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2016-2017 CSCI EETF Assessment Year End Report, June, 2017

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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 Biochemistry 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 oral and written 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 (PLO #4) was conducted in General Biochemistry Laboratory (CHEM 4430). Demonstrating knowledge in the various areas of chemistry (PLO #1) was conducted in the courses Organic Chemistry (CHEM 3303), Physical Chemistry (CHEM 3511 and CHEM 3512), and Biochemistry (CHEM 4412) through the use of standardized national exams and embedded exam questions. The laboratory assessment (PLO #2) was conducted in capstone laboratory exercises in CHEM 3303 (Organic Chemistry) and CHEM 4430 (General Biochemistry Laboratory).

D. Summary of Assessment Results

Chem 4430 - General Biochemistry Laboratory
Biochemistry PLO #4: write and speak clearly on chemical or biochemical issues.
Biochemistry PLO #2: work effectively and safely in a laboratory environment to perform experimental procedures and operate modern chemical/biochemical instruments.
Assessment Tool: Analysis of written notebook and embedded questions on final exam

Fall 2016 data

Learning Goals	Embedded Questions on Final Exam or other Assessment tool
1. know buffer theory and how to prepare a laboratory buffer.	Questions 5 & 6
2. know how to perform protein and enzyme activity assays and how to calculate results from laboratory-derived data.	Question 8& 9
3. know how to calculate data commonly found in Protein Purification Tables and how to interpret this information.	Question 7
4. know how to perform enzyme kinetic data analysis and how to present this data in graphical format.	Multiple Choice Questions 5-10 & Analysis in lab notebook
5. know theory and practical details of chromatographic procedures --including gel filtration chromatography, ion-exchange chromatography, and high performance liquid chromatography (HPLC).	Question 10
6. know the theory and practical details of electrophoresis of proteins and DNA.	Question 12 and photograph of a successful SDS-PAGE protein gel.
7. know how to develop a well-written laboratory notebook.	Laboratory notebook score

BS BiochemistryMajor:16 students

Goal	Assessment tool	Number of correct answers*	Percentage
1	Q5	13	81%
1	Q6	9	56%
2	Q8	14	88%
2	Q9	3	19%
3	Q7	11	69%

4	Analysis in lab notebook and report	11	69%
4	MC 5-10	6	38%
5	Q10	6	38%
6	Q12	3	19%
6	Gel photograph	14	88%
7	Final lab notebook score	14	88%

*Partial credit was applied to exam questions and lab notebook grading. If 75% off all possible points were earned, the answer was counted as correct.

Analysis: The embedded questions Q9 and Q12 resulted in a very low number of correct answers. Question Q9 addressed learning goal 2 in a quantitative manner. Students had to calculate concrete quantities of chemicals to prepare a buffer. Students performed much better on the qualitative question Q8 that covered the same learning goal. The low score on Question Q12 is unexpected as it is a simple recall question on the full name of a chemical abbreviation paired with a chemical explanation for the purpose of a specific chemical compound. Nevertheless 88% of students were able to master the practical side of learning goal 6. 88% of the students were also able to demonstrate mastery of SLO #7, know how to develop a well-written laboratory notebook which maps to PLO #4 concerning written communication.

Winter 2017 data

Learning Goals	**Embedded Questions on Final Exam or other Assessment tool**
8. know buffer theory and how to prepare a laboratory buffer.	Questions 5 & 6
9. know how to perform protein and enzyme activity assays and how to calculate results from laboratory-derived data.	Question 8& 9
10. know how to calculate data commonly found in Protein Purification Tables and how to interpret this information.	Question 7
11. know how to perform enzyme kinetic data analysis and how to present this data in graphical format.	Multiple Choice Questions 5-10 & Analysis in lab notebook
12. know theory and practical details of chromatographic procedures --including gel filtration chromatography, ion-exchange chromatography, and high performance liquid chromatography (HPLC).	Question 10
13. know the theory and practical details of electrophoresis of proteins and DNA.	Question 12 and photograph of a successful SDS-PAGE protein gel.
14. know how to develop a well-written laboratory notebook.	Laboratory notebook score

BS BiochemistryMajor: 8 students

Goal	Assessment tool	Number of correct answers*	Percentage
1	Q5	6	75%
1	Q6	4	50%
2	Q8	5	62.5%
2	Q9	4	50%
3	Q7	6	75%
4	Analysis in lab notebook and report	7	87.5%
4	MC 5-10	5	62.5%
5	Q10	4	50%
6	Q12	5	62.5%
6	Gel photograph	8	100%
7	Final lab notebook score	8	100%

*Partial credit was applied to exam questions and lab notebook grading. If 75% off all possible points were earned, the answer was counted as correct.

BA Biochemistry Major: 3 students

Goal	Assessment tool	Number of correct answers*	Percentage
1	Q5	2	67%
1	Q6	1	33%
2	Q8	2	67%
2	Q9	0	0%
3	Q7	2	67%
4	Analysis in lab notebook and report	11	100%
4	MC 5-10	3	100%
5	Q10	2	67%
6	Q12	1	33%
6	Gel photograph	2	67%
7	Final lab notebook score	3	100%

Analysis: All learning goals reached scores of 50% or higher. This is an improvement compared to the previous quarter, which resulted in extremely low scores for embedded questions Q9 and Q12 with only a 19% score (or 3 out of 16 students with correct answers). However, the three

students pursuing a BA Biochemistry degree (see next table) were unable to answer Q9 correctly. This is disappointing, as problems similar to Q9 were practiced in lecture and in group work. The overall analysis has to be seen as tentative due to the low number of students pursuing either a BA or BS Biochemistry degree enrolled in the course. For the same learning goal, learning goal number 1, embedded questions that addressed qualitative answers (Q5 for example) rather than quantitative calculations (Q6) yielded higher scores in student exams. 100% of the students were also able to demonstrate mastery of SLO #7, know how to develop a well-written laboratory notebook which maps to PLO #4 concerning written communication.

Biochemistry
CHEM 4412 Winter 2017
Biochemistry 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 on midterm exams and the final exam

Student Learning Outcomes:

1. Distinguish the classes of lipids found in biological systems.
2. Demonstrate knowledge of biological membrane structure/function and mechanisms of active and passive membrane transport.
3. Explain the basic principles of bioenergetics and analyze the standard and actual free energy changes of biochemical reactions.
4. Outline and summarize key cellular metabolic processes.
5. Discuss the importance of metabolic regulatory mechanisms.

Learning outcome	BA Biochem (2 students)	BS Biochem (25 students)	BS Chem (2 students)	Total (29 students)	Question source
#1 with >70% correct answer	0/2 (0%)	14/25 (56%)	2/2 (100%)	16/29 (55%)	Midterm 1 #1
#2 with >70% correct answer	1/2 (50%)	11/25 (44%)	0/2 (0%)	12/29 (41%)	Midterm 1 #4 or #6 in versions A and B, respectively
#3 with	1/2	6/25	0/2	7/29	Midterm 2 #2 or

>70% correct answer	(50%)	(24%)	(0%)	(24%)	#4 in versions A and B, respectively
#4 with >70% correct answer	1/2 (50%)	8/25 (32%)	1/2 (50%)	10/29 (34%)	Final exam #10 or #11 in versions A and B, respectively
#5 with >70% correct answer	1/2 (50%)	8/25 (32%)	0/2 (0%)	9/29 (31%)	Final exam #4 or #7 in versions A and B, respectively

Plans: Suggested improvement to course includes adding additional graded assignments focusing on all SLOs, especially on #3, 4, and 5.

Organic Chemistry
CHEM 3303 Spring 2017
Biochemistry PLO #1: demonstrate knowledge in the various areas of chemistry, including inorganic chemistry, analytical chemistry, organic chemistry, physical chemistry, and biochemistry.
Biochemistry 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 will identify two unknown organic compounds, one solid and one liquid. This requires purification by distillation, the knowledge of chemical reactivities and classification tests, 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

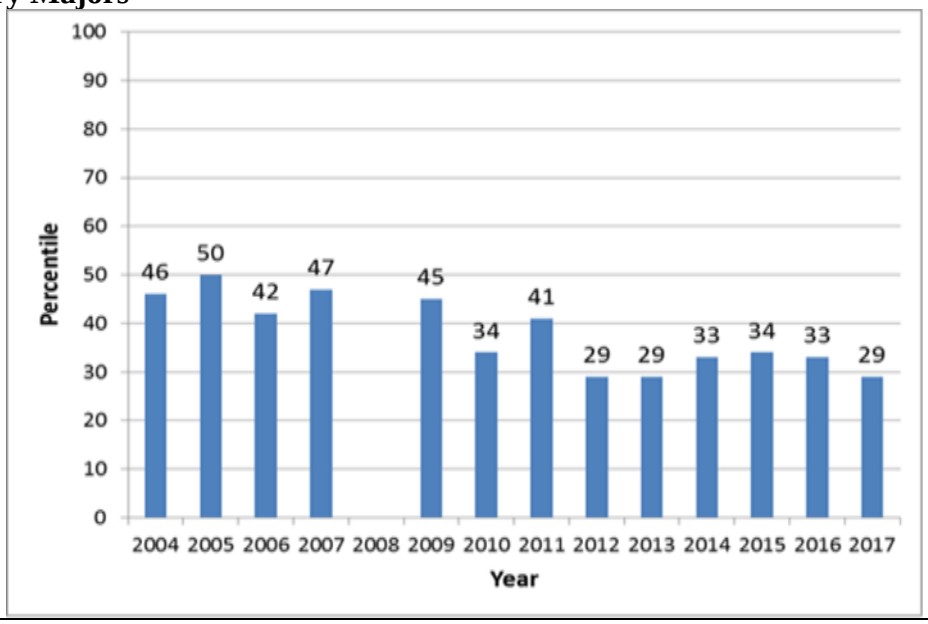
Correct identification of two unknown compounds during the Organic Chemistry Capstone Experience for 2017 is shown in the following table:

	# 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**

Physical Chemistry
CHEM 3511 Fall 2016
Biochemistry 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 on 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
Biochemistry 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 on final exam

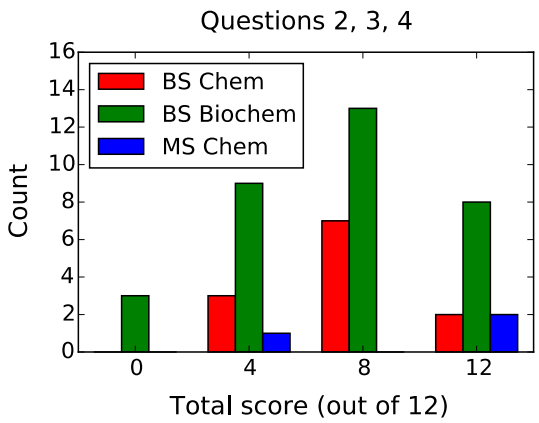
CHEM 3512 provides an introduction to molecular quantum mechanics and takes place in the second quarter of a three-quarter sequence in Physical Chemistry. Topics include: fundamental principles of time-independent quantum mechanics; translational, vibrational, and rotational motion; atomic structure;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

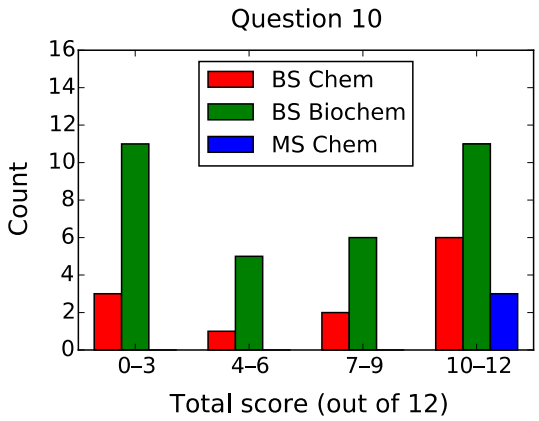
Several specific learning outcomes are assessed using embedded questions in the final exam. The learning outcomes and the corresponding distribution of scores are shown below, broken down

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.

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