Understanding How Birds Fly

Developed by EM Date-Huxtable

Flight Experiment

Learning Outcomes 1&2:

- To understand how changing the length and width of the glider's wings changes its 'flight performance'
- To explain the forces acting on the glider when it is 'flying'

Instructions: you will use a toy glider as a model of a bird. Firstly, observe the shape of the glider's wings. After assembling it, 'test fly' the glider and observe how far and high it glides when you launch it with different force or 'thrust'. Now observe what happens when you launch the toy glider after you change the area of its wings.

Materials required:

1. Toy foam glider purchased from a toy or department store
2. Discarded styrofoam packaging, eg. from a new fridge or washing machine
3. Sharp knife for cutting and paring the styrofoam
4. Discarded cardboard, eg. cereal and pizza boxes
5. Scissors and sticky tape
6. Digital (kitchen) scales that measure in tenths of a gram
7. 25m measuring tape
8. Small fan with several (at least 3) speed settings

Method:

1. Assemble the glider (follow the instructions on the box)
2. Ask your teacher to help you cut and pare the styrofoam to make two wings (the wings can be made by adults beforehand), each the same width as the originals but twice as long; shape the styrofoam so that the lower surface remains relatively flat and the upper surface is curved like an airfoil (see diagram of airfoil cross-section on powerpoint presentation).
3. Fit the new wings on to the glider and launch it (throw 'javelin-style'), measure with 25m tape how far it glides, repeat 10 times and calculate the average distance that it 'flies'
4. Suspend the glider so that the belly just touches the ground, point the fan at its nose and switch it on to the lowest speed, then the next fastest and so on, and record what happens to the glider
5. Trace the 2D shape of the Styrofoam wings on to cardboard, cut the cardboard 'wing extensions' out and attach them with sticky tape to the back edge of the Styrofoam, use the scales to decide how to adjust the weight of the wings so that they are approximately equal (within 1g difference) by adding a strip of cardboard to the lighter wing along the back edge of the Styrofoam on the upper surface (the wing extensions can be made by adults beforehand)
6. Repeat steps 3. & 4.
7. What difference did you observe in the glider's flight path between the two modifications?
8. Try making some tail modifications and test fly/glide again (repeat steps 3. & 4.)

Results:

Wing Shape/Size	Distances Flown	Wing Shape/Size	Distances Flown

- Describe differences in flight path and lift you observed between the wing shapes/sizes:

Evaluate the Experiment:

What was the experimental question asked?

Identify the variables in the experiment.

After completing the guided experiment, what can you predict about the effect of wing size on flight performance?

Do you think the experiment was a fair test of the question? Why or why not?

Design and Plan another Investigation, using the wing shapes available and/or other wing designs:

New Question:

Variables:

Method of Measurement:

Predicted Results:

Classifying Bird Wing Shapes and Predicting their Flight Patterns

Learning Outcome 3: to accurately observe and describe wing shape and flight behaviour of some birds

Instructions: Watch David Attenborough's 'The Life of Birds', Episode 2 'The Mastery of Flight'

- Observe the different types of birds and their wing shapes. Try to describe each bird's body size and shape, such as long and thin, short and round, large and torpedo-shaped, jetfighter-shaped, etc. Try to describe the wing shape. Also note the way the feathers are shaped at the outer ends of the wings. For example, an albatross has very long wings that are relatively narrow, many flight feathers that are also short relative to wing length, and the wing feathers are pointed at the outer end: therefore, their wings are 'very long, narrow and pointed'.
- Describe the main flying behaviour(s), such as soaring, flapping, diving with wings partly folded, undulating or alternately flapping and gliding, high-speed flying or soaring, hovering, etc. How do birds use their body, wings and tail to adjust their flying speed and direction?
- Observe the 'flight environment' for each different bird. Is it windy? Hot or cold weather? Are there lots of obstacles in the way like trees? Do the birds appear to use updrafts and thermals?
- Tabulate your observations (Table 1):

Species	Body size and shape	Wing shape	Outer wing feather arrangement	Observed flight environment	Observed flight pattern	Wing Shape Type
Albatross	Large, torpedo-shaped	Very long and narrow	Pointed	Very windy, launch by taxiing/running, updrafts from waves/cliffs	Mostly soaring, some shallow flapping, controlled crash to land	High Aspect Ratio (to be completed after the presentation)

Learning Outcome 4: to classify wing shape descriptively and numerically

Instructions:

- Watch the presentation about wing shape measurement and classification
- Add a column to Table 1 from the previous activity called 'Wing Shape Type' and classify the wing shape of each species according to the four wing shapes described in this activity
- Plot Wingspan (y-axis) against Wing Chord (x-axis) for the Australian bird species in Table 2 below and label the points by their codes
- Classify each species according to Wing Shape type and add to the Table 2 (**Hint**: use reference images to assist in classifying)

Table 2. Australian Bird Species' wing measurements for plotting and interpretation of graph (use Microsoft Excel to plot graph). W=waterbird, LW=large waterbird, O=ocean-going, R=raptor, AF=aerial forager, G=ground, S=shorebird, PD=pigeon/dove, P=parrot, C=cuckoo, N=nightjar, KR=kingfisher/roller, E=perching bird

Species	Code	Wingspan (S) cm	Wing Chord (C) cm	Wing Shape/Flight Pattern
Australasian Grebe	W	39	7.67	
Wandering Albatross	O	350	23.66	
Little Pied Cormorant	W	90	14.99	
Great Frigatebird	O	230	21.72	
Straw-necked Ibis	W	120	14.50	
Magpie Goose	LW	180	29.95	
Wandering Whistling-Duck	W	90	15.96	
Musk Duck	W	87	14.41	
Black Swan	LW	200	30.30	
Australian Shelduck	W	132	19.57	
Maned/Wood Duck	W	80	15.48	
Pacific Black Duck	W	100	15.32	
Hardhead	W	70	12.89	
Wedge-tailed Eagle	R	230	41.41	
Peregrine Falcon	AF	105	15.42	
Australian Brush-Turkey	G	85	26.39	
Painted Button-Quail	G	38	7.33	
Purple Swamphen	W	88	20.53	
Eurasian Coot	W	64	11.65	
Pacific Golden Plover	S	72	7.32	
Bar-tailed Godwit	S	75	10.56	
Little Tern	S	55	7.95	
Wompoo Fruit-Dove	PD	70	17.12	
White-headed Pigeon	PD	70	17.28	
Diamond Dove	PD	32	7.09	
Sulphur-crested Cockatoo	P	103	28.99	
Rainbow Lorikeet	P	46	8.45	
Budgerigar	P	30	5.02	
Fan-tailed Cuckoo	C	42	8.58	
Channel-billed Cuckoo	C	107	20.20	
Powerful Owl	R	140	29.69	
Barn Owl	R	100	17.35	
Tawny Frogmouth	N	95	20.96	
Australian Owlet-Nightjar	N	50	9.35	
White-throated Needletail	AF	49	6.03	
Sacred Kingfisher	KR	37	7.24	
Dollarbird	KR	65	12.61	
Superb Lyrebird	E	76	29.90	
Southern Emu-wren	E	19	4.78	
Yellow-faced Honeyeater	E	26	7.49	
Brown Thornbill	E	16	4.87	
Grey-crowned Babbler	E	35	10.86	
Golden Whistler	E	30	8.22	
Grey Fantail	E	22.5	6.61	
Australian Magpie	E	85	18.69	
Zebra Finch	E	17	4.65	
Welcome Swallow	AF	31	5.79	

Interpret from the graph the range of values of Wingspan and Wing Chord that characterise each wing shape type:

High Aspect Ratio

High Speed

Slotted High Lift

Elliptical

Do any species not fit into the four categories? How would you describe their wing shape?

Predict the flight pattern of each species; to inform your answer, use the position of each species relative to other species on the graph:

High Aspect Ratio

High Speed

Slotted High Lift

Elliptical

Do any species not fit into the four categories? How would you describe their flight pattern?