NSF RET Lesson Plan

Lesson Title: Soaring High	**Grade Level/Subject:** 9th Grade/Algebra 1
Maximum # of Students: Students in classroom	**Total Time Required:** 3-50 minute class periods (3 days)

Prior Knowledge Needed:
Pre-activity simulation:
https://phet.colorado.edu/sims/html/projectile-motion/latest/projectile-motion_en.html

Materials:
Per Student: Tape measure, Measuring Tape, Ruler, Safety Glasses, White Copy Paper, 3 paper clips per airplane, Data Sheet, Ruler, Colored Pencils, School Chromebook with Google Sheets

Performance Objectives/Learning Targets:

Students will be able to determine the effects of adding and moving weight on a paper airplane.

Standards:

Data & Probability (D)	
A1.D.1 Display, describe, and compare data. For linear relationships, make predictions, and assess the reliability of those predictions.	**A1.D.1.1** Display, describe, and compare data sets using summary statistics (central tendency and spread (range)). Utilize technology (e.g., spreadsheets, calculators) to display data and calculate summary statistics.
	A1.D.1.2 Collect data and analyze scatter plots for patterns, linearity, and outliers.
	A1.D.1.3 Make predictions based upon the linear regression, and use the correlation coefficient to assess the reliability of those predictions using graphing technology.

Lesson Procedure

Day 1:	Ask engaging questions to motivate students with lesson ● What effect does adding or moving weight have on an aircraft? ● How do you think adding weight to the front, middle, and back of an aircraft will affect its lift and flight capabilities? During the mini-lesson, present students with data that was collected from a similar previous experiment. Then demonstrate how to create tables and charts from the data in

	Google sheets, as well as how to utilize some basic formulas. This lesson should follow a section on data collection and graphs from a school-provided curriculum resource. Using: https://phet.colorado.edu/sims/html/projectile-motion/latest/projectile-motion_en.html Students will be given a simulation to create a data set by adjusting initial velocity. Students will generate a chart from the data and a corresponding graph. Then, as a class, discuss how different changes affect the distance a projectile flies.
Day 2:	In small groups (2-3) students will fold the Nakamura Lock paper airplane. https://www.origamiway.com/plane-nakamura-lock.shtml ● The group will have a designated thrower, measurer, and recorder to ensure consistency. Each group will fly their airplane 3 times and record the distance each time on their data sheet. ● First experiment: students add a paperclip to front of airplane (repeat 3x) ● Second experiment: students add 2 paper clips to front of airplane (repeat 3x) ● Third experiment: students add 3 paper clips to front of airplane (repeat 3x) ● After data collection, students will find averages for each trial then manually graph. ● Next students will analyze the data and create a Google Sheet with a chart. Then students will compare their own graph to their Google Sheet graph.
Day 3:	● To close the lesson, students will present a short oral presentation to share their findings with the class and submit their Google Sheet and Manual Graph for assessment. A rubric will be used to assess presentations, data sheet and graph, and Google sheet. ● Lastly, class discussion on how the paper airplanes were affected by the change and movements of weights, and what impact could this have on actual aircraft?
5E Model: *(Engage, Explore, Explain, Evaluate, Elaborate)* Engage: Inquiry-Based Questions Explore: Creation of Paper Airplane Explain: Mini-Lesson over teacher collected data Evaluate: Oral Presentation Elaborate: Class Discussion	

Differentiation:

Before: Gather paper, tape measures, masking tape, rulers, paperclips, and data sheets for all students/groups. Prepare the launch location using the tape measure to mark every foot with masking tape for 35ft.

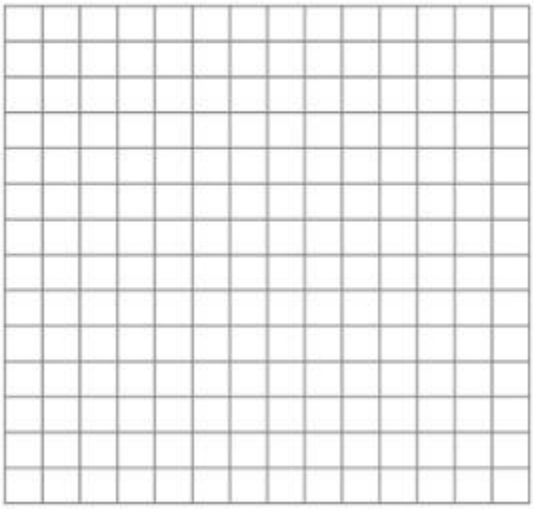
During: One group at a time launches their planes per station. Keep stations separate enough to prevent collisions. One person per group throws the airplane, another measures, a third group member may be recording the distance on graph paper.

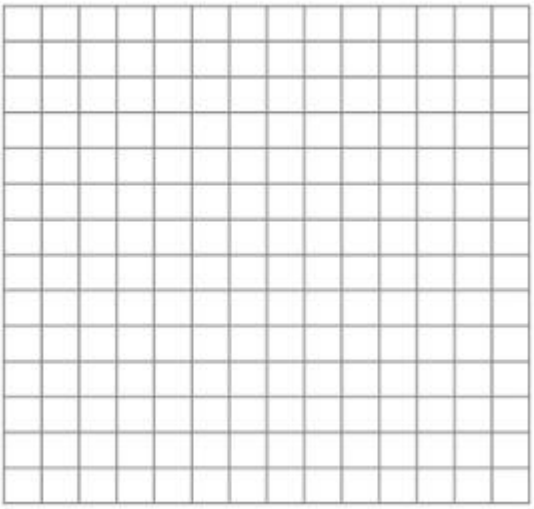
After: The goal is to construct a table in Google Sheets using their data. Then using that table to create a graph. Graphs will be submitted and then graded for each group. The next day the data could be compiled to compare and contrast to the full data set. Then discuss the variables. As an extension, have students fold their own design and repeat the experiment. This may be done with different weights of paper as well, i.e. construction paper, card stock, or any other material suitable for folding airplanes.

Data Sheet

Control Plane	No paper clips	1 paper clip (Red)	2 paper clips (Blue)	3 paper clips (Green)
Trial 1				
Trial 2				
Trial 3				
Avg				

Individual Design	No paper clips	1 paper clip (Red)	2 paper clips (Blue)	3 paper clips (Green)
Trial 1				
Trial 2				
Trial 3				
Avg				





Soaring High Project Rubric

Expectation	Level of Completion	Notes
<u>Data Sheet:</u> ● *Was the content easy to follow?* ● *Were the graphs complete?(Were both axes of each graph labeled? Was a logical scale chosen?Were the graphs neat and legible?)*	1, 2, 3, 4, 5 1, 2, 3, 4, 5	
<u>Google Sheet:</u> ● *Did the Google Sheet use appropriate formulas? (calculating averages)* ● *Was the chart chosen appropriate for the data collected?(scatter, bar, pie, line)* ● *Is the data organized and easy to follow?*	1, 2, 3, 4, 5 1, 2, 3, 4, 5 1, 2, 3, 4, 5	
<u>Presentation:</u> ● *Was the content easy to follow?* ● *Were the graphs complete?(Were both axes of each graph labeled? Was a logical scale chosen?Were the graphs neat and legible?)*	1, 2, 3, 4, 5	
Total Points (out of 30)		
Final Grade		