Interdisciplinary Approach to Investigating Popcorn

Developers:

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Grade Level:

Middle School (5–8)

Disciplines:

General Science (Life Science and/or Physical Science), Language Arts, Math, Reading, Social Studies (These activities may also be used in self-contained Special Education Classes.)

Goals:

To use a model investigation to introduce and integrate the teaching of the scientific method into the math, reading, social studies, and language arts programs.

1. Students will learn and demonstrate the process of the scientific method of investigation.
2. Students will use this knowledge in designing an experiment.
3. Students will use skills in math, language arts, and reading to design and explain the experiment.
4. Students may use the format presented to design experiments to test common household products.

If you are unable to use the following investigations in a multidisciplinary setting, they can be easily adapted for regular classroom instruction.

Specific Objectives:

- Students will learn proper testing procedures.
- Students will research the topic of "Popcorn" in reading class.
- Students will formulate a hypothesis and test it.
- Students will collect data and record information in charts and graphs in math class.
- Students will evaluate the validity of the results.
- Students will draw a conclusion based on the results and write it in a coherent fashion in language arts class.

Background:

Why Popcorn Pops

Not only is it the steam trying to escape that makes popcorn pop, but it is also the special construction of the pericarp or hull (outer covering), the amount of moisture in the kernel, and the microscopic structure of the endosperm (the starch granules which expand) that are key to its popping ability. The extra strong pericarp must be tough enough to seal in the steam until the pressure is great enough for the kernel to explode.

Materials:

Popcorn Experiment

White Popcorn
Yellow Popcorn
Hot Air Poppers
Paper bags for collecting the popped popcorn

Curriculum Activities:

The following sequence of activities is designed to enhance the understanding of major scientific testing concepts. For most effective learning, the activities should be performed in the sequence presented below.

1. **Math Class**
   This activity demonstrates the idea that more trials lead to more accurate or valid results.

   Penny Flip
   Introduce the idea of making predictions, determining sample size, and variations within one set of trials.
   Discuss the importance of controlling as many factors as possible (i.e., the way the penny is flipped, height, when caught, left to drop, etc.).
   Method: After giving students one penny each, have them flip them once. For each trial record the results of how many heads and tails there were. After about the second or third trial, note the results. Emphasize what begins to happen as you accumulate more results. What happens to the **reliability** of these results?

2. **Science Class**
   Introduce the students to the idea that they will test a product. To do this, they will need to know **proper testing procedures**. The General Experiment Outline Guide (following) should be handed out and the concepts, vocabulary, and ideas carefully explained. This is in preparation for the popcorn experiment.

   Experiment Outline "Fish" Game
   You may find it helpful to make up decks of cards which have the headings and the explanations of the sections of the outline on them to be used in a game of fish — optimally played with two students. Pupils must ask for the "match" of their cards. For example, one card "Materials" matches with "the equipment needed to do the experiment" card. (The outline can be reproduced on oak tag or any durable paper and cut apart to make the individual cards. A class set of 15 decks – for 30 students is recommended.)

   When introducing the vocabulary of the experimental outline, be sure to emphasize the difference between the *experimental* and *controlled variables.*

3. **Math Class**
   Brainstorm
   Introduce the challenge of testing popcorn. Brainstorm with the class all of the possible **variables** that can be investigated. Select the factor of "kernel color" as the one the class will test. They may wish to test other variables on their own or for a science fair project when they complete the "model" experiment. With the class, decide on the **purpose** or **problem** and discuss possible **hypotheses** or **predictions**.

4. **Reading Class**
   Research
   Discuss what the students **already know** and have **observed** about popcorn. Teach students the necessary research skills not only to find out how popcorn pops but also to learn about the popping properties of the various popcorn varieties.

5. **Social Studies**
   Research
   Students learn about the history of corn, how it is grown, processed, used, etc. In the library, students should gather and record this information and include a bibliography. Students should then use this information to help form the **hypothesis** or **prediction**.

6. **Language Arts Class**
   Write
   With the notes that were gathered in the library during reading and social studies classes, students should complete a grammatically correct paragraph explaining how popcorn pops. They then should use this information to write the hypothesis for the experiment. Before doing the experiment in math class, teach proper outlining procedures (as shown on the General Experiment Outline Guide) with appropriate margins maintained, so that they may use this technique in their experiment write-ups.

7. **Math Class**
   Test
   Guide the students in setting up the investigation outline in their notebooks from the **I. Purpose** to the **VII. Materials** section of the outline. Refer to the **Popcorn Experiment Sample**. Next, design a chart for the experiment (you may wish to use the blank sample chart). Before the students pop the corn, teach them how to use the graduated cylinder and beaker.

   After popping the corn, be sure to **review the results** and **discuss what they mean**.

8. **Language Arts Class**
   Syntheses
   Once data have been collected and recorded in math class, the language arts teacher can guide the students in the writing of their individual conclusions. Questions posed in the Conclusion section of the General Experiment Outline Guide should be answered and based directly on both their collected data as well as their anectedotal records.

   * The following pages include a sample chart and an outline which may be copied and used as student guides.

General Experiment Outline Guide

I. Title

This should tell what the experiment is investigating. It is the name of the experiment and may be in the form of a question. Be specific.

II. Purpose

Identify the problem and state it carefully. Why are you doing the experiment? "To see if...."

III. Hypothesis

Before you do the experiment, what do you predict will happen? This should be based on **Observations and Preliminary Research**."If..., then..., because..."

IV. Experimental Variable

What is the one condition that you changed? What are you comparing or testing? You may want to include a test where you do nothing to your sample to see what would happen if it were "left alone." This is called the **"Control."**

V. Controlled Variables

List the things that you plan to keep the **same** during your experiment, so that they will not affect your results. These are the conditions that you do **not** want to test at this time to make your testing **fair**. (List at least 6.)

VI. Procedure

List in a **step by step** way how to do the experiment. If you do a good job, someone reading your procedure will be able to repeat it accurately. You should include at least **TEN** trials or samples. Try to do your tests in a random (changing) order. Analyze results and discard any that show a major error.

VII. Materials

List the equipment you need to do the experiment. Be specific; list the kinds and amounts.

VIII. Results (Observations)

Use charts and graphs to record your data. All calculations should be clearly labeled. Be sure to keep a journal of all information gathered while doing your investigation.

IX. Conclusion

A. What was proved? Analyze what your results meant. What were the differences between the factors or products you tested? Check the ingredients or makeup of your variable. (Be careful not to confuse close results with a major difference. Is it close enough to be considered of "no significant difference" due to possible experimental error?

B. What conditions may have affected your results causing an experimental error?

C. How would you change the design of the experiment to eliminate the problems and make it a better test?

D. What were some of the conditions that were impossible to control?

E. What did you learn from your experiment that you did not expect?

F. If your results are accurate, what recommendations would you make as a result of your experiment?

The following explanation can be used for teaching the concept of "controls" from the Experiment Guide. If you were testing to find out which fertilizer makes petunia plants grow taller, it would be important to know what would happen if one of your plant sets has ***no*** *fertilizer added. Then you could compare the results to those of the fertilized plants. The set with plain water and no fertilizer would be considered your control set.*

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Popcorn Experiment Sample:

For this classroom experiment, each group of students should pop a portion of the 10 trials, testing at least one sample of yellow and white corn and placing its data on the class chart.

I. Title:
Will yellow corn kernels pop more than white?

II. Purpose:
To see if the color of the corn kernel (white or yellow) affects the amount of popped popcorn kernels.
Before formulating the hypothesis, students should record their observations of each sample of 100 unpopped kernels; note weight (mass), size and shape variations, etc. to help make the hypothesis.

III. Hypothesis:
If both yellow and white varieties of corn are popped, then I predict that a higher percentage of white will pop than yellow, because the white ones are larger on average than the yellow ones.

IV. Experimental Variable:
The color of the corn (white and yellow)

V. Controlled Variables:
A. Same number of kernels tested for each trial
B. Same popping procedure
C. Same brand of popcorn
D. Both sets of colored kernels are without salt or butter
E. Kernels are kept at the same temperature and humidity
F. Same time popcorn popped
G. Same temperature at which popcorn is popped

VI. Procedure:
A. Prepare the two samples of kernels by counting out 100 of each type of popcorn and recording the approximate volume of each in a graduated cylinder.

B. Pop the first sample using a hot-air popper for 2 minutes.

C. Collect all of the popcorn flakes and unpopped kernels. (You may need to turn the popper upside down to get them all out.)

D. Record the volume of the flakes in a graduated cylinder or beaker.

E. Repeat for a total of 10 trials.

Since this will be done in the classroom (electric outlets are necessary), you can have as many groups testing as you wish, depending on the amount of available time and hot air poppers (preferably 4 or more for a class of 28). ***Caution: Be careful not to overload outlets. Know where the circuit breakers are before you begin.***

VII. Materials:

A. Yellow and white popcorn kernels
B. Hot air poppers
C. Paper bags for collecting the flakes and unpopped kernels
D. Metric ruler
E. Graduated cylinder (for finding the volume of the kernels)
F. 600-mL beaker (for finding the volume of the flakes)
G. Triple beam balance

VIII. Results (Observations):

Here students develop a chart for recording the collected data. A large class chart should be made to reflect at least 10 trials so that an average may be taken. They should also keep a record of everything observed as anecdotal information to help in reaching their conclusions.

Comparing the Volume of White and Yellow Popcorn

	White Corn		Yellow Corn	
Trials	# Popped Flakes	Volume of Flakes	# Popped Flakes	Volume of Flakes
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
Total				
Average				

Journal:

Sample Results:

Yellow Corn

Trials	Mass in grams	Size range (in cm)	Volume (in grad. cyl.)	# Unpopped Kernels	# Popped Flakes	Volume of Popped Flakes
1	11.45	.6 – 1.0	14cc	12 (1.12g)	88 (9.13g)	375cc
2	11.78	.7 – .8	14cc	19 (1.85g)	81 (8.60g)	310cc
3	11.48	.6 – .8	14cc	16 (1.57g)	84 (8.70g)	310cc

White Corn

Trials	Mass in grams	Size range (in cm)	Volume (in grad. cyl.)	# Unpopped Kernels	# Popped Flakes	Volume of Popped Flakes
1	11.57	.6 – .9	14cc	23 (2.38g)	77 (8.01g)	350cc
2	11.86	.4 – 1.1	15cc	20 (2.01g)	80 (8.58g)	400cc
3	12.00	.6 – .9	15cc	23 (2.36g)	76 (8.50g)	350cc

Additional questions for consideration:

1. If there is a difference between the initial mass of the corn and the popped corn, what happened to account for this change?
2. How much variability is there in the samples of each kind of corn? Why do you think this is true?
3. What happens to the reliability of the results as the sample size is increased?
4. What practical problems are there in the unpopped kernels and the popped corn? How can you limit these?

Special Note:

Although comparing results in microwave ovens to those in hot air poppers may sound like a good idea, there are a lot of practical considerations that may make it prohibitive. The factors of "time" and "temperature" are difficult to control for the small sample size of 100 kernels. Since a microwave may be used to make popcorn, it is suggested that prior to the students' investigation, the teacher should determine the correct power level and time needed.

Suggested Extensions:

Other variables can be tested, such as kernel size, flake size, volume, profitability (comparing the ratio of the volume of flakes to the weight of the kernels), using the same outline form. Since the main purpose of these activities is to provide students with a model for controlled scientific investigation, students should be encouraged to test many of the household products they use.

References:

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Sibley, Lynn K., "Popcorn", *Chem Matters*, American Chemical Society, Washington, D.C., October 1984.