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Faculty Success Center

QuickTool 9.2

TFS QuickTool 9.2: How to Accurately Assess Laboratory Learning

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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 of 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.

The 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:

- Define an acid and a base.
- Define molarity.
- Define normality.
- Write the stoichometric reaction of NaOH with sulfuric acid.
- List the steps of titrating 1M NaOH with an unknown concentration of H2SO4.
- Collect stock solutions without causing contamination to the original solutions.
- Use NaOH pellets to make the correct molarity solution.
- Properly mass the NaOH showing how to use a tare and standard.
- Use the appropriate liquid measuring techniques for conducting the titration.
- Handle the chemicals with appropriate personal protection equipment.
- List the steps in properly using a pH meter.\
- Dispose of the chemicals appropriately.
- Use proper technique to clean the laboratory work area.
- Record data as called for in the laboratory notebook.

- Perform the correct calculations to determine the molarity of the sulfuric acid.
- Corroborate their findings with other students to determine the probable molarity of H_2SO_4.
- 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 Help You Create a Skill Assessment Inventory

Describe an action the student will perform in the lab.

Step A. Assess delineated skills: (*See page 2 for an example.*)

Enter a Delineated Skill Statement: The student will…

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

Step B. Assess General Skills (*See page 2 for an example.*)

Enter a General Skill Statement: The student…

Enter specific steps (What the student does):

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Step C. Assess Higher-order Skills

Construct a set of questions typical of those that assess higher order thinking using the sample starter terms provided

Interpret the…

Describe the…

Apply the…

Classify the…

Identify the…

How would you perform…

Evaluate the results of…

You should know have a much clearer idea of the, delineated, general, and higher order thinking skills on which to accurately assessing and grade the performance of your laboratory students. If you need help on understanding exactly what are higher order skills, continue on to page 5 for a worksheet.

Assessing Higher-order Laboratory Skill, Worksheet

Lesson Number:	Class Date:	Lesson or Chapter Title:
Enter the General Lesson Objective (goal or outcome here)…		

Thinking level	What students do (verb examples are listed)	Describe what students will do to demonstrate mastery at the thinking skill level indicated.
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.	