Helicopter seeds and hypotheses... that's funny!

by Leslie Wampler and Christopher Dobson

The most exciting phrase to hear in science, the one that heralds new discoveries, is not "Eureka! I found it!" but rather, "Hmmm, that's funny!"

Isaac Asimov

Investigating maple samaras, or helicopters seeds, can give students a "that's funny" experience and catalyze the development of inquiry skills. In this article, we describe how to use maple helicopter seeds (samaras) to engage students in focused observation and hypothesis testing. This activity requires only basic classroom equipment and maple samaras, which can be found throughout most of the United States or purchased online.

Flying fruit

Science comes alive for students when it coincides with play. Many students have spent time playing with maple helicopter seeds, also known as whirlybirds. Capture your students' interest by holding up one of these familiar seeds and asking, "Where do these come from? What happens when they fall?" If students are unfamiliar with samaras, give small groups several to observe. Even those who have played with helicopter seeds may be unaware that they contain the seeds of maple trees and are also known as *samaras*. Most, however, will be able to predict that the seeds will twirl or spin as they fall to the ground. At this point, toss the seed into the air to let the class observe its behavior. Build student confidence by celebrating their accurate predictions.

Ask students why they think samaras spin. They may hypothesize that the spinning helps them fly or ride the wind. Have students brainstorm how this motion might benefit maple trees. They should recognize that the helicopter's structure allows for wind-powered seed dispersal. Remind students that plants, like animals, have structures with specialized functions. Fruits are structures that flowering plants produce to disperse their seeds. Some fruits are edible and dispersed by animals. Samaras are dry fruits, specialized for wind dispersal. Maple trees have double samaras (Figure 1), each containing one seed, that usually fall separately.

Now the stage is set for further exploration. Students have drawn on previous knowledge and probably think they know how the samara works. So let's dig deeper.

Does size really matter?

Maple samaras come in a variety of shapes and sizes (Figure 2). It takes more energy to make large samaras. Use guided discussion to encourage students to think about why a plant invests that extra energy and what advantage size gives to a seed. Remind students that seeds contain an embryo (or baby plant) and food source needed for germination. Large seeds can carry bigger embryos and more nutrients. But what about the wing? Why do maple trees allocate additional energy to the samara's wing? Student responses often relate to the length of time samaras can stay in the air, giving them more opportunity to be carried by the wind.

Does size affect the length of time a samara remains airborne? Let's find out. Hold a "reverse race" between two single samaras of different size. The one that stays aloft longer wins. Why would this be an advantage in nature? Hold up the two samara racers. "Ready… Set… Wait!" Before dropping the seeds, remind students that science requires focused observation, or thinking about what we see. In math, we ask students to estimate to

FIGURE 1 Maple trees produce double samaras

check their answers; in reading, we ask them to predict what will happen to build reading skills. In science, we ask students to observe carefully, to see with the brain engaged. How can we spot the unusual if we don't know what we expect to see? Scientists are good observers. Science also involves the formation of hypotheses, or possible explanations. Hypotheses are the basis for specific predictions, like whether the large or small samara will stay aloft longer when released simultaneously from the same height. The hypothesis supplies the rationale behind the prediction. Have students provide explanations (hypotheses) for their predictions (Figure 3). Most students predict that the small samara will stay aloft longer because it is lighter, or the big samara will stay in the air longer because of its larger wing. Make sure students understand that predictions allow us to test hypotheses. If the prediction is right, their hypothesis is supported; if not, their hypothesis is falsified.

Finally, we're ready to race. Hold each samara above your head at the same height, gripping the seed with the wing pointing down. Ask a few student volunteers to confirm simultaneous release (controlled variable). Release the seeds and watch as they twirl downward.

Testing hypotheses

As a class, discuss these questions: Does this outcome confirm our hypothesis? Are there other possible explanations for the result? Is one trial sufficient? Suggest that students investigate for themselves by conducting their own races. Give small groups several large and small samaras for their exploration. Encourage students whose previous predictions were incorrect to show that the result was a one-time fluke and that their hypothesis really is correct. Inform students that wise scientists design experiments with the potential to falsify their hypothesis. If they are unable to falsify it, they tentatively accept the hypothesis, very aware that they may have missed the one experiment that would not support it. This is the tentative nature of science—hypotheses can be strongly supported, but at what point have they been confirmed?

One experiment with the potential to falsify the mass-related hypothesis—small samaras will stay aloft longer because they are lighter—involves separating the seed from the wing in both the small and large samaras. Have students race the two seeds without the wings, sharing their predictions first, as they did with the samara race. If the heavier seed reaches the ground first, the hypothesis is supported. If not, it must be rejected. Use scissors to separate the samaras' wings and seeds. To help students remember which seed and wing came from the larger samara, mark both pieces with a colored dot. Mass the seeds using a balance that can display milligrams. With wings removed, gravity is the primary force influencing downward motion of the seeds. Because acceleration due to gravity is not dependent on mass, the seeds should reach the ground simultaneously if they are released at the same time. Therefore, the mass-related hypothesis is not supported.

If students seem unimpressed, or if some seem to be clinging to the hypothesis that heavier objects fall faster, hold up a sheet of notebook paper and a thick textbook. Ask students which will hit the ground first and why. Crinkle the paper into a ball and drop it at the same time as the book. They will hit the ground at the same time. Clearly, acceleration due to gravity is not dependent on mass.

Because dropping seeds gave a different result than dropping samaras, what would happen if two different-sized wings were raced? Students will find that the wing with the larger surface area stays aloft longer, even though it weighs more. Hmmm…that's funny! Now your students are ready to use the gray matter between their ears.

FIGURE 2 Samaras grow in a variety of shapes and sizes

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What now?

At this point, few students will have a hypothesis that fits what we've observed. What will your students suggest the class try next? Encourage questions and suggestions. New discoveries are often the result of curiosity. What else can your students discover about how the parts behave differently than the whole?

We found that small samaras usually stay aloft longer than large ones, although there can be variation in the out-

FIGURE 3 Testing your hypothesis

Question: Will a large or small samara stay aloft longer?
Prediction: ___________________________________

Hypothesis (possible explanation for prediction):
____
____

Another way to look at this is if your hypothesis is true, then your prediction will occur. Reminder: If your prediction does occur, your hypothesis may still be incorrect—you haven't necessarily proved it!

come, depending on release technique. The small samaras that we measured also happened to have lower wing loading (total weight/wing area), a characteristic that results in more lift in aircraft. In plants, rates of descent are correlated with the square root of wing loading for a variety of wind-dispersed species (Augspurger 1986). The upshot is that neither mass nor wing size alone account for the smaller samara's advantage in staying airborne.

Tell students that, when stumped, scientists often return to the observation phase. In other words, it's playtime again! Provide students with rulers and balances, and have them investigate the mass, surface area, and "flight patterns" of intact samaras, as well as their separated constituent parts (seeds and wings). As students apply their freshly honed powers of observation, they will find that samaras spin, wings float down, and seeds merely fall.

Compile class data on the board. Ask for interpretation of the data. Students will see that most of the intact samara's mass is in the seed, while the wing contributes the majority of surface area. The autorotation, or spinning, of the samara results from the combination of the wing's surface area and the off-center concentration of mass in the seed. When samaras fall from a low height without spinning, gravity is the primary force at work and they reach the ground at nearly the same time. See Walker (1981) for a thorough explanation of maple samara aerodynamics.

Ask students for examples of how flowering plants produce fruits to disperse their offspring (seeds) and how different types of fruits are specialized for different types of dispersal (animal, wind, water). In the case of the maple samara, the structure of the fruit (wing) is marvelously designed to accomplish its function of flight. The longer the samara can stay airborne, the greater chance it has of being dispersed from the parent tree by the wind. This is a wonderful example of structure fitting function, one that your students are not likely to forget any time soon!

Extensions

Have students manipulate helicopter mass and surface area by applying pieces of tape and clipping the wings, respectively, and then predict the impact on rates of descent (Thomson and Neal 1989). See what else is "Blowing in the Wind" (*http://waynesword.palomar.edu/plfeb99.htm*), or print out the poem poster on plant adaptations for flight produced by the Savannah River Ecology Laboratory at the University of Georgia (*www.uga.edu/srel/kidsdoscience/sci-method-copters/plant-seed-poster.pdf*).

Connect across the curriculum as highlighted in *Science Scope's* recent history-of-science issue (October 2007). Investigate lift and drag using the storyline approach of the Wright brothers and the history of flight (Isabelle 2007). Or, use a literature-circle approach, incorporating biographies of the Wright brothers and their invention of flight (Straits 2007).

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