STEM Curriculum Planning Guide

This instructional design guide serves as the template for the design and development of STEM units of instruction at the Dayton Regional STEM Center in Dayton, Ohio. The guide is anchored to the *STEM Education Quality Framework* also developed at the Dayton Regional STEM Center.

STEM Unit Title	**The Great Space Race**
Economic Cluster	Environmental Engineering Human Performance & Medicine Aerospace
Targeted Grades	5th Grade
STEM Disciplines	Science Technology Engineering Math
Non-STEM Disciplines	ELA Social Studies Fine Arts Extension: Write a 5 paragraph explanatory essay

Section I: STEM Unit Overview

Unit Overview

Students will be able to show their knowledge of the standard by creating various design challenges that show mastery of the standard. The goal of the unit is for students to learn the cycles and patterns of motion between Earth and the Sun, and how seasons result from these cycles and patterns. Students will demonstrate their learning through designing mini-games as an engineering design challenge. Students will first learn about the format of the mini-games, or “Minute to Win It” games, the celestial bodies in the solar system, and the importance of the rotation and revolution of the Earth. Then, they will be tasked to design and re-design “Minute to Win It” challenges, including creating a digital answer key for their challenges. In this unit, students will practice graphing and converting measurement units. They will practice writing informative texts, engage in collaborative discussions, and create visual presentations. They will relate latitude and longitude to climate.

Essential Question

How can the predictable cycles and patterns of motion between Earth and the sun be used to construct an interactive game using multiple intelligences?

Enduring Understanding

The solar system is made up of the sun and all the celestial bodies that orbit it. The sun is one of the many stars that make up our universe, while Earth is one of the planets that can be found in our universe. Most of the cycles and patterns of motion between the Earth and sun are predictable. The tilt of Earth's axis, along with Earth’s revolution around the sun, affects the amount of direct sunlight that Earth receives in a single day and throughout the year. The average daily temperature is related to the amount of sunlight a place on Earth receives. These changes in average temperature throughout the year are known as seasons.

Engineering Design Challenge

Over the past several years, “Minute to Win It” has gained popularity as a TV game show, which has progressed to party games, and even used by teachers within their classrooms. Students will design three educational “Minutes to Win It” games that reinforce three different learning targets from the 5th Grade Earth and Space Science standards. The challenges are required to be active and demonstrate mastery of content in four minutes or less. Students will test and revise challenges in order to create the best possible learning experiences for their peers.

Time and Activity Overview

Day	Time Allotment	Actvities
1	60 Minutes	Pre-test Unit and Project Introduction
2	60 Minutes	The Planets of the Solar System
3	60 Minutes	Scaling the Solar System
4	60 Minutes	Celestial Bodies in the Solar System
5	60 Minutes	Earth’s Rotation
6	60 Minutes	Earth's Revolution: 1 year = 365 days
7	60 Minutes	Direct and Indirect Sunlight
8	60 Minutes	Challenge Creation
9	60 Minutes	Challenge Creation and Test Run Part 1

10	60 Minutes	Challenge Creation and Test Run Part 2
11	60 Minutes	Game Play and Feedback
12	60 Minutes	Redesign, Present & Post-test

Academic Content Standards

Pre-requisite Knowledge & Skill	Students should have background knowledge of climate zones, biomes, etc. This allows students to better understand the connection between the location and the season. Students should understand latitude and longitude. Students should know how to plot points on a coordinate plane.

Add Standard	**Mathematics** 
Grade/Conceptual Category	Grade 5
Domain	Geometry
Cluster	Graph points on the coordinate plane to solve real-world and mathematical problems.
Standards	5.G.2 Represent real-world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation

Add Standard	**Mathematics** 
Grade/Conceptual Category	Grade 5
Domain	Measurement and Data
Cluster	Convert like measurement units within a given measurement system
Standards	5.MD.1 Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems

Add Standard	**Mathematics**	
Grade/Conceptual Category	Grade 5	
Domain	Number and Operations - Fractions	
Cluster	Apply and extend previous understandings of multiplicationand division to multiply and divide fractions. (Fractions neednot be simplified).	
Standards	5.NF.5 Interpret multiplication as scaling (resizing). a. Compare the size of a product to the size of one factor on the basis of the size of the other factor, without performing the indicated multiplication. b. Explain why multiplying a given number by a fraction greater than 1 results in a product greater than the given number (recognizing multiplication by whole numbers greater than 1 as a familiar case); explaining why multiplying a given number by a fraction less than 1 results in a product smaller than the given number; and relating the principle of fraction equivalence a/b = (n×a)/(n×b) to the effect of multiplying a/b by 1.	

Add Standard	**English Language Arts**	
Grade	Grade 5	
Strand	Writing	
Topic	Text Types and Purposes	
Standard	W.5.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly.	

Add Standard	**English Language Arts**	
Grade	Grade 5	
Strand	Speaking and Listening	
Topic	Comprehension and Collaboration	
Standard	SL.5.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly	

Add Standard	English Language Arts	
Grade	Grade 5	
Strand	Speaking and Listening	
Topic	Presentation of Knowledge and Ideas	
Standard	SL.5.5 Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes.	

Add Standard	Social Studies	Ohio
Grade	Grade 5	
Theme	Regions and People of the Western Hemisphere	
Strand (pk-8 only)	Geography	
Topic	Spatial Thinking and Skills	
Content Standard	5. Latitude and longitude can be used to make observations about location and generalizations about climate.	

Add Standard	Science	Ohio
Grade	Grade 5	
Theme	Earth and Space Science	
Topic	Cycles and Patterns in the Solar System	
Content Standard	5.ES.1 The solar system includes the sun and all celestial bodies that orbit the sun. Each planet in the solar system has unique characteristics.	

Add Standard	Science	Ohio
Grade	Grade 5	
Theme	Earth and Space Science	
Topic	Cycles and Patterns in the Solar System	
Content Standard	5.ES.2 The sun is one of many stars that exist in the universe.	

Add Standard	Science	Ohio
Grade	Grade 5	
Theme	Earth and Space Science	
Topic	Cycles and Patterns in the Solar System	
Content Standard	5.ES.3 Most of the cycles and patterns of motion between the Earth and sun are predictable.	

Add Standard	Science	Ohio
Strand		
Course Content		
Content Elaboration		

Add Standard	Fine Arts	Ohio
Enduring Understanding	Producing / Performing	
Progress Points	Visual Arts	
Grade Level	Grade 5	
Content Statement	5PR During collaborative art making experiences, demonstrate respect and support for peer ideas and creativity.	

Add Standard	Fine Arts	Ohio
Enduring Understanding	Producing / Performing	
Progress Points	Visual Arts	
Grade Level	Grade 5	
Content Statement	5RE Express what was learned and the challenges that remain when assessing their artworks.	

Assessment Plan

What evidence will show that students have acquired the enduring understandings for this STEM unit?

Performance Task, Projects	Appendix 12.2: Engineering Design Challenge Rubric Appendix 5.1: Exploring Shadows Activity Appendix 5.2: Earth's Rotation Simulation Practice
Quizzes, Tests, Academic Prompts	Appendix 1.1: Pre/Post Test Earth and the Sun interactive- http://www.e-learningforkids.org/science/lesson/center-of-the-ocean-the-sun-the-earth/ Appendix 6.3: Exit Slip Identifying Seasons
Other Evidence (e.g. observations, work samples, student artifacts, etc.)	Appendix 2.2: Planet Fact Sheet Appendix 3.1: Scaling Our Planets by Size Worksheet Appendix 3.2: Scaling our Planets by Distance from the Sun Worksheet Scale Models Appendix 4.1: Lesson Guide/Notes Celestial Bodies in the Solar System Appendix 4.2: The Great Space Race Designer's Log Earth and the sun interactive http://www.e-learningforkids.org/science/lesson/center-of-the-ocean-the-sun-the-earth/ Appendix 7.4: Identifying Earth's Points Teacher Observation Appendix 8.2: Planning Sheets Appendix 11.1: Exit Slip of Favorite Game
Student Self- Assessment	Appendix 12.1: Self-Assessment Rubric

Technology Integration

ADISC Technology Integration Model*

	Type of Integration	Application(s) in this STEM Unit
A	Technology tools and resources that support students and teachers in ***adjusting, adapting, or augmenting*** teaching and learning to meet the needs of individual learners or groups of learners.	Smart Board Chromebook or other personal computer "Minute to Win It Australia - Season 1, Episode 5, Part 3" https://www.youtube.com/watch?v=byH8R01OODI (8:17) "Minute to Win It Episode 1 - Finale - Down to the Wire" https://www.youtube.com/watch?v=GXqmr_ci6fI (3:29) "Minute to Win It Episode 2 - Joe v Caroline - Face the Cookie"https://www.youtube.com/watch?v=5RH6rMBgX9k&t=8s (2:33)
D	Technology tools and resources that support students and teachers in ***dealing effectively with data***, including data management, manipulation, and display.	Digital Thermometer
I	Technology tools and resources that support students and teachers in conducting ***inquiry***, including the effective use of Internet research methods.	“Here Comes The Sun: Crash Course Kids #5.1” https://www.youtube.com/watch?v=6FB0rDsR_rc (3:03) “The Biggest Stars in the Universe” https://www.youtube.com/watch?v=Bcz4vGvoxQA (4:25) “Learning About the Planets in Our Solar System” https://www.youtube.com/watch?v=jEXWxNbpTzU (20:01) "Asteroids: Crash Course Astronomy #20" https://www.youtube.com/watch?v=auxpcdQimCs (11:32) "What are Asteroids? Facts & Information | Mocomi Kids" https://www.youtube.com/watch?annotation_id=annotation_973285&feature=iv&index=9&list=PL6vCwGtCTVtPLInDKcxw_Lp6T67VJL-Mx&src_vid=EvhJgAOky-E&v=Jzyugh0dXRc (1:59) "What Is An Asteroid?" https://www.youtube.com/watch?v=iy19nHTVLEY (2:14) "Comets: Crash Course Astronomy #21" https://www.youtube.com/watch?v=yB9HHyPpKds (2:14) "Clip from COSMOS - "Halley's Comet" | FOX Home Entertainment https://www.youtube.com/watch?v=1UfnbCLDLAI (1:02) "What is a Comet? Facts & Information | Mocomi Kids" https://www.youtube.com/watch?v=EvhJgAOky-E (2:30) "Meteor Hits Russia Feb 15, 2013 - Event Archive" https://www.youtube.com/watch?v=dpmXyJrs7iU (10:11) "What Is A Meteor?" https://www.youtube.com/watch?v=lLyCtPmuZ8Y (1:58) "February 2017 meteor in Midwest region (Lake Michigan)" http://www.chicagotribune.com/news/local/breaking/ct-northern-illinois-meteor-20170206-story.html (2:06) "What Happens When a Meteorite Strikes Earth? -- Extreme Science #1" https://www.youtube.com/watch?v=iJwZ3uBzQV0 (6:09) "Know Your Science: Why We Kicked Pluto Out Of The Planet

		Club; You'll always be the ninth planet in my heart, Pluto" http://www.upworthy.com/know-your-science-why-we-kicked-pluto-out-of-the-planet-club (4:45) "Universe today: Why Pluto is No Longer a Planet" http://www.universetoday.com/13573/why-pluto-is-no-longer-a-planet/ (watch until 4:23) "Following the Sun: Crash Course Kids #8.2" https://www.youtube.com/watch?v=1SN1BOpLZAs (4:52) "Earth's Rotation and Revolution" https://www.youtube.com/watch?v=l64YwNl1wr0&t=19s (4:00) "Day and Night and Earth's Rotation" https://www.youtube.com/watch?v=pLl8sDZRSYg&t=14s (1:28) Google Earth
S	Technology tools and resources that support students and teachers in ***simulating*** real world phenomena including the modeling of physical, social, economic, and mathematical relationships.	"Tilt a Cup" https://www.youtube.com/watch?v=CWr1R5BiIjQ&list=PL1gj2vsR6ByjujneITcP3ObdNxX8Xw2NT (0:37) "Ready Spaghetti" https://www.youtube.com/watch?v=0pLQ9V5vrX8 (0:31) "Sharp Shooter" https://www.youtube.com/watch?v=ksr2JPk2MnM (0:23) "Ruler of the World" https://www.youtube.com/watch?v=_VGPMvXp2_o (0:25) "Office Tennis" https://www.youtube.com/watch?v=od6KoCYr4nw (0:32) "Face the Cookie" https://www.youtube.com/watch?v=oLvLVL_rfD4 (0:28) "Back Flip" https://www.youtube.com/watch?v=_f4cO74Tb1Q (0:28) Gizmos Foss Simulations Interactive Season Simulation
C	Technology tools and resources that support students and teachers in ***communicating and collaborating*** including the effective use of multimedia tools and online collaboration.	Google Slide Show
	**The ADISC Model was developed by James Rowley PhD, Executive Director of the Institute for Technology-Enhanced Learning at the University of Dayton*	

Career Connections

Career Description

Astronomer: Observational astronomers write observing programs for a telescope or spacecraft to make observations on space objects to answer a question or test the predictions of theories. Theorist astronomers work with computer models to understand appearances and properties of stars or to formulate and test theories. Astronomers spend their time in an office analyzing the data, creating computer programs that allow them to more efficiently search through the data, writing research papers, and completing other tasks like attending meetings and communicating their discoveries. Astronomers use cutting edge technology and their analytical skills to dissect and solve problems. (Source: National Optical Astronomy Observatory)

Digital Media Designer/Multimedia Artist: Multimedia artists and animators create two- and three-dimensional models, animation, and visual effects for television, movies, video games, and other forms of media.

Game Designer: Game designers create games ranging from simple interaction games such as Pong to complex games that resemble digital worlds with many life-like characters like Metal Gear. Game designers start by creating the objective of the game, the possible actions a player can do, and how the game responds to these player actions. Then, they implement these ideas using software, taking into consideration how the player would play it. The game designer has to implement the game so that it can be run in game consoles smoothly. Games not only include what one would typically consider a game, but also games that help with research. 3D games have been released to the public such that the processes that make a player win are solutions to hard problems in molecular biology.

Graphic Designer: Graphic designers create visual concepts, using computer software or by hand, to communicate ideas that inspire, inform, and captivate consumers. They develop the overall layout and production design for various applications such as for advertisements, brochures, magazines, and corporate reports. Graphic designers combine art and technology to communicate ideas. (Source: US Department of Labor)

Marketing Managers/Analysts: Market research analysts study market conditions to examine potential sales of a product or service. They help companies understand what products people want, who will buy them, and at what price. They typically have strong analytical and mathematical skills. They are good at using computer software to collect data and interpret what the data means for their client. They often make charts, graphs, infographics, and other visual aids to present the results of their research. (Source: US Department of Labor)

Mathematician: Mathematicians look for patterns and find formulas that explain these patterns. For example, gravity makes objects fall to the ground, and the formulas that describe this can be used to study how gravity affects a variety of objects, at different heights and different initial velocities. Mathematicians also generalize formulas, so that they are applicable in a wide variety of cases. The formulas that describe gravity on Earth were generalized to also describe how objects of different masses affect each other. These formulas were fundamental in reaching the moon and their discovery was necessary for space exploration. The mathematician helps science by finding formulas that describe the world around us.

Meteorologist/Atmospheric Scientist: Meteorologists design and utilize softwares to collect and analyze atmospheric data to make predictions of weather and climate. They work closely with environmental scientists or government agencies to help establish policies and develop strategies to protect people from natural or anthropogenic disasters. They use computers extensively and have strong analytical skills.

Research Scientist: Research scientists are scientists who pursue a deeper understanding on a variety of topics through making observations, developing hypotheses, designing experiments, and interpreting data. They are curious and inquisitive by nature and often have teaching duties at college and university level. They have good analytical skills and routinely write and present their research findings.

Section II: STEM Lesson Plan

Title of Lesson

Day 1: Unit and Project Introduction

Time Required

60 Minutes

Materials

Appendix 1.1: Pre/Post-test (1 per student)
Appendix 1.2: Pre/Post-test Answer Key (for teacher)
Appendix 1.3: “Minute to Win It” Intro Letter (1 per student)
Appendix 1.4: The Great Space Race Videos and Links
Notebook paper (or Science Notebooks) (1 per student)

Computer with projection capability
"Minute to Win It Australia - Season 1, Episode 5, Part 3" https://www.youtube.com/watch?v=byH8R01OODI (8:17)
"Minute to Win It Episode 1 - Finale - Down to the Wire" https://www.youtube.com/watch?v=GXqmr_ci6fI (3:29)
"Minute to Win It Episode 2 - Joe v Caroline - Face the Cookie"https://www.youtube.com/watch?v=5RH6rMBgX9k&t=8s (2:33)

Various materials depending on which “Minute to Win It” challenges you choose to have students perform:
“Tilt a Cup”- 8 solo cups, 6 ping pong balls (per student participating),
https://www.youtube.com/watch?v=CWr1R5BiIjQ&list=PL1gj2vsR6ByjujneITcP3ObdNxX8Xw2NT (0:37)

“Ready Spaghetti”- 3 empty soda cans, dry spaghetti (per team participating),
https://www.youtube.com/watch?v=0pLQ9V5vrX8 (0:31)

“Sharp Shooter”- rubber bands, 3 clothes pins, 3 playing cards (per each student participating),
https://www.youtube.com/watch?v=ksr2JPk2MnM (0:23)

“Ruler of the World”- yardstick or meterstick, marble, bucket (1 for each student participating),
https://www.youtube.com/watch?v=_VGPMvXp2_o (0:25)

“Office Tennis”- 2 clipboards, paper wad (per team participating),
https://www.youtube.com/watch?v=od6KoCYr4nw (0:32)

“Face the Cookie”- cookie (1 cookie for each student participating),
https://www.youtube.com/watch?v=oLvLVL_rfD4 (0:28)

“Back Flip”- 6 pencils (per student participating),
https://www.youtube.com/watch?v=_f4cO74Tb1Q (0:28)

Objectives

1. The students will show their knowledge of the predictable cycles and patterns of motion between Earth and sun by completing a Pre-test.
2. Students will be introduced to a "Minute to Win It" type game that the challenge will be based on.

Instructional Process

Lesson Preparation:
1. Have students placed into teams of 3-4.
2. Copy “Minute to Win It Intro.”
3. Ensure that the included videos will play in your classroom.

Lesson Delivery:

1. Administer the Pre-test.
2. Assign students to teams. You may want to have teams sit together as they will be working together throughout the duration of the unit.
3. Pass out the “Minute to Win It” Challenge Intro Letter. Tell students that you received this exciting letter from the “Minute to Win It” company that will direct the challenge they will work on throughout the unit. Read the letter out loud to your students.
4. Allow students to construct a “Need to Know” list based on the letter. A “Need to Know” drives learning throughout the unit. From the letter, students should come up with the required learning targets, as well as what “Minute to Win It” is, its rules, and how it is played. This list can be created on notebook paper or in students' existing science notebooks.
5. In order for students to become familiar with “Minute to Win It,” show the following clips highlighting challenges from the show:
   a. "Minute to Win It Australia - Season 1, Episode 5, Part 3" https://www.youtube.com/watch?v=byH8R01OODI (8:17)
   b. "Minute to Win It Episode 1 - Finale - Down to the Wire" https://www.youtube.com/watch?v=GXqmr_ci6fI (3:29)
   c. "Minute to Win It Episode 2 - Joe v Caroline - Face the Cookie" https://www.youtube.com/watch?v=5RH6rMBgX9k&t=8s (2:33)
6. Have students practice doing “Minute to Win It” in the classroom to gain even more familiarity with the game. In order to avoid the chaos of having all students compete, draw names of students to complete some of the challenges. Several are listed, but do as many as you feel comfortable with:
   a. https://www.youtube.com/watch?v=CWr1R5BiIjQ&list=PL1gj2vsR6ByjujneITcP3ObdNxX8Xw2NT (0:37)- “Tilt a Cup”- students have to bounce a ping pong ball into a cup, repeating the process until they have stacked 6 cups.
   b. https://www.youtube.com/watch?v=0pLQ9V5vrX8 (0:31)- “Ready Spaghetti”- teams of students have to move soda cans using hard spaghetti suspended from their mouth.
   c. https://www.youtube.com/watch?v=ksr2JPk2MnM (0:23)- “Sharp Shooter”- students have to shoot rubber bands at playing cards and knock over 3.
   d. https://www.youtube.com/watch?v=_VGPMvXp2_o (0:25)- “Ruler of the World”- students have to get a marble to roll down a yardstick into a designated bucket below.
   e. https://www.youtube.com/watch?v=od6KoCYr4nw (0:32)- “Office Tennis”- A team of 2 students have to get a wad of paper into a trashcan by passing it back and forth using clipboards as rackets.
   f. https://www.youtube.com/watch?v=oLvLVL_rfD4 (0:28)- “Face the Cookie”- students have to get a cookie from their cheek to their mouth using no hands.
   g. https://www.youtube.com/watch?v=_f4cO74Tb1Q (0:28)- “Back Flip”- students have to flip and catch pencils on the back of their hands.
7. As a class, discuss features of the challenges. What makes them exciting?

Differentiation

Pre-test can be modified to meet the needs of all of your students.

Assessments

Pre-test

Section II: STEM Lesson Plan

Title of Lesson	**Day 2: The Planets of the Solar System**
Time Required	60 minutes
Materials	Appendix 2.1: Solar System Vocabulary (1 per student) Appendix 2.2: Planet Fact Sheet (1 per student) Appendix 2.3: Solar System Sort - Differentiation Activity Extension Activity (1 per team) Computer with projection capability “Here Comes The Sun: Crash Course Kids #5.1” https://www.youtube.com/watch?v=6FB0rDsR_rc (3:03) “The Biggest Stars in the Universe” https://www.youtube.com/watch?v=Bcz4vGvoxQA (4:25) “Learning About the Planets in Our Solar System” https://www.youtube.com/watch?v=jEXWxNbpTzU (20:01)
Objectives	Students will learn about the sun, the center of the solar system, and stars. They will research, identify and describe the eight major planets of the solar system.
Instructional Process	Lesson Preparation: 1. Copy Solar System Vocabulary and Planet Fact Sheet. 2. Ensure that the included videos will play in your classroom. Lesson Delivery: 1. Ask students, "What is a solar system?" After listening to answers tell them that today they will learn about parts of our solar system starting with the its center. 2. Students watch “Here Comes The Sun: Crash Course Kids #5.1” https://www.youtube.com/watch?v=6FB0rDsR_rc (3:03) 3. Ask students, "How big is the sun?" Have them watch only the first 2:20 minutes of “The Biggest Stars in the Universe”. https://www.youtube.com/watch?v=Bcz4vGvoxQA (4:25) 4. Ask students several lead-in questions about the planets of the solar system. (How many planets are there? Is Pluto a planet? What planet is the largest? What’s planet is the smallest? Are they all the same except for size?) 5. Pass out the Planet Fact Sheet. Tell them they will be watching a video to start their research on information about the planets. “Learning About the Planets in Our Solar System.” https://www.youtube.com/watch?v=jEXWxNbpTzU (20:01) 6. After watching the video. Allow students to finish researching for any remaining information needed to complete the table.
Differentiation	Students complete a planet fact sort activity (Appendix 2.3). A free resource for this activity is available at http://researchparent.com/solar-system-cards/
Assessments	Collect and check the Planet Fact Sheet. Students compare their table with another student’s table to evaluate the accuracy.

Section II: STEM Lesson Plan

Title of Lesson

Day 3: Scaling the Solar System

Time Required

60 Minutes

Materials

Appendix 3.1- Scaling our Planets by Size Worksheet (1 per student)
Appendix 3.2 - Scaling our Planets by Distance from the Sun Worksheet (1 per student)
Masking Tape (1 roll)
Sharpie or other permanent marker (1 per team)
Construction Paper (2-4 pieces each; 9"x12" and 18"x24")
Bulletin Board Paper (4 pieces approximately 60" in length)
Meter Stick (1 per team)
Compasses (1 per team)

Objectives

1. Students will learn that the Solar System has many celestial bodies that orbit the sun and each has unique characteristics.
2. Students will be able to show sizing of planets and distance from the sun within a given scale.
3. Students will make observations about the spacing of our planets as well as the comparative sizes of our planets using the scaled models.

Instructional Process

Lesson Delivery:
1. Discuss with students what it means to scale an object (the ratio between the size of something and a representation of it). Have students discuss things that might be scaled, for example, we can scale things up (such as cells) or scale things down (such as buildings, cars, maps, etc.). This allows us to get a visual representation showing us how close things are together and/or how big they are in relation to each other.
2. Pass out the “Scaling our Planets by Size” worksheet. In this activity, students will be using the scale 1 cm. = 1,000 km. Discuss how to find the scaled distance. (Divide each actual distance by 1,000 to get the scaled distance.)
3. Have students complete the scaling on the worksheet. Discuss the answers as a class.
4. Assign student teams to a planet. Have each team make a scale model of their planet.
   a. Teams with inner planets will need construction paper and a compass. You may need to discuss how to use the compass if they have never used one before. Make sure to note that the measurement markings on the compass actually measure the radius of the circle it will draw, so students will need to cut the scaled distance in half. For example, students doing Mercury will need to make a model with the diameter of 4.9 cm. If they round to the nearest whole number (5), they will need to put the compass on 2.5, as that will be the radius of their model. Have them use the compass to draw the circle on construction paper, cut it out, and label it with a marker.
   b. Teams with the outer planets will need to use butcher/bulletin board paper as there are not compasses large enough to make the circles needed. For some planets (i.e. Jupiter), you may even need to book tape 2 large sheets of bulletin board paper together in order to make a large enough planet. In order to draw a circle, have students use a meter stick and mark a point at the zero point of the stick, and at the length needed for the diameter. For example, for Jupiter, they will need to put a mark at 0 and 143 cm. Have them also put a mark at the center point. (For example, Jupiter would be marked at 71 ½ cm.) Then have them rotate their meterstick, lining up the center point again (for Jupiter at 71 ½). Once their center point is lined up, have them again make a mark at the zero and at the end (143 for Jupiter). Have them rotate the meter stick and do this several times so that they have many points close together around the circumference of the circle. This will make it easier to connect the dots and make a more “perfect” circle. Have them draw the circle, cut it out and label it with the planet name.
5. As students finish, hang the models around the room so that students can see them comparatively.
6. Have students make observations about the sizes of the planets in relation to each other.
7. After scaling by size, pass out the “Scaling our Planets by Distance from the Sun” worksheet. In this activity, students will be using the scale 1 cm. = 10,000,000 km. Discuss how to find the scaled distance. (Divide each actual distance by 10,000,000 to get the scaled distance.)

8. Place a strip of masking tape on the floor in the classroom and label it “the sun”. Call on students to measure and mark each subsequent planet. For example, a strip of tape labeled “Mercury” will need to be placed 5.79 cm. from the sun. This is also a good time to discuss how to mark 5.79 cm, since it will not be exact. They should recognize that the tape should go slightly past the 5 ¾ cm mark. Place a strip of masking tape down for each planet, measuring the scaled distance from the “sun” masking tape.
9. Have students make observations about the model, noting that the inner planets are much closer together than the outer planets.

Differentiation

Students only scale inner planets.
Students decorate scaled size planets, adding facts for a hallway display.

Assessments

Scale Models
Appendix 3.1: “Scaling our Planets by Size” worksheet
Appendix 3.2: “Scaling our Planets by Distance from the Sun” worksheet

Section II: STEM Lesson Plan

Title of Lesson

Day 4: Celestial Bodies in Solar System

Time Required

60 Minutes

Materials

Appendix 2.1: Solar System Vocabulary
Appendix 4.1: Celestial Bodies in the Solar System (1 per student)
Appendix 4.2: The Great Space Race Designer's Log (1 per student)
Appendix 4.3: Engineering Design Process (1 per student)
Computer with projection capability
Suggested Videos listed in Step 2 of the Lesson Delivery
Assortment of materials for students to create a "Minute to Win It" challenge. Suggested items:
paper towel rolls, toilet paper rolls, string, marbles, tennis balls, golf balls, ping pong balls, index cards, plastic cups, empty egg cartons, flashlights, etc.

Objectives

Students will explain what comets, asteroids, meteors, meteorites and dwarf planets are and then compare and contrast them. Students will use this to create a "Minute to Win It" challenge.

Instructional Process

Lesson Preparation:
1. Preview suggested videos and choose appropriate ones for students in class. (starred videos are ones chosen to create the The Great Space Race Designer's Log in Appendix 4.2)
2. Prepare materials and space for the challenge creation.
3. Copy Celestial Bodies in the Solar System (Appendix 4.1) and The Great Space Race Designer's Log (Appendix 4.2).

Lesson Delivery:
1. Review with students the second day's lesson about the sun and planets. Remind students that the definition of a solar system includes the sun, planets and all the other celestial bodies orbiting the star. Explain to students that today we will explore what the "other celestial" bodies means. At the end of the lesson students will be given the first opportunity to brainstorm and create possible "Minute to Win It" challenges.
2. Pass out the Celestial Bodies in the Solar System handout and ask students to cut out the boldfaced vocabulary words. Explain to students that they will be watching a series of very short videos that will define, explain, and show visual examples of each of the "other celestial bodies." Tell students that you will pause after each video to give them time to evaluate the information in each descriptor box. Each box has from one to six descriptors about comets, asteroids, meteoroids, meteors, meteorites, and dwarf planets. When they have determined the correct vocabulary word that matches the correct descriptor box they should place the word at the top of the box.

Suggested videos:

Asteroids
"Asteroids: Crash Course Astronomy #20" https://www.youtube.com/watch?v=auxpcdQimCs (11:32) (recommended to preview and decide how much and what parts you wish to show based on the time allotted for the class)
***** "What are Asteroids? Facts & Information | Mocomi Kids" https://www.youtube.com/watch?annotation_id=annotation_973285&feature=iv&index=9&list=PL6vCwGtCTVtPLInDKcxw_Lp6T67VJL-Mx&src_vid=EvhJgAOky-E&v=Jzyugh0dXRc (1:59)
"What Is An Asteroid?" https://www.youtube.com/watch?v=iy19nHTVLEY (2:14) (does include a theory about how moon was formed –should preview first)

Comets
"Comets: Crash Course Astronomy #21" https://www.youtube.com/watch?v=yB9HHyPpKds (2:14)
***** "Clip from COSMOS - "Halley's Comet" | FOX Home Entertainment https://www.youtube.com/watch?v=1UfnbCLDLAI (1:02)
*** "What is a Comet? Facts & Information | Mocomi Kids" https://www.youtube.com/watch?v=EvhJgAOky-E (2:30)

Meteors
"Meteor Hits Russia Feb 15, 2013 - Event Archive" https://www.youtube.com/watch?v=dpmXyJrs7iU (10:11) (only first minute or two - shows sound of impact breaking windows)
***** "What Is A Meteor?" https://www.youtube.com/watch?v=lLyCtPmuZ8Y (1:58) (gives good definition of meteoroids, meteors, and meteorites)
"February 2017 meteor in Midwest region (Lake Michigan)" http://www.chicagotribune.com/news/local/breaking/ct-northern-illinois-meteor-20170206-story.html (2:06) (there are several videos posted on this Chicago Tribune site – I used first one)

Meteorite
"What Happens When a Meteorite Strikes Earth? -- Extreme Science #1" https://www.youtube.com/watch?v=iJwZ3uBzQV0 (6:09)

Dwarf Planet
"Know Your Science: Why We Kicked Pluto Out Of The Planet Club; You'll always be the ninth planet in my heart, Pluto" http://www.upworthy.com/know-your-science-why-we-kicked-pluto-out-of-the-planet-club (4:45)

*****"Universe today: Why Pluto is No Longer a Planet" http://www.universetoday.com/13573/why-pluto-is-no-longer-a-planet/ (watch until 4:23)

3. Pause videos as frequently as necessary to encourage discussion and ask questions. When all videos have been watched, go over student answers for the Celestial Bodies in the Solar System handout.
4. Following the above procedures, have students pull out The Great Space Race Designer's Log. Review the challenge as introduced in the "Minute To Win It" Intro letter. Remind students the steps of the Engineering Design Process using the graphic, making sure to focus on the "Think" and "Design" steps. Direct students to The Great Space Race Designer's Log page and explain that they will be spending 5-10 minutes brainstorming ideas for challenges. They should fill out as many ideas as they can in that time period for days 2-4. Have the materials available to manipulate to encourage the process.
5. Give students time to design the challenge.
6. Give students time to play their challenges within their own teams while members take notes and write down ideas for improving or changing the challenge to make it more effective. Remember to point out to students the cyclic process of the Engineering Design Process.

Differentiation

Quizlet and/or Kahoot games for recall of information.

Assessments

As the teacher walks around the classroom, listen to team discussions, and look at each teams' brainstorming, challenges, and notes for redesign. As observations are made the teacher should walk around and intercede when students seem to be misunderstanding.

Section II: STEM Lesson Plan

Title of Lesson

Day 5: Earth's Rotation

Time Required

60 Minutes

Materials

Computer with projection capability
"Following the Sun: Crash Course Kids #8.2" https://www.youtube.com/watch?v=1SN1BOpLZAs (4:52)
"Earth's Rotation and Revolution" https://www.youtube.com/watch?v=l64YwNl1wr0&t=19s (4:00)
"Day and Night and Earth's Rotation" https://www.youtube.com/watch?v=pLl8sDZRSYg&t=14s (1:28)
Appendix 5.1: Exploring Shadows Activity (1 per student)
Appendix 5.2: Earth's Rotation Simulation Practice (1 per student)
Appendix 5.3: Earth's Rotation Activity (1 per student)
Appendix 5.4: Sundial Activity (1 per student) (optional)
Flashlights (1 per pair)
Mini globes or Globes (1 per pair)
White paper (1-2 per pair)
Small solid (opaque) 3-D objects (dice, marbles, etc.; 1 per pair)
Ruler (1 per pair)
Construction Paper-Black (1 per pair)
Brass Brads (1-2 per pair)
Assessment: Earth and the Sun interactive -
http://www.e-learningforkids.org/science/lesson/center-of-the-ocean-the-sun-the-earth/

Objectives

1. Students will be able to explain and demonstrate with manipulatives why Earth has day and night.
2. Students will understand why the sun and stars seem to move across the sky in a predictable pattern.
3. Students will be able to define and represent the concept of rotation.
4. Students will understand what affects the length and width of a shadow.

Instructional Process

1. Students will watch the video for an introduction to their understanding of what causes a shadow to change, how shadows can be used to identify what time of day it is, and where a shadow is casted based on the location of the light source.
"Following the Sun: Crash Course Kids #8.2" https://www.youtube.com/watch?v=1SN1BOpLZAs (4:52)

2. Students work in pairs using a flashlight, small solid (opaque) object, white paper, and a ruler to experiment with factors that affect the size of a shadow. Please refer to the "Exploring Shadows" activity worksheet for detailed procedure steps, instructions, and visual demonstrations (Appendix 5.1).

3. Use one or both of the suggested videos to introduce the motion causing day and night, which is Earth's rotation :
"Earth's Rotation and Revolution" https://www.youtube.com/watch?v=l64YwNl1wr0&t=19s (4:00)
"Day and Night and Earth's Rotation" https://www.youtube.com/watch?v=pLl8sDZRSYg&t=14s (1:28)

4. Students complete Earth's Rotation Simulation Practice Appendix 5.2. Students work in pairs using a globe and flashlight to answer the questions on the handout to gain a deeper understanding of Earth's rotation and what causes day and night. You can have the 'Earth spin animation' playing on the smart board while they do this activity.

Earth spin animation https://www.youtube.com/watch?v=QI9ta7qkazU&t=40s (Video is 1:00:00 long. However, it shows the continuous rotation of the earth. Therefore, watch for as long as you feel necessary.)

5. Allow students time to complete the Earth's Rotation activity Appendix 5.3. Students color the sun and Earth. Then, cut out Sun, Earth and text box. Students glue Sun to left side of dark colored construction paper and use brass brad to secure Earth to paper. The text box can be glued at bottom of page. Glue a 4" x 7" piece of black construction paper so that half of the earth is covered in "night" Be certain to only glue 3 edges so the Earth can 'rotate'.

6. Implement instructional assessment: Earth and the sun interactive http://www.e-learningforkids.org/science/lesson/center-of-the-ocean-the-sun-the-earth/
Students will click on the link and answer the questions in each of the 4 boxes. After they answer the questions in the box, they will earn 1-2 gold stars based on how they did. After they have answered the questions in all 4 boxes they will be able to show you how many gold stars they earned out of 8 total.

Differentiation

Enrichment extension: Appendix 5.4: Making a sundial
Students will create a monthly calendar for Ohio where the 12 months are arranged in a circle (like a clock) based on Earth's position relative to the Sun.

Assessments

Earth and the Sun Online Interactive Simulation http://www.e-learningforkids.org/science/lesson/center-of-the-ocean-the-sun-the-earth/
Students will click on the link and answer the questions in each box. It will give them one or two stars based on how they did. There are four boxes, so they can earn up to 8 stars. Their score will be how many gold stars they earned out of 8.

Section II: STEM Lesson Plan

Title of Lesson

Day 6: Earth's Revolution: 1 year =365 Days

Time Required

60 Minutes

Materials

Chromebooks or Computer (1 per student or team)
"Rotation and Revolution of Earth - Educational Video For Kids" https://www.youtube.com/watch?v=cDed5eXmngE (3:39)
Stand Alone Light Bulbs (1 per team)
Mini Gloves with a tilt (1 per team)
Small numbered stickers (3 per team)
Appendix 6.1: Temperature Recording Sheet (1 per student)
Digital Laser Thermometer (1 per team)
Foss Simulation: http://www.fossweb.com/delegate/ssi-foss-ucm/Contribution%20Folders/FOSS/multimedia/Planetary_Science/binders/earth/earth_motions/seasons_simulation_1.html
Appendix 6.2: Foss Simulation Worksheet (1 per student)
Appendix 6.3: Seasons Exit Slip (1 per student)

Objectives

1. Students will be able to explain and demonstrate with manipulatives that it takes Earth approximately 356 days to revolve around the sun.
2. Students will be able to express why seasons occur.
3. Students will represent different seasons in relationship to Earth's path of revolution.
4. Students will be able to define and represent the concept of revolution.

Instructional Process

Lesson Preparation:
1. Acquire stand alone light bulbs and mini globe with tilt for each group.
2. Place small numbered stickers on different places on globe for students to take readings.
3. Prepare copies of printable resources for each student.

Lesson Delivery:
1. Review the concept of rotation with students and introduce the concept of revolution.
2. Show the following video: "Rotation and Revolution of Earth - Educational Video For Kids" https://www.youtube.com/watch?v=cDed5eXmngE (3:39)
3. Setup stand alone light bulbs and mini globes. Instruct teams to place globe in different spots to represent different seasons on different parts of the globe. Students will record temperatures on the Temperature Recording Sheet.
4. Model for students how to set their globe to represent winter for the Northern Hemisphere.
5. Students take readings of temperature at all stickered locations and record.
6. Once students have completed readings, they can complete the following Foss Simulation, in pairs or teams: http://www.fossweb.com/delegate/ssi-foss-ucm/Contribution%20Folders/FOSS/multimedia/Planetary_Science/binders/earth/earth_motions/seasons_simulation_1.html. Adobe Flash Player is required for this site.
7. Students complete Foss Simulation worksheet.
8.. Students complete Seasons Exit Slip.

Differentiation

Students can place their own stickers on the globe for other students to record temperatures and seasons. Students can complete Foss Simulation activity independently.

Assessments

Students complete exit slip correctly, identifying both seasons marked on a globe in comparison to its revolution around the sun.

Section II: STEM Lesson Plan

Title of Lesson	**Day 7: Direct and Indirect Sunlight**
Time Required	60 Minutes
Materials	Chromebook or computer (1 per student or team) Seasons Interactive: http://highered.mheducation.com/sites/007299181x/student_view0/chapter2/seasons_interactive.html Appendix 7.1: Seasons Interactive Data Table (1 per student) Appendix 7.2: Discover Your Own Island (1 per student) Appendix 7.3: Google Earth Directions (1 per student) Appendix 7.4: Earth's Points (1 per student)
Objectives	1. Students will differentiate between direct and indirect sunlight and the effect it has on temperatures of the Earth. 2. Students will be able to use latitude and longitude coordinates on Google Earth and determine what season a particular location is experiencing and why.
Instructional Process	Lesson Preparation: 1. Copy all Appendix worksheets for students. 2. Gather all supplies for experiments. Lesson Delivery: 1. Instruct students to log onto the Seasons Interactive website (http://highered.mheducation.com/sites/007299181x/student_view0/chapter2/seasons_interactive.html) to see angle and height of sunlight, along with tilt and average daily temperature in order to make observations about direct and indirect sunlight. Students will follow directions on Seasons Interactive Data Table worksheet and complete. 2. Review latitude and longitude. Allow each student to practice plotting their latitude and longitude points on the "Discover and Island" coordinate grid paper. 3. Download Google Earth at https://www.google.com/earth/ if not done before the lesson. Use Appendix T: How to Use Google Earth to get started. 4. Students use given coordinates to find places on Earth and determine the season (in relationship to our current season) and the type of sunlight the location is experiencing at that time (direct or indirect). 5. Students complete Appendix 7.4: Earth's Points as an assessment.
Differentiation	Calculate area of sunlight near equator versus poles: Use cardboard to build a cuboid with open ends (10cmx10cmx30cm). Insert 4 long skewers sticks at each of the 4 corners. Place the cuboid on a sphere near equator or near the pole. Push sticks out and mark on the sphere where the sticks touch the sphere. Use pipe cleaners to make a rectangle created by the 4 stick marks on the sphere. Calculate area of the rectangle. Assuming sunlight energy, coming from the cuboid, is the same, (let's set at 100%), divide the sunlight energy by the areas. Students should be able to see that areas with less direct sunlight receive less percentage of energy per area. Students can choose their own coordinates on Earth's Points and have classmates try to identify their chosen location.
Assessments	Use the Appendix 7.4: Earth's Points as a formative assessment. Collect at end of class.

Section II: STEM Lesson Plan

Title of Lesson	**Day 8: Challenge Creation**
Time Required	60 Minutes
Materials	Appendix 1.2: Minute to Win It Letter Appendix 4.2: Great Space Race Designer's Log Appendix 8.1: The Great Space Race Student Planning Sheet Example (1 per student) Appendix 8.2: The Great Space Race: Student Planning Sheet (1 per student + 2 additional per team)
Objectives	1. Students will brainstorm ideas for their Minute to Win It Challenges using provided graphic organizer in Great Space Race Designer's Log. 2. Students will assess above challenges using criteria for their Engineering Design challenge.
Instructional Process	Lesson Preparation: 1. Copy the Planning Sheet Example (Appendix 8.1) and blank Student Planning Sheet (Appendix 8.2) front to back for each student. 2. Copy additional blank Student Planning Sheets as needed for each team. Lesson Delivery: 1. Reread the Introduction Letter. Remind students of the challenge. 2. Revisit the Minute to Win It challenges completed on Day 1. 3. Have students review Great Space Race Designer's Log and give students a chance to brainstorm their own independent idea for activities for days 5 and 7. After this is complete have students meet with their teams to share their ideas. 4. Review the Student Planning Sheet Example page. Discuss the guidelines with the planning sheet and explain that teams need to do a minimum of two activities but can complete more, if time permits. Instruct teams to think of 2-3 ideas as a group. 5. Teams check in with the teacher to ensure the activity will be applicable. Groups fill out Student Planning Sheets (Appendix 8.2) after the teacher approves the team's activities. 6. Teams work on Student Planning Sheets. 7. Give students 5 minutes at the end of class to clean up any materials.
Differentiation	Flexible teaming: Students can be teamed heterogeneously in order to have a variety of thinking. Teacher can provide extra guided support for teams if needed. Students may create additional challenges and include additional Student Planning Sheets (Appendix 8.2) for each activity.
Assessments	Formative assessments can be done while meeting with individual teams and checking in on their progress with the Student Planning Sheet. Teacher should check to make sure each team has at least one idea by the conclusion of today's lesson. Teacher observation notes

Section II: STEM Lesson Plan

Title of Lesson	**Days 9 and 10: Challenge Creation and Test Run**
Time Required	60 Minutes
Materials	Appendix 4.2: Great Space Race Designer's Log Appendix 8.1: The Great Space Race: Student Planning Sheet Example Appendix 8.2: The Great Space Race: Student Planning Sheet Appendix 9.1: The Great Space Race: Feedback Form (1 per student) Devices for saving answer key digitally (iPads, chromebooks, etc) Assortment of materials for students to create a "Minute to Win It" challenge. Suggested items: paper towel rolls, toilet paper rolls, string, marbles, tennis balls, golf balls, ping pong balls, index cards, plastic cups, empty egg cartons, flashlights, etc.
Objectives	1. Students will use their knowledge about the predictable cycles and patterns of motion between Earth and the sun to create three Minute To Win It Challenges for their peers to play. 2. Students will play peers' Challenges, testing them against the given rubric and give feedback.
Instructional Process	Lesson Preparation: 1. Prepare space in the classroom for each team to work on challenges and test their challenges. 2. Have devices for each group to record answer key. 3. Copy Appendix 9.1: The Great Space Race Feedback Form. Lesson Delivery: 1. Review the Student Planning Sheet Example to ensure students know how to correctly complete it. 2. Remind students that their team will be responsible for creating at least three Minute to Win It challenges that will be played by other members of the class. Each challenge should be written down on the Student Planning Sheets (one sheet per challenge). 3. Have students reference their Great Space Race Designer's Log from previous lessons to to help with ideas for challenges. 4. Teachers should check in with each team to ensure students are creating applicable challenges. 5. After each team has completed their Student Planning Sheet, members of the group should do a test run of the challenge and make corrections, if needed. 6. Remind teams that the answer key for their challenge must be saved digitally (Google Slides). Have devices ready for groups to create an answer key, after they have had their lesson approved by the teacher and have done a test run. 7. Give students 5-10 minutes at the end of class to clean up materials.
Differentiation	Flexible teaming: Students can be teamed heterogeneously in order to have a variety of thinking. Teacher can provide extra guided support to teams, if needed. Students may create additional challenges and include a Student Planning Sheet for each activity.
Assessments	Collect at least three Student Planning Sheets from each team.

Section II: STEM Lesson Plan

Title of Lesson	**Day 11: Game Play and Feedback**
Time Required	60 Minutes
Materials	Appendix 4.2: Great Space Race Designer's Log Appendix 9.1: Feedback Form (1 per team, per challenge) Appendix 11.1: Exit Slip: Summary of Favorite Game (1 per student) Materials for Games Electronic Device for Answer Key (1 per team)
Objectives	Students will share Minute To Win It Challenges with class.
Instructional Process	Lesson Preparation: 1. Make copies of printable resources for this lesson. Make the amount of copies needed as referenced in the materials list. 2. Have electronic devices available for teams. Lesson Delivery: 1. Give each team five minutes to set up their game. Make sure teams have supplies and their planning sheet laid out for game play. 2. Discuss expectations for game play and explain the Feedback Form. Explain that teams will be redesigning their games tomorrow based on the Feedback Form. 3. Teams will play at least two other games. Before, during, and after game play teams must fill out the Feedback Form. 4. Teams will turn in the Feedback Form. 5. Each student will fill out the Exit Slip: Summary of Favorite Game. 6. Discuss as a class why the redesign process is so important. Brainstorm what other fields/items have to redesign their products. 7. If time is allotted, teams can receive the Feedback Forms and start on the redesign process.
Differentiation	Students can design a logo for their game and type the planning sheet. Students can create a marketing plan to sell their game.
Assessments	Formative assessment can be completed while teams discuss and fill out their Feedback Forms. Another formative assessment is the exit slip.

Section II: STEM Lesson Plan

Title of Lesson	**Day 12: Redesign, Present, & Post Test**
Time Required	60 Minutes
Materials	Appendix 1.1: Pre/Post-test (1 per student) Appendix 1.2: Pre/Post-test Answer Key (teacher) Appendix 9.1: Feedback Forms (filled out on day 11) Electronic Device for Answer Key Appendix 12.1: Self- Assessment (1 per student) Appendix 12.2: Minute To Win It Design Rubric (1 per team)
Objectives	1. Students will redesign their Minute To Win It Challenges according to feedback and rubric from peers. 2. Students will be present and share the redesign of their game. 3. Students will take post-test to demonstrate their knowledge of the predictable cycles of the Earth and the sun.
Instructional Process	Lesson Preparation: 1. Print the post-test for each student. Make modifications, if needed. 2. Have devices for each team to make changes (if needed) to answer key. Lesson Delivery: 1. Teams will be working on redesigning their games. Teams review the Feedback Forms for their game to help with the redesign process. Teams fill out the redesign portion on their Planning Sheet and finalize the Planning Sheet to turn in at the end of the class period. 2. Administer Post-Test. 3. Teacher fill out Minute To Win It Design Rubric for each group.
Differentiation	Students can design a logo for their game. Students can create a marketing plan to sell their game and create a Google Slide presentation to present their marketing plan. Post-test can be modified to meet the needs of all of your students.
Assessments	The Post-Test is the summative assessment.

Section III: Unit Resources

Materials and Resource Master List

PRINTABLE MATERIALS:
Appendix 1.1: Pre/Post-test (1 per student at beginning of unit and 1 per student at end of unit)
Appendix 1.2: Pre/Post-test Answer Key (teacher)
Appendix 1.3: “Minute to Win It” Intro Letter (1 per student)
Appendix 2.1: Solar System Vocabulary (1 per student)
Appendix 2.2: Planet Fact Sheet (1 per student)
Appendix 2.3: Solar System Sort - Differentiation Activity Extension Activity (1 per team)
Appendix 3.1- Scaling our Planets by Size Worksheet (1 per student)
Appendix 3.2 - Scaling our Planets by Distance from the Sun Worksheet (1 per student)
Appendix 4.1: Celestial Bodies in the Solar System (1 per student)
Appendix 4.2: The Great Space Race Designer’s Log (1 per student)
Appendix 4.3: Engineering Design Process
Appendix 5.1: Exploring Shadows Activity (1 per student)
Appendix 5.2: Earth’s Rotation Simulation Practice (1 per student)
Appendix 5.3: Earth’s Rotation Activity (1 per student)
Appendix 5.4: Sundial Activity (1 per student) (optional)
Appendix 6.1: Temperature Recording Sheet (1 per student)
Appendix 6.2: Foss Simulation Worksheet (1 per student)
Appendix 6.3: Seasons Exit Slip (1 per student)
Appendix 7.1: Seasons Interactive Data Table (1 per student)
Appendix 7.2: Discover Your Own Island (1 per student)
Appendix 7.3: Google Earth Directions (1 per student)
Appendix 7.4: Earth’s Points (1 per student)
Appendix 8.1: The Great Space Race Student Planning Sheet Example (1 per student)
Appendix 8.2: The Great Space Race: Student Planning Sheet (1 per student + 2 additional per team)
Appendix 9.1: The Great Space Race: Feedback Form (1 per student)
Appendix 11.1: Exit Slip: Summary of Favorite Game (1 per student)
Appendix 12.1: Self- Assessment (1 per student)
Appendix 12.2: Minute To Win It Design Rubric (1 per team)

CHALLENGE / ACTIVITY MATERIALS:
DAY 1:
Notebook paper (or Science Notebooks) (1 per student)
Various materials depending on which “Minute to Win It” challenges you choose to have students perform:
Solo Cups (8 per per student participating in "Tilt a Cup" game)
Ping Pong Balls (6 per student participating in "Tilt a Cup" game)
Empty Soda Cans (3 per team participating in “Ready Spaghetti” game)
Dry Spaghetti (per team participating in “Ready Spaghetti” game)
Rubber Bands (1 bag)
Clothes Pins (3 per student participating in “Sharp Shooter” game)
Playing Cards (3 per each student participating in “Sharp Shooter” game)
Yardstick or meterstick (1 for each student participating in “Ruler of the World” game)
Marble (1 for each student participating in “Ruler of the World” game)
Bucket (1 for each student participating in “Ruler of the World” game)
Clipboards (2 per team participating in “Office Tennis” game)
Paper wad (1 per team participating in “Office Tennis” game),
Cookie (1 for each student participating in “Face the Cookie”)
Pencils (6 per student participating in "Back Flip" game)

DAY 3:
Masking Tape (1 roll)
Sharpie or other permanent marker (1 per team)
Construction Paper (2-4 pieces each; 9"x12" and 18"x24")
Bulletin Board Paper (4 pieces approximately 60" in length)
Meter Stick (1 per team)
Compasses (1 per team)

DAYS 4, 9, 10:

Assortment of materials for students to create a “Minute to Win It” challenge. Suggested items:
Paper Towel Rolls
Toilet Paper Rolls
String
Marbles
Tennis Balls
Golf Balls
Ping Pong Balls
Index Cards
Plastic Cups
Empty Egg Cartons
Flashlights

DAY 5:
Flashlights (1 per pair)
Mini globes or Globes (1 per pair)
White paper (1-2 per pair)
Small solid (opaque) 3-D objects (dice, marbles, etc.; 1 per pair)
Ruler (1 per pair)
Construction Paper-Black (1 per pair)
Brass Brads (1-2 per pair)

DAY 6:
Stand Alone Light Bulbs (1 per team)
Mini Gloves with a tilt (1 per team)
Small numbered stickers (3 per team)
Digital Laser Thermometer (1 per team)

ELECTRONIC RESOURCES:
Computer with projection capability
Chromebook, Computer, iPad (1 per student or team, depending on the day)

DAY 1:
"Minute to Win It Australia - Season 1, Episode 5, Part 3" https://www.youtube.com/watch?v=byH8R01OODI (8:17)
"Minute to Win It Episode 1 - Finale - Down to the Wire" https://www.youtube.com/watch?v=GXqmr_ci6fI (3:29)
"Minute to Win It Episode 2 - Joe v Caroline - Face the Cookie"https://www.youtube.com/watch?v=5RH6rMBgX9k&t=8s (2:33)
“Tilt a Cup”- https://www.youtube.com/watch?v=CWr1R5BiIjQ&list=PL1gj2vsR6ByjujneITcP3ObdNxX8Xw2NT (0:37)
“Ready Spaghetti”- https://www.youtube.com/watch?v=0pLQ9V5vrX8 (0:31)
“Sharp Shooter”- https://www.youtube.com/watch?v=ksr2JPk2MnM (0:23)
“Ruler of the World”- https://www.youtube.com/watch?v=_VGPMvXp2_o (0:25)
“Office Tennis”- https://www.youtube.com/watch?v=od6KoCYr4nw (0:32)
“Face the Cookie”- https://www.youtube.com/watch?v=oLvLVL_rfD4 (0:28)
“Back Flip”- https://www.youtube.com/watch?v=_f4cO74Tb1Q (0:28)

DAY 2:
“Here Comes The Sun: Crash Course Kids #5.1” https://www.youtube.com/watch?v=6FB0rDsR_rc (3:03)
“The Biggest Stars in the Universe” https://www.youtube.com/watch?v=Bcz4vGvoxQA (4:25)
“Learning About the Planets in Our Solar System” https://www.youtube.com/watch?v=jEXWxNbpTzU (20:01)

DAY 4:
"Asteroids: Crash Course Astronomy #20" https://www.youtube.com/watch?v=auxpcdQimCs (11:32)
"What are Asteroids? Facts & Information | Mocomi Kids" https://www.youtube.com/watch?annotation_id=annotation_973285&feature=iv&index=9&list=PL6vCwGtCTVtPLInDKcxw_Lp6T67VJL-Mx&src_vid=EvhJgAOky-E&v=Jzyugh0dXRc (1:59)
"What Is An Asteroid?" https://www.youtube.com/watch?v=iy19nHTVLEY (2:14)
"Comets: Crash Course Astronomy #21" https://www.youtube.com/watch?v=yB9HHyPpKds (2:14)
"Clip from COSMOS - "Halley's Comet" | FOX Home Entertainment https://www.youtube.com/watch?

v=1UfnbCLDLAI (1:02)
"What is a Comet? Facts & Information | Mocomi Kids" https://www.youtube.com/watch?v=EvhJgAOky-E (2:30)
"Meteor Hits Russia Feb 15, 2013 - Event Archive" https://www.youtube.com/watch?v=dpmXyJrs7iU (10:11)
"What Is A Meteor?" https://www.youtube.com/watch?v=lLyCtPmuZ8Y (1:58)
"February 2017 meteor in Midwest region (Lake Michigan)" http://www.chicagotribune.com/news/local/breaking/ct-northern-illinois-meteor-20170206-story.html (2:06)
"What Happens When a Meteorite Strikes Earth? -- Extreme Science #1" https://www.youtube.com/watch?v=iJwZ3uBzQV0 (6:09)
"Know Your Science: Why We Kicked Pluto Out Of The Planet Club; You'll always be the ninth planet in my heart, Pluto" http://www.upworthy.com/know-your-science-why-we-kicked-pluto-out-of-the-planet-club (4:45)
"Universe today: Why Pluto is No Longer a Planet" http://www.universetoday.com/13573/why-pluto-is-no-longer-a-planet/ (watch until 4:23)

DAY 5:
"Following the Sun: Crash Course Kids #8.2" https://www.youtube.com/watch?v=1SN1BOpLZAs (4:52)
"Earth's Rotation and Revolution" https://www.youtube.com/watch?v=l64YwNl1wr0&t=19s (4:00)
"Day and Night and Earth's Rotation" https://www.youtube.com/watch?v=pLl8sDZRSYg&t=14s (1:28)
Earth and the Sun interactive - http://www.e-learningforkids.org/science/lesson/center-of-the-ocean-the-sun-the-earth/

DAY 6:
"Rotation and Revolution of Earth - Educational Video For Kids" https://www.youtube.com/watch?v=cDed5eXmngE (3:39)
Foss Simulation: http://www.fossweb.com/delegate/ssi-foss-ucm/Contribution%20Folders/FOSS/multimedia/Planetary_Science/binders/earth/earth_motions/seasons_simulation_1.html

DAY 7:
Seasons Interactive: http://highered.mheducation.com/sites/007299181x/student_view0/chapter2/seasons_interactive.html

Key Vocabulary

Asteroid- left over pieces from the formation of the solar system, made of metal and rock
Axis- the line on which a rotating body turns
Comet- balls of dust and ice
Constellation- a group of stars forming a recognizable pattern that is named for its shape
Convert- to change something into a different form or property
Direct- a straight course or path
Galaxy- a large collection of planets, gas, dust, and millions or billions of stars, bound together by gravity
Gravity- the force that draws objects toward the center of the Earth or any other large celestial body
Indirect- not in a direct course or path; deviating from a straight line
Latitude- lines that go around the globe that refer to the directions north and south
Longitude- lines that go from the top to the bottom of the globe and refer to the directions east and west
Mass- the measure of the amount of matter in an object
Meteor- appear when a chunk of metallic or stony matter enters the atmosphere from outer space
Orbit- to revolve around another object
Planet- a celestial body in orbit around a star
Revolution- when a celestial object makes one complete orbit
Rotation- to spin on an axis
Star- a celestial body in outer space made of hot gasses
Solar System- includes the sun and all celestial bodies that orbit the sun including the eight planets, their moons, asteroids, meteors and comets
Sun- a star that is the central body of the solar system
Terrestrial- referring to land
Universe- all things that exist in space

Technical Brief

The patterns of motion between Earth and the sun determine different features that affect us, such as daylight duration and seasons. Daylight duration is determined by Earth rotation. The seasons are determined by how the tilt of the Earth stands with respect to the sun, which also affects daylight duration. The tilt is relatively static, but as Earth orbits around the sun, the hemisphere that faces the sun changes between north and south. The hemisphere that faces the sun receives more direct sunlight and we experience summer there.

The period for day and night, and the period of the seasons were very important for survival since ancient times, so they were given specific names: one day and one year. These time units govern our everyday lives and understanding them is crucial in different areas such as agriculture, engineering, anthropology, and biology.

The earth's tilt is 23.5 degrees. When the northern hemisphere is maximally facing the sun (in June), the circle of latitude +23.5 receives direct sunlight. This also corresponds to the southern hemisphere being maximally facing away from the sun. Similarly, when the southern hemisphere is maximally facing the sun (in December), the circle of latitude -23.5 receives direct sunlight. In general, if the tilt of a planet is T degrees, then the circle with latitudes +T and -T will receive direct sunlight some time during the year. Latitudes further north than +T or further south of -T will never receive direct sunlight.

Knowing the precise angle and duration of sunlight requires geometric analysis involving angles, projections, fractions, operations in base 10, and measurements conversions. Analyzing the patterns and relationships is necessary when making decisions such as when to visit certain locations on the planet, when to start cultivating, choosing the static or dynamic angle of solar panels, and the cardinal orientation of buildings. Other questions that require careful analysis are how long daylight lasts in a specific location in a specific time of the year, or where we are if we know how long daylight lasts.

The duration of sunlight (S) can be computed knowing the tilt of the earth (T), the latitude (L), and the number of days after the December solstice (D). The formula is
S=arccos(tan(L)*tan(A))*24/pi, where A=arcsin(sin(T)*cos(D)).
Here A is the sun declination as seen from Earth.

The three variables in this formula are S, L, and D. Knowing two of these we can find the value of the missing variable.

A simpler formula can be used if we have a model of the earth (with correct positioning). Measuring the fraction of a latitude that receives sunlight (F), we simply compute F*24.

It has been shown that teaching a concept requires a better understanding than that required for answering questions correctly. Similarly, designing questions (and answers) regarding a topic involves a deeper understanding than just answering questions. Therefore, activities where students have to design the questions and answers will give them a deeper understanding of the patterns of motion between Earth and the sun.

Safety and Disposal

Throughout the design process, ensure the safety of students by enforcing lab safety rules:

Respect group members.
Be careful when building design and wear closed toed shoes.
Recycle and/or dispose of extra challenge materials appropriately.

References

[Andrew Bass Bayan]. (2010, Jul 20). Minute to win it Australia -season 1, episode 5, part 3. [Video File]. Retrieved from https://www.youtube.com/watch?v=byH8R01OODI.

[The British Museum]. (2010, Dec 22). Young explorers: a brief history of time telling. [Video File]. Retrieved from https://www.youtube.com/watch?v=ggvRga_JqXw.

[Brittany Argall_Staff - CentennialMS]. (2016, Oct 12). Day and night simulation directions. [Video File]. Retrieved from https://www.youtube.com/watch?v=h2uZWhEbpUU.

[Bureau of Labor Statistics]. (2015, Dec 17). Occupational outlook handbook. Retrieved from https://www.bls.gov/ooh/.

[Chicago Tribune]. (2017, Feb 6). As meteor lights Midwestern skies, Lisle cop captures ‘giant green-lighted orb’ on dashcam. [Video File]. Retrieved from http://www.chicagotribune.com/news/local/breaking/ct-northern-illinois-meteor-20170206-story.html.

[CrashCourse]. (2015, Jun 4). Asteroids: crash course astronomy #20. [Video File]. Retrieved from https://www.youtube.com/watch?v=auxpcdQimCs.

[CrashCourse]. (2015, Jun 18). Crash course astronomy #21. [Video File]. Retrieved from https://www.youtube.com/watch?v=iy19nHTVLEY.

[Crash Course Kids]. (2015, Apr 29). Earth’s rotation & revolution: crash course kids 8.1. [Video File]. Retrieved from https://www.youtube.com/watch?v=l64YwNl1wr0&t=19s.

[Crash Course Kids]. (2015, Apr 7). Here comes the sun: crash course kids #5.1. [Video File]. Retrieved from https://www.youtube.com/watch?v=6FB0rDsR_rc.

[Fox Home Ent]. (2014, Jun 9). Clip from COSMOS - “Halley’s Comet.” [Video File]. Retrieved from https://www.youtube.com/watch?v=1UfnbCLDLAI.

[Gizmos]. (2017). Seasons: why do we have them?. [Online Simulation]. Retrieved from https://www.explorelearning.com/index.cfm?method=cResource.dspDetail&resourceID=407.

Google Inc. (2017). Google Earth (Version 5.1.3533.1731) [Software]. Retrieved from https://www.google.com/earth/.

[Happy Learning English]. (2015, Apr 28). Rotation and revolution of earth | educational video for kids. [Video File]. Retrieved from https://www.youtube.com/watch?v=cDed5eXmngE.

[LittleOrisek1]. (2011, Dec 13). The axis of the rotation. [Video File]. Retrieved from https://www.youtube.com/watch?v=9n04SEzuvXo.

[Lukas [kn]]. (2015, Mar 13). Earth spin animation | silen | 1 hr. | 1080p. [Video File]. Retrieved from https://www.youtube.com/watch?v=QI9ta7qkazU&t=40s.

[McGraw-Hill]. (2017). Seasons interactive. [Interactive File]. Retrieved from http://highered.mheducation.com/sites/007299181x/student_view0/chapter2/seasons_interactive.html.

Michelle. (2015, Jul 30). Solar system cards. Research Parent: Engineering the Future Through Calculated Parenting. Retrieved from http://researchparent.com/solar-system-cards/.

[MocomiKids]. (2013, Mar 20). What are asteroids? Facts & information. [Video File]. Retrieved from https://www.youtube.com/watch?annotation_id=annotation_973285&feature=iv&index=9&list=PL6vCwGtCTVtPLInDKcxw_Lp6T67VJL-Mx&src_vid=EvhJgAOky-E&v=Jzyugh0dXRc.

[MocomiKids]. (2013, Feb 28). What is a comet? Facts & information | Mocomi Kids. [Video File]. Retrieved from https://www.youtube.com/watch?v=EvhJgAOky-E.

[MonkeySee]. (2012, Nov 13). What is a meteor?. [Video File]. Retrieved from https://www.youtube.com/watch?v=lLyCtPmuZ8Y.

[MonkeySee]. (2012, Dec 18). What is an asteroid? Facts & information. [Video File]. Retrieved from https://www.youtube.com/watch?v=iy19nHTVLEY.

[Mr. DeMaio]. (2014, May 16). Learning about the planets in the solar system. [Video File]. Retrieved from https://www.youtube.com/watch?v=jEXWxNbpTzU.

[ThePetRock]. (2011, Mar 1). Day and night and earth’s rotation. [Video File]. Retrieved from https://www.youtube.com/watch?v=pLl8sDZRSYg&t=14s.

[ScienceMagazine]. (2009, Dec 27). The biggest stars in the universe. [Video File]. Retrieved from https://www.youtube.com/watch?v=Bcz4vGvoxQA.

[Scienceworld]. Science -center of the ocean - the sun & the earth. [Interactive File]. Retrieved from http://www.e-learningforkids.org/science/lesson/center-of-the-ocean-the-sun-the-earth/.

[spotsvstripes]. (2011, Aug 30). Minutes to win it episode 1 - finale - down to the wire. [Video File]. Retrieved from https://www.youtube.com/watch?v=GXqmr_ci6fI.

[spotsvstripes]. (2011, Sept 7). Minute to win it episode 2 - Joe v Caroline face the cookie. [Video File]. Retrieved from https://www.youtube.com/watch?v=5RH6rMBgX9k&t=8s.

[StudyJams]. (2017). A day on earth. [Video File]. Retrieved from http://studyjams.scholastic.com/studyjams/jams/science/solar-system/day-on-earth.htm.

[That Blueprint Guy]. (2011, Feb 12). Minute to win it - games - back flip. [Video File]. Retrieved from https://www.youtube.com/watch?v=_f4cO74Tb1Q.

[That Blueprint Guy]. (2011, Feb 12). Minute to win it - games - face the cookie. [Video File]. Retrieved from https://www.youtube.com/watch?v=oLvLVL_rfD4.

[That Blueprint Guy]. (2011, Feb 12). Minute to win it - games - office tennis. [Video File]. Retrieved from https://www.youtube.com/watch?v=od6KoCYr4nw.

[That Blueprint Guy]. (2011, Feb 12). Minute to win it - games - ready spaghetti. [Video File]. Retrieved from https://www.youtube.com/watch?v=0pLQ9V5vrX8.

[That Blueprint Guy]. (2011, Feb 12). Minute to win it - games - ruler of the world. [Video File]. Retrieved from https://www.youtube.com/watch?v=_VGPMvXp2_o.

[That Blueprint Guy]. (2011, Feb 12). Minute to win it - games - sharp shooter. [Video File]. Retrieved from https://www.youtube.com/watch?v=0pLQ9V5vrX8.

[That Blueprint Guy]. (2011, Feb 12). Minute to win it - games - tilt-a-cup. [Video File]. Retrieved from https://www.youtube.com/watch?v=CWr1R5BiIjQ&list=PL1gj2vsR6ByjujneITcP3ObdNxX8Xw2NT.

[Turvix72]. (2013, Feb 28). Meteor hits Russia Feb 15, 2013 - event archive. [Video File]. Retrieved from https://www.youtube.com/watch?v=dpmXyJrs7iU.

[Universe Today]. (2016, Oct 16). Why Pluto is no longer a planet. [Video File]. Retrieved from http://www.universetoday.com/13573/why-pluto-is-no-longer-a-planet/.

[Upworthy]. (2012, Oct 16). Know your science: why we kicked Pluto out of the planet club. [Video File]. Retrieved from http://www.upworthy.com/know-your-science-why-we-kicked-pluto-out-of-the-planet-club.

[Vsauce3]. (2015, Sep 24). What happens when a meteorite strikes earth? -extreme science #1. [Video File]. Retrieved from https://www.youtube.com/watch?v=iJwZ3uBzQV0.

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