UNIVERSITY OF SAN FRANCISCO | College of Arts and Sciences

Chemistry Majors and Minors Aggregate Report

ASSESSMENT REPORT

ACADEMIC YEAR 2017 – 2018

REPORT DUE DATE: 10/26/2018

I. LOGISTICS & PROGRAM LEARNING OUTCOMES

Please indicate the name and email of the program contact person to whom feedback should be sent (usually Chair, Program Director, or Faculty Assessment Coordinator).

Lawrence Margerum, Faculty Assessment Coordinator and acting chair

Were any changes made to the program mission statement since the last assessment cycle in October 2017? Kindly state "Yes" or "No." Please provide the current mission statement below. If you are submitting an aggregate report, please provide the current mission statements of both the major and the minor program.

No. We felt that this length of statement was the best way to capture what all faculty desire

USF Chemistry Department Mission: To deliver a broad-based and challenging chemistry experience that will train students for graduate school in science or as professionals in a variety of health, government or private industry positions. The program will foster a culture that values our students, faculty and staff; strives to help students become self-learners; creates opportunities for students to discover the excitement and creativity of research, and promotes an understanding that social consciousness and ethical behavior are essential features of a principled chemistry community.

Were any changes made to the program learning outcomes (PLOs) since the last assessment cycle in October 2017? Kindly state "Yes" or "No." Please provide the current PLOs below. If you are submitting an aggregate report, please provide the current PLOs for both the major and the minor programs.

No, the Current PLOs are aggregated:

LO #1: Students will demonstrate their mastery of the four principle disciplines: analytical, organic, physical, and inorganic chemistry.

LO#2: Students will recognize and understand the concepts and skills learned in prerequisite courses at or before the start of the new course or laboratory

LO#3: Students or student teams will demonstrate mastery in problem solving by performing a broad variety of analytical, computational and synthetic procedures using proper safety protocols, and will critically evaluate the results

LO#4: Students will demonstrate effective scientific communications skills in both written and oral form. Students will be able to write reports and present results while following professional policies regarding intellectual property, plagiarism, and group work

LO#5: Students will be encouraged and recognized when they go beyond the minimum requirements in the major via semester or summer-long activities that apply the knowledge gained in the discipline, such as research at USF, NSF-REU programs, science internships, discipline-related volunteer or paid science positions, ongoing outreach/teaching in science or PLTL leadership experience.

Which particular Program Learning Outcome(s) did you assess for the academic year 2017-2018?

LO #1 and LO#4; but due to faculty departures we collected alternate data for Organic Chemistry courses as best we could. Some faculty choose to assess additional LO's as indicated

II. METHODOLOGY: Describe the methodology that you used to assess the PLO(s).

LO#1: ACS standardized test in select courses (every year). Benchmark = at or above national mean.

LO#4: In class presentations or CARD posters/presentation or lab reports graded by rubric and compared

Additional information: Chem 397 Research Methods: Students produced numerous drafts of posters before presenting in a formal setting, either the USF- CARD and/or the Northern California ACS Undergraduate Research Symposium. Poster presentations were evaluated by 1 - 3 faculty members using a rubric attached.

Organic Chemistry I and II (Chem 230-231): Use grade/withdrawal data from Chem. 230 and 231 to determine if there is a correlation in student performance going from Organic Chemistry I to II.

III. RESULTS & MAJOR FINDINGS

What are the major takeaways from your assessment exercise?

We choose to break down results into courses, but discussions are departmental wide:

Takeaways:

- We are on track with matching national mean scores in all ACS exam we give.
- We need to find ways better support students who come into a course with a C/C+ grade pre-requisite.
- We need to give students more practice on presentation/reports earlier in our sequence.
- Student do not get enough technical writing practice in our USF RHET courses (department opinion based on the poor grammar/argument construction and formatting of lab reports)

Results LO#1: Content knowledge

CHEM 113 General Chemistry II: ACS National Exam Form 2007 (70 MC questions in 120 min). The benchmark of at or above national mean was achieved. Approximately 55% of students were at or above the mean showing most or full mastery. The variations between 3 sections was small (all students use the same online homework assignments, but different exams) and these results are similar to the last few years.

National Statistics	N=178 in 3 sections of Chem 113
Mean = 39.4 out of 70	38.8
StdDev= 11.6	10.5
Median = 38.8	39.5
High	63.0
Low	13.0
% of National mean	98.5%

CHEM 260 Analytical Chemistry: ACS exams Form 2013

Year to year ACS scores results in Chem 260 have small sample sizes, so variations are likely in the benchmark. This year is within the range of the last 2 years for this Form 2013 (94-100% of national).

It is apparent that the students are having trouble grasping the more applied side of chromatography (see questions 46 - 49). The students also performed poorly on the electrochemistry questions (40 - 44).

National Statistics ACS exams Form 2013	N=27
Mean = 26.1	24.67
StdDev= 7.1	5.82
Median = 25.0	23.75 (50% of students mastered almost all)
High	38
Low	13
% of National mean	94.4%

CHEM 230 and 231: Data on performance in second semester of the sequence

Summary for Organic: Although there are exceptions, our overall grade data indicates that for the majority of students in Organic Chem 231 their grade drops somewhat from the first semester to the second, including those who received grades in the A range in Chem. 230.

Students who received grades in the C range in Chem. 230 often struggled in Chem. 231, ultimately receiving a C- or lower.

Results

156 students in Chem. 230 – [67 students, C-/D/F/W] = 89 eligible for Chem 231*
* C or C+ in Chem. 230 = 27 (17%)

85 enrolled in Chem 231** (54% of those starting Chem 230)
**4 Students with a C or higher didn't enroll in Chem. 231 (2.6%)

Withdrawals from Chem. 230 = 36 (23%)
Grades below C in Chem. 230 = 31 (20%)
Total = 43%

Withdrawals from Chem. 231 = 5 (6%)
Grades below C in Chem. 231 = 11 (13%)
Total = 19%

Breakdown of Grades in Chem. 231

- C-/D/F/W in Chem. 231 with C/C+ in Chem. 230 = 12 (14% of Chem 231)
- C-/D/F/W in Chem. 231 with B in Chem. 230 = 3 (1 withdrawal) (3.5% of total enrolled)
- C-/D/F/W in Chem. 231 with A in Chem 230 = 0 (0 withdrawals) (0%)

CHEM 420 Inorganic Chemistry: ACS exams

The course is in transition to a 3rd year course (Foundational) versus previous 4th year (capstone, in-depth). Thus, at least 5-8 out of 60 questions are guessing by students. For Fall 17, 75% of students were at or above the national mean which we interpret as mastering most of our material. The mean was the same as the previous year with the same instructor, but Fall 17 had double the students versus F16.

National Exam (**60 MC questions**-2009 Form)	Fall 2017 (n=21 2009 Form)
Mean = 31.8 out of 60	33.5 (105% of national)
StdDev= 8.95	6.1
Median= 31.2	33.62 (range 23-46)
% students at/above national mean	76% (mastery of most)
% students below national mean	24% (5 students); some mastery

Results LO#4: Communication of science

CHEM 260 Spring 2018. Lab reports for Experiment #8: Analysis of Metals in Industrial Waste Water. Randomly chose reports from the middle of the class (not the top students or the bottom) since they are representative of the average

At this point in the semester the students have written 4 full lab reports. For the first one, they turned in a draft to me and I gave feedback before they wrote a final draft. For the second one, each report was reviewed by two of their peers. This experiment was complex with lots of data, data analysis, and interpretation.

Results:

Weakness: Most data (in the form of calibration curves and data tables) was not explained in the text. Possible sources of error were not discussed in depth or were not realistic. The conclusions were not thoroughly backed up by the data, incomplete, or discussed without much consideration of uncertainty.

Strength: Most students are good at the formatting, at the writing the experimental sections and competent at the introduction.

The results (my grade listed first - TA's grade 2nd):

Report #1: 87% and 92% Report #2: 86% and 88% Report #3: 67% and 57%

CHEM 420 Inorganic Chemistry: This semester the course had a 100% increase in students over 2016. The 21 students had to be separated into two 4-hour lab periods (with an MS student TA added) and experimental time was reduced by 30%. Some topics (lecture and lab) were moved out to teach the course like a third-year foundational course.

Results: A PowerPoint presentation on Lab Project 5 in lab (end of semester). Rubric grading by the instructor (not reviewed by other faculty due to time constraints).

Average Score: 85% (range: 76-96%): 10 presentations

100% of the students mastered the outcomes of most parts

~20% of the students did not fully master the "professional graphing" outcome

~10% of the students did not fully master the conclusion outcome

CHEM 397 Research Methods and Practice – Assessment of Scientific Communication Skills

What was learned? Out of a possible overall score of 5 (for outstanding), only one student received an average of 4 (good), while the five other students ranged between 3 (average) and 2 (fair). On average, students effectively used graphs and other visual aids (3.9), but struggled with over-interpretation of results (generalizations and conclusions with adequate and sound evidence was 3.2).

1: strongly disagree

2: disagree

3: neither agree or disagree

4: agree

5: strongly agree

Overall the student's work shows that the student:	Average score for all 6 students
demonstrates understanding of the problem and how problem was attacked and solved.	3.4
demonstrates effective organization of their project, poster, seminar.	3.7
demonstrates effective use of graphs and other visual aids.	3.9
uses effective writing and appropriate technical vocabulary (good grammar, spelling, coherent writing. clear exposition)	3.5
shows an ability to use instrumentation useful in solving the problem.	3.4
collected reasonable data useful in solving the problem.	3.8
uses literature properly in presentation.	3.6
supports their generalizations and conclusions with adequate and sound evidence.	3.2
demonstrates effective learning of several laboratory skills.	3.7
Overall impression of the project, poster, presentation, etc. Please rate your overall impression. 1 (poor) 2 (fair) 3 (average) 4 (good) 5 (outstanding)	3.4

Assessment of LO #2: Do students understand concepts learned in the prerequisite course?

What was done? A quiz in Biochemistry II on material from Biochemistry I was given on day 1. Students worked individually on the 14 multiple choice questions and 1 open-answer question.

Material First-day assessment of BioChem I	Format (MC = multiple choice)	% correct
pH	1 MC	55%
Protein structure and function	9 MC	43%
Biochemical techniques	1 MC, 1 open-answer	23%
Nucleic acid structure	1 MC	55%
Lipids and membrane structure	2 MC	45%

What was learned? The students were woefully unprepared for Biochemistry II. Only two students met the benchmark of 60% on the assessment. Students reported that they had not learned the material in Biochemistry I because of the poor quality of instruction.

What changes will be made? Due to a shortage of full-time chemistry faculty, the instructor for the prerequisite course was an adjunct lecturer who had little college level experience. In the future, the chemistry department hopes to minimize the number of courses, especially upper-level courses, taught by adjunct lecturers.

IV. CLOSING THE LOOP

Based on your results, what changes/modifications are you planning in order to achieve the desired level of mastery in the assessed learning outcome? This section could also address more long-term planning that your department/program is considering and does not require that any changes need to be implemented in the next academic year itself.

LO 1: Changes?

General Chemistry Lecture approach will not be changed. However, based on TA and faculty feedback, the Labs (Chem 112/114) will be changed by using the following Learning Outcomes (FDF project by Margerum which started in Chem 114 S17-18; Chem 112 F18 and will last 2 years):

Goals of General Chemistry 112 Lab Changes:

- Introduce all new Green Chemistry inspired experiments by re-writing UC-Berkeley and other experiments that help students act and write like working chemists.
- TAs and students will be trained to effectively use writing and reasoning via the Science Writing Heuristic (SWH, Iowa State University) in carbon copy laboratory notebooks.
- To inspire students to think about the environment via Green Chemistry principles put into practice.
- To better prepare students for success in second semester general chemistry lab and beyond

Chem 260 Analytical: TNew active learning group activities on the fundamentals of chromatography were successfully used for the first time in S18 (developed from an NSF Workshop). The issue of low ACS scores on applied chromatography and electrochemistry will be addressed with a new student-centered activity.

Long term: This course will be change in Spring 2018 to one 4-hr lab/wk instead of two 3-hr labs/wk (30% reduction) in order to achieve two goals:

1. Reduce the lab load for second year chemistry majors who typicall have 3 or 4 Science courses in 2nd year spring.
2. Move the saved lab hours to add a new upper division, in-depth lab courses (in depth inorganic/analytical)

Chem 420 Inorganic: We learned that most of what we have in this course is foundational in content and aligns with ACS exam fairly well (averages and ranges did not go down).

Long term: In Fall 2018, the course will be re-branded as Chem 320 "Foundational" Inorganic Chemistry I, with modified outcomes (all chemistry tracks take this course). A new ACS exam is being examined that aligns more closely with Foundational Inorganic material. A new Chem 4xx Inorganic/Analytical course/Lab will be developed to align with ACS certification standards.

LO 4: What changes will be made?

Poster quality improved significantly after iterative drafts and revisions. Firmer guidelines will be given to students regarding each draft, providing them with more structure to avoid last minute editing. More faculty will be recruited to evaluate posters to provide more meaningful assessment. The low number of evaluators (in some cases, only 1) did not allow for in-depth analysis. Lastly, the faculty in charge of the course will coordinate efforts with the research advisor more regularly.

The in-lab presentations were generally good and this will continue next year in many of our lab courses.

Lab report writing: Student discussion of results and interpretations are still weak. More focus on data interpretation and error analysis would help - possibly using some group activities where the students are given data and have to interpret, analyze, and report out. Chem 420 piloted "WriteLab" software that analyzes student writing and make ssuggested changes to grammar, sentence structure and common word useage (it is not geared toward technical writing and was somewhat useful for the instructor)

What were the most important suggestions/feedback from the FDCD on your last assessment report (for academic year 2016-2017, submitted in October 2017)? How did you incorporate or address the suggestion(s) in this report?

Suggestions to scale back on the number of assessments per year was received too late, but many of us now do multiple assessment per course, regardless. AY18-19 will focus on LO#4: Communication of Science as this gives us the most issues/hair pulling as faculty evaluators.

Suggestion to get multiple reviews on rubric grading and somehow normalize them is unrealistic for in class presentations (faculty time/schedules). In courses with trained TAs we feel comfortable checking report grades as reported above. We will try to increase the use of poster rubrics with more faculty review. This falls on the professor in charge of 397.

ADDITIONAL MATERIALS

(Any rubrics used for assessment, relevant tables, charts and figures should be included here)

Poster presentation rubric report under results

Chem 420 PowerPoint Lab Project Presentation

- (10%) Presentation: speaking clearly, eye contact, shared work
- (10%) slide 1 = title, names, date and goal of project clearly stated/well organized
- (50%) slide 2, 3, 4= Professionally rendered xy plots/correlations of variables from whole class data with a linear trend line/fit + equation
- (30%) slide 5=Conclusion: How the variations in pyridine ligands change the color of these complexes
    - trends based on electron withdrawing or donating groups on the pyridine
    - Use evidence and theory to back up your claim

Lab report rubric under consideration (variations of this were used by various faculty):

From Susan Young, Hartwick College	Beginning or incomplete 1	Developing 2	Accomplished 3	Exemplary 4	Score
Title	Title page is missing	Several aspects of title page are missing	Title page is present some information missing.	Title page present, with name, class and date.	
Introduction	Very little background information provided or information is incorrect. Missing the Goal of experiment or hypothesis being tested	Some introductory information, but still missing some major points. Goal of experiment or hypothesis is not clear.	Introduction is nearly complete, missing some minor points. Goal of experiment or hypothesis being test is there, but too general	Introduction complete and well-written; provides all necessary background principles for the experiment. Goal of experiment or hypothesis being tested clearly stated	
Methods Materials (or Experimental)	Missing several important experimental details or not written in paragraph format	Written in paragraph format, still missing some important experimental details. Paragraphs not all in passive/past tense.	Written in paragraph format, important experimental details are covered, some minor details missing. Most all in passive/past tense	Well-written in paragraph format, all experimental details are covered, passive/past tense voice.	
Figures Graphs Tables	Figures, graphs, tables contain errors or are poorly constructed, have missing titles, captions or numbers, units missing or incorrect, etc.	Most figures, graphs, tables OK, some still missing some important or required features. Incomplete titles and captions.	All figures, graphs, tables are correctly drawn, but some have minor problems or could still be improved (i.e. descriptive captions)	All figures, graphs, tables are correctly drawn, are numbered and contain titles above tables and descriptive captions below figures.	

Results Discussion Conclusions	Very incomplete or incorrect interpretation of trends and comparison of data to a larger body of work indicating a lack of understanding of results. Tables/graphs/figures not placed after written introduction Conclusions missing or missing the important points	Some of the results have been correctly interpreted and discussed; partial but incomplete understanding of results is still evident. Not all Tables, graphs, figures placed after a written introduction to them. Conclusions regarding major points are drawn, but many are misstated, indicating a lack of understanding	Almost all results have been correctly interpreted, are discussed, only minor improvements are needed. Tables/graphs/figures placed after written introduction. All important conclusions have been drawn, could be better stated	All important trends and data comparisons to larger bodies of work have been interpreted correctly and discussed, good understanding of results is conveyed. Tables/graphs/figures placed after written introduction. conclusions clearly made, student shows good understanding	
Spelling Grammar Sentence structure	Frequent grammar and/or spelling errors, writing style is rough and immature	Occasional grammar/spelling errors, generally readable with some rough spots in writing style	Fewer grammar/spelling errors, mature, readable style	All grammar/spelling correct and very well-written	
Appearance Formatting	Sections out of order, too much handwritten copy, sloppy formatting, pages are not numbered	Sections in order, contains the minimum allowable amount of handwritten copy, page numbers could be missing, formatting is rough but readable	All sections in order, pages are numbered, formatting generally good but could still be improved	All sections in order, well-formatted, pages are numbered, very readable	
References: only 2 styles accepted; superscript[1] or bracket citations [1]. Numbered list at end.	Did not include any information from other sources	Included information from only one additional source other than lab manual or lab book	Included information from multiple additional sources other than lab manual or lab book but formatting is inconsistent or not in an accepted style	Included information from multiple sources other than lab manual or lab book and formatting is consistent and appropriate	