Teaching science with an inquiry-based approach can seem like an impossible challenge. However, it is achievable. One way to begin is by converting a cookbook-style lab (from the internet or a textbook) into an inquiry-based science experience (Figure 1). To convert a cookbook lab into an inquiry-based science experience, we propose the following prescriptive, step-by-step method.

**Step 1: Replace**

Begin by creating an inquiry lab sheet. Replace any introductory description and vocabulary from the cookbook lab with one to three investigative questions at the top of the page. For example, the conductor/insulator investigation shown in Figures 2 (p. 62) and 3 (p. 63) replaces the introduction statement with the investigative questions, “What materials/objects allow electricity to pass? How are these materials/objects different from others?”

Because this step involves developing questions or drawing them out of an existing cookbook lab, strong question development skills are important. Park Rogers and Abell (2008) identified several researchers who addressed asking questions in science. Gallas (1995) found that using open-ended questions produced better discussion and follow-up question development by students. Newton (2002) found improvement in scientific understanding when using questions that required learners “to reason about variables, see cause–effect relationships, and apply their understanding” (Park Rogers and Abell 2008, p. 54). Elstgeest (2001) recommended asking students productive questions. The productive questions Elstgeest suggested take the form of attention-focusing, measuring and counting, comparison, prediction, or problem-posing.

As you make replacements during this step, do not include new vocabulary with the questions. New vocabulary will be addressed in follow-up discussions with small groups or the whole class. In other words, instead of preteaching vocabulary, postteach it based on students’ tangible and shared experiences gleaned from the inquiry lab experience. As a result, new vocabulary becomes more comprehensible and memorable.
Volkmann and Abell (2003) have directed teachers to include students in the development of investigative questions when converting a cookbook lab into an inquiry lab. However, their article was directed at adolescent learners. We suggest considering characteristics such as students’ age, ability, interest, and prior knowledge. An initial immersion experience, as suggested by Etheredge and Rudnitsky (2002), may serve children better. You might leave space on the inquiry lab sheet for students to create their own questions at this point.

### Step 2: Retain and Modify

The materials and direction sections of a cookbook lab limit students’ creativity and freedom. They require modification to give students more flexibility. First, simplify the materials list and add a phrase such as, “any other reasonable requests.” Include materials that students should need along with materials that they may not need. Not only does this promote decision-making and conversation within lab groups, but the students may recognize possibilities that you had not anticipated. An initial immersion experience, as suggested by Etheredge and Rudnitsky (2002), may serve children better. You might leave space on the inquiry lab sheet for students to create their own questions at this point.

Second, simplify any detailed directions and make them less directive. This allows students to have a more active role in planning the details of their investigations. For example, general phrases such as “plan and conduct an experiment,” “record and organize your data,” and “be prepared to share your data/results” are helpful.

As you introduce any lab, it is essential that you address specific safety issues. For example, the sample labs shown in Figures 2 and 3 involve the use of electricity. Although low voltage of typical batteries such as AA or D cells produce direct current and hold no real shock hazard, the alternating current that household electrical sockets provide have enough current to cause serious injury or even death. Students should be prohibited from experimenting with alternating current in school or at home. Last, ensure that students understand any safety concerns and offer opportunities for students to ask questions about safety.

### Step 3: Remove

Students need an opportunity to grapple with data and create their own method for organizing and displaying it. Therefore, remove any existing charts or tables from the cookbook lab’s worksheet on which students will record their data. Actively encourage students to develop their own skills. As the school year proceeds, you could plan for inquiry that is more directed at the beginning and less directed at the end. This would offer students more control over their own learning. In addition, if you are a novice at using inquiry-based instruction, it allows you to develop your own skills.
Sample cookbook lab involving conductors and insulators.

**Light On or Light Off?**

**Introduction:**
Electrical circuits work when there is a complete path from the source of power (the electric cell) to the energy receiver (the light bulb) and back to the source. When the bulb won’t light up, the circuit is open, or has a gap. What if we placed certain items that carry electricity, called **conductors**, into that gap? Would the bulb light up? What if we placed items that do not easily allow electricity to flow through them, called **insulators**, into the gap? Now what would happen?

**Objectives:**
- Define **conductors** and **insulators**.
- Determine the differences between materials that are conductors and insulators.

**Materials:**
- Wire
- Electric cell (battery)
- Flashlight bulb
- Tape
- Package of materials to test: pennies, erasers, pencils, rulers, scissors, plastic comb, soda can, milk carton

**Pre-Lab Questions:**
- What materials are conductors and how are they alike?
- What materials from your test group do you predict may be conductors and why?
- What materials are insulators?
- What materials from your test group do you predict may be insulators and why?

**Procedure:**
1. Using your wire, electric cell, and flashlight bulb, construct a circuit. To do this, place one end of the wire on the negative (flat) side of the electric cell (you can tape it in place) and place the flashlight bulb on the other notched or positive end of the electric cell. Touch the free end of the wire to the metal part of the flashlight bulb.
2. Take one item from the test package by placing it in the path between the electric cell (on the positive end of the electric cell) and the flashlight bulb.
3. Again, touch the ends of the wire to the negative end of the electric cell and the metal part of the flashlight bulb, creating a complete circuit.
4. Watch to see whether the flashlight bulb lights up with the item in the path between the electric cell and the bulb.
5. Place data in the table below by writing the name of the item and placing a check mark under the correct heading of “lit the bulb” or “did not light the bulb.”
6. Test the rest of the items from the test package in the same manner and record all data in a table.

**Analysis/Results:**
Describe your findings from your data table.

How could you explain which materials are conductors or insulators?

**Conclusion:**
In 2–3 sentences, explain what you learned in the lab.
Implementing the Converted Lab

Transforming the cookbook lab student sheet into an inquiry lab sheet is only the beginning stage. Classroom implementation is the true key to successful inquiry with young learners. Generally, the behaviors that students use mirror the quality of the inquiry. Students should be engaged in using scientific process skills. Bell (2008) has identified such skills as observe, measure, infer, classify, predict, experiment, and hypothesize. As students work, observe their use of process skills and then use that formative measure to inform instruction in later investigations.

The behaviors of the teacher play a major role in students’ ability to perform inquiry. Drawing from Volkmann and Abell’s (2003) inquiry analysis tool, we offer several teacher behaviors as students follow the converted lab.

- Present opportunities for students to ask and refine their own questions.
- Remind them to base explanations on evidence and ask them to explain their reasoning.
- Direct students to consider alternative explanations.
- As students struggle, fight the urge to directly answer their questions, tell them how to test their ideas, or make suggestions for organizing data.

Ensure that students have opportunities to communicate and justify their findings. As students gain experience, they will not need any kind of teacher-created lab sheet, instead creating their own documentation.

Converting a cookbook lab into an inquiry lab need not be an intimidating, arduous, or complicated experience. Even if you are completely new to inquiry-based instruction, start small and experiment with the process yourself. Do not be discouraged if your first attempt is not as successful as you would like. As you persevere, we feel confident that your students will experience deeper, richer learning.

Teaching inquiry will make science more enjoyable for both you and your students.

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**References**


**Connecting to the Standards**

This article relates to the following *National Science Education Standards* (NRC 1996):

**Content Standards**

**Grades K–8**

**Standard A: Science as Inquiry**

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry