How to Make Lab Activities More Open Ended

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When your students do laboratory activities, are they simply following directions, asking whether they are getting the "right answers," and not really learning much from the experience? Are you bored reading a hundred identical lab reports?

You probably agree with the tenets of inquiry-based instruction --- students asking and answering questions. Still, you're more comfortable and successful with the cookbook activities you've done before. You have the materials on hand. Having done the activities before, you know how long they'll take and typical difficulties students will have. To begin anew, finding different activities, and learning a new teaching style requires more time than you have --- teachers have many extra demands placed upon them.

The situation is far from ideal. But what can we do? Perhaps the school gave us a lab manual, or we feel we must cover a particular curriculum. Besides, open ended activities sound good in theory, but have you ever seen what happens if you try that? The kids have no idea what to do... there's chaos! |

In the most recent CSTA Journal, McComas (1997) described how "openness"--- the degree to which students make decisions about the problem, the procedure and/or the answers (p. 8) --- is often scarce during laboratory activities. He presented a table, reproduced below for classifying levels of laboratory openness.

Table 1. Schwab/Herron Levels of Laboratory Openness

LEVEL	PROBLEM	WAYS & MEANS	ANSWERS
0	Given	Given	Given
1	Given	Given	Open
2	Given	Open	Open
3	Open	Open	Open

A level 0 activity is one in which the teacher or lab manual decides the question or problem students will investigate, how students will do the investigation, and the validity of the investigation's results. Students make few decisions-other than deciding whether they got the "right answers."

A level 3 activity represents the other extreme. Students decide what to investigate, how to investigate it, and how to interpret the results they generate. Level 3 activities are what most scientists do; level 0 activities are what most students do.

Modifying Laboratory Activities

So, what is the dedicated teacher to do? **Gradually** modify the activities you are already doing.

To begin, analyze activities by deciding who is making the decisions --- the teacher/text or the student. Choose a couple of "cookbook" activities. They should be activities designed for goals **other** than teaching students particular skills --- you may better teach skills with a more step-by-step approach.

Ask these questions:

- Who decides the questions students are to investigate-teacher or student?
- Who decides the procedure to follow answering the question-teacher or student?
- Who decides what to observe and data to collect-teacher or student?
- Who decides the response to the question(s) investigated-teacher or student?
- Who decides how to communicate this information, including data-teacher or student?

Analyzing most activities, the response to each question will be "teacher." On the other hand, the ideal of inquiry-based instruction is something close to that of teachers supervising student investigations. Teachers in these situations would respond "student" to most questions.

Begin changing procedures by taking a level 0 activity and making a few changes to make it more like a level 1 activity. The idea is to progressively make small changes in the activities your students do. Over the course of weeks or months, students move from doing level 0 activities to doing activities that seem more like level 2 or 3 activities. By then, they are figuring things out for themselves, interpreting results, perhaps even repeating procedures. In short, they are thinking-the way scientists do-about what they are doing!

Perhaps the easiest and best place to start is with modifying who decides how to communicate the information. Many commercial activities include a preformatted data table. The teacher can remove the data table. In other words, you give students the same laboratory activity, except the data table.

What happens to a group of students accustomed to doing activities complete with data tables, suddenly confronted with an activity lacking a table? Let's assume you told students they would need to record relevant data.

Students might initially be confused. Most likely, some fraction of students would not record anything, despite your instructions. Another group of students would record much more than, perhaps, necessary. They do not know what data are relevant; fearing an error, they record everything. Another group would record the "expected" data, but less clearly than the convenient data table otherwise provided. A fourth group would record the "expected" data and use a data table similar to that which would have been provided.

Finally, a fifth group of students would record relevant data creatively, in a manner that works for them. This last group might, for example, record information in a visually appealing manner that you never would have imagined. Those with other learning styles might create similarly imaginative methods to record their data.

Three major results happen when teachers omit data tables. First, students present a variety of data display methods. Some are easier to understand than others. The situation presents you with an opportunity to discuss and teach students about the communication skills involved in helping others see information at a glance. The chance is there to help students compare data display methods and decide which methods communicate the information most easily and pleasantly. This is a valuable skill.

Second, you won't have to look at dozens of identical lab tables when reading student lab reports. A little variety and creativity in student work makes grading less tedious. Make data presentation count for part of the lab's grade.

Third, students eventually learn to think about the data they should record and how to record it. It may take a few activities sans data table for students to realize they must do these things, but most will catch on.

More Modifications

Teachers can then consider modifying student procedures, without eliminating them. For example, you can modify (or omit) many measurements given within directions. Directions might say to put 20 ml of a solution into a test tube. Why 20 ml? Why not 18? If a student used 26 ml, would the results be different?

Consider what would happen if students were told to put "a few" or "several" rnl into the various well plates. Some would put such a small volume of liquid they couldn't see what was happening; they would learn something about why 20 ml may be optimal.

Some students might use considerably more than 20 ml. If given a limited volume of chemicals to work with, they would learn about the need to think ahead and plan, especially if they ran out of reagents and were unable to complete the activity. This latter point is something you might tell students about before beginning the activity.

As with the data table discussion above, the lack of directions may initially confuse some students. However, students do eventually catch on if the teacher perseveres.

Remember: make changes gradually. You may want to leave the data table out for a few activities before starting to modify procedures. You and your students need time to accustom yourselves to new elements of teaching and learning.

More Radical Changes

Finally, after students are used to the independent thinking that comes from activities without data tables and total step-by-step directions, they (and you) may be ready for occasional activities demanding more thought on their part. You can often distill commercial activities to a single question that students answer when doing the activity. So, rather than be given complete directions, students can simply be given the question they are to investigate. As "hints" you can give students limited materials to work with or even show a sample experimental setup. You are ultimately still in control of the environment in which students work.

Still, they must decide the order to follow when doing their work, quantities of supplies to use, what to record, and how to interpret their data. You may want to try this sort of activity after students understand relevant background information. You may also want to try this first with an easier actlvlty.

I think it is realistic to say that, if you try the changes I am advocating in this article, some students will struggle. However, in this case struggle is good. Students will eventually or immediately rise to the challenge. Higher expectations are good for teachers and students alike. So, try it! You can use materials and activities you have on hand and feel comfortable with, yet still challenge your students in ways that help them think like scientists. Isn't that why we're here?

REFERENCE:

McComas, W.E (1997, spring). The nature of the laboratory experience: a guide for describing, classifying and enhancing hands-on activities. CSTA Journal 6-9.

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