Program/Discipline: Physical Science (Department) / Chemistry **Instructional Manager:** Kevin Li

Semester/Year: Spring 2013 **Assessment Coordinator:** Dr. Tracy Mitchell **Department Chair:** Dr. Doris Espiritu
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Plan Title: Using ACS Examinations to Gauge the Achievement of Student Learning Outcomes for Chemistry 201 (General Chemistry I)

Part A: Initial Plan
Part B: Midsemester Update
Part C: Further Updates

The current submission is which of the following:

□ **Initial Plan date: _____**

□ **Mid-year update date: _____** x **Final Report date: 06/15/13**

College Mission: Wright College is a learning–centered, multi-campus institution of higher education offering students of diverse backgrounds, talents, and abilities a quality education leading to baccalaureate transfer, career advancement, and/or personal development.

Program/Discipline Mission: The mission of the Department of Physical Sciences is to provide our students with solid foundations in Chemistry, Physics, and Physical Sciences so that articulation of classes and material content will allow for a seamless transition into their chosen fields of interest. Our charge is to encourage students to view physical phenomena critically and develop insights which will help them discover and understand the principles that govern events in nature. All are encouraged to develop their curiosity, enhance their intellectual skills, progressively mature, and recognize the growing role of science in society.

A. Initial Assessment Plan

Area of Focus: Critical thinking.

Your department efforts are to improve learning in what topic/area?

Evidence: What past results have led your department to conclude that this is an area needing attention?	Wright College's 2010 CAAP Scores indicated lower achievement in the areas of reading and critical thinking.
Course(s) of Interest: What courses will be involved in your plan?	Chemistry 201 (General Chemistry I)
Intended Program Student Learning Outcomes (SLOs) List each relevant SLO that this project pertains to.	DEPARTMENTAL SLO: Students who complete (physical) science courses at Wright College will be able to: 1) Reason methodically to evaluate and solve qualitative and quantitative problems using appropriate scientific models and/or mathematical manipulations. COURSE SLO's: This list of objectives is intended to cover the major topics covered by all instructors in this course. Any instructor may expand on some of these or add additional topics if time permits. The student should be able to recall definitions of scientific terms, demonstrate an understanding and solve qualitative and quantitative problems which specifically involve: **A. Matter and Measurement**: 1. Understanding the scientific method. 2. The distinction between the various types of matter. 3. The use of significant figures, scientific notation, metric units and dimensional analysis. 4. The interconversion of mass, volume and density. 5. Converting metric unit involving length, mass, volume and temperature. **B. Atoms, Molecules and Ions**: 1. The description of the structure of atoms in terms of protons, neutrons and electrons. 2. The use of chemical symbols, atomic number and mass number to express the subatomic composition of isotopes. 3. The organization of the periodic table. 4. The distinction between ionic and molecular compounds and how to name them.

5. Empirical and molecular formulas, including method of calculation.
6. The formation of ions from the gain or lose of electrons.

C. Calculations with Chemical Formulas and Equations:
1. Balancing equations.
2. Calculating molecular and formula weights.
3. Interconvert between mass, moles and number of particles using molar masses and Avogadro's number.
4. Calculating percent composition from a formula.
5. Calculating an empirical or molecular formula from percent composition of molecular weight.
6. Calculating amounts of reactants or products for a reaction, including a limiting reactant and a percent yield.

D. Aqueous Reactions and Solution Stoichiometry:
1. Recognizing compounds as acids, bases or salts, and strong, weak and nonelectrolytes.
2. Naming and knowing the formula of common polyatomic ions.
3. Various types of reactions, such as combination, decomposition, combustion, precipitation, acid/base and oxidation/reduction.
4. Calculating the oxidation number of a species.
5. Calculating the molarity of a solution and using molarity to solve stoichiometry and dilution problems.

E. Thermochemistry:
1. The terms and sign of heat, work, energy and enthalpy, including endothermic and exothermic processes.
2. Calorimetry and specific heat.
3. Using standard enthalpies of formation to calculate the change in enthalpy for a reaction.

F. Electronic Structure of Atoms
1. The concepts of wavelength, frequency and energy of electromagnetic radiation and photons.
2. Quantum numbers and how they relate to the number and type of atomic orbitals, including shapes.
3. Using the periodic table to write full and abbreviated electron configurations of atoms and determine the number of unpaired electrons in atoms.

G. Periodic Properties of Elements
1. Using the periodic table to predict the trend in atomic radii, ionic radii, ionization energy and electron affinity.
2. Using the periodic table to write full and abbreviated electron configurations of ions.

H. Basic Concepts of Chemical Bonding

1. Writing the Lewis structures of atoms, ions and molecules, including exceptions.
2. The electronegativity chart to identify nonpolar covalent, polar covalent and ionic bonds.
3. Calculating formal charges on atoms in Lewis structures.
4. Enthalpy of a reaction from bond enthalpies.

I. Molecular Geometry and Bonding Theories

1. Describing the arrangement or electrons and geometry of molecules and using the VSEPR theory.
2. Identifying the hybridization of atoms in molecules.
3. Identifying sigma and pi bonds in molecules.
4. The understanding of bonding and antibonding orbitals, including drawing of molecular orbital energy-level diagrams.

J. Gases

1. Identifying various pressure units.
2. Solving empirical gas law problems.
3. Solving ideal gas law problems, including reaction stoichiometry.
4. Calculating the molar mass or density of a gas.
5. Describing the Kinetic Molecular Theory of gases.

K. Intermolecular Forces of Liquids

1. Identifying the various types of intermolecular forces.
2. Understanding the kinetic molecular theory and the molecular description of liquids.
3. Knowing phase changes for pure substances.

L. Properties of Solutions

1. Understanding the properties of solubility.
2. Calculating various concentration units.

M. Acid-Base Equilibria

1. Understanding the various definitions and general properties of acids and bases.
2. Calculating pH from hydrogen ion concentration and and vice versa.
3. Showing familiarity with the pH scale.

Involved Faculty: List the instructor(s) participating in the assessment process for each outcome listed above.	Chemistry 201 Course Coordinator: Dr. Maria Valentino Chemistry 201 Instructors: All
Assessment/Intervention Process Address the following questions: **What** approach will be used? **Why** was this process selected? **How** will student learning be measured? **When** will data collection be completed? **Who** will analyze the results?	**What**: The First Term General Chemistry Exam consisted of 70 multiple-choice questions prepared by the American Chemical Society (ACS). The majority (about 60/70) of the ACS examination questions are linked to the Student Learning Outcomes for the course. The test was timed, where students were allowed 120 minutes, set by the American Chemical Society. The Physical Science Department established that students must have correctly answered a minimum of 27 of the 70 questions (i.e. 39%) to pass the exam, as well as the course. If a student failed the exit exam but was otherwise passing the class (D or better), the student was eligible to take a multiple-choice departmental appeals exam. Any student that failed the appeals exam received a failing grade in Chemistry 201. The national average was provided by the ACS and is based on the scores of 744 students in 9 schools. **Why:** To assess student proficiency each semester and compare our students to a nationally normed average. **How**: We can compare our student's scores from semester to semester and Wright College data can be compared to a nationally normed average. **When**: The assessment, using the ACS test as the Exit Exam, started in Spring 2010 and is on-going. **Who**: The Chemistry 201 Coordinator, Dr. Maria Valentino.

B. Midyear Update

Completely describe all actions that have occurred since this past August with respect to your department's Assessment Plan.	Not Applicable.

Attach any relative documents (rubrics, surveys, other assessment tools).	Not Applicable.
Are there any obstacles to the implementation of the plan that the Assessment Committee should know about or can assist with?	No.

Part C

Summary of Results and Analysis of Data Collected

What were the results of the assessment process?

What was learned from the results?

Results:

Range of Scores Possible: 0 – 70 (0% - 100%)
Range of Scores Achieved: 16 – 69 (23% - 99%)

Average Score: 35/70 (50%)
National Average Score: 40/70 (57%)

Number of students achieving the National Average score and above: 63/213 (29.6%)
Number of students not achieving the National Average Score: 150/213 (70.4%)

Note: Analysis of Exit Exam and ACS data for Chemistry 201 for the past 9 semesters is presented in a table on the next page of this report.

Analysis:

In past semesters, 40 questions out of the exam's 70 questions were selected to represent the Exit Exam for Chem 201. These questions were selected because they most directly corresponded to Chemistry 201's Student Learning Outcomes (SLO's). Students were NOT informed which 40 of the 70 questions represented the Exit Exam. Students were informed that 17 (or more) of the 40 questions must be correctly answered to pass the Exit Exam.

This semester the exit exam consisted of all 70 questions, and the passing score was 27/70 (i.e. 39%). Although the percentage of students passing the exit exam, average percentage of questions answered correctly, and the percentage of students scoring at or above the national average has decreased in Spring 2013, these trends may be attributed to the absence of a first week skills assessment test. In past semesters the Toledo Exam was used to assess if students placed into Chemistry 201 had the skills necessary to successfully complete the course. Students scoring lower than the benchmarks in the math and chemistry sections of the exam were counseled to drop the Chemistry 201 course and enroll in Chemistry 121 to build necessary skills. The passing score of 27/70 appears reasonable as it challenges students to perform well without penalizing them for missing questions that have a high difficulty index.

Action Plan Based on Results and Analysis

Based on what was learned, what additional steps will be taken to improve student learning?

Currently, the Physical Sciences department is developing its own first-week skills assessment test as a replacement for the Toledo Exam. The Toledo Exam was time-consuming, and exam scores were not consistent predictors of success/failure in the course. A first-week skills assessment is necessary to redirect students who technically meet the course prerequisites but don't currently possess the prerequisite skill set to support success.

Analysis of Exit Exam and ACS data for Chemistry 201 for 9 semesters

Semester	Number of students	Exit Exam average (%) Pass = 43%	% passing	ACS average (%) Nat'l average = 57%	% of students above national average
Spring 2010	208	56	80.8	49	27
Summer 2010	54	68	92.6	58	54
Fall 2010	186	58	79.6	51	32
Spring 2011	199	61	87.9	53	41
Summer 2011	55	62	87.3	57	55
Fall 2011	221	53	69.7	48	29
Spring 2012	210	55	73.8	46	25
Summer 2012	76	67	94.7	55	47
Fall 2012	211	63	86.7	55	47
	Number of students	Exam average (%) Pass = 27/70 (39%)	% passing		% of students above national average of 57%
Spring 2013	213	50	76.1%		30