THE AMAZING PAPER WHIRLIGIG

How can a simple paper whirligig be used to teach virtually every aspect of the experimental process?

It's easy! Just have students cut out and fold the whirligig and then design experiments with only 1 independent variable at a time being changed.

SAMPLE EXPERIMENTS:
1. How does the wing fold direction affect the spin direction (clockwise or counterclockwise) of the paper whirligig when dropped?

2. How does adding mass in the form of paperclips affect the fall time of the paper whirligig?

3. How does the length of the wings affect the fall time?
    - All 3 experiments have only 1 **independent** and 1 **dependent variable**.
    - All 3 experiments have a set of **constant**s which must stay the same for all trials.
    - Experiments 2 and 3 must have a **control helicopter** to which the independent variable does not apply.

Tips:
- For experiments 2 and 3, be sure to practice with 3 timekeepers to make sure the start and stop times are synchronized.

- Avoid dropping the whirligigs in a draft as from a fan or air conditioner.

- Do not allow students to stand on a chair. The teacher should be the one dropping the whirligig and all students collecting data in tables, which have been made before the experimental trials are begun.

- Do at least 3 trials for each change in the independent variable in *any* experiment you do.

The Secret of the RAP!

IN THE VERSES OF AGNES PFLUMM'S SCIENCE RAP LIE THE SECRETS OF A NO-FEAR SCIENCE FAIR PROJECT. LET'S TRY IT WITH EXPERIMENT # 2 ABOVE!

I.   **ASK A QUESTION: WHAT IS THE EFFECT OF <u>the number of paperclips</u> ON <u>the fall time of the paper whirligig?</u> (**Notice that in questions written in "WHAT IS THE EFFECT OF" manner, what follows the word "OF" is always the INDEPENDENT VARIABLE and that what follows the word "ON" is always the DEPENDENT VARIABLE.)

A. INDEPENDENT VARIABLE: THE NUMBER OF PAPERCLIPS

B. DEPENDENT VARIABLE: FALL TIME (SECS)

C. EXPERIMENTAL CONSTANTS:
   1. Same whirligig
   2. Same method of dropping, etc
   3. You list some more constants for 3-5.
   4.
   5.

D. CONTROL – those trials in which the whirligig is dropped with NO paperclips (Notice that in the CONTROL trials, the INDEPENDENT VARIABLE is taken OUT of the experiment. Having CONTROL trials is the ONLY way to determine if your independent variable is really having an EFFECT on your dependent variable -the results). This is one of the most important concepts you'll need to learn about doing a CONTROLLED EXPERIMENT like this one.

II. FIND OUT MORE (BACKGROUND INFORMATION)

NOTE: In your background information, you must be sure to read up on gravity and falling bodies, the effects of air resistance on a falling body, Galileo's demonstration from the Leaning Tower of Pisa, and the concept of terminal velocity. Only then will you truly grasp the kind of data you will get from doing this experiment.

III. MAKE A GUESS ABOUT WHAT'S IN STORE (HYPOTHESIS)
   Ex. I believe that adding paper clips will (You fill what you think will happen) the fall time of the whirligig. (Hint: Do you think it will INCREASE, DECREASE, or HAVE NO EFFECT on the fall time?)

IV. GATHER YOUR STUFF (This is your MATERIALS LIST)

1. 1 paper whirligig (see template below)
2. 3 students who have practiced so that they can synchronize their start and stop times with stopwatches.
3. 1 teacher to stand on a stool and drop the paper whirligig for all trials.

V. GET ORGANIZED (PROCEDURE STEPS)

1. All students need to set up and draw data tables like that below. Copy a table on the board as well (or on an overhead transparency). Students should have calculators ready to compute averages.

2. Bring students timers up to the front of the classroom so they can clearly hear and see when the whirligig is dropped and when it hits the ground. Practice dropping the whirligig several times with the cues "DROP!" to begin timing and "STOP!" to end timing the instant the whirligig hits the ground. Appoint a student helper to pick up the whirligig so the teacher doesn't have to get up and down off the stool.

3. Bring another student helper up to the board or overhead projector to enter data. There will be three times given for each drop. Have the data writer at the board write all three times down (to nearest 1/100th) of a second, and then require students to calculate the average time for each trial. This number will be entered as the time for Trial 1 for each change in the number of paperclips. [Note, in the case of one student missing the start or stop, just go with two times to average for a trial]. Repeat procedure for trials 2-3. Ask students to calculate the average fall time to the nearest 1/10th of a second for each change in the independent variable.

VI. SOLID DATA WILL BE YOUR PRIZE!

A. YOU MUST DO REPEATED TRIALS (at least 3)

B. Record your results in a DATA TABLE

Example

Effect of Adding Paperclips on Whirligig Fall Time

Fall Time (seconds)

Number of paperclips	Trial 1	Trial 2	Trial 3	Average
0				
2				
4				
6				
8				

C. GRAPH your data and look for relationships between the variables. Be sure to always put the independent variable on the X axis. NOTE: In general, only the AVERAGE results are shown on your final graph.

NOTE: SOMETIMES YOU WON'T SEE ANY RELATIONSHIP BETWEEN YOUR VARIABLES AT ALL. DOES THAT MEAN YOUR PROJECT'S A FLOP?

2. UNEXPECTED THINGS HAPPEN ALL THE TIME IN SCIENCE, THAT'S WHAT MAKES IT SO COOL! The following were all discovered by accident: penicillin, Post-it notes, soda water, Velcro, and silly putty.

**VII. CONCLUSIONS** (the following 5 questions must be addressed in this section):

A. Was my hypothesis confirmed?

B. What DID happen? (Here cite your exact data, noting the changes in the dependent variable with each change of the independent variable.)

C. What were some possible sources of error?

D. What would you do differently if you were to do this experiment again?

E. What other questions related to this project did you think of that might make good experiment?

For example, in our whirligig experiment, you might want to investigate how the length of the wings affects the fall time. REMEMBER, YOU CAN ONLY CHANGE ONE VARIABLE AT A TIME FOR A GIVEN EXPERIMENT. OTHERWISE YOU WON'T KNOW WHAT CAUSED THE RESULTS YOU OBSERVED.

NOW GO BACK TO THE RAP AND SEE HOW VERSES 4-11 MATCH UP TO THE STEPS YOU MUST TAKE WHILE GATHERING AND ANALYZING YOUR DATA. LEARN THE RAP. YOU'LL NEVER BE AFRAID OF DOING SCIENCE AGAIN! NOW THAT'S A SECRET WORTH SHARING!
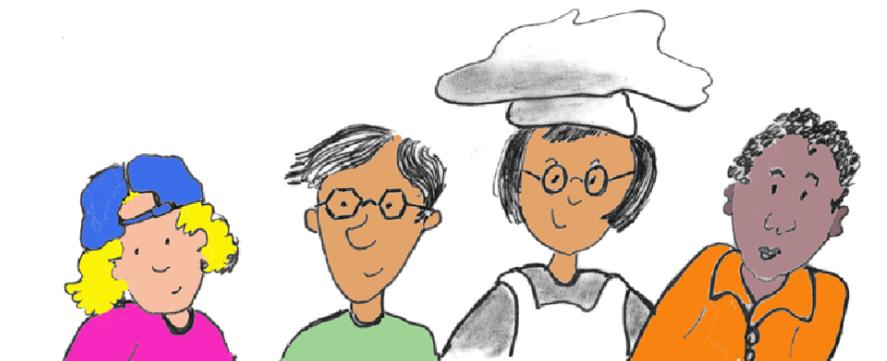
TEMPLATE AND INSTRUCTIONS FOR MAKING THE PAPER WHIRLIGIG
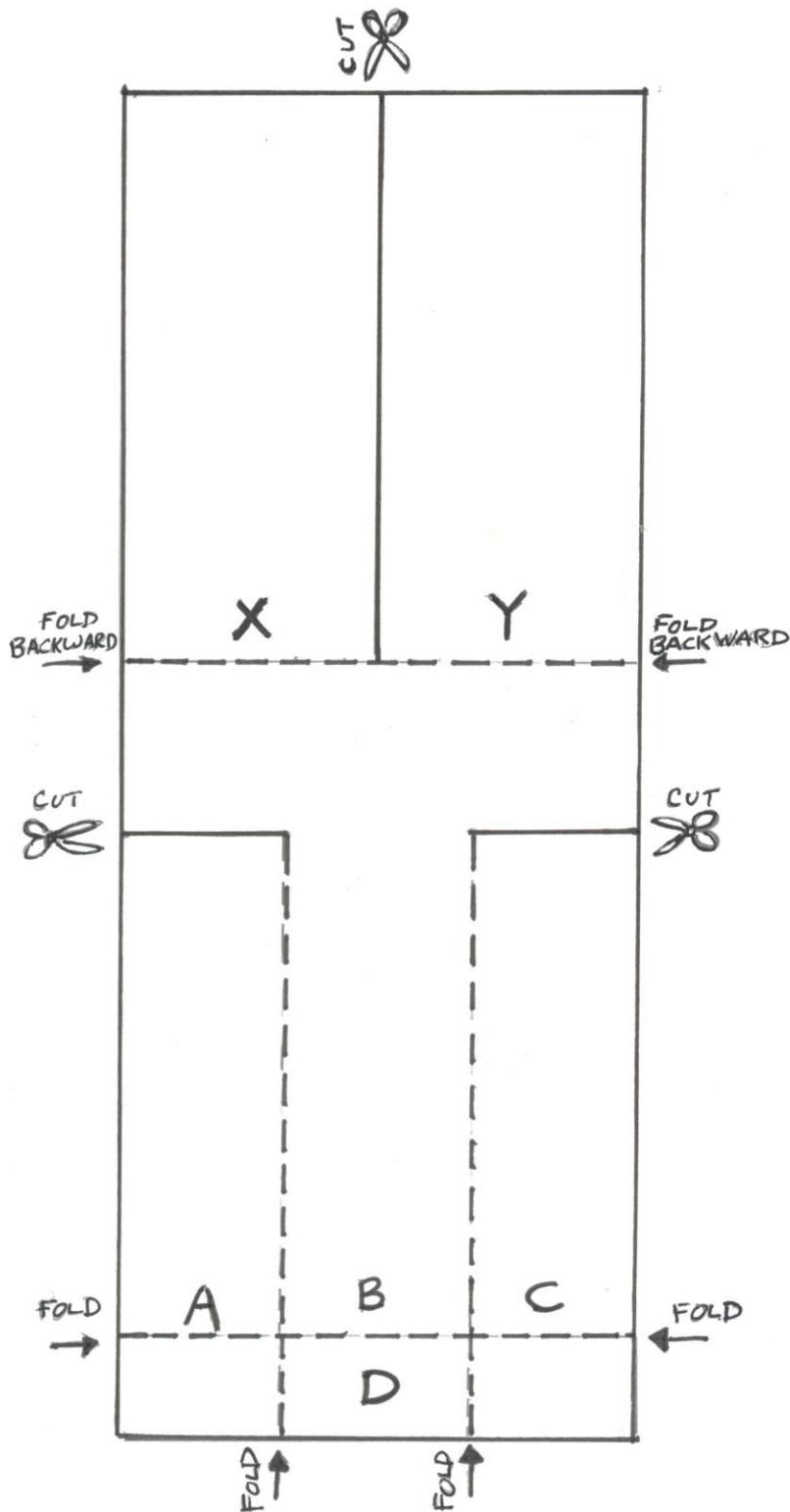
1. CUT out around the PERIMETER of the whirligig template, along the SOLID outside lines.
2. Now, CUT along the 3 SOLID INTERIOR lines, being CAREFUL to STOP when you reach a broken line.
3. FOLD along the broken lines: section C BEHIND section B, section A BEHIND section B, and section C BEHIND section B.
4. Complete the whirligig by FOLDING blade X in one direction along the BROKEN LINE, and blade Y in the OPPOSITE direction.