The Levels of Inquiry

In *National Science Education Standards*, The National Committee on Science Education Standards and Assessment and the National Research Council defined inquiry as the following:

Inquiry is a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze and interpret data; proposing answers, explanations and predictions; and communicating the results. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations (page 23).

Models of Inquiry

Joseph J. Schwab

Schwab (1962) outlined three levels of inquiry:

1. Students use classroom materials, such as textbooks or lab manuals, to pose questions and describe investigation methods.
2. Classroom materials are used to pose questions, but the methods and answers are developed by the students.
3. Students investigate scientific phenomena without the guidance of classroom materials.

Marshall D. Herron

Marshall Herron (1971) suggested an inquiry model that outlined four separate levels of inquiry:

**Confirmation** — students confirm a principle through an activity in which the results are known in advance.

**Structured** — students investigate a teacher-presented question through a prescribed procedure.

**Guided** — students investigate a teacher-presented question using student-designed/selected procedures.

**Open** — students investigate topic-related questions that are student formulated through student-designed/selected procedures.

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**Directions:**

Use Herron’s inquiry model to examine the following labs. Label each one as confirmation, structured, guided, or open inquiry.

**Lab 1: Water Transport in Plants***

**Purpose:** Students will use young bean plants to discover the forces involved in water transport in plants.

The teacher introduces the lab investigation by reviewing the structure and function of roots, stems, and leaves in plants. Students will conduct a prelab experiment by pouring equal amounts of tap water into two test tubes and placing a bare-root bean plant into one of the test tubes and pushing it to the bottom of the tube. Then, they will put both test tubes in a test tube rack and leave the rack in a warm, lighted place in the classroom until the next day. They must predict what will happen to the water level in each tube and create a data table to record the millimeters of water in each tube.

On the second day, the students will measure the amount of water left in each test tube, record the number of milliliters in each tube and calculate the difference. They must explain what accounts for the loss of water in each tube and determine how much water was actually taken up by the bean plant.

The teacher gives students instructions to create two hypotheses and design experiments to answer the following questions:

- What role does the number or size of the leaves (leaf surface area) play in the movement of water through a plant?
- What force — the absorption of water by the roots or the evaporation of water from the leaves — plays the most important role in the movement of water through a plant?

Students work with their group to design experiments for both questions. They must include diagrams that illustrate how they would set up experiments to test each hypothesis and explain the details of the entire experiment for each question. The teacher must approve the experimental design for each student.

On the final day of the lab activity, students will gather and record data as described in their experimental design and determine if their hypotheses were supported or contradicted. Their findings are presented in a formal lab report that includes stating the problems, the hypotheses, experimental designs, data, interpretations of the data obtained for both experiments, and conclusions regarding each of the hypotheses.


**Level of inquiry: ________________________________**
Lab 2: French Fries and Dialysis Tubing*

The teacher shares the result of an Internet search for French fries recipes (most of which suggest salting the fries after cooking) and poses the following questions.

- What happens to raw French fries when soaked in water?
- Would it be possible to combine the two steps by adding salt to the water and save time?
- Do you think the amount of salt will make a difference in the crispiness of the French fries?

A teacher-created demonstration occurs next, using three 500-ml beakers and raw potatoes. Beaker A contains distilled water, beaker B contains a 1 percent NaCl solution and beaker C contains a 10 percent NaCl solution. The teacher uses a French fry slicer, a knife, or a cork borer to cut the potatoes into French fry-size pieces and then records the initial mass of each French fry (or group of French fries). Students predict the results and make drawings to explain their predictions. The beakers sit overnight.

The next day the students record the mass and turgidity of the French fries in each beaker. The teacher explains that scientists often use models to help them understand processes and introduces the students to dialysis tubing as a model for a semipermeable membrane, much like the cell membrane. Students are asked to investigate if dialysis tubing is permeable to glucose, starch, or water. The teacher provides students with the materials and the procedure that they will need to perform this investigation. Students work in groups of three or four to carry out their experiments. Each group is asked to make a list of claims about the permeability of dialysis tubing and support their claims with evidence via their data table. Each group will share their claims and evidence to the rest of the class.


Level of inquiry: 

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Lab 3: What Causes Variations in Organisms?

The teacher brings in multiple samples of Petunias, which should vary by size, height, color, and number of flowers. She tells the class that they will observe multiple samples of the same plant. They should write down any observations that they make, along with any questions that they have about the plants. Students spend 10 minutes examining the plants and taking notes in their lab notebooks.

The students get together with their lab groups and talk about their observations and questions. When the teacher reassembles the class, the students talk about the questions that they came up with during their observation. One group wonders why the flowers are different colors. Another is curious if the type of soil that the plants are in would have any effect on their size.

Each lab group picks a question that they want to investigate and designs an experiment to test their hypothesis. Each group must choose a hypothesis, independent variable, dependent variable, materials, procedure, and data collection methods. The teacher must approve the experimental designs of the groups before they get started.

Once all groups have completed their experiments, they design a poster that outlines their question, hypothesis, procedure, and results. The final grade is based on the poster and an oral presentation that they give to the class.

Level of inquiry: _____________________________