HYPOTHESIS AND EXPERIMENT

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INTRODUCTION:

Most every introductory textbook starts out with a discussion of the scientific method which is an approximation of how science works. According to the classic description, there is an observation of some material, event, or phenomenon which leads to a hypothesis, or educated guess, to explain the observation(s). The hypothesis is the guide for further investigation of the observation. The investigation is the experiments which one must devise. If the experiments support the hypothesis, or modified hypothesis, along with additional support from independent investigators, then the hypothesis may be accepted as a theory. The theory is subjected to additional experiments for further verification and/or modifications, but it remains a theory. Theories do not become laws, but, occasionally, scientists may observe that a theory is always correct under all situations, and will realize that they had verified a law of nature, or, simply a law.

How does the scientific method work today? It does start out with an observation, the formation of a hypothesis and some experiments to verify the initial observation and the hypothesis. At this point, the scientist may send a correspondence to a journal to state the initial findings. This communication, in effect, is a way of telling others what that person is investigating. (Think of it as "staking out" your turf.) Now, with a publication, the researcher writes a grant proposal to a funding agency to get some funding. The grant money pays for overhead (up to 50% of the money can go to the university or company to cover the cost of the laboratory, utilities, building maintenance, university operating costs, etc.), lab technicians or graduate students, instrumentation, laboratory supplies, salaries (in the case of a university, the researcher may buy teaching time to reduce his/her load leaving more time for research), travel to conferences, and whatever else can be justified under the grant. Depending on the strength of the grant proposal, and available funds, the researcher may get some fraction or all of the money. Now, the actual experiments must be planned within the financial constraints of the available funds. The project, successful or not, must be followed up with a report to the funding agency and further publications. Successful research can yield a new or revised theory.

This activity is designed to help students visualize how experiments are devised to test a hypothesis.

MATERIALS NEEDED:

4 cards 3 in by 5 inch or larger, white or colored paper.
marker (black or other dark color)
tape, velcro, or magnetic tape to fasten cards to chalk board or wall.

SAFETY PRECAUTIONS:

There are no hazards associated with materials in this experiment.

DISPOSAL:

There is no disposal problems in this experiment.

EXPERIMENTAL PROCEDURE:

Label the cards on both sides as follows:

card 1: Vowel on one side and even number on the other side. (example: E and 8)
card 2: Vowel on one side and odd number on the other side. (example: A and 5)
card 3: Consonant on one side and even number on the other side. (example: H and 4)
card 4: Consonant on one side and odd number on the other side. (example: N and 7)

Hang cards on a vertical surface, in any order, as follows:

card 1: Vowel is visible
card 2: Odd number is visible
card 3: Even number is visible
card 4: Consonant is visible

Inform the class:

Each card contains a letter on one side and a number on the other side.

Write on chalk board (or use an overhead transparency or sign):

Hypothesis: Any card with a vowel on one side has an even number on the other side.

Pose the question to the class:

How many experiments must be carried out (i.e., cards must be turned over) in order to prove or disprove this hypothesis?

Proceed to gather information from the class, by discussion, as to how many cards must be turned over, which ones, and why? NOTE: Do not supply any information, just record the responses from the class.

At the conclusion of the discussion, turn over the cards one at a time. Explaining why the card turned over is important or not important to the hypothesis. Turn the cards over in the order of:

1. Card 4
2. Card 3
3. Card 1
4. Card 2

EXPLANATION:

This activity demonstrates how science works. We formulate a hypothesis, plan our investigation, and conduct experiments to test that hypothesis. In testing a hypothesis, we cannot do all possible experiments, so we must plan our investigation carefully - this is the class discussion.

Some students will insist that all four cards must be turned over. You might want to tell the class that you have a research grant of $4,000.00 or $5,000.00 and that it must pay for all the work done along with the laboratory costs and the salaries and benefits for all the investigators. Also, the cost of an experiment (*i.e.*, turning over a card) is $1,000.

Of the possible experiments, turning over one card may prove or disprove the hypothesis or may be irrelevant to the problem. One experiment will be too few for a thorough investigation. However, if the one experiment chosen disproves the hypothesis, no further experiments are necessary. The hypothesis is either modified or discarded.

Two experiments will probably be the best choice if carefully thought out.

Three experiments should cover the best choices with a third less important experiment.

Four experiments will be too many.

The importance of the cards are:

Card 1: A necessary experiment - it supports the hypothesis.
Card 2: A necessary experiment - it disproves the hypothesis.
Card 3: Not important. Since the even number is visible in the original set-up, it is not necessary to do this experiment. If there is a vowel on the other side, it supports the hypothesis, if it is a consonant, it is not addressed by the hypothesis. Thus, it would either support the hypothesis or be irrelevant.
Card 4: This card is irrelevant to the hypothesis since consonants are not addressed in the hypothesis.

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