Drexel-SDP GK-12 ACTIVITY

Building Paper Airplane

Subject Area(s): Math, Science, Engineering

Associated Lesson: None

Activity Title: Building Paper Airplanes

Grade Level 6 (5-7)

Activity Dependency : None

Time Required: 75 minutes (Note: 45 minutes to build planes, 15 minutes for testing, 15 minutes for reflections)

Group Size: 1-3

Expendable Cost per Group: <$1

Summary: In this activity students will use the knowledge of how planes fly to build their own paper airplanes. The catch is they are given an imaginary budget with which to do this.

Engineering Connection: This activity introduces the principles of flight and asks students to consider these ideas while constructing their own paper airplane. Students are forced to consider budgetary constraints in their design which is a huge challenge faced by all engineers. Designing a solution to a problem with a set budgetary constraint is always a condition of engineering work.

Keywords: budgets, design, paper airplanes, flight

PA Educational Standards
3.5.7, 3.6.7

Pre-Requisite Knowledge: Basic math concepts such as addition, subtraction and multiplication and addition.

Learning Objectives
After this lesson, students should be able to:

- Understand how planes are able to fly
- Understand why engineers deal with budgets
- Discuss why budgets are challenging
- Design within the limitations of a budget

Materials List
Each group needs:
- Engineering notebook
- Clean workspace

To share with the entire class:
- 8.5 x 11" paper (enough for all students to have multiple sheets)
- Scotch Tape (at least 2 rolls)
- Ruler
- String pre cut into 6" pieces (about 100 pieces for a class of 30)
- Straws pre cut into thirds (about 100 pieces for a class of 30)

Introduction / Motivation

Engineers often argue over the reason that airplanes are able to fly.. First, Bernoulli's Principle tells us how speed and density can affect pressure. This principle explains how fast moving air can help keep planes in the air. If we look at the typical shape of a wing we can view how moving air can help keep a plane in the air. The figure below shows a side view of an airplane wing and how air moves over the wing. You will notice that the wing is curved along the top and straight at the bottom. The bottom part of the wing is a shorter distance to travel than the top. In order for air to meet up on the other side of the wing at the same time the air must move faster over the top of the wing (if it has further to travel in the same amount of time that means a faster speed).

From here there are two important things to know. First, as air moves faster it creates less pressure. Second, things want to move from areas of high pressure to areas of low pressure. All of this simply means the wing is going to want to move upwards and that is how we get and the plane is able to stay in the air!

There is a second principle that can be at work here and many engineers argue over which principle is the main one that creates flight. The second idea is Newton's Laws. It is thought that when air gets to the end of the wing it is pushing downwards. Newton's laws tells us that for every action there is an equal and opposite reaction. This means there is a force upward against the wing that allows it to lift up. Either of these two explanations for lift and flight are acceptable and engineers to this day argue over which one is the principle reason that airplanes are able to fly.

Vocabulary / Definitions

Word	Definition
Newton's Third Law	For every action there is an equal and opposite reaction
Lift	Process of moving something from a lower position to a higher position
Bernoulli's Principle	Law that discusses as air speeds up it's pressure is reduced.
Budget	Sum of money allocated for a specific purpose

Procedure

Background

The idea of flight is a combination of two concepts, Bernoulli's Principal and Newton's Laws. Discuss with the students how the shape of an airplane wing allows air to move faster over the top of the wing than at the bottom and thus creates an area of lower pressure at the top of the wing. Higher pressure at the bottom pushes up on the wing creating lift (this is Bernoulli's Principal in simple terms). Newton's laws make use of the shape of the wing to explain flight because the air will travel over the top of the wing and then straight down towards the ground.

The idea of an equal and opposite reaction means the wing will push back up against the air and the plane will lift off the ground.

It is also important here to discuss the idea of a budget and how that concept in engineering can relate to other things. Engineers are required to design and build things with a certain fixed amount of money to spend. When engineers are trying to be the lead designer on a new building or design they propose to the person how they can do this and how much they think it will cost. This is actually very similar to when you are getting your car fixed. Going to get your car repaired you are given a quote for the repair and the repair place with the lowest quote usually gets your money. Engineering works in much the same way. Explain this idea to students and also explain how having a set amount of money to spend can change the materials that are used or the quality of the work. These ideas relate to so many things in their lives like buying food or clothing (it always seems like the good stuff costs more), getting a car repaired or even having a house built.

Before the Activity

- Make sure you have the straws cut into thirds and the string cut into 6 inch pieces and put into separate bags.
- It can be helpful to cut the tape into 3" pieces in advance of the lesson

With the Students

1. Give the students the list of available materials and their cost as below:
    a. Tape - $0.75 for a 3" piece
    b. String - $0.25 for a 6" piece
    c. Straw - $0.50 for a third of a drinking straw
    d. Paper - $1.00 for a 8.5 x 11" sheet
2. Ask the students to design an airplane given the materials with a budget of $5
3. The students should draw a blueprint of their design and make an itemized budget
4. Handout desired materials to each student and give them about 30 minutes to build their plane
5. Have the students test their designs after 30 minutes is complete to see how far their plane will fly.
6. Have the students answer the investigation question in their engineering notebook.
7. Students should provide a final budget table in their engineering notebook.
8. Discuss test results with the class and ask what would have made the data more scientifically correct.

Safety Issues

- Beware of kids throwing paper planes at each other

Investigating Questions

1. What made this activity difficult?
2. How would your design have changed if your materials changed?
3. What would have made this easier?
4. Is there anything we could have done during testing to make the activity more fair?

Assessment

Pre-Activity Assessment
Students should design a paper plane using the given materials and staying within their budget. Each student should have a blueprint and a preliminary budget.

Post-Activity Assessment
Did the student's plane fly?
Where they within the defined budget?
Is there a sketch (blueprint) of their design?
Ask the students to reflect on engineering and budgets. Do they think this is a challenging thing for engineers? Ask them to name one thing they think would have been made better if the engineers had a larger budget.

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