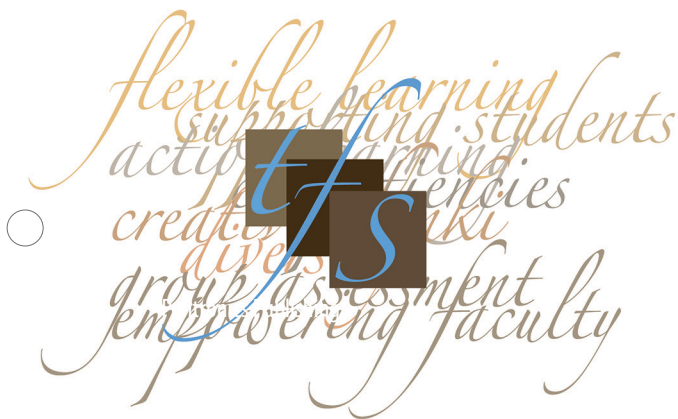




How to Accurately Assess Laboratory Learning

by Brian R. Shmaefsky, Ph.D., TFS Partner Science Editor/Author. Lone Star College

Most of you have a good grasp on what to do for assessing content knowledge learned from the textbook and classroom lectures. However, there is generally disagreement among instructors on how to assess clinic or laboratory learning.

This is not an unexpected state of affairs. After all, laboratory learning is a complex blend on communication proficiency, content, dexterity skills, protocols and social interactions that must somehow be measured using appropriate assessment strategies.

Laboratory assessment can be done adequately in a variety of manners including multiple-choice testing, laboratory reports and skill assessment observations. However, these assessments must test measurable outcomes based on what was taught or carried out during the laboratory session.

Surprisingly, even pen-and-paper tests alone can measure most of the outcomes of laboratory learning. The more difficult to conduct hands-on skills testing can be reserved for two or three well-planned comprehensive assessment sessions.

Create Assessment Knowledge List

The same care and concerns that go into developing classroom testing must be put into laboratory test design. First it's important to know what knowledge and skills are being testing. This must be determined in the design of the laboratory activity. Instructors should have several measurable outcomes listed for each laboratory exercise or experiment. For example, a chemistry laboratory on titration could be designed to measure the following learning outcomes.

Students will:

1. Define an acid and a base.
2. Define molarity.
3. Define normality.
4. Write the stoichiometric reaction of NaOH with sulfuric acid.
5. List the steps of titrating 1M NaOH with an unknown concentration of H_2SO_4 .
6. Collect stock solutions without causing contamination to the original solutions.
7. Use NaOH pellets to make the correct molarity solution.
8. Properly mass the NaOH showing how to use a tare and standard.
9. Use the appropriate liquid measuring techniques for conducting the titration.
10. Handle the chemicals with appropriate personal protection equipment.
11. List the steps in properly using a pH meter.
12. Dispose of the chemicals appropriately.
13. Use proper technique to clean the laboratory work area.
14. Record data as called for in the laboratory notebook.

15. Perform the correct calculations to determine the molarity of the sulfuric acid.
16. Corroborate their findings with other students to determine the probable molarity of H_2SO_4 .
17. Perform the appropriate statistical analysis to determine the mean, medium and mode of the probable molarity of sulfuric from the class data.

Multiple Learning

Wow, seventeen outcomes from one simple laboratory procedure! The list can be tailored for non-science majors, science majors, or chemical technology students. It can also be adjusted to emphasize particular outcomes pertinent to the goals of that laboratory activity. However, just knowing the outcomes does not mean that the assessment instrument is accurately determining student achievement.

Merging with Test Design

This is where proper test design becomes an important factor in measuring laboratory learning. Building a test that appraises higher-order learning is important in bringing out the full learning experience of laboratory activities. Again, this can be done using laboratory observations, traditional tests, and written assignments. Laboratory observations should have an outcomes check sheet that objectively measures delineated skills. Delineated skills means actions that represent proper laboratory techniques.

Example

A. Assessing delineated skills

- 1. The student properly measures volume with a graduated cylinder:
 - Student uses a clean cylinder.
 - Student reads the bottom of the meniscus.
 - Student reads the meniscus consistently.
 - Student collects the correct measure.
 - Student transfers entire volume.
 - Student cleans cylinder and returns to storage location.

B. Assessing general skills

- 2. The student properly performs titration setup:
 - Student uses graduated cylinder to measure volume.
 - Student approximates proper use of graduated cylinder.
 - Student transfers solution to appropriate titration glassware.

C. Assessing higher-order skills

- 3. When using traditional testing the following questions are typical of those that assess higher order thinking:
 - Interpret the following data (comprehension).
 - Describe the reaction between NaOH and sulfuric acid (comprehension).
 - Apply the principles of titration to the following reaction... (application).
 - Classify the following chemical reactions... (analysis).
 - Identify the cations in the following titration... (analysis).
 - How would you perform the following titration... (synthesis).
 - Evaluate the results of the following titrations... (evaluation).

A Need for Objective and Subjective questions

Traditional test questions can have directed answers as in the examples given above. They could be formatted as fill in the blank, multiple choice, or short answer. It is advisable to provide open-ended questions that evaluate the student's logic and reasoning skills. Written assignments are a good way of evaluating student knowledge, comprehension, application, analysis, synthesis and evaluation within one assessment instrument. Plus, it permits you to assess student communication and writing skills.

However, the assignment must be supplied with a format that looks at these levels of students' understanding. Standard laboratory reports can be supplemented with questions that assess these degrees of learning. You may wish to do creative thinking projects such as student forums about the data, student presentations to class, or poster sessions.

Formative testing

You should use formative testing to ensure that students have the minimum knowledge and skills needed to accurately and safely carry the laboratory session. Formative testing is generally used solely for providing students with feedback about their knowledge. You have the option of giving grades for this evaluation.

However, it should be a learning experience and not a penalty for the students. Formative evaluation can also be used in earlier laboratory assessment where students can learn the expectations without too much penalty.

At the end of a major learning segment, a graded comprehensive or summative evaluation should be reserved for the function of confirming competence after students complete one or more related laboratory sessions.

A Worksheet is Provided on the Next Page to Create a Skill Inventory for Your Class

- **1. Assessing delineated skills.** See page 2 for an example. *Describe an action the student will perform in the lab.*

- The student _____

- Specify each detail of the skill above that you will evaluate:

- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____

Assessing General Skills

- 2. The student _____

A. Student uses _____ to _____

- Student approximates _____
- Student transfers _____
- Student _____
- Student _____
- Student _____
- Student _____
- Student _____

Assessing Higher-order Skills

- 3. Construct a set questions typical of those that assess higher order thinking:

- Interpret the _____
- Describe _____
- Apply _____
- Classify _____
- Identify _____
- How would you perform _____
- Evaluate _____

If you need help with Higher-order Skills continue to page 5 for a worksheet to help you with this task.

3. Assessing Higher-order Laboratory Skills, Worksheet

Lesson Number:	Class Date:	Lesson or Chapter Title:
Write the General Lesson Objective (Goal or Outcome)—		
<u>Thinking level</u>	<u>What students do</u>	<u>Describe what students will do to demonstrate mastery at the thinking skill level indicated.</u>
Knowledge	Name, describe, select, define, match, state, etc.	
Comprehension	Summarize, explain, provide examples, predict, estimate.	
Application	Solve problems, construct charts, demonstrate usage.	
Analysis	Divide, distinguish, categorize, infer, separate.	
Synthesis	Combine, revise, organize, create new perspective.	