PRIMARY + STEM

Teaching Resource

ACTIVITY: Paper Planes

ACTIVITY OVERVIEW

Students could learn about shapes on paper. Or they could learn about shapes on paper that flies! The design used in this activity not only glides, but the paper plane also flaps its wings as it does so. It is incredible!

As students fashion paper into planes, there are many opportunities to learn about the different types of triangles with this design, and many opportunities to measure angles within those triangles. Although this activity has been written as a lesson to reinforce prior learning about shapes, there are many ways to extend this fun activity - whether in maths or in science. Given the right motivation, like bragging rights or a paper plane-flying competition, this activity is also appropriate for supporting the learning of measurements, materials and their properties, and forces.

Pioneers of flying machines had all studied paper model aircraft at some point of their lives to design their machines. It is as though every time someone now makes modifications to their paper plane, they join the ranks of these other paper plane engineers in the same spirit to conquer the skies. This experience will come with its fair share of tears, frustration, and jubilation, as students work through failed attempts and keep adjusting their planes until they soar.

SYNOPSIS

As students fashion paper into planes, there are many opportunities to learn about the different types of triangles with this design, and many opportunities to measure angles within those triangles. Although this activity has been written as a lesson to reinforce prior learning about shapes, there are many ways to extend this fun activity - whether in maths or in science. Given the right motivation, like bragging rights or a paper plane-flying competition, this activity is also appropriate for supporting the learning of measurements, materials and their properties, and forces.

Pioneers of flying machines had all studied paper model aircraft at some point of their lives to design their machines. It is as though every time someone now makes modifications to their paper plane, they join the ranks of these other paper plane engineers in the same spirit to conquer the skies. This experience will come with its fair share of tears, frustration, and jubilation, as students work through failed attempts and keep adjusting their planes until they soar.

Foundation – Year 2

- F: Sort, describe and name familiar two-dimensional shapes and three-dimensional objects in the environment.(VCMMG081)
- Y1: Recognise and classify familiar two-dimensional shapes and three-dimensional objects, using obvious features.(VCMMG098)
- Y1: Recognise and describe one-half as one of two equal parts of a whole.(VCMNA091)
- Y2: Describe and draw two-dimensional shapes, with and without digital technologies.(VCMMG120)
- F – 2: Objects are made of materials that have observable properties.(VCSSU044)
- F – 2: The way objects move depends on a variety of factors, including their size and shape. A push or a pull affects how an object moves or changes shape.(VCSSU048)

Year 3 – 4

- Y3: Identify symmetry in the environment.(VCMMG144)
- Y4: Compare and describe two dimensional shapes that result from combining and splitting common shapes, with and without the use of digital technologies.(VCMMG170)
- Y4: Compare angles and classify them as equal to, greater than or less than a right angle.(VCMMG174)
- Y4: Create symmetrical patterns, pictures and shapes, with and without digital technologies.(VCMMG173)
- Y3 – 4: Forces can be exerted by one object on another through direct contact or from a distance.(VCSSU064)

Year 5 - 6

- Y5: Describe translations, reflections, and rotations of two-dimensional shapes. Identify line and rotational symmetries.(VCMMG200)
- Y5: Estimate, measure and compare angles, using degrees. Construct angles using a protractor.(VCMMG202)
- Y6: Investigate, with and without digital technologies, angles on a straight line, angles at a point and vertically opposite angles. Use results to find unknown angles.(VCMMG231)

ACTIVITY, MATERIALS AND INSTRUCTIONS

Activity

As students make their own paper plane, they pause after each step to identify shapes, angles, and lines of symmetry. The secrets to a successful flight? Good folds, good throws, and a good temperament.

Make sure the folds are crisp, with perfect symmetry. It is all about adjusting to find what works best. Students who keep at it will eventually achieve an amazing flight.

Materials for 30 students (working individually or in pairs)

- A4 paper of any type (although paper from magazines appear to work the best, e.g. free cooking magazines from major supermarkets)
- Optional: Rulers and protractors

Instructions

1. Teacher gives instructions to make the plane or uses accompanying video.

   It is best for the teacher to be familiar with the design, and to explore how it best works, before doing this activity. There are one or two critical points at which students will need more assistance.

2. Describe shapes and their features in the process.

   What shapes do students see? Triangles? Rectangles?
   How many different types of triangles are there– right-angle, isosceles, scalene, obtuse, or acute? Can they see smaller shapes within bigger ones? Can students use words like 'corners', 'faces', and 'edges' to describe what they see?

3. Describe angles.

   Angles are formed when two straight lines meet.

   Can students identify right angles, and angles smaller than or larger than 90˚?

   For older students:
   Use protractors to measure angles in specific stages of the folding process. List how many right angles, less than right angles, and more than right angles, in that stage.

4. Describe symmetry.

   By making half-folds, do students see two equal halves on either side of the line of symmetry? A good paper plane is symmetrical.

   For older students:
   Is the shape symmetrical? Measure the length of either side of the line of symmetry. Or measure angles of either side. Are they equal on both sides?

5. Time to take flight!

   It is best to fly your paper planes in a draft-free indoor space, such as the school hall.

   Adjustments will need to be made to the paper plane to get it to fly well (e.g. a tuck here, a pinch there, making more definite folds, etc.)

   There is no substitute for patience and perseverance in this part of the process. Watch out for paper planes flying into eyes!

HOW TO USE THIS ACTIVITY WITH YOUR STUDENTS

Foundation - Year 2

Can students describe the shapes they see using terms like 'edges' and 'corners'? How many corners and edges do squares and triangles have?

And when they fold the paper plane in half, can they see how they produce two equal halves? Although the paper plane design is rather forgiving, this activity will still require a lot of teacher guidance because of the level of dexterity and fine motor skills required.

Combine this maths activity with the foundation - two Science curriculum, where students learn about materials and their properties. This paper plane activity could serve as an extension - comparing paper planes made of different types of paper with different weights, thicknesses, and flexibility.

Note – paper plane design can be simplified for younger students (e.g. Engineering Emily https://www.engineeringemily.com/4-simple-fun-paper-airplanes-steam-activity-for-kids/).

Years 3/4

There are many opportunities for students to compare angles relative to the right-angle as they make folds. At specific steps of the process, students could tally up the number of right angles, angles less than 90˚ (acute angles), and angles larger than 90˚ (obtuse angles).

As students fold shapes upon shapes, they will also be able to see how triangles and rectangles can be made from combining and splitting other triangles and rectangles. Emphasise to students that symmetry is key to a successful paper plane, and that they need to make their folds clean and crisp to achieve that symmetry.

In the year three – four Science curriculum, students learn about forces acting on objects. The forces on paper planes are thrust, drag, lift, and gravity. How these forces act on the paper planes is largely determined by the shape of the planes. As an extension, students could research and make different paper plane designs and compare how they fly.

Years 5/6

As students follow instructions to fold the paper plane, they will be making different types of triangles – right-angle, isosceles, and obtuse.

At specific steps of the folding process, students could measure angles using protractors and draw these triangles out on a piece of paper.

They can also explore the concept of symmetry by determining whether distances and angles on either side of the line of symmetry are equal. Students can also dissect (unfold) the best and worst paper planes to compare their angles and symmetry.

As an extension activity, students could organise a paper plane-flying competition, where they agree on rules and methods of measurements (e.g. the number of throws per paper plane, whether to record the farthest distance, longest time in the air, the type of paper to use, etc.).

Extra equipment students might require include a 10m tape, or a timing device.

DISCUSSION SECTION AND KEY THEMES

KEY THEMES

Shapes

We are surrounded by objects of various shapes and sizes, in two dimensions (2D) and in three dimensions (3D). It is useful to know the features of different shapes and have the vocabulary to describe them.

Two-dimensional (2D) shapes

As opposed to 3D shapes that possess length, breadth, and depth/height, 2D shapes are flat because they only have length and breadth. 2D shapes are also known as plane shapes and can be made of any number of lines segments. These lines may be straight or curved. They can also be entirely connected (closed) or not (open). If a 2D shape has the same length sides and equally sized interior angles, it is described as regular.

2D shapes made with only straight-line segments are called polygons. A polygon must have a minimum of three sides. Examples of polygons include triangles, quadrilaterals, pentagons, and hexagons. 2D shapes made with curved lines are not considered to be polygons. They include circles and ellipses.

Edges, vertices, and faces

An edge is the line segment that connects two points on a shape.

A vertex (plural: vertices) is a corner where two or more edges meet, like a corner. Vertices are sometimes referred to as 'corners' in a 2D shape.

In a 3D shape, faces are the flat surfaces on the shape.

A 2D triangle has 3 vertices and 3 edges.

A 3D triangular pyramid has 4 faces, 4 vertices, and 6 edges.

Triangles

Different types of triangles are made in the process of folding paper planes, especially the plane featured in this lesson. A triangle is defined as any three-sided polygon that comprises three edges and three vertices. The variations between the length of sides and interior angles determine the type of triangle.

- Classification by length
  - Equilateral triangle: edges of equal length, all interior angles equal
    Isosceles triangle: two edges of equal length, two equal interior angles
  - Scalene triangle: all edges of different lengths, all interior angles unequal
- Classification by angle
  - Right-angle triangle: one of the interior angles is 90˚
  - Acute triangle: all three interior angles are less than 90˚
  - Obtuse triangle: one of the interior angles measures greater than 90˚

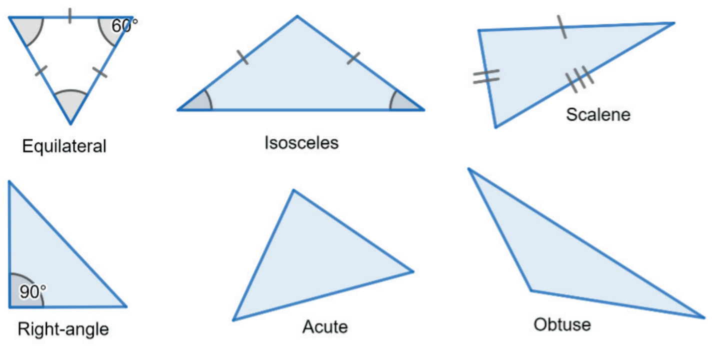

Figure 1. Triangle types

QUESTIONS AND ANSWERS

Who holds the world record for the farthest paper plane throw ever?

The current Guinness World record for the farthest flight of a paper plane is held by Kim Kyu Tae (South Korea) who threw it, Shin Moo Joon (South Korea) who folded it, and Chee Yie Jian (Malaysia) who designed it. The paper plane achieved an astounding distance of 77.134m on April 16, 2022. They smashed the previous record held by John Collins and Joe Ayoob (2012) of 69.14m.

Watch the record-breaking feat here: https://youtu.be/IVQYAdqHjcc

How about the largest paper plane ever made?

According to Guinness World Records, the largest paper plane measured 18.21m in length and flew 18m. It was constructed in 2013 by a group of 14 students and employees from the Braunschweig Institute of Technology (Germany).

Watch the launch here: https://youtu.be/6kPOyKnH2OI

Who holds the world record for the longest flying time?

The Guinness World record for the longest flying time is held by Takuo Toda of Japan. The time of 29.2s was set in Hiroshima, Japan in 2010.

Watch his feat here: https://youtu.be/YBQezzTovZY

Do paper planes fly in space?

That's a great question because when there is no gravity, how do paper planes behave? Japanese astronaut Takuya Onishi put this question to the test when he threw and recorded himself throwing paper planes onboard a space shuttle. There is air in the space shuttle, but there is no gravity. It looks like the plane moves in whichever direction it was thrown, without dropping in altitude.

Incidentally, Takuo Toda (the world record holder for the longest flying time), and a Japanese space engineer had proposed a plan to launch a paper plane out of the International Space Station and into the vacuum of space. The plan was unfortunately shelved.

Who invented paper?

According to Chinese historical records, paper was invented by the Chinese during the Han Dynasty in 105AD by a court official, but there is archaeological evidence suggesting that paper was invented centuries earlier (2BC) in China and Tibet. Plant fibres were soaked in water, pounded into pulp, and poured into bamboo moulds where the slurry eventually dried and became paper.

The Invention of Paper (thoughtco.com)

Did Leonardo da Vinci invent the paper plane?

Paper planes may have been invented by the Chinese and Japanese before the time of Leonardo da Vinci - by more than 1,000 years! What da Vinci did was to make paper models of his inventions such as the ornithopter and parachutes. According to the National Air and Space Museum (USA), the modern paper plane was first designed by Jack Northrop, co-founder of an aircraft cooperation, in the 1930s. He used paper planes as test models for larger aircraft.

What kind of paper is best for making paper planes?

It really depends on what kind of 'best' we are looking for – is it best at flying long distances? Best at flying in loops? Different kinds of paper planes would benefit from different types of paper (e.g. light or heavy, flexible or stiff, textured or smooth). The best way to find out is to test it! Decide on a 'best' characteristic and vary the paper type for this investigation. Make sure that all variables are the same, such as the size of paper, and the way the plane is launched.

Were shapes invented?

We are surrounded by shapes and the knowledge of shapes is certainly not 'invented' by any one person. Rather, geometry (the study of shapes) is the result of work by many early mathematicians and philosophers from civilisations such as the Egyptian, Greek, Indian, and Chinese.

They had discovered the relationships and patterns in shapes and expressed the ideas in numbers and equations. Over time, discoveries built upon previous discoveries have added to our collective knowledge and understanding.

How do I get a record in the Guinness World Records?

Many people who hold records would have asked this very question! The Guinness World Records is an organisation that recognises achievements across the globe in all sorts of categories.

If you want to challenge or break a current measurable record, your record must be proven as well. There are many conditions and minimum requirements to fulfil and well worth the effort if you believe you have what it takes to create a record in your name. Go to: How to Apply for a Guinness World Record (with Pictures) - wikiHow

Why is symmetry important in making paper planes?

It has to do with how forces interact with paper planes.

Symmetry is important to achieving stability on the paper plane. When forces are acting on the plane in a balanced manner, the paper plane is better able to hold steady over a long distance. This is true for real aeroplanes, as well as paper ones.

OUTSIDE OR SUPPLEMENTARY READING

Free web-based application to draw shapes

Geometry - GeoGebra

This video is of a previous Guinness world record holder, John Collins, for furthest distance flown by a paper plane set in 2012, see: https://youtu.be/3BNg4fDJC8A.

He gives instructions how to make his design in the video.

More paper plane designs

- Fold 'N Fly
  https://www.foldnfly.com/
- Engineering Emily
  https://www.engineeringemily.com/4-simple-fun-paper-airplanes-steam-activity-for-kids/
- Origami Way
  https://www.origamiway.com/cool-paper-airplanes.shtml

TOPIC WORDS

- Paper
- Plane
- Aeroplane
- Triangle
- Rectangle
- Shape
- Two-dimensional (2D)
- Three-dimensional (3D)
- Flight
- Fold
- Edge
- Vertex
- Corner
- Measure
- Angle
- Distance
- Symmetry

PRIMARY + STEM

For more teaching resources, visit

WWW.PRIMARYANDSTEM.ONLINE

Supported by

The Invergowrie Foundation

Swinburne University