Alternate assessment in general chemistry classes

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Individuals learn and retain information differently, and that should be taken into consideration in both the teaching and assessment.

Teaching should go beyond the traditional lecture techniques, associated homework questions, work sheets, problem sets, and occasional term projects to include a mixture of demonstrations, hands-on activities, homework investigations, and active hands-on testing.

There is a lot more in a chemistry course than the material in the textbook

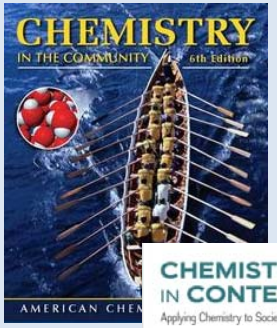
Traditional classroom teaching:

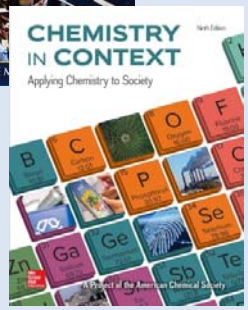
The majority of the information conveyed is through a lecture and textbook-type of approach.

In the majority of classes, information is transmitted with little physical reinforcement or visual demonstrations to provide experiential involvement of the student.

There are limited resources provided to the teacher by their districts or colleges.

Innovations such as *Chemistry in the Community* (*ChemCom*), and *Chemistry in Context* provide an excellent alternative for the non-major, but does not provide material for the science major.





Standardized testing can lock the teacher into a set curriculum leaving them with an "obligation" to cover material specifically for those tests.

When inquiring about expanding course topics to include more relevance and applications, this author has been told by teachers that "there is no time for it in the curriculum" and "it won't be on the (standardized) test".

In traditional testing,

- **Students encounter a range of questions such as true-false, matching, fill-in-the-blanks, multiple choice, essay, and problem sets.**
- **Most testing relies on memorization rather than active testing.**

Ask an individual "Can you answer every question on tests that you take?" or "Can you always solve the more difficult problems in a problem set on your first run-through?", yet, we require our students to do so and then we grade them based on what they don't know.

Chemistry is a course that involves more than simple memorization.

Classroom teaching and assessment should include a number of strategies and resources.

Current issues facing society should be discussed using articles from newspapers and magazines, and information from recent television shows and movies. Students should "research" these issues.

Such material does not replace the textbook, but enhances it.

This information should be integrated into class presentations without eliminating content needed for the curriculum.

Low cost demonstrations and activities should be used as part of active teaching.

Many of today's students do not know how to study effectively.

Students do not read ahead and prepare for class.

Students do not know how to speak up and to advocate for themselves.

Students do not know what resources are available to them in the college.

Students do not come to office hours or make appointments for help with course material.

Increasingly, students have asked for "study guides" – i.e., practice exams - before taking a regular exam.

Testing should be at various levels.

- **Short quizzes at the beginning of class encourage students to review and prepare for specific topics.**
- **Exams should bring those topics together for a more complete picture of the students' abilities.**
- **Exams should be more than just problem sets, students should be asked to draw diagrams and structures and to answer questions using sentences.**

Vary assessment techniques and testing to allow students to demonstrate their individual competencies.

If classroom topics include forensics, then the assessment component should have students solving a "crime".

If the topic is science and science fiction, then the assessment component should be to write a science fiction story or to explain the science in a story.

For the more "traditional" topics, some alternative testing strategies are building questions that can test at two levels, multi-answer multiple choice questions, and interactive questions that use small-scale experiments as part of the testing process.

Assessment techniques should also include laboratory testing.

Active Assessment (Rutgers U. and Cabrini College)

Lab practical exams

ICE Hands-on questions at UNC ICE programs

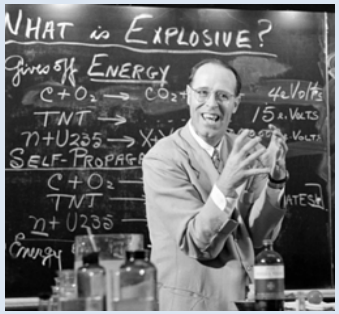
Wilbur Bergquist's Test Cubes (grad student at UNC)

Choice labs (Lab projects)

- **Originally open projects**
- **Replaced with unassigned experiments from lab manual**
- **Replaced by open inquiry experiments which were extensions of those from the semester.**

Choose your exam questions. Some mixed reactions. Less popular in recent years as students requested practice exams before regular exams.

Implementing hands-on experiment testing and laboratory practical exams has long been viewed as a difficult undertaking due to amounts of materials and apparatus needed along with the formulation of questions, time for administration of the exam, and development of grading Rubrics.

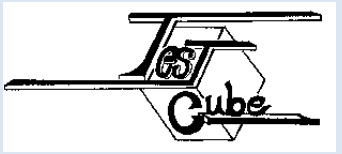


Small scale chemistry experiments:

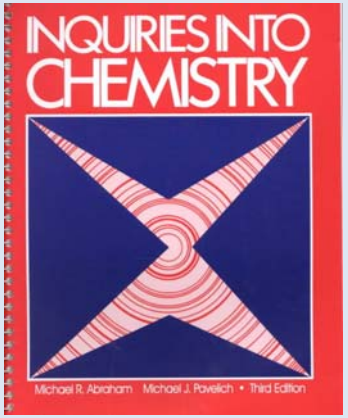
- **Hubert Alyea starting in 1961 with his TOPS overhead projection series and later with his Armchair Chemistry experiments.**

- **The availability of inexpensive and readily available materials such as Beral pipettes and well plates.**

- **Development of suitable questions and techniques by Wilbur C. Bergquist's "Test Cubes"**



- **Abraham and Pavelich's open inquiry experiments in their *Inquiries Into Chemistry***



- **Bob Silberman's (SUNY Cortland) *Small-Scale Laboratory Assessment Activities***

The experiments and techniques from classroom activities and laboratory practical exams, once set up, can be extended to hands-on testing as part of a classroom exam and have also been used as part of the 2001 and 2002 New Jersey's Rutgers Academic Challenge competition.

DIRECTIONS FOR A MENU-TYPE EXAM

This type of exam allows the students to choose among questions so that they can demonstrate what they know rather than what they don't know. They can earn more than 100 points allowing for a small amount of extra credit as well as variations in point values of different questions. Trying to answer every question, however, will penalize them as the instructor should stop grading sections as soon as the attempted point count is reached. This is an example of the directions I use on such an exam.

Chemtech College
Chemistry 100 - Exam #1
Spring 2001 - D. A. Katz

Name _____

DIRECTIONS: The following exam consists of a number of questions totaling between 124 and 136 points. You are to select questions to answer so that your total point count is no more than 105 points. Your score will be penalized for answering more than 105 points.

For each calculation, solve by dimensional analysis (factor-label method) or use the proper formula. SHOW THE SET-UP CLEARLY, including the formula used, conversion factors, and the proper units. Observe significant figures, show any set-ups for formula weight calculations, and circle or underline the final answer. Keep discussion-type answers brief and to the point, avoid long essays.

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. ***(page 1 questions and problems go in this area)***

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****Number of points answered on this page (_____)** ***[this is placed at the bottom of the page]***

CHALLENGE PROBLEM

Students can also choose the level of calculation they want to answer. The challenge problem is more complex and will earn extra points, thus letting them omit another question or problem elsewhere in the exam. They still must demonstrate a basic level of competency. Calculations cannot be omitted by the students, on the exam, they can only choose the level of calculations they want to answer.

Calculation: Complete either problem 6.1 or problem 6.2. Problem 6.1 is a *challenge* problem, that is, it is more complex than problem 6.2. DO NOT solve BOTH problems 6.1 and 6.2.

Problem 6.1 (Challenge Problem)

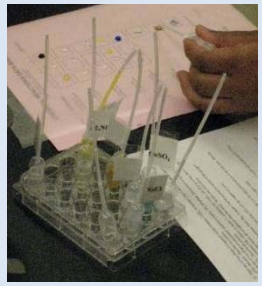
Urea, $(NH_2)_2CO$, ammonium nitrate, NH_4NO_3, guanidine, $HNC(NH_2)_2$, and ammonia, NH_3, are all used as fertilizers to contribute nitrogen to the soil. Which one of these is the richest source of nitrogen on a mass percentage basis? (15 points)

Problem 6.2

Calculate the percent composition of calcium arsenate, $Ca_3(AsO_4)_2$ (10 points)

CHEMICAL REACTION QUESTIONS

This is one type of what I call "Active Assessment" questions.



The student must physically perform a small-scale reaction. Thus, the old "complete and balance the following reactions" type of questions now have a physical significance.

The materials for the reactions sets are placed in small boxes, plastic drinking cups or beakers, and labeled with an identification number.

More than one set may be needed depending on the size of the class.

Materials can be labeled using names or formulas of the elements or compounds. Note that both the symbols and the names of the reacting substances are asked for in the problem. This is to insure that the grader knows the correct set that the student selected even if the student writes an incorrect set identification number or an incorrect formula or name.

II. CHEMICAL REACTIONS (36 points total - 12 points each)

Directions: Select 3 chemical reactions from the front desk (Please take them one at a time). Run each reaction on a piece of wax paper using one or two drops of the liquid chemical solutions (or one or two drops of liquid and a piece of solid). Complete the information below for each reaction.

Please return the reaction materials to the front desk. Discard the waste materials by crumpling up the wax paper with the drops of chemical inside and place it in the trash.

Reaction Set No.: _____

a) Symbols of reacting substances:

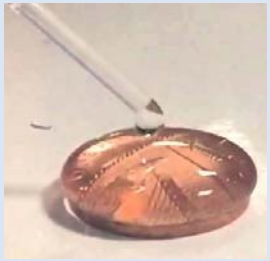
b) Names of reacting substances:

c) Evidence of a chemical reaction:

d) Write a balanced chemical equation for the reaction that occurred.

These questions, letters a) through e), involve doing or observing an experiment. The materials are available on the front desk. Select an experiment, take it to your desk and answer the question. You may answer up to two experiment questions. (10 points each)

a) You are given three pennies, pipettes, and three liquids/solutions: water, water-detergent, ethyl alcohol. How many drops of each liquid can you put on a penny? Explain the differences.



b) You are given a cotton ball that is wet with some ethyl rubbing alcohol. Touch the cotton ball to the back of your hand. What sensation do you feel? Explain.

c) On the front desk is a paper cup containing water. It is being heated by a candle. Explain.

d) You are given a washable marker, a stick of porous chalk, and a cup containing a few mL of water. Draw a line on the chalk, about 1 cm from one end, using the marker. Stand the chalk up in the cup and observe the changes that are taking place (Note: the water is moving through the chalk by a process known as capillary action.):

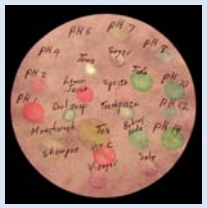
i) What changes are occurring?

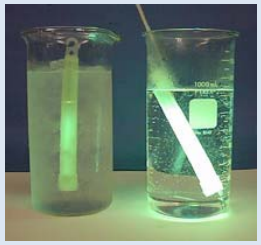
ii) Explain your observations using the principles of solutions and intermolecular forces.

e) The bottles labeled 1, 2 and 3 contain distilled water, a solution of acetic acid, and a solution of sodium chloride. Which is which? Explain how you determined your answer. (Available materials are Na_2CO_3, $AgNO_3$ solution, an indicator, and any other materials as the instructors determine.)

Other experiment problems

- An acid-base indicator problem.
- pH of household products problem.
- A zip-lock bag problem.
- Kinetics problems.





Some things to note

- **Works best with small classes – about 40 students or less.**
- **Students should have had previous experience with hands-on activities in the classroom.**
- **A negative result:**

  Some students start to cut short quizzes about half-way through the semester.

More information can be found at

http://www.chymist.com

On the left-hand menu, click on

Active Assessment

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