Paper Airplane Face-Off	Grade 6 - Flight

Lesson Plan

Coding Tool	Scratch
Cross Curricular	Math – Calculating Averages

Big Ideas

Flight occurs when the characteristics of structures take advantage of certain properties of air.

Specific Expectations

2.4 use technological problem-solving skills to design, build, and test a flying device.

2.5 use appropriate science and technology vocabulary.

3.3 identify and describe the four forces of flight – lift, weight, drag, and thrust.

Description

Students build a number of different paper airplanes and then systematically test them. Through a process of elimination, they find the best design to match their criteria. We are modeling what the design process for real airplanes is and make connections to the testing done with flight simulators before an airplane is ever built. To extend the activity, students can build their own flight data analysis tool using Scratch.

Materials

- Paper
- Scissors
- Access to internet
- Scratch

Computational Thinking Skills

- Algorithm design
- Variables
- Operations

Introduction

When designing a new airplane design engineers will look at different options and test how they affect the performance of the airplane they design. Improvements are made based on what the testing reveals. When an airplane design is finished it will have gone through many rounds of testing to lead to an optimal outcome.

Discuss nature of testing. It may involve computer simulations as well as building actual prototype planes that are tested and then improved upon.

Today we will undergo our own design process. We will do it with paper airplanes to find the best designs. We will choose designs from **foldnfly.com** (or another website with instructions for building paper airplanes – see resources).

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1

Action

Decide what characteristic we will go for (e.g. speed, distance flown, time aloft, interesting trajectory). We may also decide to stick with a certain difficulty level to start.

Actions:
- Each student then chooses an airplane design from website.
- Build the airplane.
- Test the airplanes.

Testing Instructions
- It's important to be rigorous when testing. Each airplane should be tested several times and its performance has to be evaluated based on the average of the results.
- Testing method options (see worksheets below):
  1. **By calculating an average**. Students can either accurately measure the distance flown, time aloft, (and hence the speed (distance / time). Compute the mean of at least three tests.
     - NOTE: This could be flying the same airplane several times, OR if several students built the same model they can work together and use the measurements from each plane to calculate an average.
  2. **By doing a "play-off"**. Students can race two or more airplanes against each other (at least three times). The declared winner (of several trials) can then square off with another winner – continue until only one airplane remains standing.
     - NOTE: In this case taking measurements is not required. We simply compare the results and see who wins.

- Once one winning design for a particular challenge has been found, you can ask students to repeat the process to meet a different criterion and/or a higher difficulty level.

Consolidation/Extension

Looking at the various designs, how do drag, lift, and weight compare? Does the amount of thrust (how hard the airplane is thrown) affect its performance?

Discussion:
- Why was one design better than another? What about the design makes it better? (In particular, how does the design affect airflow and forces on the airplane to result in the wanted characteristics?).

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2

- Is more complicated always better? (Likely not)
- Was the winning design the one you expected to perform the best? Why or why not?

Comparison to computer simulations:
- To test real airplanes a model is created digitally. Then tested in a simulated environment.
- This allows the engineers to find bugs without destroying real airplanes…
- The performance of the model is then used to make improvements until the best final product is found. This is a process of "**debugging**" and **optimization**.
- Pilots often also learn how to fly any new aircraft in a flight simulator before getting a chance to fly the real thing. This allows them to identify problems or get used to how it handles in various situations.
- This lesson was all about testing designs to find the optimal design through an iterative process.

Coding Elements:
- To extend this activity, students can create an analysis tool to calculate their average results. This Scratch program takes each of their results and produces an average based on the test being performed. An example of the program can be found here:
- https://scratch.mit.edu/projects/374985383/
- An airplane has a number of characteristics that can be defined by **variables**. Such as: wing width, wing length, overall shape, tail height, weight, etc.
- We use a **loop**, where we update or change the variables used and measure the outcome.
- The loop continues until the outcome meets certain criteria, which is an "**IF THEN ELSE**" statement (IF outcome met THEN stop ELSE continue by changing variables)

Assessment
The handouts can be assessed for accuracy of the calculations.

Additional Resources
Paper airplane instructions:
- https://www.foldnfly.com/
- https://www.origamiway.com/paper-airplane-designs.shtml
- https://www.youtube.com/watch?v=JhYZy1ugI3Q
- https://www.amazon.ca/Ultimate-Paper-Airplanes-Kids-Instruction/dp/4805313633

A real flight simulator: https://www.youtube.com/watch?v=L8JUWUKXV08

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3