CALIFORNIA STATE UNIVERSITY EAST BAY

College of Science (CSCI)
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2016-2017 CSCI EETF Assessment Year End Report, June, 2017

Program Name(s)	EETF Faculty Rep	Department Chair
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[NOTE: Items A, B, C, and D are identical to your Page 2 on your Annual Report for CAPR. Please simply cut and paste from there. Item E is unique to the CSCI EETF.]

A. Program Student Learning Outcomes

Students graduating with a Chemistry B.A./B.S. from Cal State East Bay will
1. demonstrate knowledge in the various areas of chemistry, including inorganic chemistry, analytical chemistry, organic chemistry, physical chemistry, and biochemistry.
2. work effectively and safely in a laboratory environment to perform experimental procedures and operate modern chemical/biochemical instruments.
3. use quantitative reasoning to analyze chemical problems and evaluate chemical data.
4. write and speak clearly on chemical or biochemical issues.
5. work collaboratively in teams to solve chemical problems.

B. Program Student Learning Outcome(s) Assessed

4. write and speak clearly on chemical or biochemical issues.

C. Summary of Assessment Process

As stated in our five-year assessment plan, in 2016-2017 we specifically concentrated on Program Learning Outcome #4 which concerns assessing communication. In addition we continued to assess program content through Program Learning Outcome #1 (Demonstrate knowledge in the various areas of chemistry) and Program Learning Outcome #2 (Work effectively and safely in a laboratory environment to perform experimental procedures and operate modern chemical/biochemical instruments).

Written communication assessment was conducted in Bioanalytical and Forensic Chemistry Laboratory (CHEM 3200). Demonstrating knowledge in the various areas of chemistry was conducted through the courses Organic Chemistry (CHEM 3301-02-03), Physical Chemistry (CHEM 3511-12-13), Instrumental Methods of Analysis (CHEM 4240), and Advanced Inorganic Chemistry (CHEM 4162) through the use of standardized national exams and embedded exam questions. The laboratory assessment was conducted in capstone laboratory exercises for the ability to critically analyze experimental results in CHEM 3303 and CHEM 4240.

D. Summary of Assessment Results

Bioanalytical and Forensic Chemistry Laboratory
CHEM 3200 Spring 2017
Chemistry PLO #4: write and speak clearly on chemical or biochemical issues.
Chemistry PLO #2: work effectively and safely in a laboratory environment to perform experimental procedures and operate modern chemical/biochemical instruments.

Assessment tool: Analysis of typed laboratory reports on 'Separation of a mixture of drug molecules by liquid-liquid extraction, and characterization via TLC and FT-IR analysis' using a defined rubric that scored the following characteristics on a scale of 1 to 3 (3 being the highest).

	No. of students scoring 3 in all assessed areas			
	BS Chem	BA Chem	BA Biochem	Total
Report organization	5/6 (83%)	2/2 (100%)	0/1 (0%)	7/9 (78%)
Visualization	6/6 (100%)	2/2 (100%)	0/1 (0%)	8/9 (89%)
Mechanics	6/6 (100%)	2/2 (100%)	1/1 (100%)	9/9 (100%)
Subject Knowledge	4/6 (67%)	1/2 (50%)	0/1 (0%)	5/9 (56%)
Overall Communication	4/6 (67%)	1/2 (50%)	0/1 (0%)	5/9 (56%)

Analysis: Total no. of students scoring 3 in all assessed areas (total 15 points): 5 out of 9 (56%).
Total no. of students scoring 13 points: 7 out of 9 (78%).
Total no. of students scoring 11 points and higher: 9 out of 9 (100%).

Plans: Implement an in-class writing exercise next year.

Organic Chemistry
CHEM 3303 Spring 2017
Chemistry PLO #1: demonstrate knowledge in the various areas of chemistry, including inorganic chemistry, analytical chemistry, organic chemistry, physical chemistry, and biochemistry.
Chemistry PLO #2: work effectively and safely in a laboratory environment to perform

experimental procedures and operate modern chemical/biochemical instruments.

Assessment Tool: Standardized national exam taken as the final exam and analysis of capstone project lab reports

Students who successfully complete the year-long series of organic chemistry should:

1. be able to predict bonding, nomenclature, chemical properties and some physical properties of organic compounds if the molecular structure is known.
2. be able to identify common organic functional groups and show a knowledge of the chemistry and reactivity of each functional group.
3. be able to use the results of the common spectroscopic methods (NMR, IR, UV and mass spectroscopy) to determine the structures of simple organic compounds.
4. know and understand the common reaction mechanisms of organic reactions, and be able to indicate the mechanism and type of intermediate involved in the reactions.
5. be able to safely carry out standard laboratory techniques for the purification of organic compounds, including distillation, recrystallization, column chromatography, thin layer chromatography, and extraction.
6. be able to measure the infrared spectrum of an unknown solid or liquid and be able to identify the functional groups present.
7. be able to carry out standard functional group transformations of organic compounds, and isolate and characterize the resulting products.

The outcomes criteria for objectives 1-4 are based on percentiles obtained on the American Chemical Society standardized Organic Chemistry exam given as the final exam in CHEM 3303. The outcomes criteria for objectives 5-7 are based on a capstone laboratory assignment. Students identify two unknown organic compounds, one solid and one liquid. This requires purification by distillation, the knowledge of chemical reactivities and classification tests, and the ability to obtain and interpret spectroscopic data. The synthesis of derivatives of each unknown is also required, requiring a chemical transformation, and purification and characterization of the products.

American Chemical Society Standardized Organic Chemistry Exam Spring 2017 Data

	Average Percentile	# of students above 40 percentile	% of students above 40 percentile	# of students above 70 percentile	% of students above 70 percentile
Chemistry and Biochemistry Majors (19)	29	5	26%	3	16%

Analysis: The ACS standardized exam allows us to compare our students' performance to students nationwide who have completed a year-long undergraduate series of courses in organic chemistry. Our goal is for our students to be at or above the 40th percentile in the nation. While our average score was only the 29th percentile, 5/19 (26%) of our Chemistry and Biochemistry majors accomplished the goal of 40th percentile or better. 3/19 (19%) of our majors were at or above the 70th percentile which we consider outstanding. Analysis of the most frequently missed questions by our chemistry and biochemistry students determined that the most problematic areas were in determining the difference between nucleophilic and electrophilic aromatic substitution reactions and predicting reagents and products of radical reactions.

Plans: The instructors of the course will keep the topics of the most missed questions in mind during the next year and give more emphasis to the theory and application of these areas. They will also incorporate more of these types of questions in the quizzes as practice.

Unknown Lab Assessment Spring 2017 Data

Correct identification of two unknown compounds during the Organic Chemistry Capstone Experience for 2017 is shown in the following table:

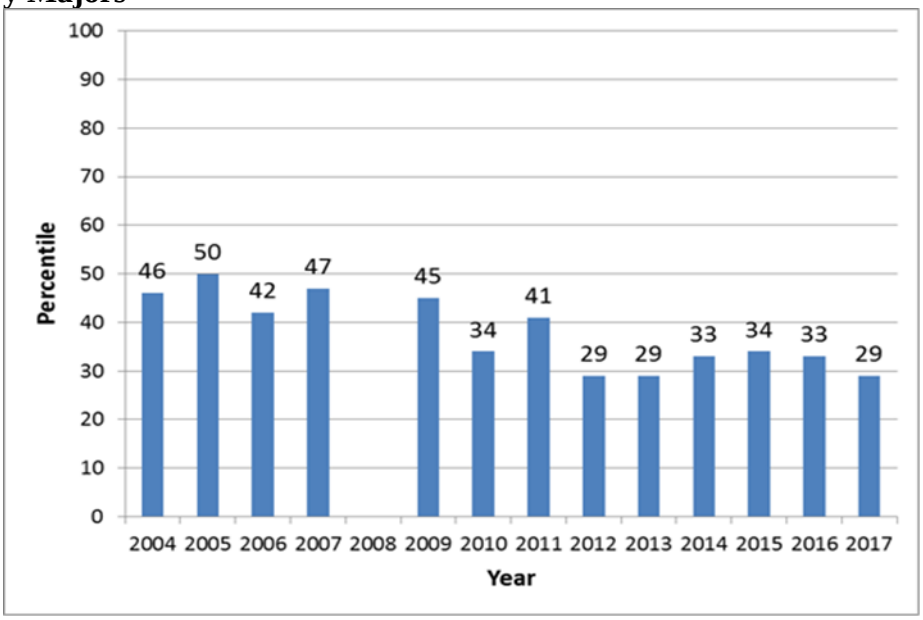
	# of students	**Both correct**	**At least one correct**	**None correct**	**% Both correct**	**% One or more correct**
Chemistry and Biochemistry Majors	19	14	17	2	74 %	89 %

Analysis: Of the 19 chemistry and biochemistry majors who finished the lab, 89 % identified at least one of the two unknowns and 74 % identified both. Having close to 90 % of the chemistry and biochemistry majors able to satisfactorily complete the process and identify at least one of their unknowns leads us to believe that student learning objectives in the Organic Chemistry lab are being met. Therefore we have no plans to make changes in the lab portion of the course.

Comparison to Previous Years: In an on-going effort to improve our students' success in meeting the student learning outcomes, we compare the results of this years' assessment data with previous years. As shown in the following graph and table, the results of this year's lecture assessment is on par with the results from recent years. The results of this year's laboratory assessment slightly better than last year and indicates that we are reaching our goals in

demonstrating lab competence.

Results of Capstone Organic Lecture Assessment during 2004 – 2017 for Chemistry and Biochemistry Majors



Results of Capstone Organic Laboratory Assignment during 2004 – 2017 for Chemistry and Biochemistry Majors

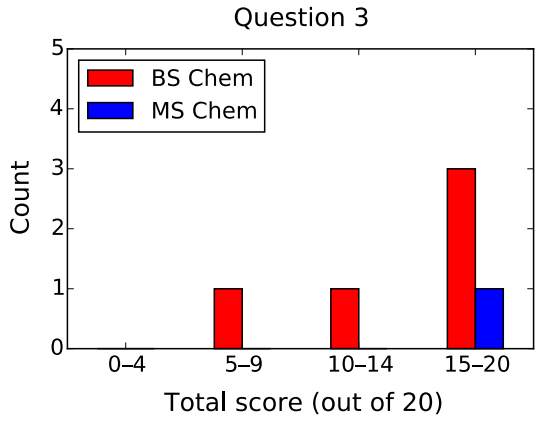
Year	# of Chem/Biochem Majors	# with both correct	**% Both Correct**	# with at least one correct	**% At least one correct**
Sp 2004	18	13	**72**	17	**94**
Sp 2005	22	9	**41**	22	**100**
Sp 2006	22	18	**82**	22	**100**
Sp 2007	12	5	**42**	10	**83**
Sp 2008	10	7	**70**	9	**90**
Sp 2009	17	10	**74**	14	**95**
Sp 2010	25	12	**48**	21	**84**
Sp 2011	26	15	**58**	23	**88**
Sp 2012	25	13	**52**	21	**84**
Sp 2013	32	21	**66**	29	**91**
Sp 2014	24	11	**46**	22	**93**
Sp 2015	26	16	**62**	25	**96**

Sp 2016	23	14	**61**	20	**87**
Sp 2017	19	14	**74**	17	**89**

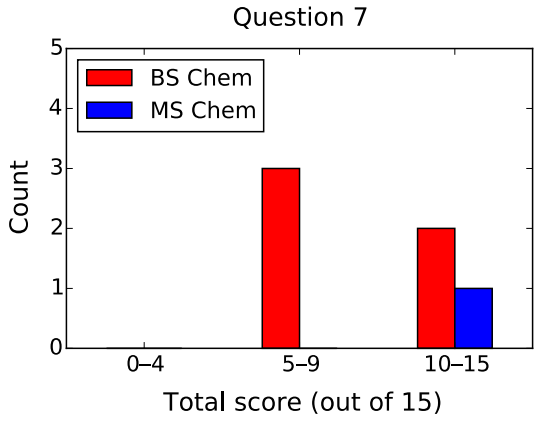
Advanced Inorganic Chemistry
CHEM 4162 Winter 2017
Chemistry PLO #1: demonstrate knowledge in the various areas of chemistry, including inorganic chemistry, analytical chemistry, organic chemistry, physical chemistry, and biochemistry.

Assessment Tool: Several specific learning outcomes are assessed using embedded questions in the final exam. The learning outcomes and the corresponding distribution of scores are shown below, broken down by degree program (red is B.S. Chemistry, blue is M.S. Chemistry). The total course enrollment is 6 students: 5 B.S. Chemistry and 1 M.S. Chemistry.

***Learning outcome**: Illustrate and classify the structures of coordination complexes.*



***Learning outcome**: Formulate and apply theories for the bonding and magnetic properties of coordination complexes.*



Plans: In the Winter 2017 quarter, we incorporated the regular use of in-class, active, cooperative learning activities. For the next year, we plan to further develop and improve upon these in-class activities. In addition, we will also develop and introduce a new module on nanoscale materials in order to comply with the most recent (2015) requirements for the American Chemical Society (ACS) degree certification.

Physical Chemistry
CHEM 3511 Fall 2016
Chemistry PLO #1: demonstrate knowledge in the various areas of chemistry, including inorganic chemistry, analytical chemistry, organic chemistry, physical chemistry, and biochemistry.

Assessment Tool: Embedded questions in Final Exam

The student Learning Outcomes (SLOs) for the course are as follows:
Upon successful completion of this course, the student will be able to

1. Explain and apply the fundamental postulates of kinetic molecular theory and apply them to gas-phase equations of state.
2. Model heat and work flow in chemical systems using the first law of thermodynamics.
3. Utilize the second law of thermodynamics to predict spontaneity of chemical processes.

4. Calculate third-law entropies from experimental data.
5. Relate thermochemical properties to chemical systems at equilibrium.
6. Synthesize and utilize quantitative descriptions of phase equilibrium.

Questions (1-4, 7-10, 14, and 15) were embedded into the final. Taken together, these questions touch on SLOs 1, 2, 5, and 6.

The questions map to the SLOs according to the following table:

Question\SLO	1	2	3	4	5	6
1		X				
2		X				
3					X	
4						X
MC7	X					
MC14					X	
MC15					X	
TF8					X	
TF9					X	
TF10					X	

Table 1 – Entire class (50 students)

Question	Number (Percent) of students receiving at least			
	25%	50%	75%	100%
Q1	35 (70%)	28 (56%)	10 (20%)	9 (18%)
Q2	49 (98%)	48 (96%)	43 (86%)	18 (36%)
Q3	35 (70%)	28 (56%)	17 (34%)	8 (16%)
Q4	42 (84%)	37 (74%)	33 (66%)	20 (40%)
MC7				42 (84%)
MC14				39 (78%)
MC15				32 (64%)
TF8				29 (58%)
TF9				34 (68%)
TF10				28 (56%)

Table 2 – BA Chemistry (3 students)

Question	Number (Percent) of students receiving at least			
	25%	50%	75%	100%
Q1	1 (33%)	1 (33%)	0	0

Q2	3 (100%)	3 (100%)	3 (33%)	1 (33%)
Q3	2 (67%)	2 (67%)	2 (67%)	0
Q4	3 (100%)	2 (67%)	2 (67%)	1 (33%)
MC7				3 (100%)
MC14				1 (33%)
MC15				2 (67%)
TF8				2 (67%)
TF9				3 (100%)
TF10				2 (67%)

Table 3 – BA Biochemistry (2 students)

Question	Number (Percent) of students receiving at least			
	25%	50%	75%	100%
Q1	1 (50%)	1 (50%)	0	0
Q2	2 (100%)	2 (100%)	2 (100%)	2 (100%)
Q3	1 (50%)	1 (50%)	0	0
Q4	2 (100%)	2 (100%)	2 (100%)	1 (50%)
MC7				2 (100%)
MC14				2 (100%)
MC15				2 (100%)
TF8				1 (50%)
TF9				1 (50%)
TF10				1 (50%)

Table 4 – BS Biochemistry (24 students)

Question	Number (Percent) of students receiving at least			
	25%	50%	75%	100%
Q1	17 (71%)	13 (54%)	4 (17%)	3 (12.5%)
Q2	23 (96%)	22 (92%)	18 (75%)	9 (37.5%)
Q3	16 (67%)	12 (50%)	5 (21%)	1 (4.2%)
Q4	21 (87%)	18 (75%)	16 (67%)	10 (42%)
MC7				18 (75%)
MC14				18 (75%)
MC15				15 (62.5%)
TF8				16 (67%)
TF9				13 (54%)
TF10				12 (50%)

Table 5 – BS Chemistry (11 students)

Question	Number (Percent) of students receiving at least			
	25%	50%	75%	100%
Q1	8 (73%)	6 (55%)	5 (45%)	2 (18%)
Q2	11 (100%)	11 (100%)	10 (91%)	3 (27%)
Q3	7 (64%)	4 (36%)	3 (27%)	3 (27%)
Q4	8 (73%)	8 (73%)	6 (55%)	4 (36%
MC7				9 (82%)
MC14				9 (82%)
MC15				8 (73%)
TF8				4 (36%)
TF9				9 (82%)
TF10				8 (73%)

Analysis: The fraction of students receiving at least 75% of the points on questions 1-3 is disappointing. Question 3 was particularly challenging to the class. Despite attempting to address this issue, the class continues to struggle on this question! Additionally, the results for question 15 indicate that students continue to struggle with the conceptual partial pressures in gas-phase equilibrium problems (although there has been some improvement.)

Physical Chemistry
CHEM 3512 Winter 2017
Chemistry PLO #1: demonstrate knowledge in the various areas of chemistry, including inorganic chemistry, analytical chemistry, organic chemistry, physical chemistry, and biochemistry.

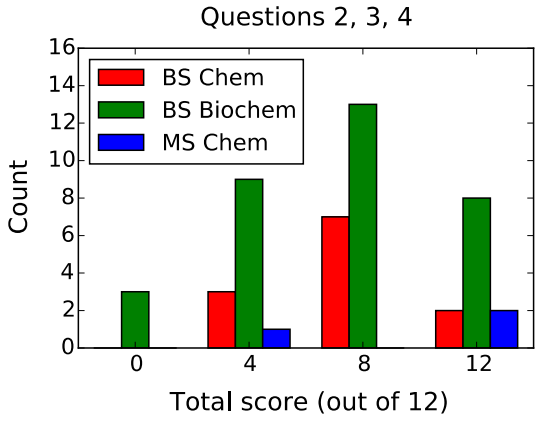
Assessment Tool: Embedded questions in Final Exam

CHEM 3512 provides an introduction to molecular quantum mechanics and takes place in the second quarter of a three-quarter sequence in Physical Chemistry. Topics include: fundamental principles of time-independent quantum mechanics; translational, vibrational, and rotational motion; atomic structure; valence bond and molecular orbital theory.

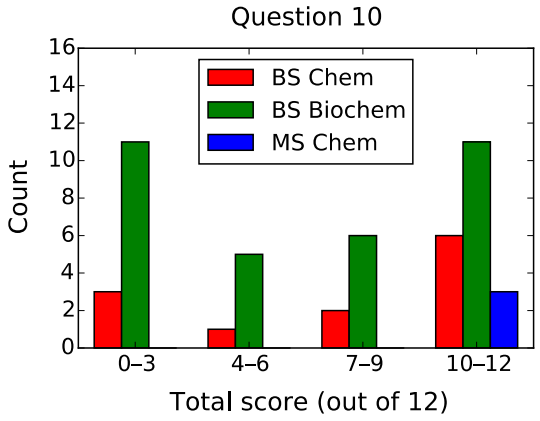
The total course enrollment is 50; however, 2 of these students did not have the required prerequisites (1 year calculus and 1 year physics with a C– grade or higher). Therefore, only the 48 students with the necessary preparation are considered here. The breakdown of these 48 students by degree program is: 12 B.S. Chemistry, 33 B.S. Biochemistry, and 3 M.S. Chemistry.

Several specific learning outcomes are assessed using embedded questions in the final exam. The learning outcomes and the corresponding distribution of scores are shown below, broken down by degree program (red is B.S. Chemistry, green is B.S. Biochemistry, blue is M.S. Chemistry).

***Learning outcome**: Formulate the mathematical description for the quantum mechanical motion of a particle.*



***Learning outcome**: Model the vibrational and rotational motion of molecules.*



Plans: In the Winter 2017 quarter, we eliminated the textbook that we had used in the previous year (Engel and Reid, *Physical Chemistry*, $134 new), and transitioned all course materials to freely available, open educational resources (OER). For the next year, we plan to further develop and improve upon the OER for the course.

Instrumental Methods of Analysis
CHEM 4240 Winter 2017
Chemistry PLO #1: demonstrate knowledge in the various areas of chemistry, including inorganic chemistry, analytical chemistry, organic chemistry, physical chemistry, and biochemistry.
Graduate PLO #2: work effectively and safely in a laboratory environment using modern chemical/biochemical instrumentation and methods to test hypotheses or design solutions to problems.

Assessment Tool: Embedded questions in Final Exam
Student Learning Outcomes for undergraduate students:
Undergraduate students who successfully complete this course will be able to:

1. Understand the basic nature of light and its interaction with matter.
2. Understand the concept of Beer's law and its application for UV/Vis spectroscopy.
3. Understand difference between Atomic Spectroscopy and Molecular Spectroscopy.
4. Be familiar with the basic components and the layout of optical instruments.
5. Understand the physical principles of NMR and analyze the first order NMR spectra of organic compounds.
6. Understand the fundamental principles of chromatography and its application for analysis of mixtures of organic compounds.
7. Work in a group and communicate clearly with project partners through working on resonance assignment projects.

Embedded Questions in the midterm and final exam (accumulated)

Embedded Question	SLO #	# of undergrads Students	# of students with correct answer	% with correct answer*
Midterm Q4	1	15	9	60
Final Q1	2	15	6	40
Midterm Q5	3	15	5	33
Final Q9	4	15	7	47
Final Q2	1	15	6	40

Final Q5	5	15	5	33
Final Q6	5	15	2	13
Final Q7	6	15	8	53
Final Q11	6	15	8	53

*Where partial credit was given the answer was counted as correct if at least 67% of the total possible points were awarded. Unfortunately, the midterms of two undergrads were never returned that their data were not recorded.

Summary

Student Learning Outcome	Average Percentage of Students Able to Answer the Questions
1	50 %
2	40 %
3	33 %
4	47 %
5	23 %
6	53 %

Analysis: In this quarter, about 50% or more undergraduate students did not quite reach their learning outcomes from #1-#6, which shows their lack of understanding and knowledge regarding the subjects of matters in this course. It is concerning since more than 65% students reached their learning outcomes at least #1 and #2 in the previous two years (2015 & 2016). Notably, many students had hard time in understanding the topic of NMR spectral analysis as well as various relaxation mechanisms in molecular spectroscopy. Out of 15 undergraduate students assessed, two students got "almost" failing graces such as C- or below.

E. Suggestions and Recommendations for the CSCI EETF in the Future