http://www.sjsu.edu/ugs/assessment/ge/materials/

COORDINATOR SUMMARY
General Education Course Assessment Sheet
Areas B1, B2 and B3: SCIENCE

Course Summary Information
Course Prefix and Number Chem 30A _ Course Title: Introductory Chemistry

Results reported for: _XX__ F06 ___ S07 semester(s) **(check all that apply)**

Number of sections offered during reported semester(s): 2
Summary includes data from instructors' reports for the following number of sections: _2_

Course Coordinator: Maureen Scharberg_ email: Maureen.Scharberg@sjsu.edu

Course Certification
Were any issues or concerns identified when the course last received certification or continuing certification (see letter from AVP of Undergraduate Studies)? XX Yes No

If yes, briefly summarize course modifications that have been implemented to address issues or concerns identified in the course certification letter.

In Bob Cooper's letter as Chair of BOGS (dated March 10, 2003), he stated that "The Board felt that the course met all of the student learning objectives quite well, but was a bit weak on the content objective for diversity".

After careful reflection of this comment, I made some content and pedagogy changes to address the diversity issue. For the content, socio-economic aspects of society being able to access breakthroughs in chemistry, such as new drugs, are now discussed in lecture. For the two-page essay, many students chose to write on this topic. We also discussed how various countries do or do not have access to clean drinking water and alternative energy sources. For alternative energy sources, students had to research one of several alternative energy sources and then a representative of their group presented the most interesting facts to the class, including access to these alternative energy sources. We also discussed the growing roles of women in science.

Students were given an extra credit assignment to complete a service learning project. We piloted this assignment during the Fall 2006 semester. For this assignment, Chem 30A students conducted hands-on chemistry experiments with 4^{th} and 5^{th} graders who were, for the most part, from minority populations attending school in the local Five Wounds neighborhood (organized through ComUniverCity). This experience was the first time that these 4^{th} and 5^{th} graders had hands-on, inquiry-based science. Chem 30A students were mentored to use languages other than English if required. It was a smashing success that will be required in future Chem 30A courses.

With respect to the pedagogy in Chem 30A, many modes of learning the material were available to the students. Dr. Resa Kelly and I piloted an updated Chem 30A curriculum during the Fall 2006 semester, based upon the latest research in chemical education on how students learn chemistry. PowerPoint presentations were placed on WebCT before lectures so students could download them and have them during lecture. Process-oriented guided inquiry learning (POGIL) activities were conducted by teams of students at the beginning of the weekly laboratory period. POGIL activities allow students to be actively engaged and thinking by working together in self-managed teams to understand concepts and solve problems in chemistry. All material was integrated as a weekly module. Various student learning styles were taken into consideration in designing the course materials from reading assignments, laboratory assignments, take-home quizzes, homework as well as midterms and final exams.

Students Learning Objectives
Based on the assessment summaries submitted by course instructors, please answer the following questions: *(If this is a multi-section course, please provide examples from several sections for the following questions or indicate that the activity/assignment is being used in more than one section)*

Learning Objective 1: Students should be able to use the methods of science and knowledge derived from current scientific inquiry in life or physical science to question existing explanations.

Out of approximately 300 students assessed, what percentage would you estimate:
Mastered LO1 at a high level 20% (averaged a "B+" or better on assessment activities)
Mastered LO1 at an average level 60% (averaged between a "C" and a "B+" on assessment activities)
Either failed to master LO1, or did so at a marginal level 20% ("C-" or below on assessment activities)

What criteria (both formal and informal) did you use to estimate mastery of LO1?

- In-class questions to check for understanding. Students' answers determined if instructors moved on to new concepts. Typically, we would present a demo or a model and ask students to explain what happened. For example, we ran simulations of that illustrated various components of the gas laws and asked students to determine relationships between pressure, volume, temperature and number of moles.
- Each laboratory experiment and activity were based on guided-inquiry learning principles that allowed students to use methods of science and their own knowledge to understand a new concept in chemistry.
- Formal questions on take-home weekly quizzes, midterm exams and the final exam often provided data in which students had to explain or solve using methods of science. For example, students had design a possible scenario for transforming mechanical energy from turning water turbines into electricity.

Briefly summarize 2 or 3 examples of activities/assignments that have been successful in helping students meet GE Student Learning Objective 1.

- The activities of metals experiment allows students to explore how metals and their corresponding aqueous salt solutions react with other metals and their salt solutions. From a group of six metals, students must rank each metal from most active (most reactive) to least active (least reactive). Although the data collection is rather straightforward, students discuss their results in a post-laboratory discussion using deductive reasoning strategies based on their results. Often there are contradictory results, prompting some students to repeat one of their experiments. This reinforces the thoroughness in reporting their results. Students then write balanced chemical reactions that correspond to their observed reactions. Students find that each metal reacts differently and can indeed rank them from most active to least active.
- Classification of Matter POGIL (Process Oriented Guided Inquiry Learning—www.pogil.org) activity: This is the first POGIL activity that students complete. In this activity, students, working in self-managed teams, start by discussing how a flower and a tree can be the same, but are also different. Then, they analyze critical information that chemists use to classify matter before they classify items that are available in the lab. Each group must justify why they placed certain items in the following categories of elements, compounds, homogeneous mixtures and heterogeneous mixtures. Students are then a ziplock bag Legos™ building blocks and instructed to classify the Legos™ models as an element, a compound and a heterogeneous mixture. As the assessment for this activity, each group must develop and submit a flow chart for classifying matter.

- 10-week sodium chloride crystal growing experiment: The objectives of this experiment are for students to learn how to make detailed observations over a relatively long time period (two months) and to learn how to summarize their observations as well as to explain changes that occurred during this experiment. At each weekly laboratory period, students wrote detailed observations to record the process of forming salt crystals. At the end of 10 weeks, students wrote a two-page laboratory report. Each student was given a laboratory report grading rubric.

Learning Objective 2: Students should be able to demonstrate ways in which science influences and is influenced by complex societies, including political and moral issues.

Out of approximately 300 students assessed, what percentage would you estimate:
Mastered LO2 at a high level 25%(averaged a "B+" or better on assessment activities)
Mastered LO2 at an average level 55%(averaged between a "C" and a "B+" on assessment activities)
Either failed to master LO2, or did so at a marginal level 20%("C-" or below on assessment activities)

What criteria (both formal and informal) did you use to estimate mastery of LO2?

- Throughout the entire course, we discuss the top challenges facing humanity today. Energy, clean drinking water and food are in the top ten and are woven throughout the Chem 30A curriculum. Where appropriate, we discuss the politics behind the chemistry. For example, when discussing combustion reactions, we use ethanol and link it to the fact that ethanol does not provide a lot of energy when it is added to gasoline. In lecture, we ignite a hydrogen balloon so students understand why we cannot simply have hydrogen gas stations right now—the science is simply not available to make hydrogen gas a safe fuel for consumer use.
- We used take-home quizzes, midterms and the final exam as well as appropriate laboratory activity answers to estimate mastery of LO2.

Briefly summarize 2 or 3 examples of activities/assignments that have been successful in helping students meet GE Student Learning Objective 2.

- Alternative Energy Assignment: For take-home quiz #9, students are assigned to research one of the following alternative energies: hydroelectric energy, wind energy, solar energy, biomass energy, geothermal energy and nuclear energy. All alternative energies are found in California and the latest research and current politics behind each alternative energy were discussed. Each student are required to write a 2-3 sentences summary. During the next lecture, students worked in groups to decide what 3-5 interesting facts that their alternative energy spokesperson would present to the class. All alternative fuel facts are combined into one document and posted on WebCT. In Midterm #3, two short paragraph questions are given based on these alternative fuel facts.
- Nuclear Chemistry Laboratory: Students often have many misconceptions regarding nuclear chemistry and energy, mainly because these topics are usually skipped in previous science and chemistry courses. Once again, from survey data, students enjoy Chem 30A laboratory activities in nuclear chemistry that are held in the Nuclear Science Facility in Duncan Hall. The experiments provide students with "hands-on" inquiry-based activities in which students determine the half-life of a radioisotope as well as the number of pieces of paper in an unknown sample. Students use electronic nuclear detection devices and counting equipment. In both experiments, students must graph their results in order to determine and report their findings.
- In The Air Around Us unit, students are surprised to learn that the ozone produced from automobile exhaust (specifically from unused hydrocarbons and nitrogen dioxide) cannot be transported to fill the ozone hole in the stratosphere. In observing various reactions of metals and non-metals with oxygen and writing their observations, students begin to understand the components of acid rains and how it is formed. Acid rain is again revisited in the Acids and

Bases unit near the end of the semester. In the laboratory component, students construct a visible pH meter from various pH indicators (including red cabbage juice) and then test a variety of household products to determine their pH values. Students then group their results into acidic, neutral and basic categories.

Learning Objective 3: Students should be able to use the methods of science, in which quantitative, analytical reasoning techniques are used.

Out of approximately 300 students assessed, what percentage would you estimate:
Mastered LO3 at a high level 10% (averaged "B+" or better on assessment activities)

Mastered LO3 at an average level 50% (averaged between "C" and "B+" on assessment activities)
Either failed to master LO3, or did so at a marginal level 40% ("C-" or below on assessment activities)

What criteria (both formal and informal) did you use to estimate mastery of LO3?

- In lecture, we have students perform calculations in chemistry. We show them how to problem solve and have them work in small groups to help each other out. Many students comment in their end-of semester surveys that they finally have gained confidence in solving problems using their calculators.
- Take-home quizzes, laboratory report sheets and activities, midterms and the final exam have appropriate calculations that reflect quantitative concepts in chemistry such as chemical conversion problems, gas laws, stoichiometry, and acid/base problems.

Briefly summarize 2 or 3 examples of activities/assignments that have been successful in helping students meet GE Student Learning Objective 3.

- Develop an airbag: Students have to determine the volume of carbon dioxide that would create a plump sandwich ziplock bag from the reaction of baking soda and vinegar. This experiment involves using an Ideal Gas Law calculation as well as calculating the amount of baking soda and vinegar that would create a plump airbag. Students start by measuring the volume of the ziplock bag, writing the balanced equation of the reaction of baking soda and vinegar and then converting the ziplock bag volume to the number of moles of carbon dioxide using the Ideal Gas Law. Using the balanced equation, students can then find the number of moles of baking soda and vinegar. For the vinegar, students convert grams of vinegar to mL of vinegar by assuming that the density of the vinegar is approximately the same as the density of water. Once students calculate these amounts of baking soda and vinegar, students use an analytical balance to measure the amount of baking soda needed and a graduated cylinder to measure the volume of vinegar. They also must design how they are going to add these reagents before actually running the experiment. Students are graded on the "plumpness" of their airbag. The goals are to give students an experience in designing and carrying out a scientific experiment as well as to understand a model for an automobile airbag.
- Epsom Salt Lab: Students weigh out a quantity of Epsom Salt. Epsom Salt is a hydrate salt, meaning that each magnesium sulfate has a certain number of water molecules associated with it. The goal of this experiment is to determine the number of water molecules per magnesium sulfate. Using an analytical balance, students weigh their samples before and after heating them. Then, they can calculate the number of water molecules (actual number is seven) attached to each magnesium sulfate. Students also have to discuss the numerous sources of error associated with this experiment.

Assessment Activity Summary

a. Indicate where assessment activities have revealed that students had difficulty in meeting the Areas B1, B2, B3 Student Learning Objectives, and comment briefly on your experiences.

__XX__ Students had difficulty expressing mastery of Objectives in their writing (other than grammar, syntax, spelling, etc.)
_____ Students had difficulty expressing mastery of Objectives in their oral presentations
_____ Students had difficulty demonstrating mastery of Objectives in their interactions with other students
_____ Student research skills were inadequate to successfully complete assigned projects
__XX__ Student analytic skills were too weak to meet Objectives
_____ Students had difficulty applying scientific methods and theory to problems.
One or more of the Objectives were not sufficiently clear to the students and/or the professor (please explain briefly)

b. Which Learning Objective proved most difficult for students to master?

____LO3_____

Briefly, why was this so?

Since many students enrolled in Chem 30A are in remedial math, they have low confidence in their math abilities. However, with a lot of encouragement and opportunities to solve problems, we do observe an increase in their ability to solve problems in chemistry, especially conversion problems.

c. Briefly summarize course modifications that are planned or have been implemented to address any difficulties in meeting GE learning objectives that were summarized in previous questions.

Writing: To assist students in writing, we have provided rubrics for the various writing assignments, including written laboratory reports.
Analytical Skills: We provide many opportunities for students to develop their analytical skills. For Fall 2006 semester, we piloted POGIL worksheets. From listening in on the conversations, lab instructors could provide guidance and help students develop their analytical skills. These POGIL activities were immediately followed by laboratory activities that relate to the POGIL activities.

d. Briefly summarize course modifications that are planned or have been implemented to address any difficulties in meeting writing proficiency (both grammar, etc. and content expression/mastery) that were summarized in previous questions.

- Students' answers to questions that require a written explanation must be in complete sentences.
- We give students rubrics for report writing.
- We recommend that students have someone proof their work.

Inclusion of Content Objectives for Science Courses:

The following Content Objective is specific to Areas B1, B2 and B3

- All Science courses should demonstrate how scientists seek proof for causal relationships between microscopic phenomena and macroscopic observables.
- Area B1 - *Physical Science* courses focus on: laws of thermodynamics; structure of matter; interaction of matter and energy; behavior of physical systems through time; systems of classification; and physical processes of the natural environment.

- Area B2 - *Life Science* courses focus on: structures and functions of living organisms; levels of organization of living systems, from atom to planet; strategies for survival and reproduction; patterns of evolution; principles of genetics, including the basis for variation; and interaction of organisms and their natural environment.

Chem 30A Content Objectives Information:

The Chem 30A Fall 2006 course content has been aligned with the science content objectives. Please note that the alignment took into considering all activities, including lecture and laboratory, that were completed for a particular topic. The following key is used:

a. Causal relationships between microscopic phenomena and macroscopic observables.
b. Law of thermodynamics
c. Structure of matter
d. Interaction of matter and energy
e. Behavior of physical systems through time
f. Systems of classification
g. Physical process of the natural environment.

Chem 30A Course Content:

1. Molecular Reasons – Content Objectives a, c, f, g
2. Atoms and Elements – Content Objectives a, c, e, f, g
3. Light and Color – Content Objectives a, c, d, e, g
4. Molecules, Compounds, Chemical Reactions – Content Objectives a, b, c, d, e, f, g
5. Chemical Bonding – Content Objectives a, b, c, d, f
6. Energy – Content Objectives a, b, c, d, e, g
7. Nuclear Energy – Content Objectives a, b, c, d, e, f, g
8. Energy for Tomorrow – Content Objectives a, b, c, d, e, f, g
9. The Air Around Us – Content Objectives a, c, d, e, f, g
10. Oxidation and Reduction – Content Objectives a, b, c, d, e, f,
11. Especially Water/Soap – Content Objectives a, b, c, d, e, f, g
12. Acids & Bases – Content Objectives a, b, c, d, f, g
13. Organic Functional Groups – Content Objectives a, c, f

a. In light of what you have learned from your assessment activities, please give some examples of activities/assignments that have been particularly effective in incorporating issues of diversity into the course.

After careful reflection of this comment, we made some content and pedagogy changes to address the diversity issue. For the content, socio-economic aspects of society being able to access breakthroughs in chemistry, such as new drugs, are now discussed in lecture. For the two-page essay, many students chose to write on this topic. We also discussed how various countries do or do not have access to clean drinking water and alternative energy sources. For alternative energy sources, students had to research one of several alternative energy sources and then a representative of their group presented the most interesting facts to the class, including access to these alternative energy sources. We also discussed the growing roles of women in science.

Students were given an extra credit assignment to complete a service learning project. We piloted this assignment during the Fall 2006 semester. For this assignment, Chem 30A students conducted hands-on chemistry experiments with 4th and 5th graders who were, for the most part, from minority populations attending school in the local Five Wounds neighborhood (organized through ComUniverCity). This experience was the first time that these 4th and 5th graders had hands-on, inquiry-based science. Chem

30A students were mentored to use languages other than English if required. It was a smashing success that will be required in future Chem 30A courses.

b. Which Content Objective(s) proved most difficult for students to master? Structure of Mattter, Causal relationship between microscopic phenomena and macroscopic observables.
Briefly, why was this so?

- We cannot physically place our fingers on a molecule in a chemical reaction. So, we have to use models throughout the course for students to understand Structure of Matter. For example, students build ball-and-stick models that represent molecules. They then balance chemical reactions using these models. Still, some students struggle because it is difficult to them to create mental 3-D images of molecules and understand where or where not the electron density is that is involved in a chemical reaction.
- Also, the language of chemistry that we use can be confusing. We write NaCl(s) which means an extended lattice of sodium ions and chlorine molecules. There is no such thing as a single NaCl(s) molecule. Strong acids dissociate in water. For most people, "strong" means things stay together. Therefore, we are very careful in providing clear instruction when speaking the language of chemistry. We check for understanding several times during lecture, take-home quizzes, laboratory reports, midterms and final exams.

c. Describe how you meet the 1500 word-writing requirement (e.g. essay exams, 2, 3-page papers, etc.) Please briefly summarize the focus of 2 or 3 assignments that are particularly effective in meeting the writing goals of the course (include both in-class and out-of-class examples).

- Two formal 2-page laboratory reports are required.
- The POGIL worksheets have several questions where students can write down their answers. Also, their laboratory team must answer questions as a "ticket to leave" before leaving lab.
- All other laboratory worksheets have at least one question requiring students to write answers and conclusions based on their experimental results.
- All midterms have a short answer section that is worth at least 30% of the grade.
- At the end of the semester, students write a 1-2 page essay describing how their course helps them understand chemistry in their life. In Fall 2006, we expanded the list to include access to healthcare, alternative energy sources, and other public policy issues regarding chemistry.

Coordination

a. If this is a multiple section course or if different faculty teach this course during different semesters, please summarize how you coordinate the sections and the effectiveness of coordination activities in helping all sections meet GE Student Learning Objectives and implement the assessment plan. (N/A if not applicable)

Communication is the key. Dr. Resa Kelly and I co-teach this course during the Fall semester (as of Fall 2005). Dr. Ed Chichester typically teaches this course in the Spring semester. But, during the Fall semester, Dr. Chichester is the laboratory coordinator and attends all of our Chem 30A laboratory instructor meetings. He uses my laboratory activities, course structure, quizzes, handouts and assessment instruments when he teaches in the Spring.

All laboratory instructors are provided with a "Chemistry 30A Laboratory Instructor's Manual" binder. This binder contains grading keys and rubrics, safety instruction for each activity, in-depth instructions on the pedagogy required for each laboratory activity. The Chemistry 30A Assessment Plan is included in this binder.

We also have weekly Chem 30A laboratory instructor meetings to clarify and reinforce important issues to meet GE Student Learning Objectives. Student progress is reviewed during these meetings.

b. Have faculty teaching in this course had discussions regarding measurement or grading of the accomplishment of Core GE Learning Outcomes? _____ Briefly _XX____ In-depth _____ No
Have any rubrics or other formal measuring tools been developed that could be used across sections?
__XX___ Yes _____No
If yes, please describe briefly or attach. (As an example, attached is the Chem 30A NaCl Crystallization Report Rubric.

If no to both questions, and if different faculty use different assessments for the same Objective, how do the Coordinator and the faculty ensure that comparable assessments are being made?

Evaluation of the Assessment Activities

Are the assessment activities you are using unchanged from the plan submitted with the GE certification request? No

In terms of the original assessment plan submitted with the course certification, the assessment plan
_____met our needs and continues to be used
XX_____requires/required some modification
_____requires/required major changes to be useful

Please explain your response to the above, and include a summary of modifications that have been made or that you intend to make to your assessment activities:

Modifications that have been made: In Fall 2006, we piloted take-home quizzes instead of giving quizzes during the first 30 minutes of laboratory. This change was made to allow students to discuss the weekly chemistry concepts and problems together and to use laboratory time more efficiently and directed toward learning. Therefore, we added two more midterms for individual accountability. It worked pretty well during the Fall 2006 semester. Students definitely felt the take-home quizzes were effective. Most commented on the end of semester survey that they felt they learned the material better when they could discuss it with each other. We also introduced POGIL activities in place of the weekly quizzes. We still have some revising to do, but I am confident that we will make these changes permanent for the Fall 2007 semester.

Additional Comments
Please include any additional comments you have here.

We piloted WebCT with 300 students during the Fall 2006 semester. It was extremely well received by the students.

The Service Learning component was awesome and will be mandatory for Fall 2007 semester.

Data Collection
Please attach a copy of the report format or form you used to collect data from instructors teaching this course.
We use our weekly laboratory meeting to collect and review data from instructors. I note changes in the master curriculum folder. Regarding students' low quiz and midterm scores, we try to identify these students early and encourage them to see the course instructor for assistance.

Date Summary Completed: January 23, 2007