Airplane Design Challenge | Grade 6 - Flight

Lesson Plan

Coding Tool	Offline Coding
Cross Curricular	Math

Big Ideas

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

Specific Expectations

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

3.4 describe, in qualitative terms, the relationships between the forces of lift, weight, thrust, and drag that are required for flight.

3.5 describe ways in which flying devices or living things use unbalanced forces to control their flight.

3.6 describe ways in which the four forces of flight can be altered.

Description

In this lesson students look at what the effect of different airplane designs are on its flying characteristics. We then look at various missions and see what airplane design is best suited to complete it. We then modify the designs to suit each mission. The lesson touches on coding principles by following a process from design to testing to revision and re-testing.

Materials

1. Airplane parts and characteristics cards (included PowerPoint file)
2. Worksheet (attached)

Computational Thinking Skills

- Algorithm Design
- Conditional Statements
- Variables

Introduction

When we look at airplanes, we find a wide variety of designs. Why? (Because they are suitable for different tasks, etc.)

When engineers design a new airplane, they have to look at the design of each part of the airplane to make sure it's ideally suited to the task the plane is meant to accomplish. For example, a passenger plane will look very different from a plane designed to fly in acrobatics competitions.

Airplane design process

The process engineers follow to design an airplane has the following steps:

1. Know what the airplane is meant for. What kinds of things does it have to do? What characteristics does it have to meet? (load carrying capacity, speed, stability vs maneuverability, etc.)
2. Plane is built as a simulation and tested to see how it performs.
3. Engineers adjust the design of each part of the airplane until the simulation gives the expected outcome.
4. Based on the simulation, a real plane is built. It is tested again and further modification are made.

You may have heard of the Boing 737 MAX airplane. In this airplane some critical steps of the design process were flawed. It was not properly tested either in the simulation nor when the final plane was released – and two planes crashed within a year of each other. So – this is serious business! You don't want to get it wrong!

Your task

Today we will be airplane engineers who have to put together a plane for a number of different tasks. We will follow the same steps as engineers do in the real world. Our simulation will not be a complex computer program but just a simple set of characteristics we can compare to what we need to accomplish our task.

If necessary, we'll make some changes until our plane is just right!

This is the SIMULATION stage of airplane design. A fancier version of this would be to write the computer code for a flight simulator program and then test your airplane – like a flying game. But let's keep it simple!

Action

Design an airplane to complete a task:

- Choose a task from the given examples or come up with your own.
- Explain to students that they will need to make their best guesses as to what kind of elements the plane should have to make it the best at the given mission.
- Students then pick their airplane components (fuselage, wing length, airfoil shape, engine type, landing gear)
    - Note: You can either cut out cards for each student (or team of students) and ask them to actually choose the cards to complete the aircraft. Alternatively, you can show the options on a screen and the students write down their choices. The first option is maybe more fun. The second option likely more practical.

- Use the worksheet to add up the characteristics for the airplane

Analyse result:

- Once students have picked all the airplane parts and design elements show them the characteristics that go with each choice.
- Have students add up the totals for their airplane.
    - For example, an airplane with a small fuselage and long wings has a weight of 1000 kg (fuselage contribution) + 2000 kg (wing contribution). If it has a propeller engine that adds another 500 kg. Etc.
- Once that is done show them the actual requirements (or those could have been revealed from the beginning). Compare.

Repeat

- Redo the exercise with better knowledge now until all students agree on the correct design needed.
- Then try a different task (either as a class or give each student the option of doing whichever one they want)

Note on maneuverability: If one element gives "low" and another one gives "high" then the end result is "medium".

Consolidation/Extension

Discussion

- Why do elements change the characteristics of the airplane as they do? Discuss in the context of what students know. (e.g. thin airfoils create less lift than thick airfoils. On the other hand, a large wing will create more lift etc.).

Extensions:

- Students could add their own parts and design elements research the impact they would have on an airplane. For example, what is the impact of the tail design on an airplane's flight characteristics?
- Use an online game such as "Engineering the Wright Way" to build on this activity (see below).

Coding Elements:

- The design process follows an iterative process "**IF** condition not met **THEN** change design UNTIL condition met". This is a conditional loop. Something is repeated until a desired result is achieved.
- The airplane characteristics consist of a number of **variables** (load carrying capacity,

weight, range, etc.). Every choice leads to a change in these variables. Comparing the variables to a set of requirements establishes whether design conditions have been met.

Additional Resources

- Otter aircraft: https://en.wikipedia.org/wiki/De_Havilland_Canada_DHC-3_Otter
- Beaver aircraft: https://www.talkeetnaair.com/
- Engineering the Wright Way lesson plans and simulation game: https://airandspace.si.edu/exhibitions/wright-brothers/online/workshop/resources/index.html