UBTECH

EDUCATION

ADVANCED KIT

Or-Bot

Designing Robots that Understand our Solar System

INTERACTIVE TEACHER GUIDE

UBTECHEDUCATION.COM

UBTECH
EDUCATION

UNIT SEQUENCE 20-26 sessions (60 minutes each)

LESSON	DRIVING QUESTION	DESCRIPTION
UNIT INTRODUCTION **1 session (60 minutes)**	How can robots be used to assist in space and planet exploration?	Students will be introduced to the laws of motion, gravity, and our solar system. They will discuss the driving question for the unit.
LESSON 1: SOLAR SYSTEM SIMULATION **4-5 sessions (60 minutes each)**	Why do planets orbit the sun in our solar system?	Students will be introduced to gravity, our solar system, and eclipses. They will learn the basics of block programming in uCode as they create a simulation of the planets orbiting the sun and a simulation of an eclipse. Students will share their understanding of the solar system, gravity, and that models can represent real-world systems.
LESSON 2: CHANGE OF SPACE **5-7 sessions (60 minutes each)**	How did you work through an iterative process while building and programming your robot?	Students will design, build, and program a robot to walk and then transform into a vehicle. Students will expand on the basic concepts of uCode by programming a robot with servo motors.
LESSON 3: MAY THE FORCE BE WITH YOU **4-6 sessions (60 minutes each)**	How do forces and the laws of motion apply to the Transforming Robot?	Students will analyze the movement of the Transforming Robot as it pertains to Newton's laws of motion. They will use that knowledge to perform various tests with their robot.
LESSON 4: INTERSTELLAR PERFORMANCE **5-6 sessions (60 minutes each)**	Why are robots used to explore places such as the ocean and outer space?	Students will redesign the Transforming Robot and program it to assist humans with space exploration and collecting data on other planets.
UNIT WRAP-UP/ ASSESSMENT **1 session (60 minutes)**	How can robots be used to assist in space and planet exploration?	Students answer the driving question using the experiences they have had throughout this unit.

LESSON 1

Solar System Simulation

DRIVING QUESTION

Why do planets orbit the sun in our solar system?

DESCRIPTION

Students will be introduced to gravity, our solar system, and eclipses. They will learn the basics of block programming in uCode as they create a simulation of the planets orbiting the sun and a simulation of an eclipse. Students will share their understanding of the solar system, gravity, and that models can represent real-world systems.

LEARNING GOALS

STUDENTS WILL:

- **DISCUSS** the role gravity plays in our solar system.
- **COLLECT** data on the sun and planets.
- **USE** collected data to create a simulation.
- **CREATE** models in uCode to simulate real-world systems such as the solar system and eclipses.
- **EXPLAIN** why planets orbit the sun, including the interaction of gravity based on the mass of the sun and planets and the distance between them.

STANDARDS
MS-ESS1-1
MS-ESS1-2
MS-ESS1-3
MS-PS2-4
MS-PS2-5

GETTING STARTED

TIME ESTIMATE

4-5 sessions (60 minutes each)

MATERIALS FOR EACH GROUP

- Internet-enabled device

LESSON RESOURCES

- Or-Bot Interactive Student Notebook
- Unit Vocabulary
- Gravity & Our Solar System
- Solar System Data
- How to Code: Solar System Simulation

- uCode
- uCode Getting Started Guide
- uCode Block Guide
- What is an Eclipse?

VOCABULARY

ECLIPSE	an eclipse of the sun by the moon; when the moon passes between the Earth and the sun
GRAVITY	an attractive force that acts between any two objects with mass
LUNAR ECLIPSE	when the moon passes partially or completely through the umbra of the Earth's shadow; when the Earth is between the sun and moon
MASS	a measure of the amount of matter in an object; usually measured in grams (g) or kilograms (kg)
ORBIT	a path described by one body in its revolution about another (as by the Earth about the sun or by an electron about an atomic nucleus) *also:* one complete revolution of a body describing such a path
SIMULATION	something that is made to look, feel, or behave like something else especially so that it can be studied or used to train people
SOLAR ECLIPSE	an eclipse of the sun by the moon; when the moon passes between the Earth and the sun
SOLAR SYSTEM	the sun together with the group of celestial bodies that are held by its attraction and revolve around it
UCODE	block-based programming environment for UKIT Advanced

TEACHER PREP

- Review the lesson resources listed and decide how to distribute these to the students, either digitally or print, if applicable.
- Review the Evaluate section for this lesson and consider how students will be assessed. This will determine the need to print assessment materials or provide additional materials for students to record their responses.
- Ensure available devices have the Arduino IDE app installed and uCode is accessible through a web browser. A desktop or laptop with the Chrome browser is preferred. This note applies to all lessons in this guide.
- Determine student pairs or groups for this lesson.
- If time permits, try coding the solar system simulation. This will help you anticipate problems your students might have.

5E LESSON PLAN

ENGAGE

To gauge students' current understanding of the lesson topics, have them complete a padlet or jot down in five minutes why they think planets orbit the sun instead of falling. Discuss student responses.

Following the discussion, share the Gravity & Our Solar System resource with students. Read through this resource as a class, in small groups, or in pairs. Ask students to highlight or take notes on the facts they feel are important. As a class, discuss the resource to verify students' understanding of the vocabulary and facts that have been presented.

To prepare for the next activity, students will need to spend some time researching basic facts about the sun and planets. Using the Solar System Data sheet, have students collect the data in the table. NASA and other space-focused websites would be good resources to find the needed information. Share with students the unit of measure you would prefer they use. Refer to the Solar System Data Answer Key as needed.

When they are finished, have students compare their data and answer the two questions that are listed below the table. This data should be used for students to better gauge the size of and distance between the planets in their solar system. Incorrect data or answers could lead to incorrect simulations. This data will also be used in Lesson 4.

Their simulations will not be exactly to scale, but students should make sure the size of the planets or the distance between is consistent with the data they collected. For example, if they found that the sun is the largest body in our solar system, it should be the largest in the simulation.

EXPLORE

Explain to students that, using the data they just collected, they will be creating their own **SIMULATIONS** of the solar system in **UCODE**. Students will be programming their simulations to show the planets rotating while orbiting the sun, roughly to scale.

Ensure each pair of students has an Internet-enabled device and a copy of How To Code: Solar System Simulation. This resource will walk students through the process of programming the simulation in uCode and is broken up into the following five parts:

1. How to upload a backdrop and sprites (removing the background if necessary)
2. Programming the sun
3. Programming Mercury
4. Programming Venus, Earth, Mars, Jupiter, and Saturn
5. Programming Uranus and Neptune

Note: *Uranus and Neptune will go off the screen at certain points in the simulation due to the different orbits. The codes for these planets have been provided because of this. Your students will need to re-create these and adjust the numbers to fit their simulation.*

Based on your students' experience with coding, you could have them work through the entire resource and check in periodically or provide them with only one part at a time to work through. Because this activity might span several class periods, you will want students to save their programs each day. This will allow them to pick up where they left off as opposed to starting over. If students are new to uCode or block coding, allow them time to explore the platform. The uCode Getting Started Guide and uCode Block Guide might also be of help.

There are also two tutorial videos linked within the resource that students can view. The written instructions coincide with these videos and give a good visual of how to navigate uCode.

Note: *In the Mercury video tutorial, it is mentioned that students could map out the location of the planets on graph paper before they determine the coordinates to use in their code. If time allows, this would make for a great math extension on coordinates and the coordinate plane.*

Based on the size of the images they find, students might need to go back and tweak the size of planets they have already worked on. They should use the data they collected to help determine how large or small the sun and planets will appear in comparison to each other.

Watch the Solar System Simulation video or view the sample code through uCode for an idea of what to look for in a finished product. Sample code path in uCode: Resource Center pop-up > Sample Code tab > Animation > Solar System.

EXPLAIN

Allow students to present their simulations to the class. As students share, have the audience analyze and compare how other groups completed their simulations.

Take some time to discuss the science concepts and vocabulary that has been introduced thus far. Ask students to explain why the sun is in the center of our solar system and why it has the most gravitational pull. The sun has a much greater mass than any other planet and therefore a greater gravitational pull.

ELABORATE

Ask students how they can apply what they have learned from the previous activity to simulate an eclipse. Have students read What is an eclipse? to gain a better understanding of eclipses. Review the main points and vocabulary as a class to ensure understanding before assigning the next activity. There is also a place on the resource for students to sketch each eclipse mentioned.

Using what they learned in the resource and any additional resources available to them, challenge students to design and program a simulation of an eclipse in uCode (option of lunar or solar) either in pairs or individually. If students need some guidance, reference the Eclipse Sample Code provided in Teacher Resources, view the sample code animation in uCode, or show this Eclipse video for an example of how it could look.

When all students have completed the activity, have them share their simulations with classmates and compare and contrast how groups created their code to perform the same task. Ask students if they all created the same program in the end. If not, should they have? Did they reach the same outcome with different programs?

EVALUATE

Wrap up the lesson by having students address the following:

- Explain how gravity plays a part in the planets orbiting the sun.
- Explain an eclipse.
- How can we use technology to create simulations to study and investigate real-world models? How are these models beneficial?

Informal Assessment Ideas

- Observation
    - Students were active participants during the hands-on activities and contributed to all class or group discussions.
        - Student presentations of a solar system simulation were complete and accurate.
        - Student presentations of an eclipse simulation were complete and accurate.
- Self-Assessment Rubric
    - Ask students to rate the following:
        - Participation in discussions and activities
        - Understanding of science content
        - Confidence and understanding in creating simulations within uCode

Formal Assessment Ideas

- Written Response Rubric
  - Score written responses to questions posed in this lesson using a rubric. Consider focusing on the driving question, science content, programming knowledge, and/or learning goals for this lesson.
- Lesson 1 Rubric
  - Score solar system simulation models using the provided rubric.
- Lesson 1 Quiz
  - Assign a quiz in digital or print format to gauge students' understanding of the science concepts covered in this lesson.

DIFFERENTIATION

SIMPLIFY THIS LESSON

- Give students more time to create the solar system simulation instead of moving onto the eclipse simulation.
- Provide students with preloaded images of the planets and sun.
- Students who have finished Uranus and Neptune should assist other students as needed. They could also do a class presentation on how to complete this task.

TAKE THIS LESSON TO THE NEXT LEVEL

- Students could add a pen color as the planets are orbiting. This extension can be found as an add-on in uCode.
- Encourage students to create different backdrops for the eclipse.
- Have students expand on their knowledge of space by creating models of other systems in relation to gravity.

CROSS-CURRICULAR EXTENSIONS

ELA

- Have students write an explanation as to why the planets circle the sun instead of flying randomly through space.
- As students research the planets, they could spend time researching one specific planet and writing an informative piece on it. This could also be shared in a presentation.

HISTORY

- This lesson could be expanded to include research on how the planets/solar system came to be. The information collected during the research could then be used to create a timeline of these historical events.

MATH

- Work with students to create a scaled-model of the solar system using materials commonly found in the classroom.

STANDARDS

NGSS STANDARD	DESCRIPTION	LESSON(S) COVERED 1	2	3	4
MS-ESS1-1	Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.	X			
MS-ESS1-2	Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.	X			
MS-ESS1-3	Analyze and interpret data to determine scale properties of objects in the solar system.	X			
MS-PS2-4	Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.	X		X	
MS-PS2-5	Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.	X			X
MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.		X	X	X
MS-ETS1-4	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved		X	X	X
MS-PS2-2	Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.			X	
MS-ETS1-1	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.			X	X
MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.			X	X