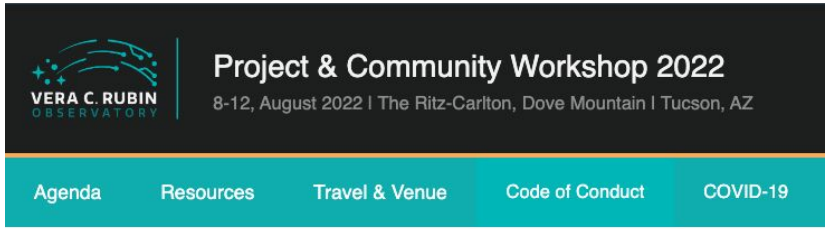
Exploring the Solar System with Rubin EPO - Part 2

Ardis Herrold, Rubin Observatory
Justine Schaen, NSF's NOIRLab

Slack #day4-thu-multislot-exploring-solar-system-epo

Friendly reminders - CoC & Covid



Harassment and unprofessional conduct (including the use of offensive language) of any kind is not permitted at any time and should be reported.

Rubin Observatory adheres to the principles of kindness, trust, respect, diversity, and inclusiveness in order to provide a learning environment that produces rigor and excellence.

Check name-tags for these contact comfort level stickers.

Thank you for masking indoors!

Use the confidential email rubin2022-covid@lists.lsst.org to request a test, report your test results, or ask questions.

Reporting bullying, harassment, or aggression.

The Rubin 2022 Organizing Committee has appointed designated contacts:

- Ranpal Gill (rgill@lsst.org)
- Andrew Connolly (ajc@astro.washington.edu)
- Melissa Graham (mlg3k@uw.edu)

Contact via email, Slack, or the Community Forum.

Goals of the Workshop

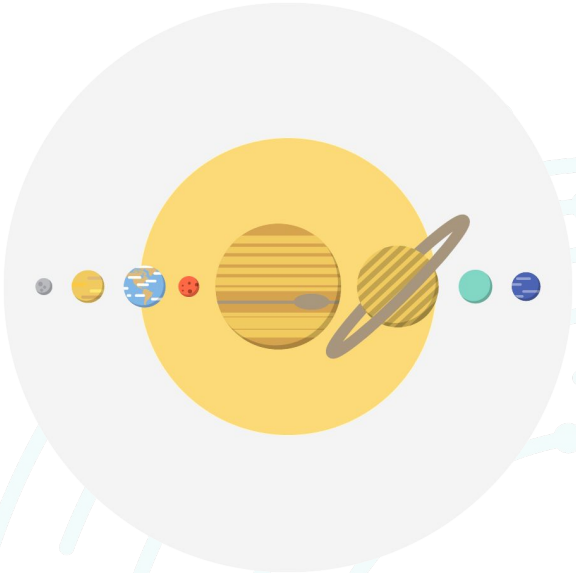
1. To introduce the Rubin Education program design (Part 1)
2. To unpack all the elements of an investigation (Parts 1 & 2)
3. To show how to navigate through an investigation and implement its features (Part 2)

Part 1 Recap

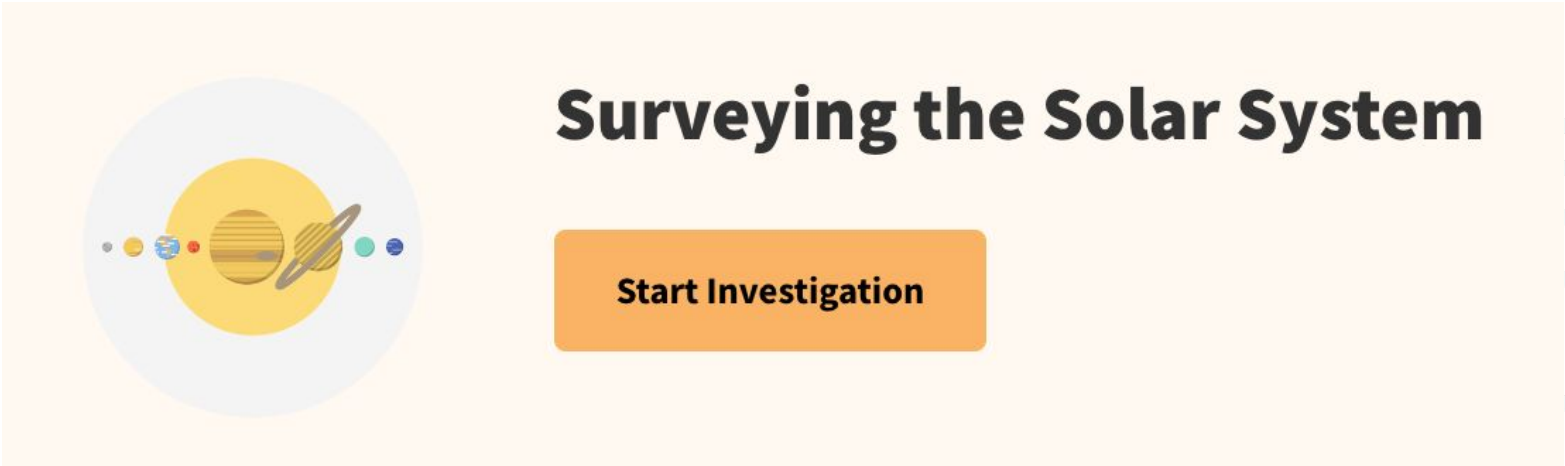
1. Program Overview
2. Navigating the Education Website
    - Accessing Investigations & Support Materials
    - Website Features
3. Getting Started with the Investigation
    - Pre-Test
    - Phenomenon

Surveying the Solar System

1. Administer Pre-Test ✅
2. Phenomenon ✅
3. Investigation
    - Formative Assessment Opportunities
        - General Understanding Checks
        - Revisiting Phenomenon
    - Key Assessment Questions
4. Summative Assessment
5. Administer Post Test to measure gains

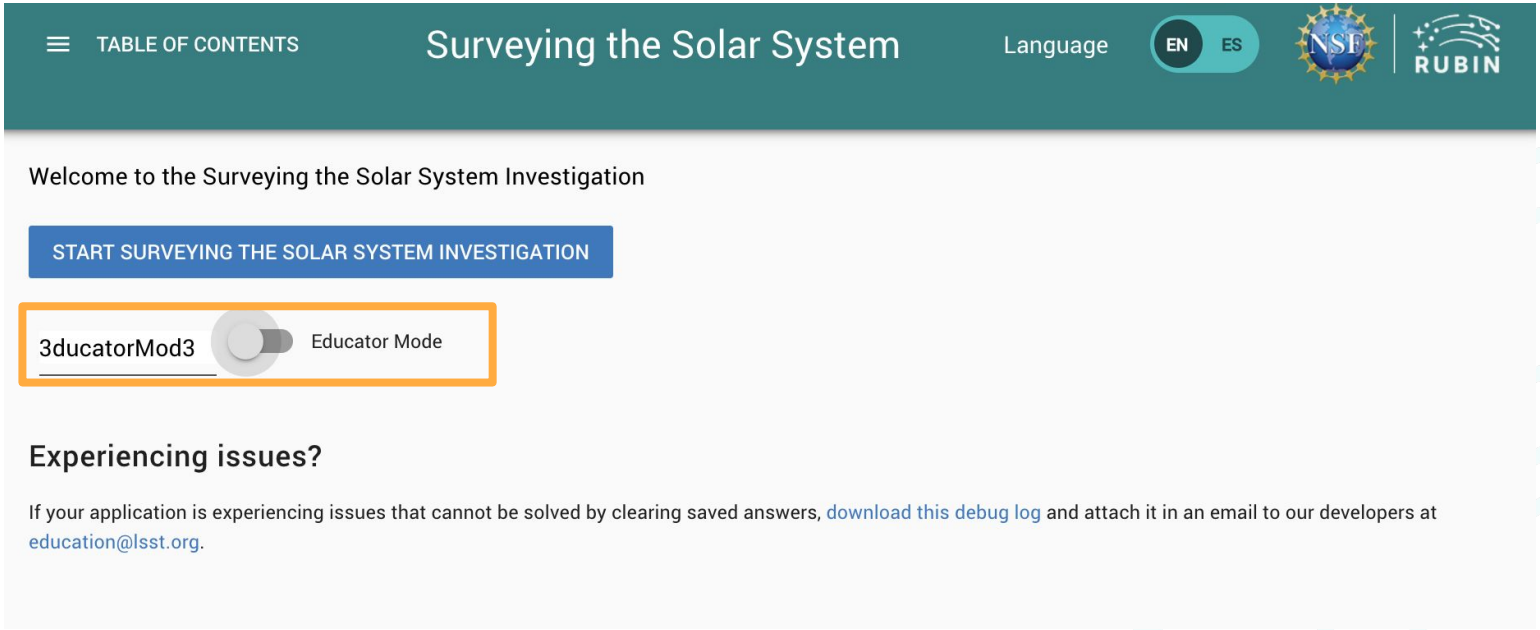


Work collaboratively on the investigation



https://surveyingthesolarsystem.netlify.app/

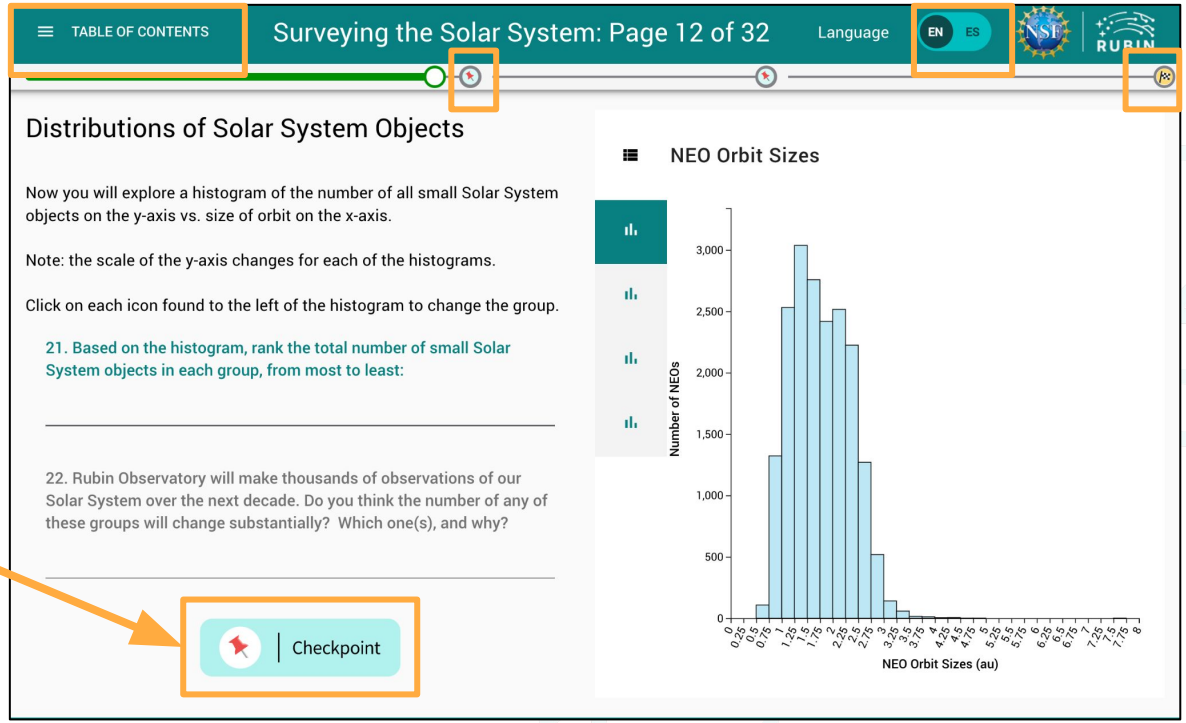
Educator Mode



Passphrase **3ducatorMod3**

Work collaboratively on the investigation

STOP at the First Checkpoint
Page 12



First Checkpoint (p.12)

1. Which group of objects have orbits closest to the Earth?

NEOs **A**

MBAs **B**

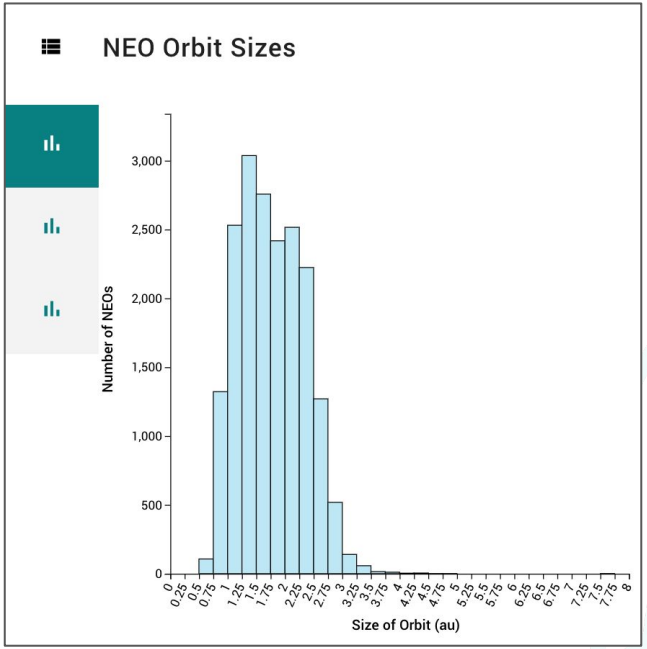
TNOs **C**

Comets **D**

First Checkpoint (p.12)

1. Which group of objects have orbits closest to the Earth?

A NEOs



First Checkpoint (p.12)

1. Which group of objects have orbits closest to the Earth?

   NEOs

2. Which group of objects have orbits between Mars and Jupiter?

NEOs **A**

MBAs **B**

TNOs **C**

Comets **D**

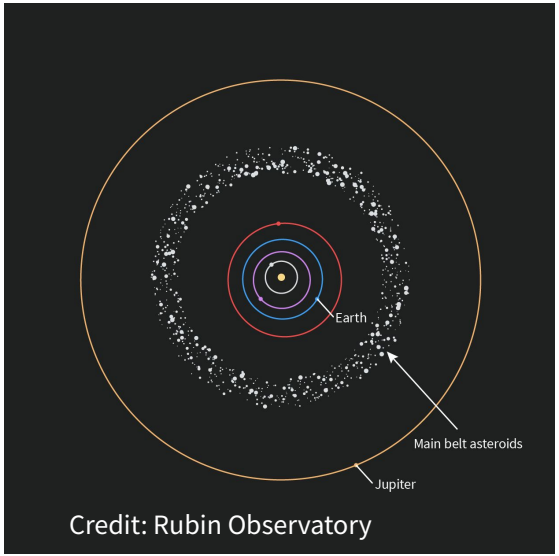
First Checkpoint (p.12)

1. Which group of objects have orbits closest to the Earth?

   NEOs

2. Which group of objects have orbits between Mars and Jupiter?

   B MBAs



First Checkpoint (p.12)

1. Which group of objects have orbits closest to the Earth?
   NEOs
2. Which group of objects have orbits between Mars and Jupiter?
   MBAs
3. Which group of objects has the greatest range of orbit sizes and inclinations?

NEOs **A**

MBAs **B**

TNOs **C**

Comets **D**

First Checkpoint (p.12)

1. Which group of objects have orbits closest to the Earth?

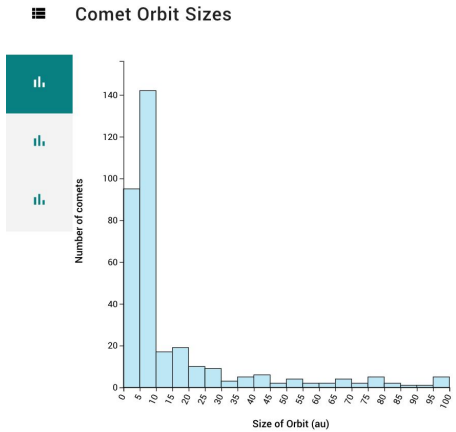
   NEOs

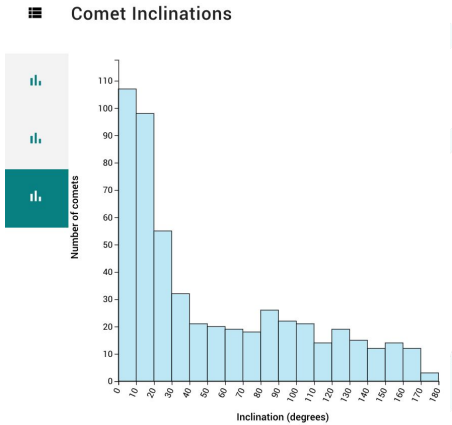
2. Which group of objects have orbits between Mars and Jupiter?

   MBAs

3. Which group of objects has the greatest range of orbit sizes and inclinations?

   D **Comets**



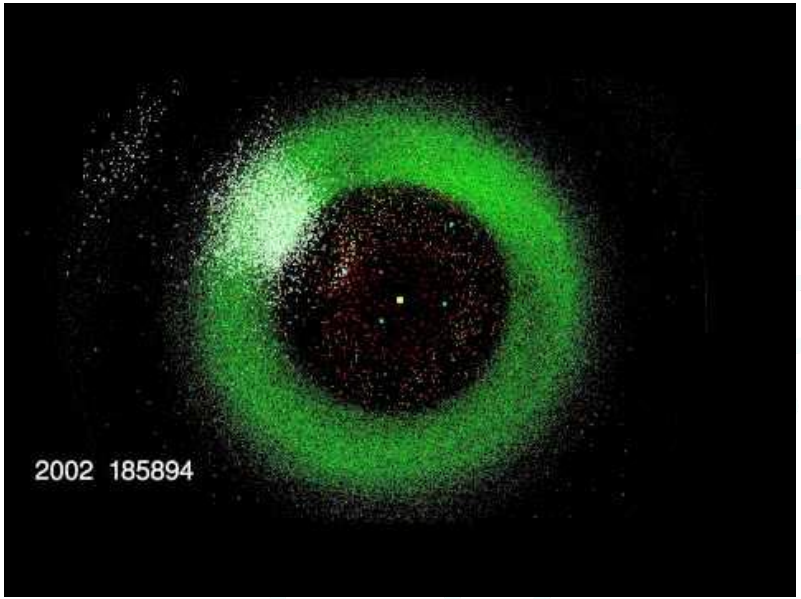


First Checkpoint (p.12)

Revisit Phenomenon

The video did not include TNOs and Comets.

Draw a top and side view model of what the Solar System would look like, including TNOs and Comets.



First Checkpoint (p.12)

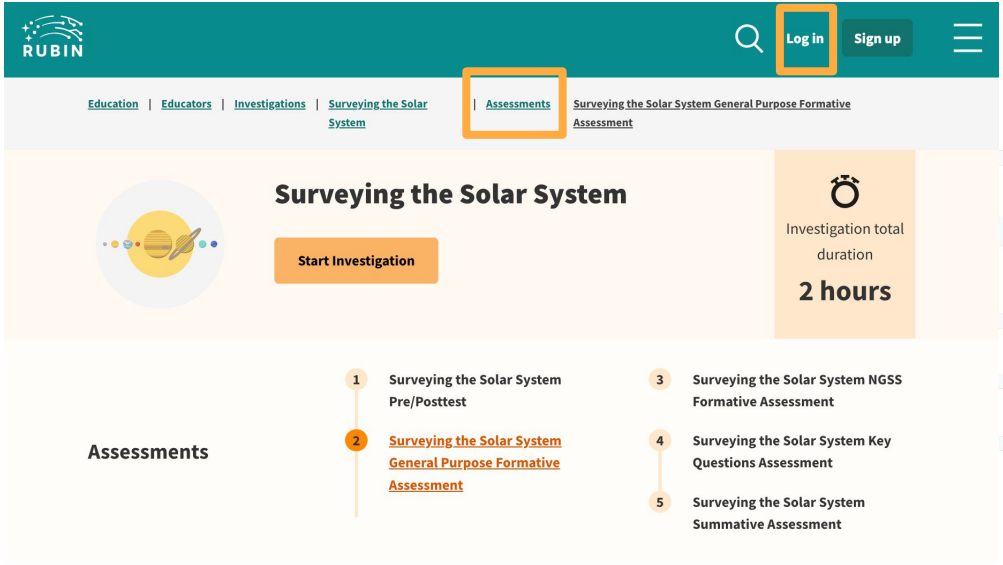
Making Sense of the Phenomenon Possible Answers

Models should indicate:

- **Orbit sizes beyond Neptune for TNOs.**
- **Orbits within both the inner and outer Solar System for comets.**
- **More eccentric orbits for comets.**
- **Higher inclinations for comets.**

Accessing the Formative Assessments

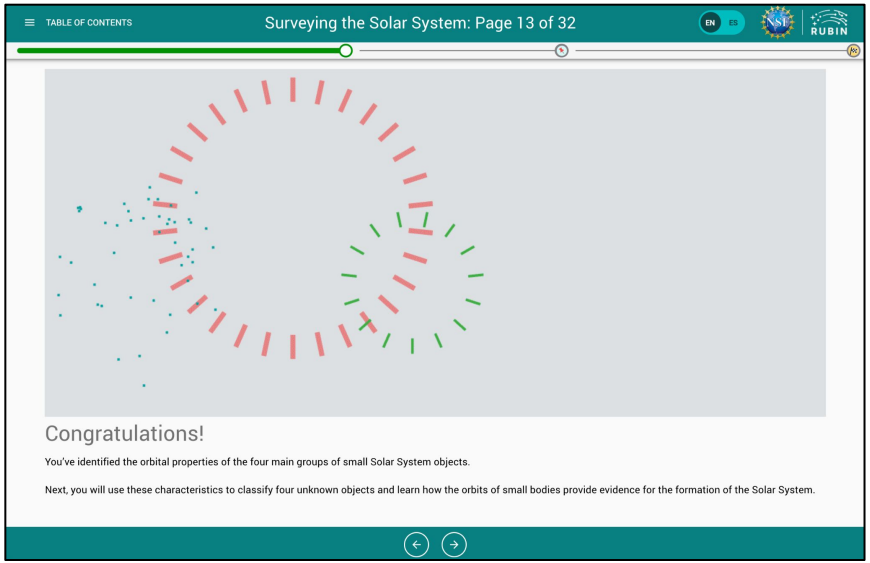
1. Administer Pre-Test
2. Phenomenon
3. Investigation
   - Formative Assessment Opportunities
     - General Understanding Checks
       Revisiting Phenomenon

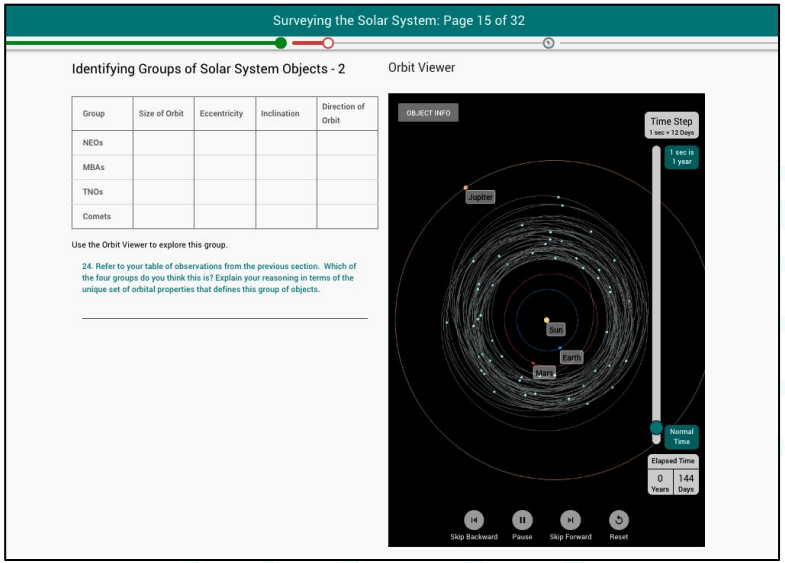


Surveying the Solar System General Purpose Formative Assessment

The table below is correlated to checkpoints in the investigation, which are places where students should have acquired key skills and understandings that are needed in the subsequent sections. Sample questions with answers in bold are listed below.

Transition to Section 2





Second Checkpoint (p.20)

What orbital characteristic (and value) allows you to know that the majority of all Solar System objects orbit the Sun in the same plane as the planets and orbit the Sun in the same direction as the planets?

Eccentricity, less than 0.5 **A**

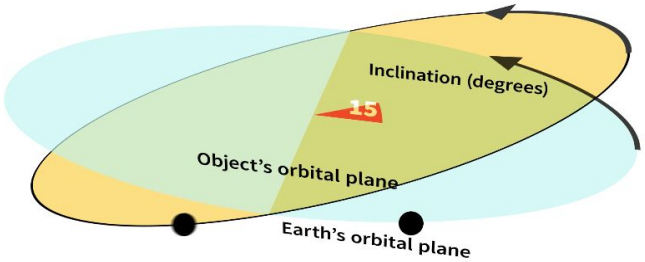
Inclination, greater than 90° **B**

Eccentricity, greater than 0.5 **C**

Inclination, less than 90° **D**

Second Checkpoint (p.20)

What orbital characteristic (and value) allows you to know that the majority of all Solar System objects orbit the Sun in the same plane as the planets and orbit the Sun in the same direction as the planets?

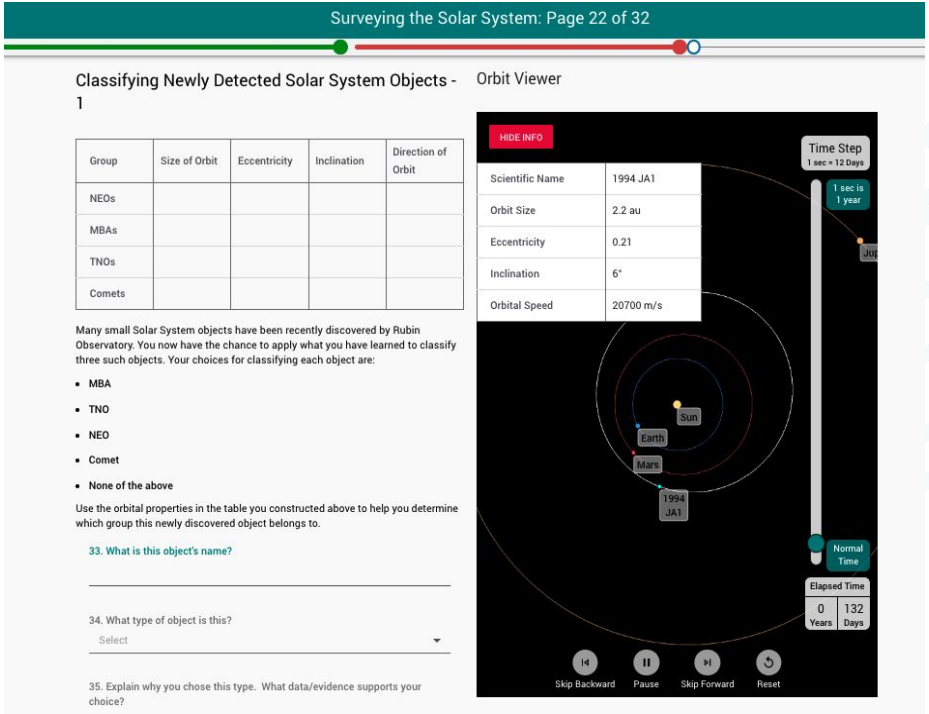


i=15°

D **Inclination, less than 90°**

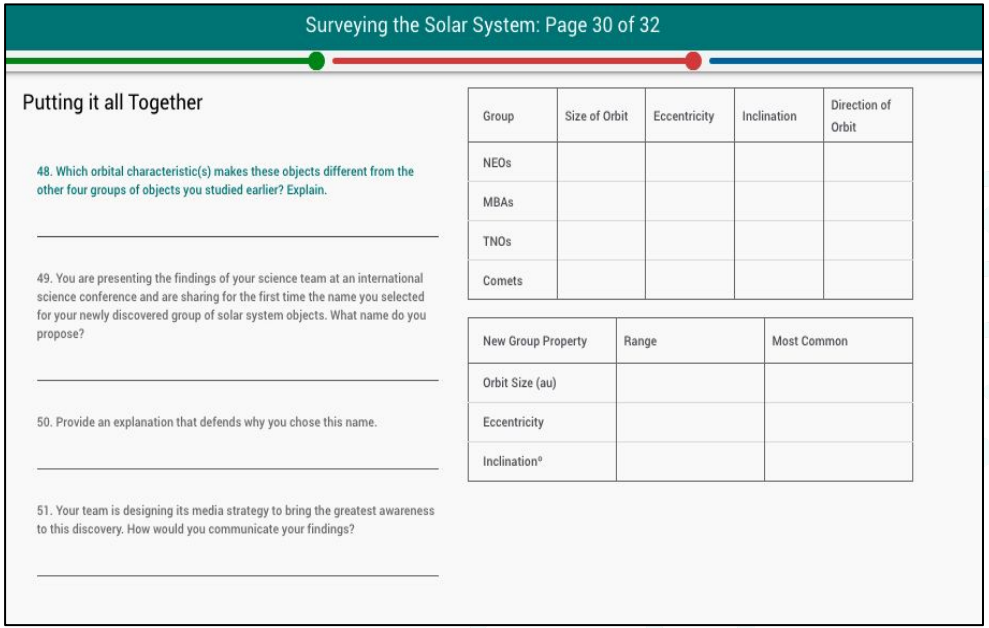
Transition to Final Section

- Randomized newly-detected Solar System objects
- Continue working until q. 50 - let us know when you get here



Diversity, Equity, and Inclusion Questions (q. 49 - 51)

- Student make connections to their own experiences.
- How would you use these questions in your settings?



Surveying the Solar System: Page 30 of 32

Putting it all Together

48. Which orbital characteristic(s) makes these objects different from the other four groups of objects you studied earlier? Explain.

49. You are presenting the findings of your science team at an international science conference and are sharing for the first time the name you selected for your newly discovered group of solar system objects. What name do you propose?

50. Provide an explanation that defends why you chose this name.

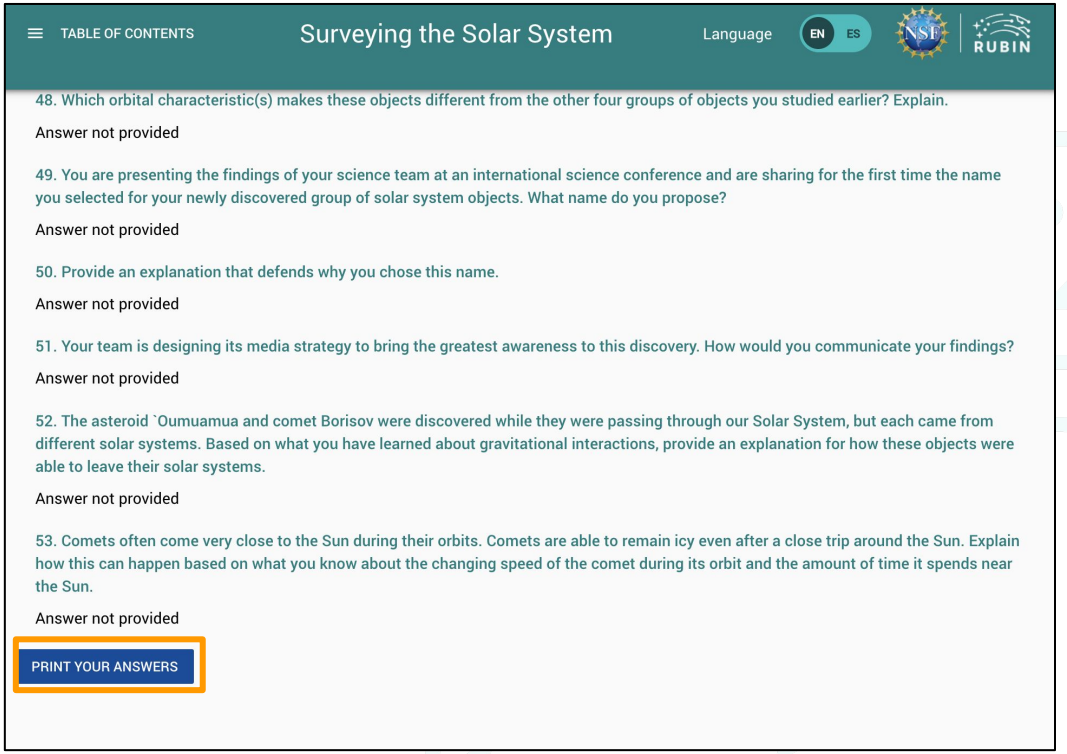
51. Your team is designing its media strategy to bring the greatest awareness to this discovery. How would you communicate your findings?

Group	Size of Orbit	Eccentricity	Inclination	Direction of Orbit
NEOs				
MBAs				
TNOs				
Comets				

New Group Property	Range	Most Common
Orbit Size (au)		
Eccentricity		
Inclination°		

Saving Work

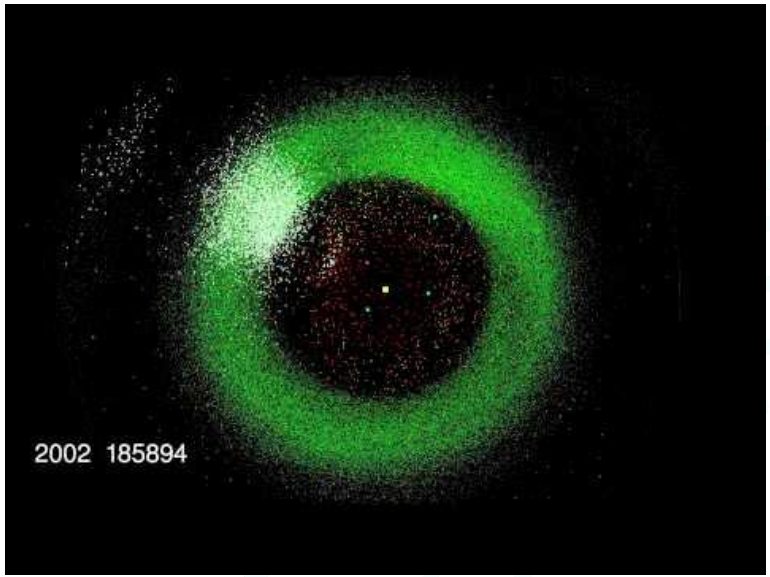
- Save your work
  - Temporary Issue until Student Account Feature is Available
- Strategies for turning in PDF



Final Connections to the Phenomenon

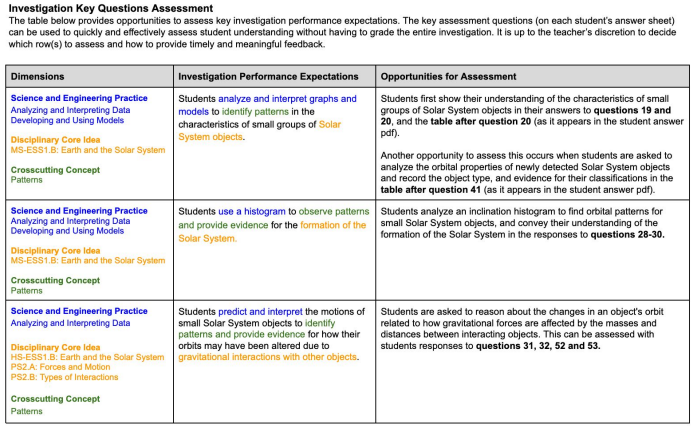
Making Sense of the Phenomenon

- Predict how the video would look different if it were to be updated in 2030, including TNOs and comets.
- There is a group of yellow objects that become more apparent towards the end of the asteroid discovery video. These yellow objects are different from NEOs, MBAs, TNOs, and comets. Make a claim based on orbital property evidence to defend how these yellow objects are different.



Key Assessment Questions

1. Administer Pre Test (Formal Education Setting)
2. Phenomenon
3. Investigation
    - Formative Assessment Opportunities
        - General Understanding Checks
        - Revisiting Phenomenon
    - Key Assessment Questions



Investigation Key Questions Assessment

The table below provides opportunities to assess key investigation performance expectations. The key assessment questions (on each student's answer sheet) can be used to quickly and effectively assess student understanding without having to grade the entire investigation. It is up to the teacher's discretion to decide which row(s) to assess and how to provide timely and meaningful feedback.

Dimensions	Investigation Performance Expectations	Opportunities for Assessment
Science and Engineering Practice Analyzing and Interpreting Data Developing and Using Models **Disciplinary Core Idea** MS-ESS1.B: Earth and the Solar System **Crosscutting Concept** Patterns	Students analyze and interpret graphs and models to identify patterns in the characteristics of small groups of Solar System objects.	Students first show their understanding of the characteristics of small groups of Solar System objects in their answers to **questions 19 and 20**, and the **table after question 20** (as it appears in the student answer pdf). Another opportunity to assess this occurs when students are asked to analyze the orbital properties of newly detected Solar System objects and record the object type, and evidence for their classifications in the **table after question 41** (as it appears in the student answer pdf).
Science and Engineering Practice Analyzing and Interpreting Data Developing and Using Models **Disciplinary Core Idea** MS-ESS1.B: Earth and the Solar System **Crosscutting Concept** Patterns	Students use a histogram to observe patterns and provide evidence for the formation of the Solar System.	Students analyze an inclination histogram to find orbital patterns for small Solar System objects, and convey their understanding of the formation of the Solar System in the responses to **questions 28-30.**
Science and Engineering Practice Analyzing and Interpreting Data **Disciplinary Core Idea** MS-ESS1.B: Earth and the Solar System PS2.A: Forces and Motion PS2.B: Types of Interactions **Crosscutting Concept** Patterns	Students predict and interpret the motions of small Solar System objects to identify patterns and provide evidence for how their orbits may have been altered due to gravitational interactions with other objects.	Students are asked to reason about the changes in an object's orbit related to how gravitational forces are affected by the masses and distances between interacting objects. This can be assessed with students responses to **questions 31, 32, 52 and 53.**

Key Assessment Questions

Investigation Key Questions Assessment

The table below provides opportunities to assess key investigation performance expectations. The key assessment questions (on each student's answer sheet) can be used to quickly and effectively assess student understanding without having to grade the entire investigation. It is up to the teacher's discretion to decide which row(s) to assess and how to provide timely and meaningful feedback.

Dimensions	Investigation Performance Expectations	Opportunities for Assessment
Science and Engineering Practice Analyzing and Interpreting Data Developing and Using Models **Disciplinary Core Idea** MS-ESS1.B: Earth and the Solar System **Crosscutting Concept** Patterns	Students analyze and interpret graphs and models to identify patterns in the characteristics of small groups of Solar System objects.	Students first show their understanding of the characteristics of small groups of Solar System objects in their answers to **questions 19 and 20**, and the **table after question 20** (as it appears in the student answer pdf). Another opportunity to assess this occurs when students are asked to analyze the orbital properties of newly detected Solar System objects and record the object type, and evidence for their classifications in the **table after question 41** (as it appears in the student answer pdf).
Science and Engineering Practice Analyzing and Interpreting Data Developing and Using Models **Disciplinary Core Idea**	Students use a histogram to observe patterns and provide evidence for the formation of the Solar System.	Students analyze an inclination histogram to find orbital patterns for small Solar System objects, and convey their understanding of the formation of the Solar System in the responses to **questions 28-30.**

Key Assessment Questions

Summative Assessment

1. Administer Pre Test (Formal Education Setting)
2. Phenomenon
3. Investigation
    - Formative Assessment Opportunities
        - General Understanding Checks
        - Revisiting Phenomenon
    - Key Assessment Questions
4. Summative Assessment

Summative Assessment & Scoring Guide

Surveying the Solar System
Summative Assessment

Introduction
Three new Solar System objects (A, B, and C) have been discovered by Rubin Observatory and their orbital properties are provided in the table below.

	Semi-Major Axis (au)	Eccentricity	Inclination (°)
Object A	2.5	.1	5
Object B	10	.9	130
Object C	42	.3	10

Model of the Three New Solar System Objects
Provide a sketch of the Solar System that illustrates the orbital properties of the three objects (A, B and C). Your sketch must include the Sun and Mars, Jupiter, and Neptune. Be sure to label the three orbits you draw (A, B, and C).

Top View	Side View

Surveying the Solar System

Students use models and data to identify spatial and physical similarities and differences between groups of small Solar System objects and their orbital properties, then identify patterns in their data to classify newly-discovered objects.

Level	Performance Expectations	Possible Student Responses
4 Exceeds	In addition to meeting level 3 performance expectations, the student model and explanations include information that demonstrates an advanced understanding of the topic which goes beyond the learning goals of the investigation.	Student asserts that Object B orbits in an opposite direction to the planets in the Solar System based on its inclination. Student asserts that Object B does not provide evidence to support the solar nebula theory. Student argues that Object B likely has experienced significant gravitational interactions with other objects in the Solar System causing its orbit to be highly elliptical and highly inclined. Student drawing demonstrated an advanced understanding of size and scale in the Solar System.
3 Meets	Student analyzes and interprets data to construct an accurate model representing each of the newly discovered objects': • Orbit size • Eccentricity • Inclination Student identifies patterns in the newly discovered objects to accurately classify the objects as NEOs, MBAs, TNOs, comets, or other, and is able to explain the reasoning behind their classification of the newly discovered objects based on orbital property evidence.	See answer key.
2 Approaches	Student analyzes and interprets data to construct a model which contains an error	Student incorrectly models inclination with all objects drawn on the same

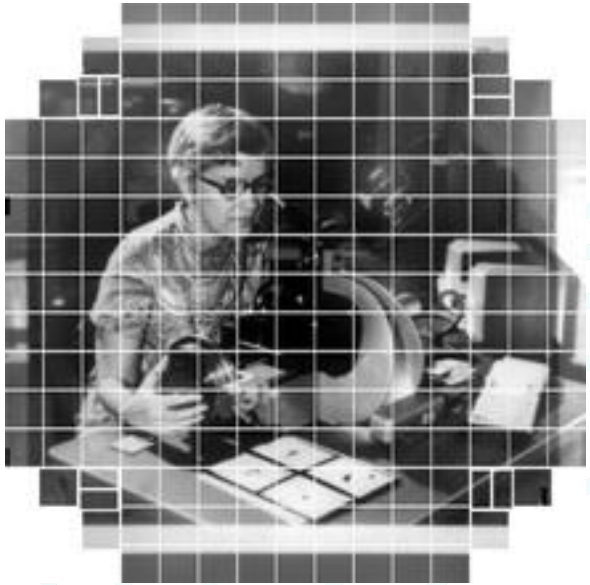
Summative Assessment

Post Assessment

1. Administer Pre Test (Formal Education Setting)
2. Phenomenon
3. Investigation
    - Formative Assessment Opportunities
        - General Understanding Checks
        - Revisiting Phenomenon
    - Key Assessment Questions
4. Summative Assessment
5. Administer Post Test to measure gains

Workshop Reflection & Discussion

- PIP/Reflection
- Remaining Thoughts and Questions



Join our Community of Practice!

Facebook: Rubin Observatory Educators

Email discussion list: Contact education@lsst.org or indicate your preference on the workshop evaluation to join the list.

Thank you for attending our workshop!

Contact us at education@lsst.org

Please take a few minutes to complete our workshop evaluation:

https://ls.st/2022

Ardis Herrold, Rubin Observatory aherrold@lsst.org
Justine Schaen, NSF's NOIRLab justine.schaen@noirlab.edu