The Shape of Fish: A Marine Science Activity

JAYASHREE RAMADAS
LISA NOVEMSKY
HOWARD KIMMEL

All moving things on Earth have to push their way through either air or water. Water, because it is both denser and more viscous—resistant to flow—than air, is harder to move through. The ease with which something can move through its surroundings depends on its shape. Given the greater resistance that water presents, the body shapes of fish become extremely important. Being able to move easily through water helps them to capture food and to escape predators.

Objectives

Although, this activity was designed for students in grades five through seven, it can be easily modified to use with grades three and four also. This is a physical science activity to teach students concepts that help them understand biological adaptation. The activity is planned for two periods of 45 minutes each.

Students begin by tossing through the air sheets of paper shaped into various forms. Appropriate test forms would include a flat sheet of paper, a folded sheet, a crumpled ball, a tube, a paper airplane, and any other forms that the students may devise. They, then, construct shapes from Ivory soap that can be pulled through water in a tub. A coiled wire attached to the shapes demonstrates the relative difficulty of pulling the various shapes through the water. Finally, the easiest-to-pull shapes are compared with the shapes of fish.

JAYASHREE RAMADAS is a staff member of the Homi Bhabha Centre for Science Education in Bombay, India. She spent a year working as a research associate at the New Jersey Institute of Technology on a marine science program for urban elementary students. LISA NOVEMSKY is coordinator of educational research and outreach programs for the Center for Pre-College Programs at the New Jersey Institute of Technology (NJIT), Newark, New Jersey. HOWARD KIMMEL is assistant vice-president for academic affairs at NJIT. This work was financed by a grant from the New Jersey Department of Higher Education.

Materials (per class)

1 sheet of paper per student, all the same size (an old catalog is an excellent source of equal-sized sheets)
At least 5 bars of Ivory soap
Plastic knives, 1 per bar of soap
Newspapers to cover worktables
1 1′-long gauge nickel wire per bar of soap
Pencils to coil wire
1 tub of water, at least 3′ long
Optional:
Plasticine
Models of cubes, cones, and spheres
Fish in aquarium

Lesson One

Procedure for Lesson One

1. Give each student a sheet of paper.
2. Ask the students to predict how far they can throw the paper. Then let each student try throwing the flat sheet of paper.
3. Introduce the idea that something is resisting the movement. For the paper it is air; for the fish it is water. The element in which something moves is called the *medium*.
4. Ask students what they should do to the sheet of paper in order to be able to throw it farther.
5. Each student should construct a paper shape to use in a contest to see whose shape goes the farthest.
6. Different shapes can be tried such as a folded

sheet, a tightly crumpled ball, a triangular football, a hollow ball, an airplane, etc. See classroom discussion points 1 through 3 in this lesson.

7. Reiterate the idea that how far a thing moves, or how easily it passes through the air, depends on its shape. Convince the students that all the shapes thrown have the same weight and that they have tried to throw them equally hard.

8. Bring out the concept that the shapes that go farthest are compact and have pointed ends. See classroom discussion point 4.

Classroom Discussion Points for Lesson One

1. When students are asked to guess why certain of the shapes made from paper traveled farther, a variety of responses can be expected. If someone suggests that the force with which the papers are thrown matters, you can suggest that one student throw all the shapes and try to throw them equally hard.

2. Students may think that the shapes thrown have different weights. They are likely to imagine that the tightly folded shapes are heavier than the loosely folded ones. Other students may say that the small shapes are lighter. Such misconceptions are commonly arrived at by elementary students. These responses show that students have not learned to distinguish between weight and volume.

To convince the students that weight does not change when changing the shape of an object reduces its volume, ask the students if all the shapes are made of the same amount of paper—has anything been added to the sheet of paper or taken away from it. You may have to repeat this discussion more than once before students fully understand the concept.

3. A major benefit of this discussion is the idea of controlling variables. Point out in simple terms that if the effect of changing the shape of an object is to be judged, then other factors, like the weight of the object and the force of launching it must be kept the same. In learning to control variables, the students are beginning to construct proper experiments.

4. The streamlining of body shape is important in both natural and human-made objects. See how many examples of streamlined manufactured objects the students can think of. Compare the shape of the Model T with today's cars—compare the shape of these cars with racing cars. Steamlined shapes move faster and use less fuel because they don't waste extra energy overcoming the resistance of the air. Further discussion can include the shapes of bullets, airplanes, and submarines.

Lesson Two

Procedure for Lesson Two

1. Introduce the idea that fish have to move through water, which offers more resistance than air. See classroom discussion point 1 in this lesson.

2. Divide the students into groups of four or five individuals. Cover the worktables with newspapers. Give each group a cake of Ivory soap and a plastic knife.

We used Ivory soap rather than wax models as was used in Marshall (1966) because molding the shapes from wax would be too dangerous for elementary students. Because Ivory soap floats near the surface but mostly under water, the drag of the water can be nicely demonstrated. Ivory soap dissolves in water very slowly and from all sides equally, and therefore, the results are not affected.

3. Ask the students what shapes they would like to try to move through water. Some basic shapes such as a cube, a ball, a cone (blunt end or pointed end forward), and a fish shape might be tried.

Because students often have difficulty visualizing three-dimensional shapes while they are cutting them from soap, it is a good idea to show them models. They can also form basic shapes in plasticine before carving the soap. Students should try to get the largest size of shapes that they can out of the bars of soap. However, it is more important to try to make the shapes as equal in weight as possible.

4. Distribute the 1′-lengths of wire and the pencils to each group. Ask one student in each group to coil the wire around the pencil in one direction only, with the coils placed close together, so that a spring is formed.

5. Tell the students to carefully insert one end of the wire into the soap. They should not dangle the soap downward or the spring will come uncoiled.

Because the spring must respond to small pulls, a stiff spring will not do. A lab spring balance is not sensitive enough, so a light nickel wire was chosen. However, this kind of wire uncoils easily, so be gentle and pull only horizontally.

6. Place the shapes, two at a time, into the tub of water and pull them along side by side. Compare the length the coils are extended by the two shapes as they are pulled along at the same speed.

The tub must be a minimum of 3′ long so that there is enough time to see the extension of the wire and judge the force needed to pull the shape. Because the differences in pulls may be very slight, it is better for the same person to be pulling both shapes in order for that person to feel the difference as well as see the changes in the shape of the springs.

7. The difference in pulls for a cube and a fish shape will be immediately felt. The differences between the shapes of a ball and a cube or between those of a cone and a fish may not be as obvious. However, all the students should pull simultaneously both a streamlined and nonstreamlined shape at some time during the experiment because the differences between these can be easily distinguished.

Classroom Discussion Points for Lesson Two

1. Ask students to move their hands through the air and through the water. The difference, in trying to move your hand palm forward or with finger pointed forward, is seen more obviously in water. Thus streamlining is more important for fish than it is for animals that live in air.

An interesting fact that illustrates the greater difficulty of moving in water is that a racing pigeon weighing 1 pound can easily fly for hours at a speed of 50 mph, but a darting trout of the same weight can barely reach 5 mph for a short time.

2. Streamlined shapes are compact and have the minimum of projections or flapping parts. In fast-moving fish, the dorsal and anal fins, which are not useful for moving, fold flat against the body so that they are not in the way. In some species, there are even grooves into which these fins retract.

Many fish spread out their pectoral fins to use as brakes when they want to stop. Angel fish, which have vertical pectoral fins, brake more effectively than goldfish, whose fins are horizontal. Have students observe aquarium fish to notice how fins are used in changing speed. Ask them to describe in writing how the fish move.

3. There are some fish that do not have a streamlined shape. Although these fish cannot move through the water swiftly, such fish have other methods of catching prey or escaping predators. For example, the angler fish uses an appendage that acts like a rod, line, and bait to catch its prey. The globe fish is round, but it has spines to protect itself from predators.

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