Annual Assessment of Program Learning Outcomes

BS CHEMISTRY FALL 2016-SPRING 2017

Section I: Academic Details

1. Assessment Year (Choose one)

a. AY 2016-2017

2. College/School (Choose one)

a. College of Arts & Sciences

3. Degree Program Name and Modality of Delivery (e.g., online, on-ground, hybrid)

On-ground

Section II: Program Learning Outcomes Assessment

4. Program Learning Outcome Assessed (Write only one PLO)

LO #1: Student will demonstrate his/her mastery of the four principle disciplines: analytical, organic, physical, (biochemistry) and /or inorganic chemistry

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5. Indicate how the PLO mentioned in Question #4 aligns with one or more of the Institutional Learning Outcomes (ILOs) (Check all that apply)

a. ILO2 (Students explain and apply disciplinary concepts, practices, and ethics…)
b. ILO3 (Students construct, interpret, analyze, and evaluate information…)

6. Indicate which of the following Direct Measures of Assessment were used to assess the PLO mentioned in Question 4 – (Check all that apply)

Please note that a PLO can be assessed using both direct and indirect measures

a. Published (Standardized) Test (e.g., Major Field Test)
b. Class Tests & Quizzes with Embedded Questions

7. Indicate which of the following Indirect Measures of Assessment were used to assess the PLO mentioned in Question 4 – (Check all that apply)

NONE

Section III: Results

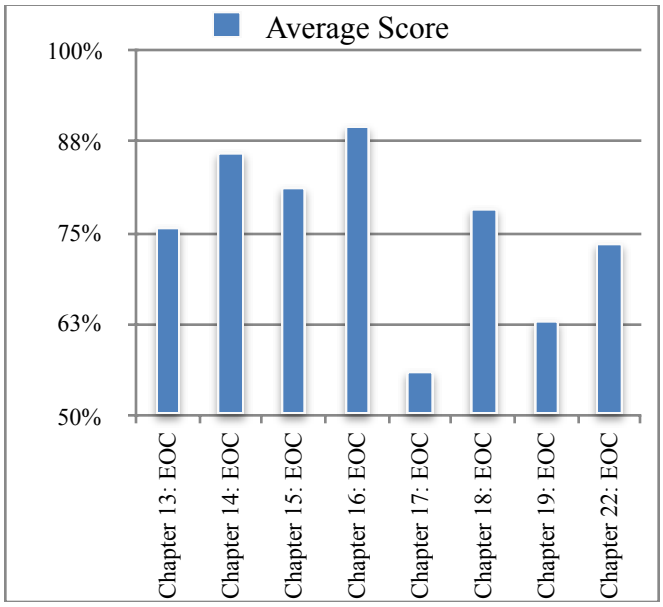
8. Mention KEY Results of the Assessment Process

A. The American Chemical Society (ACS) standardized subject exam was administered at the end of General, Analytical and Inorganic Chemistry (Chem 113, 260 and 420) to all students (~10-15% chem majors in Chem 113, 90-100% in Chem 260/420).

% of National Average ACS subject exam	Section 1(WM)	Section 2(JCC)	Section 3(LDM)
Chem 113	97.6%	91.2%	104.9%
Chem 260(RW)	89.2%		
Chem 420(LDM)	125.1%		

These results fall a bit below our benchmark of at or above national average in some sections of chem 113 and 260. Yet, the results have large variations and are in-line with data going back to 2008-09 (chem 113 range: 87-97%; chem 260 range: 89-103%; chem 420 range (99-126%). As senior chem majors in chem 420 our students consistently score above the national average despite having only 1 semester in Inorganic chemistry.

B. **OWL for Chem 113**: On-line Homework Result (End of Chapter performance: 2 attempts/no help or online feedback, not timed) in Chem 113.



These chapter scores are all slightly above the global average (not shown). Further analysis shows our student underperformed the global average on only 3 of 17 questions in Ch.17:EOC, so this material (Kinetics) is difficult.

In addition, OWL time on task for student homework giving a **weekly average time of 7hr 4 min** over the entire semester on all question types (Mastery, EOC, MultiMedia). Considering that a 3 unit lecture course should have 9-12 hours study time outside of class, this value is a bit low if students are not doing much else besides on-line homework.

C. We embedded the same questions on the final exam for the three sections of the **Organic Chemistry II** lecture. These questions attempted to ascertain student understanding of the following key aspects of organic chemistry: mechanisms, molecular orbital theory, synthesis, relative acidity, and spectroscopy.
Data for 3 sections (74 students total)

	Mechanism	Theory	Synthesis	Acidity	Spectroscopy
Section 1 (JL, n=25)	57%	63%	77%	81%	87%
Section 2 (WK, n=25)	37%	72%	70%	66%	75%
Section 3 (JH, n=24)	60%	73%	63%	59%	65%
Weighted Average for all sections (n=74)	**52%**	**69%**	**70%**	**69%**	**76%**

Only the student's ability in mechanism is significantly below our benchmark of 60% correct. However, this is skewed by one section's students (section 2) doing particularly poorly on this question. It is difficult to determine why the students in section 2 performed at a lower level on this question. All three instructors did a significant amount of in-class and homework problems practicing this skill. Therefore this difference between the sections is difficult to explain. Regardless of the difference between sections on the mechanism question, in general student performance on that question was borderline at best. The question involved an intramolecular reaction mechanism, and students often have difficulty with those.

Students are strong in most areas, especially NMR and IR spectroscopy. Their performance has particularly improved in synthesis, relative to recent years.

C. No data for Chem 341 and 351 was collected this year.

Section IV: Continuous Improvement

9. Indicate Actions the Program Faculty Have Taken in Response to Results
(Check all that apply)

a. Changes in pedagogical practices

General Chemistry (Chem 111/113 + Labs):

No large changes are anticipated in topics for Chem 111/113.

OWL homework was changed to include required *Adaptive Study Modules* (students take an assessment quiz on each chapter and are directed to extra problems in the chapter Learning Objectives that they did not pass). In addition, timed practice exams were created as an optional assignment.

Chem 114Lab was re-structured (LDM) to embrace Guided-Inquiry Lab Problems with a Green Chemistry Theme via modification of some UC-Berkeley lab materials. Research Notebooks were required for the first time, with pre-lab copies handed in for grading with focused mini-lab reports (3 or 4) uploaded to Canvas.

Our chemistry diagnostic test (advisory only for placement into Chem 111 or Chem 001) was taken 402 times from April-August 2017. Fall 2017: 270 students enrolled in Chem 111, 30 students in Chem 001 (75% of test takers). Evidently many students are taking the diagnostic and putting off Chemistry or not taking it at all (unclear).

Average score was 46% of the points (23 correct answers x 5 points - 19 incorrect x 1 point). We advise students they are prepared for Chem 111 at 49% and above (a low bar). Based on the evidence the diagnostic is at least showing students their preparation level or lack there of. Yet despite our extra support offering PLTL workshops, TA office hours (2 hr/week/TA) not enough students use these tools.

Organic Chemistry (Chem 230/231 + Labs):

In all categories but one (mechanisms), students performed significantly above our benchmark of 60%. We may incorporate more practice questions involving intramolecular reaction mechanisms, and explicitly help students understand which parts of the product derive from which parts of the reactant molecule.
We are considering changing textbooks for Chem 230/231. The current book does not provide enough good practice problems related to key mechanistic concepts. Hopefully this change will improve students' performance on mechanisms. There is also a new course, Advanced Organic Synthesis (Chem 334), in which students gain more experience not only in synthesis but also in mechanisms.

Analytical Chemistry 260 + Labs

The ACS subject exam here is one of the lower scoring in general (not all topics are covered in our 1 semester course). In future, there will be a greater emphasis on separations (GC-MS and HPLC) and less on titration analysis.

Inorganic Chemistry 420

This senior level course will be changing to a foundational junior level course (no Physical Chemistry pre-requisite) by fall 2018. A new faculty member in Inorganic Chemistry will also start teaching in that new course.

In fall of 2017 there were 9 students with LDM doing lecture and JCC doing 2x6 hr lab per week. LDM changed philosophy in the course by implementing CriticalThinking.org teaching techniques and philosophy (pre-lecture reading notes, flash cards, group inquiry learning, daily presentations of problems). JCC was able to work with this smaller cohort of students at a high level for lab techniques and laboratory report writing). The ACS exam score average was the highest we have seen since giving the exam (small data set of especially good students).

USF Chemistry Map PLO—> Institutional Learning Outcomes

Institutional Learning Outcomes —>	**ILO #1**	**ILO #2**	**ILO #3**	**ILO #4**	**ILO #5**	**ILO #6**	**ILO #7**
USF BS Chemistry PLO (Program Learning Outcomes)	Students reflect on and analyze their attitudes, beliefs, values, and assumptions about diverse communities and cultures and contribute to the common good. **(Critical Thinking)**	Students explain and apply disciplinary concepts, practices, and ethics of their chosen academic discipline in diverse communities. **(Critical Thinking)**	Students construct, interpret, analyze, and evaluate information and ideas derived from a multitude of sources. **(Critical Thinking; Quantitative Reasoning; Information Literacy)**	Students communicate effectively in written and oral forms to interact within their personal and professional communities. **(Written and Oral Communication)**	Students use technology to access and communicate information in their personal and professional lives. **(Component of Information Literacy)**	Students use multiple methods of inquiry and research processes to answer questions and solve problems. **(Critical Thinking; Quantitative Reasoning; Information Literacy)**	Students describe, analyze, and evaluate global interconnectedness in social, economic, environmental and political systems that shape diverse groups within the San Francisco Bay Area and the world. **(Critical Thinking)**
#1. *Students will demonstrate their mastery of at least four principle core disciplines: analytical, organic, physical, biochemistry and inorganic chemistry.*		x	x			x	
#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.*		x	x			x	
#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.*	x	x	x	x	x	x	
#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 ethical group work.*			x	x	x	x	
#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.*	x	x	x		x	x	x

Assessment Plan Date:	**July 1, 2016**
School/College:	**College of Arts and Sciences**
Department/Program:	**Chemistry/BS**
Person completing the Plan:	**Professor Larry Margerum**

Chemistry Department Mission Statement:

The Mission of the Undergraduate Chemistry Program at the University of San Francisco is 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.

BS Program Student Learning Goals:

- To offer a coherent program of course work in the core areas of chemistry and biochemistry that provides a modern foundation for subsequent in-depth course work or research experiences
- To challenge student teams with hands-on laboratory and computational experiences, using modern, sophisticated instrumentation supported by qualified staff that encourages students to extend their chemical understanding by application of the scientific method
- To emphasize the accumulation, retention and transfer of scientific concepts and skills throughout a curriculum in which faculty members accommodate a variety of learning styles and use personalized feedback to help students become responsible problem solvers and self-learners
- To foster a community of chemists that values the excitement and discovery inherent in teaching, learning and researching all the areas of chemistry and biochemistry
- To help students attain the professional skills necessary to succeed in their chosen careers, including an appreciation for safe, ethical and socially conscious behavior

BS Chemistry Program Learning Outcomes (LO):

1. Students will demonstrate their mastery of the principle core disciplines and/or areas of emphasis: analytical, biochemistry, inorganic, medicinal, organic and physical chemistry. (*Knowledge, Application*)

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 (*Knowledge and Comprehension*)

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 (*Application, Synthesis and Evaluation*)

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 ethical group work. (*Comprehension and Analysis*)

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 (Peer Led Team Learning) leadership experience. (*Knowledge, Application, Synthesis and Evaluation*)

BS Chem Curriculum Map: PLO—> Courses: Years 1-3 (Fall 2016-S2019)

Chemistry Program Learning Outcomes I = Introduced U= Utilized **A=Assessed**	**113**	**114L**	**230**	**232L**	**231**	**234L**	**260**	**340/341**	**3XX**	**332**	**350/351**	**352L**	**410**	**420**	**397**	**Electives**
Year 1: AY 16-17 **Year 2: AY 17-18** **Year 3: AY 18-19**	**General II**	**General Lab II**	**Organic I**	**Organic Lab I**	**Organic II**	**Organic Lab II**	**Analytical + Lab**	**Physical**	**Advanced Lab**	**Medicinal**	**Biochemistry I/II**	**Biochemistry Lab**	**Integrated Lab**	**Inorganic**	**Research**	
LO #1: Student will demonstrate his/her mastery of the four principle disciplines: analytical, organic, physical, and inorganic chemistry	I		I		A		A	A			A		U	A	U	
year of assessment					1-3		1-3	1-3			1-3			1-3		
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	I		A		U		A	A	U	U	A	U	U	A		U
year of assessment			1				1	2			2			3		
LO#3: Students or student teams will demonstrate excellent problem solving skills in performing a broad variety of analytical, computational and synthetic procedures using proper safety protocols, and will critically evaluate the results		I		I	U	U	A		A			A	A	A	U	
year of assessment		1-3					1-3		2			2	3	3		
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		I				A	A	U	U	A		U	U	A	A	
year of assessment (written)		1				2	2							3	1-3	
year of assessment (oral)								2-3		2-3					3	
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.						I	I		I			I	U		A	U
year of assessment															1-3	1-3