Geometric Rockets

-Math Connections in STEM Unit Plan-

by Kendyl Stromberg

Introduction

This 4th grade unit will be rooted in rockets! It will integrate the mathematical topic of geometry with science, art, technology, and engineering and be guided by the 5E process. Students will be engaged with creating soda straw rockets. Students will explore geometric features of rockets and explore the energy and motion of soda straw rockets related to geometric features. Students will learn geometric vocabulary and how it applies in the real-life scenario of rockets. Students will be evaluated initially with an Anticipatory Set, then with an exit ticket as a formative assessment. Finally, their Google Slide or poster to model their project results combined with an essay to draw conclusions will be a summative assessment.

Statement of Purpose

Fourth grade students are supposed to learn the basic vocabulary of geometry and its application into real life structures according to CCSS-M. Rockets will be an engaging “real life structure” to apply their understanding of geometry. Fourth grade students also are supposed to learn about the transfer of energy and collision according to NGSS. Combining this science topic with rockets will further promote student engagement in both science and math. Student learning will be enhanced by connecting both subjects to an interesting theme, rockets!

Fourth grade students often ask the question, “Why do we have to learn this?” Students want their learning to have relevance in their life and to the real world. Students need a connection to life for motivating their learning efforts. The practical application of geometry blended with energy transfer comes together in the real world topic of rockets! In my experience teaching 8 - 10 year olds, students are capable of making their own models, and they are highly interested in testing something that moves, crashes, or flies.

Students will develop their geometry skills in this unit. Students will learn and apply the vocabulary terms: points, lines, line segments, rays, angles, perpendicular lines, parallel lines, lines of symmetry, right triangles, squares, rectangles, trapezoids, and rhombus. Students will use 2-D rockets to identify these geometric figures.

This unit plan provides for differentiation by going through Webb's Depth of Knowledge in its objectives by beginning with recall, when students draw and identify geometric features, then with skills and concepts when students collect and organize data. The depth of knowledge then transitions into strategic thinking when students justify the Conservation of Energy and into extended thinking when students relate plans, draw conclusions, and make connections from their rockets results. The final product in this unit plan allows for student choice. Students may work individually or in a group; they may make a poster or make a Google Slide. Plus, the teacher can modify for students who need modifications by using a chart that has been referenced throughout the unit instead of writing a paragraph for the final conclusion.

Standards

CCSS-M	**Math Concept: Geometry**
4.G.1	Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures.
4.G.2	Classify two-dimensional figures based on the presence or absence of parallel or perpendicular lines, or the presence or absence of angles of a specified size. Recognize right triangles as a category, and identify right triangles.
4.G.3	Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts. Identify line-symmetric figures and draw lines of symmetry.
Standards for Mathematical Practice	3) Construct viable arguments and critique the reasoning of others. 5) Use appropriate tools strategically. 6) Attend to precision. 7) Look for and make use of structure.
NGSS	**Science Concept: Energy and Motion**
4-PS3-4	Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.* [*Assessment Boundary: Devices should be limited to those that convert motion*

	energy to electric energy or use stored energy to cause motion or produce light or sound.]
4-PS3-3	Ask questions and predict outcomes about the changes in energy that occur when objects collide. [Clarification Statement: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact.] [*Assessment Boundary: Assessment does not include quantitative measurements of energy.*]
Crosscutting Concepts	<u>Energy and Matter</u> ● Energy can be transferred in various ways and between objects. (4-PS3-1),(4-PS3-2),(4-PS3-3),(4-PS3-4)
Crosscutting Concepts	<u>Cause and Effect</u> ● Cause and effect relationships are routinely identified and used to explain change. (4-ESS3-1)
Science and Engineering Practices	<u>Planning and Carrying Out Investigations</u> Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. ● Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (4-PS3-2)
Science and Engineering Practices	<u>Constructing Explanations and Designing Solutions</u> Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. ● Use evidence (e.g., measurements, observations, patterns) to construct an explanation. (4-PS3-1) ● Apply scientific ideas to solve design problems. (4-PS3-4)

Essential Questions

How would an object fly straight through the air? (energy transfer, no obstacles, and appropriate geometric shape)
How might the shape of something help it move quickly in the most energy efficient manner? (aerodynamic shape - triangle/ cone nose, parallel line sides/ long and skinny, triangle fins)

Objectives

- Students will draw and identify points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines in two-dimensional rocket illustrations and in two-dimensional shapes; demonstrating 80% accuracy or higher on the 2-D Shape Exit Ticket.
- Students will plan, develop, test and solve design problems in a mini paper rocket, using scientific and geometric reasoning; reflecting 80% completion with Soda Straw Instructions (pg 1), the Geometric Rocket Plan Sheet (pg 3), and the Rocket Scientist Data Sheet (pg 4).
- Students will collect and organize their data from testing their mini paper rockets; reflecting 80% completion of the Geometric Rocket Data Sheet (pg 1) and Rocket Data Analysis Sheet (pg 2).
- Students will justify that energy is transferred from one form to another, and is never destroyed, even in a collision; demonstrating their understanding in a CER.
- Students will draw conclusions and make connections between their mini paper rockets' results and the results of others; demonstrating their understanding of the essential questions in the Successful Launch Conclusion Sheet (pg 5) or in the Student Wondering Phenomena - Before, During, After Chart as a modification.

Integration of NASA Resources and Data

3..2..1...Liftoff! Educator's Guide (select pages)
Soda Straw Instructions (page 1)
Soda Straw Instructions Web View with Photos
How are We Going to the Moon? YouTube Video
CBC Kids - Rocket Lift Off YouTube Video

Lesson Activities

Lesson Number	*Lesson Title*	*5E Process*	*Time Allotted*
Lesson 1	**“3.2.1. Blast Off!”**	**ENGAGE**	**45 minutes**

Materials
Projector/ Screen for: Geometric Rockets (Google Slideshow) (Slides 3-11)
Speakers for videos
Pencil & Paper
Two plastic straws (with paper coverings still on them)
Student Wondering Phenomena - Before, During, After Chart (class set)

Procedure

1. Give the student Anticipatory Set on the Google Slideshow; have students use pencil and paper. (Slide 4)
2. Show students the Phenomena (Slide 5)
    a. CBC Kids - Rocket Lift Off YouTube Video
    b. “The Investigative Phenomena is designed to help students work toward the goal of figuring out why or how something happens. Students should build their knowledge about the phenomena as they move through the Unit” (STEMscopes, 2020).
3. Two essential questions are connected to the Phenomena. (Slides 6-7)
    a. Engage in class discussion, perhaps starting with elbow buddy, then as a class. Type students’ ideas about the questions in the “Before Instruction” box to keep recorded through the unit.
        i. If students use science journals, print the PDF to be glued in, or as a template for students to draw their own.
        ii. Student Wondering Phenomena - Before, During, After Chart
        iii. Students will need to write the Essential Questions on the lines provided.
    b. As you progress through the unit, refer back to the questions and modify Slide 7. Ask students at the end of each lesson if they think you should add anything to the “During Instruction” box of the slide.
4. Then, guide students through “Take a moment to notice” activity. (Slide 8-9)
    a. Students should list as many things as they can about the image in the next slide. Working with a partner or small group, students should take turns stating one thing that they see, then let another person state what they see.

b. Come back together as a class to write in the box “Together, what do WE see? Is there information that you can form general thoughts or conclusions from?”
    i. Take the opportunity to direct the student discussion toward the shape of the rocket using the terms: line segments, parallel, angle, and symmetric.
    ii. Discuss “Why do you think they all have a point, like a triangle on the top? And are long and skinny? And are symmetrical?”
    iii. Connect back to the phenomena video. “What might happen to the rocket in liftoff if it had something sticking out on one side? Why do you think rockets can fly straight up?

5. Introduce Demo models of a Soda Straw Rocket (Slide 10)
    a. Have two straws with paper on them, prepared as “test rockets”
        i. One paper over straw has the nose as the regular paper covering is made, and one end open to blow air through the straw to launch the paper off.
        ii. Other straw with paper on it, has both ends opened (with intent to show air blown through will not move the paper off since both ends are open)
    b. Allow students a chance to predict what might happen to the paper on each straw. And give a reason to support their prediction.
    c. Simply hold the straws without blowing into them. “Did anything happen to the paper? NO! Something must give them energy to make them move.”
    d. Blow into each straw. Inquire if students made correct predictions.
        i. Why did the one fly off? How did it fly (straight, turning, etc.)?
        ii. Why did the other one not fly off? (open end, “broken nose”).
6. Introduce the problem for students to think about and to solve in the next lessons. (Slide 11)
    a. ATTENTION HOUSTON, WE HAVE A PROBLEM! The nose of a rocket has been knocked off. You only have a limited amount of material to fix it.
    b. What shape are you going to design to fix it?
    c. How will that design help the rocket fly straight?
    d. How might that help the rocket to move more quickly than other shapes?

Lesson 2	Energy is Everywhere	EXPLORE	45 minutes

Materials
Projector/ Screen for: Geometric Rockets (Google Slideshow) (Slides 12-19)
Speakers for videos
Pencils
Scissors
Energy Detectives Printable (class set)

Procedure

1. Begin by leading a class discussion, gauging students' prior knowledge about energy. Allow students to discuss with partners or neighbors, then together as a whole group. (Slide 13)
2. Have a group of students run in place for a minute. Ask them how they feel (warm?). Ask other students if they feel the same. Explain that heat being produced is a sign that energy was used.
3. Identify and explain the two types of energy:
    a. "All energy can be considered to be either potential or kinetic. **Potential energy** is stored energy. A tractor filled with fuel, snow at the top of a hill, a student sitting at a desk, and water behind a dam are all examples of potential energy.
    Kinetic energy is energy possessed by a moving object. A tractor moving, snow tumbling down a hill, students moving, and water flowing through a dam are all examples of kinetic energy" (Project Learning Tree, 2006).
    b. Show the music video to reinforce meaning: Potential vs Kinetic Energy Song (Slide 14)
4. Explain that we cannot see energy, but there are different clues that reveal energy being used. Facilitate the following exploration activities.
    a. Guide students to explore the poster, "Energy is Everywhere." (Slide 15)
        i. This may be a class activity, partner work, or small groups.
        ii. Use page 1 of the student printable: Energy Detectives
    b. Lead students in a classroom exploration, where each student has at least 6 clue cards from page 2 of the student printable.
        i. Students cut out and place their cards around the room on objects that use energy (like lights, heater, electrical appliances, things that move, etc).
        ii. If students are struggling, review the concept of energy.

iii. Call students together to discuss their discoveries. Students may add to page 1 of the “Energy Detectives” printable.

5. Explain that energy is transferred from one form to another, but is never created nor destroyed.
    a. Guide students to investigate what energy is being transferred, one form of energy is used and produces another form of energy, in the following videos and record their investigation on page 3 of the “Energy Detectives” printable (students may use words OR draw pictures in the boxes provided).
        i. The Law of Conservation of Energy Video (Slide 16)
        ii. Science of Energy Transfer Video (Slide 17)
        iii. Rockets 101 Video (Slide 18)
        iv. Conclude with student discussion of their discoveries from the videos and expand to what energy transfers they see or use personally on a regular basis.
6. Conclude the lesson, by referring to the wondering phenomena (essential questions). (Slide 19)
    a. Give students a few minutes to discuss and add anything to the class chart (Slide 7) or their personal charts.
    b. Student Wondering Phenomena - Before, During, After Chart

Lesson 3	Start Shapes in Rocket Ships	EXPLORE	45 minutes

Materials

Projector/ screen for: Geometric Rockets (Google Slideshow) (Slides 20-33)
Speakers for videos
Youtube access
Dry Erase Markers (one per student)
25 page protectors (class set)
25 printed pages from 3..2..1...Liftoff! Educator's Guide
    5 copies of pg. 74, *Figure 2. Side View of Space Shuttle*
    5 copies of pg. 75, *Figure 3. Parts of the Space Shuttle*
    5 copies of pg. 76, *Figure 4. Proton Rocket*
    5 copies of pg. 77, *Figure 5. Soyuz Rocket*
    5 copies of pg. 82, *Figure 11. Space Shuttle Parts*
    [Prepare ahead - put one copied page into one page protector]

Procedure

1. Activate students’ background knowledge about geometry, “What do you know?” (Slide 21)

    a. What shapes do you already know?
    b. Do you know what kind of features make up shapes?
2. Distribute the dry erase markers and the variety of rocket photos, which are in page protectors. Students may work individually, be paired off or work in groups of five, where each student has a different rocket picture.
3. Facilitate figure finding on the rocket pictures.
    a. Discuss each term (line, ray, line segment, parallel lines, perpendicular lines, right angle, acute angle, and obtuse angle) (Slide 22, 23, 26 & 28)
    b. Highlight the examples on the slideshow. Perhaps have students come to the screen to point out other ones they found.
    c. Four music videos are incorporated to enhance student understanding and engagement.
        i. Line, Ray, Line Segment, Plane, Point - Music Video (Slide 24)
        ii. Types of Lines - Music Video (Slide 25)
        iii. Angles - Music Video (Slide 27)
        iv. Symmetry - Music Video (Slide 29)
4. Prepare students before watching a NASA rocket launch, trip, and landing video that…(Slide 30)
    a. "As you watch the video in the following slide, pay special attention to two things."
        i. The shape of the rocket nose for thrust when the rocket is getting moving. (*Discuss "thrust" if needed. Shape is a cone, triangular, acute angle*)
        ii. The shape of the pod for drag when it is coming back to land on earth. (*Discuss "drag" if needed. Shape is a cylinder, circular, flat*)
    b. How are We Going to the Moon? Video (Slide 31)
    c. After watching, discuss what the students noticed.
5. Remind students about the problem they pondered at the end of the first lesson and forecast what they will be doing in the next lesson, (continuing with the geometric ENGAGE section of the unit). (Slide 32)
6. Conclude the lesson, by referring to the wondering phenomena (essential questions). (Slide 33)
    a. Give students a few minutes to discuss and add anything to the class chart (Slide 7) or their personal charts.
    b. Student Wondering Phenomena - Before, During, After Chart

Lesson 4	Test Shapes in Rocket Ships	EXPLORE	45 minutes

Materials
Projector/ screen for: Geometric Rockets (Google Slideshow) (Slides 34-38)
Speakers for videos
Plastic straws (class set)
Ziplock bags (class set)
Tape (preferably 5 dispensers - one per shape group)
Metric measuring tape
Soda Straw Instructions (pg 1) (class set of copies)
Geometric Rocket Data Sheet (pg 1) (class set)

Procedure

1. Pose the problem to students: (Slide 35)
    a. The nose of a rocket has been knocked off!
    b. **Let's design some different options to test.**
        i. What shapes could we use to fix it?
        ii. Will that design help the rocket fly straight?
        iii. Would that help the rocket to move more quickly than other shapes?
2. Allow the class to decide on the five shapes that will be tested. (Slide 36)
3. Assign 5 students to each shape (assuming it is a class of 25 students).
    a. Students work as a group to have identical nose pieces.
    b. One student makes the initial shape by drawing and cutting, then others trace and cut to have a similar copy.
4. Support students to individually make their own Soda Straw rocket, following page 1 of the following PDF
    a. Soda Straw Instructions PDF
        i. Modify Step 4, instead of students securing a cone, tape on their shape.
        ii. Each group needs to tape their nose shape on with the same orientation, so that the only variable tested is the difference in shape.
    b. Soda Straw Instructions Web View with Photos
        i. Use this for the picture guidance on assembling the Soda Straw Rockets.
5. Prepare to test the shapes of rocket ships! (Slide 37)
    a. Distribute the Geometric Rocket Data Sheet (pg 1)
    b. Find or create a cleared area for rocket testing
    c. Set up the measuring tape to be in centimeters

d. Have groups test with their group, to get all 5 tests per shape in a row.

6. Ensure students have put their names on their data sheets and initials on their straws and rockets (put straws and rockets in individual ziplock bags for each student to keep separated and more sanitary; or wash the straws) before collecting materials to use in another lesson.
7. Conclude the lesson, by referring to the wondering phenomena (essential questions). (Slide 38)
   a. Give students a few minutes to discuss and add anything to the class chart (Slide 7) or their personal charts.
   b. Student Wondering Phenomena - Before, During, After Chart

Lesson 5	Harnessing Energy	EXPLAIN	45 minutes

Materials
Projector/ screen for: Geometric Rockets (Google Slideshow) (Slides 39-49)
Speakers for videos
Students' soda straws/ rockets
Pencils & lined paper
Document camera (to display read aloud)
Awesome Space Tech by Jenn Dlugos & Charlie Hatton - Amazon Look Inside

Procedure
1. Activate students' background knowledge by having them list as many types of energy as they know with an "Elbow Buddy." Record their ideas on the white board or on paper in the provided box on the Slideshow. (Slide 40)
2. Compare their knowledge with the types of energy on the next slide.
   a. Question - Answer. Encourage students to ask questions about ones they don't know or understand. Encourage other students to respond if they know the answer. (Slide 41)
   b. Echo - have students echo what their peers explained in their own words.
   c. Show the video for depth of meaning. Law of Conservation of Energy YouTube Video. (Slide 42)
   d. Lead in discussion, so that students have a basic understanding of each type of energy and can give an example of each. (Electrical, Thermal, Light, Sound, Potential, Kinetic).
3. Facilitate student discussion with the following slide of questions. Emphasize that energy transfers from one form into another form. (Slide 43)

a. What energy does a light bulb use and produce? *(uses electrical transfers to produce light & heat - was not light energy in the wall all the way to the bulb)*
b. What energy does a car use and produce? *(uses fuel, gasoline and/ or stored battery, electrical to produce Kinetic or mechanical energy, which is seen as motion)*
c. What energy do you use and produce? *(Uses stored chemical energy in food to produce Kinetic energy, sound, and heat)*
d. Is the energy that something uses the same type of energy it produces? *(Not usually. Typically, there is a transfer of energy from one form to another, as in the examples above)*

4. Read aloud selections from Awesome Space Tech by Jenn Dlugos & Charlie Hatton - Amazon Look Inside (Slide 44)
    a. Preferably use a document camera to project the pages onto a large screen so that students can see the infographics.
    b. Choose selections that deal with energy, rocket structure, and flight.
    c. Example: Fuels Rush In pg 3 or Anatomy of a Space Shuttle pg 22
    d. Discuss the energy of a rocket, what energy it uses and what energy it produces (*fuel into motion/ kinetic energy, heat, light, sound*).
    e. Discuss "Soda Straw Rockets," what energy they use and what energy they produce (*Human force that was chemical energy from food originally into motion/ kinetic energy*).
5. Before playing the video, instruct students to listen for what things are used to produce kinetic energy: How do Rockets Work? Video (Slide 45).
6. After the video, discuss what would stop a rocket from taking off or from getting to outer space? Energy/ fuel. Geometric shape. Guide the thought toward open air with nothing to collide into. (Slide 46)
7. Direct the focus to collisions. Tell students that they need to come up with a plan to test if the energy in their soda straw rocket gets destroyed when it collides with something. (Slide 47)
    a. Once they have a plan, where and they will test a collision (against a wall or towards the floor?), distribute students' soda straw rockets from yesterday. They may want to make a new nose for it first.
    b. Prepare students for writing a CER (Claim, Evidence, Reasoning) once they have conducted their test. Distribute lined paper for students to use.

c. After students have written their CER, show part of the rocket launch fail videos (not necessary to watch the full video): 10 Incredible Rocket Launch Failures Video (Slide 48)
    i. Discuss what their straws did. Kinetic energy stopped, but transfer of energy into sound and thermal energy.
    ii. When something collides, there is thermal energy from friction, even if we don't see great big explosions like in the video.

8. Ensure students have put their names on their CER and initials on their straws and rockets (put straws and rockets in individual ziplock bags for each student to keep separated and more sanitary; or wash the straws) before collecting materials to use in another lesson.
9. Conclude the lesson, by referring to the wondering phenomena (essential questions). (Slide 49)
    a. Give students a few minutes to discuss and add anything to the class chart (Slide 7) or their personal charts.
    b. Student Wondering Phenomena - Before, During, After Chart

Lesson 6	Going Geometric	EXPLAIN	45 minutes

Materials
Projector/ screen for: Geometric Rockets (Google Slideshow) (Slides 50-56)
Speakers for videos
Youtube access
Markers and highlighters
Bright colors or white construction paper (for mini posters)
2-D Shape Worksheet (class set)
2-D Shape Worksheet with Labels (teacher copy)
2-D Shape Exit Ticket
Extension activity 3..2..1...Liftoff! Educator's Guide
About 15 copies of pg. 86, *Figure 18. Tangram pieces*

Procedure

1. Review geometric terms from the explore activity: line, ray, line segment, parallel lines, perpendicular lines, right angle, acute angle, and obtuse angle.
    a. Watch the corresponding videos as part of the review.
    b. Line, Ray, Line Segment, Plane, Point - Music Video (Slide 51)
    c. Types of Lines - Music Video (Slide 52)
    d. Angles - Music Video (Slide 53)
    e. Symmetry - Music Video (Slide 54)
2. Instruct students that they will be identifying these characteristics, using their appropriate terms in 2-Dimensional shapes. (Slide 55)

    a. Pass out 2-D Shape Worksheet
    b. Students will need several different highlighter or marker colors.
    c. Guide students through marking their shapes one step at a time with instructions from the slide in the slideshow.
    d. As a class name each shape and list its identifying characteristics.
        i. Example: A square has 4 right angles, 4 sides, 2 sets of parallel lines.
        ii. Use the teacher sheet for the labels to help: 2-D Shape Worksheet with Labels
3. Set students up for success to make a mini poster as a visual reminder for the class about a shape they learned. (Slide 56)
    a. Place students into partners or small groups, each with a sheet of construction paper, to make mini class posters for the shape they are assigned.
    b. Make sure that all of the shapes from the worksheet are assigned.
    c. Use the slide on the slideshow to guide what students should include on their mini poster.
    d. Let each group share their mini poster, describing the shape's geometric features.
4. As groups finish at different rates, guide students to complete the exit ticket, 2-D Shape Exit Ticket.
5. Fast finishers may create their own 2D Shape Rocket from the bottom half of pg 86 of 3..2..1...Liftoff! Educator's Guide

Lesson 7	**Rocket Scientists**	**ELABORATE**	**45 minutes**

Materials
Projector/ screen for: Geometric Rockets (Google Slideshow) (Slides 57-63)
Speakers for videos
Scissors & tape (preferably 5 dispensers - one per shape group)
Students' soda straws/ rockets
Metric measuring tape
Stop watches (one per group)
Geometric Rocket Data Sheet (pg 1) (completed in prior lesson)
Rocket Data Analysis Sheet (pg 2) (class set)
Geometric Rocket Plan Sheet (pg 3) (class set)
Rocket Scientist Data Sheet (pg 4) (class set)
Soda Straw Instructions (pg 1) (class set of copies)

Procedure

1. Guide students in data analysis by returning students Geometric Rocket Data sheet and passing out the Rocket Data Analysis Sheet. (Slide 58)
    a. Students organize their data on the analysis sheet.
    b. The shape name goes on the left.
    c. There are five units for each of the five tests that were conducted for each shape to be recorded in distance horizontally.
2. Prepare students for the engineering and design process. (Slide 59)
    a. Remind students about the "problem."
    b. Ask students, "What do you already know based on the data analysis?" (consistent distance, farthest, didn't go straight, did go straight)
    c. Direct students' attention to be listening for the forces involved in a rocket launch and how the shape is important. Play 4 minutes of the video (:30 to 4:47) Rocket Aerodynamics Explained Video (Slide 60)
    d. Have students draw a plan for their rocket, which includes labeling geometric features and shapes: Geometric Rocket Plan Sheet (pg 3) (Slide 61).
    e. Return students' straws to create new soda straw rockets based off of their designs: Soda Straw Instructions (pg 1)
3. Facilitate the testing and data collecting. (Slide 62)
    a. Groups students in 5 to gather data.
    b. Use the Rocket Scientist Data Sheet (pg 4)
        i. One person times the flight of the rocket with a stopwatch.
        ii. Then, they measure the distance it went.
        iii. Each person tests their rocket three times.
        iv. Calculate the Speed = Distance ÷ Time
        v. Calculators are fine, since division is not one of the objectives of this lesson.
4. Conclude the lesson, by referring to the wondering phenomena (essential questions). (Slide 63)
    a. Give students a few minutes to discuss and add anything to the class chart (Slide 7) or their personal charts.
    b. Student Wondering Phenomena - Before, During, After Chart

Lesson 8	Successful Launch	EVALUATE	45 minutes

Materials
Projector/ screen for: Geometric Rockets (Google Slideshow) (Slides 64-69)
Speakers for videos
Construction paper (for mini poster option)
Markers
Chromebooks (for Google Slide option)
Rocket Scientist Data Sheet (pg 4) (completed in prior lesson)
Successful Launch Conclusion Sheet (pg 5) (class set)

Procedure

1. Provide the tools that students may use to model their data. (Slide 65)
    a. They may choose to work in groups with the students that they gathered data with or work independently. (Slide 66)
    b. Options are to make a mini poster with markers
    c. OR Google Slide "Data Display" on Chromebooks.
    d. Students must include: (Slide 67)
        i. A title
        ii. Each person's name and their data
        iii. The data must be organized in a model that helps scientists analyze it.
        iv. Reference the requirements rubric on the slideshow for students to know what is expected.
2. Dedicate time for students to share their findings with the class or in three larger groups.
3. Lead students to draw conclusions, by completing the Successful Launch Conclusion Sheet (pg 5), which answers the essential questions:
    a. How would an object fly straight through the air?
    b. How might the shape of something help it move quickly in the most energy efficient manner?
    c. A variation may be done to simplify for students with reading/ writing special needs on the Student Wondering Phenomena - Before, During, After Chart
4. Rewatch the initial "Wondering Phenomena" to tie the unt together. (Slide 68)
5. Conclude with the Anticipatory Set from the beginning. Pass back students' papers (or if using science journals, open those) and have them answer the questions again, but on the right side. (Slide 69)

Rubric/ Assessments

This unit plan provides ample opportunities for teachers to assess student discussion and many different types of student work. Diagnostic assessments are strategically placed throughout the first three lessons of the unit plan, which emphasize “Engage” and “Explore” of the 5E Model. The Anticipatory Set in lesson #1 on Slide 4 is a diagnostic assessment, which is also meant activate background knowledge and show growth in the students’ frame of reference at the end of the unit in lesson #8 on Slide 69. “Take a Moment to Notice” on Slide 8 for Slide 9’s image is another discussion method to informally assess students before getting into the geometric shape and features of objects. The “Straw Test” on Slide 10 is similar to this discussion method, but it gauges students’ understanding of forces and energy. The “Class Discussion” on Slide 13 and “Take a Moment to Notice - Energy is Everywhere” on Slide 15 explicitly ask what students’ already know about energy in anticipation for the lessons and activities to come. The teacher gets to diagnose the whole class’ prior knowledge about where energy exists as they further engage in the classroom activities on Slide 15, for lesson #2, Energy Detectives. The “What Do You Know” discussion on Slide 21 explicitly asks students what they know about geometry. All of these activities serve as ways to engage and explore science and math, but their deeper purpose is to provide the teacher with direct diagnostic feedback.

There are many formative assessments throughout the unit to continuously monitor students’ understanding. The discussion on Slide 7 is formative toward students’ answers of the essential questions. Students’ ability to identify geometric figures is formatively assessed on Slides 22, 23, 26, and 28. The “Design Lab” on Slides 35, 36, and 37 informally assess students’ ability to plan, develop, and test design-problems as well as collect and organize data with the use of the Geometric Rocket Data Sheet (pg 1). Students’ knowledge about relevant terms regarding energy is formatively assessed by the “Types of Energy” discussion and questions on Slides 40, 41, and 43. Students’ application of geometric figures is formatively assessed again in class through the use of 2-D Shape Worksheet and activity guide on Slide 55. Students get to practice organizing and displaying their data from the Geometric Rocket Data Sheet (pg 1) to the Rocket Data Analysis Sheet (pg 2), as guided by Slide 58. These activities give the teacher the opportunity to reteach concepts and correct misconceptions before the summative assessments.

Summative assessments measure the learning objectives in the second half of the unit plan, which emphasize the “Explain,” “Elaborate,” and “Evaluate” aspects of the 5E Model. After some discussion and testing, students’ mastery is assessed to see if they can justify that energy is not destroyed, even in a collision, in the CER on Slide 47. Students’ application of geometric figures to identify 2-D shapes can be summatively assessed through group work with the “Create a Mini Poster” activity on Slide 56 and individually with the 2-D Shape Exit Ticket. The “Design Lab” on Slides 61 and 62 more formally assess students’ ability to plan, develop, and test design-problems as well as collect and organize data with the use of the Geometric Rocket Plan Sheet (pg 3) and Rocket Scientist Data Sheet (pg 4). Students again organize and display their data from the Rocket Scientist Data Sheet (pg 4) to the “Student Choice” activities on Slide 66 as guided by the rubric on Slide 67. The very final, summative assessment, is a written conclusion as included in the rubric of 67. The Student Wondering Phenomena - Before, During, After Chart is referred to in seven of the eight lessons to guide students' growth to mastery of answering the essential questions; in the end it can be used as a summative assessment for students who need a modification to the written conclusion. The written conclusion on the Successful Launch Conclusion Sheet (pg 5) determines if students have successfully launched out of this unit plan.

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