EDUC 3780

Part K: The Laboratory Method

Content

Laboratory Method

At the heart of any science experience is the laboratory. What is a laboratory? It has been said that

> "laboratory is really an attitude; an attitude demanding that you explore the unknown, invent explanations, and discover whether or not your inventions are valid. Laboratory is exploring hypotheses can be formulated and subjecting those hypotheses to the most rigorous tests that can be devised. Laboratory is not a place; the halls, the grounds, home, and the bus all represent laboratory opportunities. Laboratory is observing, formulating, interpreting, testing, measuring, experimenting, predicting."

Given that definition, the laboratory method does not need to be reserved for the science classroom. Any curricular area in which hypotheses can be formulated and tested can utilize the laboratory method. After all, it is an “attitude” of exploration that any classroom can undertake. Keep in mind that laboratory exercises teach the professional skills of the field of study. How does the historian DO history? How do accountants DO accounting? Professionals in every field have acquired the tools of their trades. Laboratory experiences allow students to learn and practice those skills in controlled environments where skills are isolated and distractions are minimized.

Laboratory experiences, as distinguished from demonstrations, necessitate a high degree of student involvement. They are direct, firsthand experiences which place the student face-to-face with the problem he/she is exploring or the task he/she is performing. Laboratory experience if well planned and properly motivated will minimize the student's role as a passive observer. Careful consideration should be given to those aspects of the curriculum that can best be taught through a laboratory experience. Making the content meaningful by giving students hands-on experiences will bring the curriculum alive and solidify the concepts in the students’ brains. When using the laboratory method, science processes should be utilized. Those processes are: **observing, communicating, comparing, organizing, relating, inferring, and applying**.

Keeping the following concerns in mind during your preliminary planning will greatly increase the probability of success.

<u>What are the resources available?</u>

1. Are there sufficient quantities of materials available? Remember: this is a hands-on activity, not a demonstration.
2. Will some of the materials need to be ordered?
3. Are there adequate funds to permit purchasing of these materials? If so, is there time to order them?

4. Can the supplies and equipment be borrowed from other schools in the area? There may be a teacher network established in the school district or region which provides a support base for each other. It may be that a substitution of materials will still provide the desired outcomes of the lab.

Be familiar with the time schedule for the day on which you plan to do the lab.

1. Find out, if possible, if there is going to be an assembly or other program scheduled that will decrease the length of the period or eliminate it entirely.

Do a "dry lab" before having the students try it. This has a couple of advantages:

1. It allows the instructor a chance to tryout all the experimental procedures,
   and that all the procedures are workable and can be accomplished during the time available. Many teachers underestimate the time needed to complete a lab.
2. A "rule of thumb" to follow in estimating the time for the students to do the lab would be to multiply how long it took for the dry run by one and one-half.
3. Identify all the pitfalls the students may encounter and modify the procedures to avoid them. Remember, most students will not have the expertise in interpreting instructions or handling materials that the teacher possesses.
4. Another advantage of a "dry lab" allows the teacher sufficient time for the assembly of equipment so that it can all be pre-tested before the students do any work.
   - Decide if the equipment is best assembled beforehand by the teacher, or whether it should be assembled by the students during the lab session.
   - This usually depends on the nature of a specific lesson. If the students are to assemble the equipment, etc., then they must provide have clear and concise instructions.
   - This will also be a consideration in allocating time during the lab.

Determine the most efficient and effective size of student group.

1. It may be that individual work is the most effective, and yet in another experience, groups of two or three students is the most productive.
2. In many cases the amount of materials and equipment available will pre-determine group size. In any event try to establish a group size (2 to 5 students) where the tasks can be shared and yet all the

students in the group will contribute to the total solution or investigation.

Determine how the materials needed will be distributed to the students.

1. Will the materials be brought to each group's work area in bulk or in preorganized trays?
2. Are materials all readily available at work stations or lab benches, or will they need to go to a supply area to secure them?
3. Who does the transporting of materials and equipment–the teacher, a designated student from each group, or a lab aide?

Determine how materials and equipment will be handled after class.

1. Can needed equipment and materials be left out in the work area safely and undisturbed for use the following day?
2. Is there another class that could use the same set-up of materials during the subsequent period on the same day as this lab experience? (This may save materials and set-up time and preparation.)

Consider safety precautions and the safe disposal of materials.

1. Any potentially hazardous or difficult techniques should be demonstrated by the teacher prior to the students performing it.
2. Make sure students are wearing protective goggles when working with potentially hazardous materials. This is a state law and the teacher could be held liable by not adhering to this requirement.
3. Give students instructions on location and use of safety equipment in the lab area and provide facilities for safely disposing of waste materials, unused materials, and products.
4. It is important also that the teacher **always** be in the room during a lab exercise. Liability increases in the absence of the teacher should an injury occur.

Control the behavior of student during the lab activities.

1. Once the students have begun the lab exercise, the teacher functions as a guide and consultant.
2. It is important to move about the class, talking to each individual student or work group.
3. The teacher then has a chance to question procedures, offer suggestions, observe progress in an experimental procedure, check on safety, answer questions that arise, and last, but certainly not least, make sure students are on task. By moving around the room and not spending too much time with anyone group, the teacher not only can detect emerging behavior problems, but it encourages students to think for themselves and to work out

problems they encounter so that they learn independence and self-confidence.

4. **Horseplay or rowdy behavior during the lab must absolutely not be tolerated.**

Clean-up, discussion/processing the lab, and evaluation is another important part of the laboratory experience.

1. Watch the time so that there is sufficient time to clean the work area and leave it in order and ready for the next group to use it.
2. Proper cleaning up after a lab experiment is essential to the total process.

After the cleanup, the students (under the teacher's guidance) can then correlate the data gathered in order to determine the solution to the problem and draw generalizations about the exercise they have done.

1. Making appropriate observations is a learned experience.
    - Relationships are often established by the quality of the observations which are made.
    - Observations should be based upon the results observed at the time they occur and not established from memory.
2. It is an important part of investigation for students to keep a data book as their personal record of the investigation.
    - They should develop the habit of recording anything that might be important to their lab exercise.
    - Not only should they record observations, measurements, or the results of experiments, but they should also note the dates and time (when appropriate).
    - Students should also take a few minutes after each lab exercise to summarize what they did and what they thought about it.

If observational data is used in a homework assignment, it should help students focus on concepts and evaluate the importance and relevancy of the exercise. Follow-up discussions should emphasize the utilization of the data or information or skills developed by the student during the lab exercise. Unless properly used, the results of the exercise will represent just a period of time and may not result in conceptual understanding.

Five Types of Laboratory Experiences

A laboratory activity is a common concrete experience. There are five different types of labs. Each offers experiences necessary at some point during the learning cycle (moving students from the concrete to representational to the abstract.) These labs allow students to explore and discover many concepts.

Type I activities develop such skills as measurement and observation. Type I labs do not require formal reasoning, they teach important skills used in subsequent labs.

Type II activities verify concepts or principles previously studied in a textbook or presented in a class discussion. Students can replicate an experiment already performed by someone else. The problem is stated, results predicted, and the procedures are specified. Students should pool their data, discuss trends, and draw conclusions. Ask them to explain how they verified the principle or concept. A Type II lab usually follows the teacher's presentation of a concept or principle

Type III experiences are guided discovery activities; students practice finding relationships in their data. They get directions from the teacher or the book, but they do not know what results or conclusions to expect. The major differences between Type II and Type III exercises is the timing of the activity in relationship to the content of a lesson. A Type III lab serves as an introduction to a concept or principle. The discovery process takes more time, and fewer commercially prepared materials are designed in this fashion, but the benefits are worth the extra time and efforts. Don't rely however, on Type III too much since it is frustrating for students to have to "discover" everything.

Type IV labs are problem-solving activities. Students are presented with a problem, and they develop their own methods for collecting data. This can be an extension of another type of lab. As students gain from this experience, do not underestimate the contributions of even your lowest achiever. If we are to stretch our students' cognitive abilities, then we must allow them to practice. Students can practice such data collecting skills as measuring, identifying, and controlling variables at the same time they uncover a scientific concept or principle. Because all students (or teams of students) will come up with their own solutions to the problem, encourage them to write these up in a report. In a Type IV lab, a student acts like a scientist scouring out the solution to a problem. If used too often, the Type IV approach may be as time consuming and frustrating for students as Type III activities. Type IV also demands patience and flexibility on your part for each student plans a more active role. Poorly motivated students or those who need more immediate rewards sometimes find Type IV activities boring and very frustrating.

Type V laboratory activities place the entire burden of an investigation on the student, who must formulate both the problem and the method of data collection. In addition, he or she must interpret the data and arrive at a conclusion. The problem can be a logical extension of a class discussion or an idea generated by the student's own experience. This is a true research project. The most difficult task may well be that of limiting the scope of the problem to fit each student's stage of cognitive development. In order for Type V investigations to be successful, students must be knowledgeable and skillful, and the teacher must be comfortable with the role of a resource person, rather than the source of knowledge.

SHOW AND TELL

When there is a shortage of equipment, a shortage of time, or the experiment calls for dangerous chemicals, the teacher can demonstrate concrete examples of a concept or principle, or demonstrate laboratory experiments. Under proper conditions, a well organized demonstration can adequately substitute for a laboratory experience. The obvious disadvantage is that students are not as involved as they would be if they were doing the experiment themselves. Thus, the teacher must be careful not to let a handful of students dominate the discussion. A group problem-solving experience, however, can be very valuable and is much more valuable for student learning than lecturing on the concept or principle.

Laboratory Lesson Plan Format

Things to consider as the teacher:

Lesson Content

Objectives:

- Core Curriculum
- Laboratory task
- Group formation and maintenance

Preparation:

- Materials list
- Health and safety provisions
- Procedures list (assignments)
- Processing questions

Presentation:

- Lesson introduction
- Objectives (see above)
- Overview of activity and expectations including lab procedure(s) and data collection and reporting
- Transition–form groups and signal the beginning of work period
- Teacher monitors groups as they work on the lab
- Transition–clean up and be ready for class discussion
- Discuss/process as a class–interpretation and conclusions drawn from lab experience
- Closure–summary, transfer, and/or relate to real life

Evaluation and Reflection:

- As the teacher evaluate the lab experience and reflect upon what went well, what should be changed and/or adapted for future use of the lab

Real World Performance Tasks

Performance Tasks/Projects are complex, authentic challenges that adults face and require a tangible product/performance.

Use real or simulated settings with appropriate constraints, background noise, incentives, and opportunities

- Require students to address a specific audience
- Based on a specific purpose
- Allow students greater opportunity to personalize the task
- Are not secure: task, criteria, & standards are known in advance to guide student work

To best write a performance task, use the GRASPS model:

G: goal
R: role
A: audience
S: situation
P: product or performance
S: standards

Examples:

1. "Garden Design (mathematics, grades 6-8). You have been asked to plan a flower garden with a logo that has side-by-side circular, rectangular, and triangular shapes. Your final product should be a labeled scale drawing and a list of how many plants of each type and color you need to execute the plan." (*Understanding by Design 2nd edition*, 2005, p. 159)

2. "Fitness Plan (physical education and health, secondary level). Playing the role of a trainer at a health club, you will develop a fitness program, consisting of aerobic, anerobic, and flexibility exercises, for a new client. The fitness plan needs to take into account the client's lifestyle, age, activity level, and personal fitness goals. You will be given detailed descriptions of various clients." (*Understanding by Design 2nd edition*, 2005, p. 160)