BUILDING A MODEL OF AN EARLY TYPE GLIDER

INTRODUCTION

In 1891, German engineer, Otto Lilienthal, studied aerodynamics and worked on a design to build a glider that would fly. He was fascinated by the idea of flight based on his study of how birds fly. In 1889 he published a book on aerodynamics that was used by the Wright Brothers as the basis of their design. Lilienthal was the first person to design a glider that could fly a person long distances. Orville and Wilbur Wright spent many years learning about the early development of flight. They first began to test the early theories with balloons and kites. Later, after learning how wind could help flight and how it affected various surfaces, they tested the shapes of gliders and how to control them. The Wright Brothers designed a wind tunnel and tested the shapes of wings and tails of gliders. After finding a shape that would fly consistently, they took to the Outer Banks of North Carolina to test their glider. The rest, they say, is history!

In this activity, students will research the early history and the idea of flight. They will then apply their knowledge of the structure and design of early gliders to make a glider of their own that will fly in a straight line for at least 10 meters. Students will learn about the forces that act on an aircraft in flight, including the relationship of different scientific principles, which are the basis of flight.

Students will use Worksheet A as a guide for their research. Worksheet B will be used as a template for their design and explanations for any modifications based on trial and error of the flight of their gliders. A final rubric will be used to assess the overall design of students' gliders and the distance that the gliders flew in a straight line.

LEARNING OUTCOMES

- Students will explain the foundation and history of the idea of flight.
- Students will demonstrate their knowledge of the design process of early gliders.
- Students will create a glider that can fly properly.
- Students will distinguish appropriate materials for their glider
- Students will recognize the forces acting on an aircraft in flight, including Bernoulli's law and Newton's basic laws of motion.
- Students will apply the relationship of different scientific principles to their design.
- Students will describe forces acting on their glider.
- Students will demonstrate knowledge of the structure, propulsion and control of the principles of flight.

CURRICULUM ALIGNMENT

NORTH CAROLINA ESSENTIAL STANDARDS: 7TH GRADE SCIENCE

7.P.1 Understand motion, the effects of forces on motion and the graphical representations of motion.

7.P.1.1 Explain how the motion of an object can be described by its position, direction of motion, and speed with respect to some other object.

7.P.1.2 Explain the effects of balanced and unbalanced forces acting on an object (including friction, gravity and magnets).

NORTH CAROLINA ESSENTIAL STANDARDS: PHYSICAL SCIENCE

PSc.1.1 Understand motion in terms of speed, velocity, acceleration and momentum.

PSc.1.1.1 Explain motion in terms of frame of reference, distance, and displacement.

PSc1.1.2 Compare speed, velocity, acceleration and momentum using investigations, graphing, scalar quantities and vector quantities.

PSc.1.2 Understand the relationship between forces and motion.

PSc.1.2.1 Explain how gravitational force affects the weight of an object and the velocity of an object in freefall.

PSc.1.2.3 Explain forces using Newton's three laws of motion.

NORTH CAROLINA ESSENTIAL STANDARDS: PHYSICS

Phy.1.1 Analyze the motion of objects.

Phy.1.1.3 Analyze motion in two dimensions using angle of trajectory, time, distance, displacement, velocity, and acceleration.

Phy.1.2 Analyze systems of forces and their interaction with matter.

Phy.1.2.3 Explain forces using Newton's laws of motion as well as the universal law of gravitation.

Phy.1.2.4 Explain the effects of forces (including weight, normal, tension and friction) on objects.

CLASSROOM TIME

Five 90-minute block periods

CRITICAL VOCABULARY

Aerodynamics: the study of how air moves around objects

Air resistance: a force that opposes forward motion through the air, also called drag

Bernoulli's Principle: in a fluid, such as air or water, higher velocities cause lower pressure

Gravity: the force that pulls an object to the center of the earth or towards any other mass

Drag: a force that opposes forward motion, also called air resistance

Inertia: a property of matter to stay in motion or stay at rest unless acted on by a force

Lift: upward force

Thrust: forward or propulsive force

Glider: an aircraft for unpowered flight

Monoplane: an aircraft with one set of fixed wings

MATERIALS NEEDED

Glider research and design should be done several days in advance so that students and teachers will have time to gather materials needed.

- Measuring tape will be needed to measure distance
- Computer
- Worksheet A for research
- Worksheet B for design and modifications
- Rubric

High School students will create a materials list based on previous research.

For middle school students, teachers may want to have some materials from which students can choose to make their gliders from including, but not limited to:

- Balsam Wood
- Glue
- Scissors
- Tape
- Paper towel tubes
- Styrofoam trays
- Cardboard
- Clay (for weight)
- String
- Straws
- Construction paper
- Plastic/plastic grocery bags
- Recycled materials found available
- Toothpicks
- Popsicle sticks/coffee stirrers

TECHNOLOGY RESOURCES

Students will need to use a computer to do research on the history and design of early type gliders. This research will be the background needed in order to design an effective glider.

PRE-ACTIVITIES

1. Students should be introduced to the concepts and principles of flight through mini inquiry based labs. See attached lab activities.
2. Students should be introduced to the early history of flight and the thought process and/or ideas of early flight trials.
3. Teachers will need to have booked time for the use of the computer lab/mobile lab for research or reserve enough computers for students to use. (See attached power point on the early history of flight if computers are not available for students.)
4. Teachers will need to gather materials needed to make gliders. For high school students this will need to be done after students have researched and designed their gliders. They will need to create a list of materials they will need. Ask shop teachers and art teachers for scrap materials that you may be able to use. You need to leave a few days between design and development for gathering materials.
5. Measure and mark in 1-meter intervals up to 15 meters from the area of launch on the day of assessment. Another option is to use the football field.
6. Make copies of worksheets A and B, including the rubric for the students and explain in detail the grading and what is expected.
7. The students should be familiar with laboratory safety.

ACTIVITIES

1. Place students in groups of 2-3 depending on class size. This may be a good time to force group or have students pick partners that are not their friends.
2. Students will research the history and design of early gliders online using Worksheet A.
3. Students will design a glider based on their research and explain why they chose to use this design using Worksheet B.
4. Students will use materials provided or of their choosing to build their design of an early type glider that can fly properly based on prior research of the history of the first gliders.
5. Students will hand throw gliders from a high, safe area such as the back of bleachers or a tall ladder. Gliders should fly for a distance of at least 10 meters in a straight line.
6. Students will modify their designs and remake if needed. Students should explain their modifications using Worksheet B.

*Students may have to build more than one glider to improve their design and construction based on tests, so you may want to make sure there are enough materials supplied for more than one trial.

ASSESSMENT

Use the attached Rubric to grade the design and development of the student's gliders. Gliders should fly at least 10 meters in a straight line.

MODIFICATIONS

Teachers in middle school or on a time constraint may wish to have students do research of the early ideas of flight and development of gliders, but give students a selection of materials in which to work with. (See materials list). You may also use the attached PowerPoint presentation to introduce students to early aviation instead of having students do research if computers are not available for every student or group.

ALTERNATIVE ASSESSMENTS

Teachers can assess students on work ethic and creativity of their gliders if they do not actually fly 10 meters in a straight line.

WEBSITES AND RESOURCES

These web sites may be used as starting points for student research:

Leonardo da Vinci and his Flying Machines
http://www.angelfire.com/electronic/awakening101/leonardo.html

Leonardo da Vinci's Ornathopter
http://www.auuuu.com/airtravel/32.html

Octave Chanute's Gliding Experiments
http://www.spicerweb.org/chanute/glid_exp.aspx

Smithonian's A Century of Flight
http://www.smithsonianmag.com/people-places/century-of-flight.html

FirstFlight Flyers
http://firstflight.open.ac.uk/cayley/cayley.html

COMMENTS TO THE TEACHER

Students may come up with material requests that you had never thought of using in their design. Be open to new ideas and let them attempt to use them. You never know what will work. Do not tell students what will or will not work. As an inquiry-based project, students will learn based on trial and error just as the early aviators learned. Students may come up with something that you know will not work, but they need to learn WHY they did/not work. They will need to explain any modifications or changes they may have made to their design. This is part of the learning process.

AUTHOR INFORMATION

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WORKSHEET A: RESEARCH OF EARLY GLIDERS AND THE IDEA OF FLIGHT

Student Name _____ Date_____

Using a computer or the lesson your teacher provided on The History of Early Flight, research and answer the following questions in as much detail as possible:

1. The idea of flight had its strongest proponent in Leonardo da Vinci (1452-1519), what were his ideas based on? Explain his contribution to the idea of flight.

2. Daniel Bernoulli's work made our understanding of the physical nature of flight possible. Explain in your own words his findings.

3. Who is named "Father of Aerial Navigation" and how did he obtain this title?

4. Although known for being able to advance the science of aviation and the art of flying, Otto Lilienthal's work had one major weakness, flight control. Explain his success with gliders and their construction.

5. What was the "Katydid" and why did its design not work?

6. Up to the point of the Wright brothers, there was no accurate accepted scientific body of knowledge about manned flight. They proposed problems that needed to be addressed.
   - For people to fly, they must first comprehend the physical principles involved. Only then could they mechanically reproduce bird's flight. What are the physical principles involved?

   - The issue of lift and equilibrium needed to be solved. How did they solve them?

- A three-dimensional control system was needed. What did that mean?

- The vehicle needed to be strong enough to support a person.

- The pilot needed sufficient training and skill to fly the machine and not destroy it. Who will be flying your glider on the day of reckoning and why did you choose this person out of your group?

7. Since doing this research, are there some things you have thought of trying? Are there things you know NOT to do to your glider? List any notes here.

WORKSHEET B- DESIGN AND MODIFICATIONS

What roles will the people in your group have? (Your name first)

1. I, _____ will:

2. _____ will:

3. _____ will:

4. _____ will:

What is the name of your glider? _____

Draw your preliminary design:

What materials will you need to make this glider? List them and their approximate amounts. Provide justification for your choice of materials.

DATA TABLE 1:

Trial Number	Meters flown	Explain what went wrong.
1		
2		
3		

List modifications made from trial 1 and explain why you made these changes in detail.

List modifications made from trial 2 and explain why you made these changes in detail.

After 3 trials, did your glider make it to 10 meters? Why or Why not?

From the materials that you used, can you think of a different material that would have made your glider fly farther? How?

What did you learn?