CALIFORNIA STATE UNIVERSITY
EAST BAY

College of Science (CSCI)
North Science 135
25800 Carlos Bee Boulevard, Hayward CA 94542

2015-2016 CSCI EETF Assessment Year End Report, June, 2016

Program Name(s)	EETF Faculty Rep	Department Chair
Chemistry/Biochemistry	Anne Kotchevar	Ann McPartland

[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

3. use quantitative reasoning to analyze chemical problems and evaluate chemical data.

C. Summary of Assessment Process

As stated in our five-year assessment plan, in 2015-2016 we specifically concentrated on Program Learning Outcome #3 which concerns assessing quantitative reasoning. In addition we continued to assess program content through Program Learning Outcome #1 (Demonstrate knowledge in the various areas of chemistry, including inorganic chemistry, analytical chemistry, organic chemistry, physical chemistry, and biochemistry) and Program Learning Outcome #2 (Work effectively and safely in a laboratory environment to perform experimental procedures and operate modern chemical/biochemical instruments).

Quantitative reasoning assessment 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 4161 and 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

CHEM 3303 Organic Chemistry

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 the average percentile obtained on the American Chemical Society standardized Organic Chemistry exam. The exam is given as the final exam in CHEM 3303. The outcomes criteria for objectives 5-7 are based on a capstone assignment for CHEM 3303 laboratories. Students will identify two unknown organic compounds, one solid and one liquid. This will require purification by distillation, the knowledge of chemical reactivities and classification tests, the ability to obtain spectroscopic data, especially FT-IR, and the ability to interpret the results. The synthesis of derivatives of each unknown is required, requiring a chemical transformation and purification and characterization of the product.

American Chemical Society Standardized Organic Chemistry Exam Spring 2016 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 (23)	33	9	39%	2	13%
All Students in Class (119)	28	42	35%	11	9 %

American Chemical Society Standardized Organic Chemistry Exam Spring 2016 Analysis

The ACS standardized exam test student learning outcomes 1-4 for the year-long Organic Chemistry series and 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. In 2016, 9/23 of our Chemistry and Biochemistry accomplished this goal. 3/23 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 recognizing intermediates of reactions, determining reaction equilibria, and putting together multi-step reaction sequences. The instructors of the course will keep this in mind during the next year and give more emphasis to the theory and application of these areas. They will also include more questions of this type in the quizzes to give students greater practice at applying these concepts.

Unknown Lab Assessment Spring 2016 Data

Correct identification of two unknown compounds during the Organic Chemistry Capstone Experience for 2016 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	23	14	20	3	61 %	87 %
All Students in Class	119	75	109	10	63 %	92 %

Unknown Lab Assessment Spring 2016 Analysis

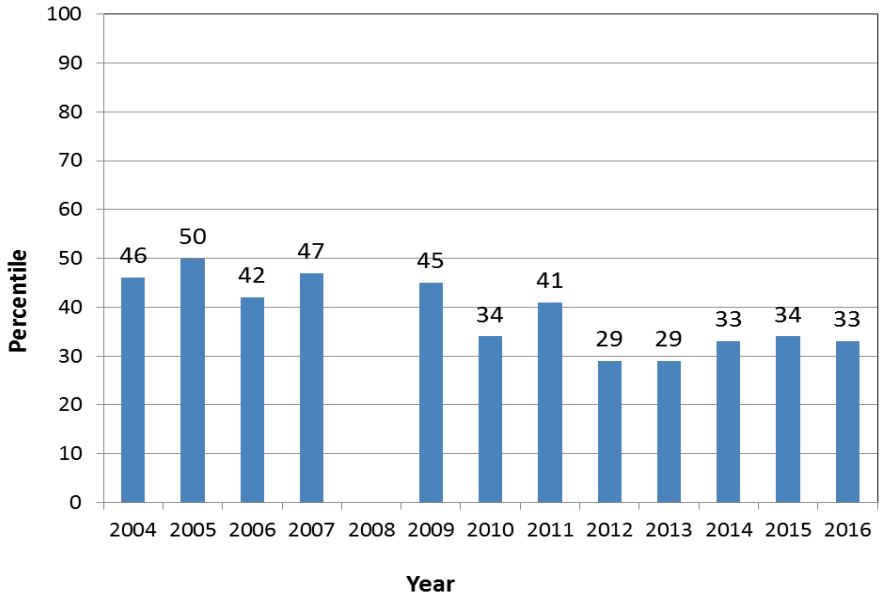
Of all students completing the lab, 92 % identified at least one of the two unknowns and 63 % identified both. Of the 23 chemistry and biochemistry majors who finished the lab, 61 % identified at least one of the two unknowns and 87 % identified both. In order to accomplish the identification of their unknowns, students must use the knowledge they gained in the theory and practice of organic chemistry during the year-long Organic Chemistry series. They must first come up with a plan for identification and then look up the experimental procedures to carry it out. At each stage they need to critically analyze their results and make decisions for the next experiments based on those results. At defined stages in the process students meet privately with the lab instructor to orally defend their process and conclusions, at which point they also get feedback from the instructor. At the end of the experiment students write a lab report which includes a substantial analysis of the data they collected to explain how their results support their

conclusions. 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.

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, although not the best that we have achieved. The results of this year's laboratory assessment are slightly lower than last year but still at our goal for demonstrating lab competence.

Results of Capstone Organic Lecture Assessment during 2004 – 2016 for Chemistry and Biochemistry Majors



Results of Capstone Organic Laboratory Assignment during 2004 – 2016 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**

CHEM 4240 Instrumental Methods of Analysis

Student Learning Outcomes:

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.

Assessment Data on undergraduate students:

Embedded Questions in the midterm and final exam (accumulated)

Embedded Question	SLO #	# of undergrads Students	# of students with correct answer	% with correct answer*
Midterm Q3	1	20*	14	70.0
Final Q8	2	22	18	81.8
Midterm Q8	3	20*	10	50.0

Final Q3	4	22	4	18.2
Final Q4	4	22	13	59.1
Final Q1	5	22	7	31.8
Final Q12	5	22	4	18.2
Final Q7	6	22	12	54.5
Final Q10	6	22	12	54.5

*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	70 %
2	82 %
3	50 %
4	39 %
5	25 %
6	55 %

Analysis: In this quarter, more than or about half of undergraduate students did not quite reach their learning outcomes #3, #4, and #6, which shows their lack of understanding and knowledge regarding NMR analysis, Atomic Spectroscopy, and key components of optical instruments. Notably, many students had hard time in understanding the topic of NMR spectral analysis. Out of 22 undergraduate students assessed, one student got D+ that is "almost" failing grade.

CHEM 3512 Physical Chemistry Assessment Data, Winter 2016

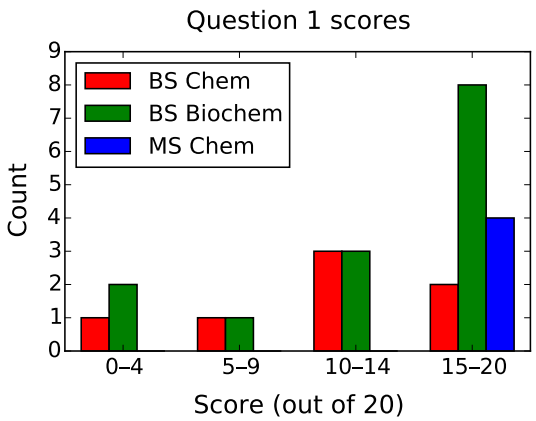
CHEM 3512 provides an introduction to molecular quantum mechanics and takes place in the second quarter of a three-quarter sequence in Physical Chemistry. Topics include: fundamental principles of time-independent quantum mechanics; translational, vibrational, and rotational motion; atomic structure;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

The total course enrollment is 37; however, 12 of these students did not have the required

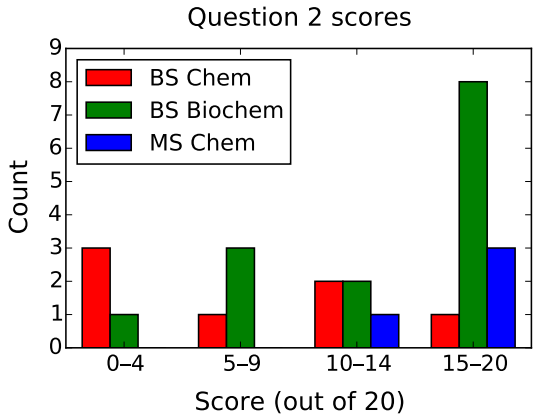
prerequisites (1 year of calculus and 1 year of physics with a C– grade or higher). Therefore, only the 25 students with the necessary preparation are considered here. The breakdown of these 25 students by degree program is: 7 B.S. Chemistry, 14 B.S. Biochemistry, and 4 M.S. Chemistry.

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.*



Analysis: In the Winter 2016 quarter, we introduced the regular use of in-class, active, cooperative learning activities, which were very well received by students. For the next year, we plan to incorporate computational exercises using Mathematica into the curriculum.

CHEM 3513 Physical Chemistry Assessment Data, Spring 2016

Assessment criteria relevant for Chem3513	Questions embedded in the Final exam
1. understand the importance of rates of chemical reactions in the overall	Not assessed

scheme of chemistry.	
2. be able to calculate reaction order from the time dependence on concentration.	Final Question 10
3. be able to understand and describe transition state theory.	Final Question 7
4. understand how statistics and probability can be used to develop thermodynamic concepts.	Midterm Question 10
5. be knowledgeable about catalysis	Final Question 14

BS Chemistry Major: 4 students

Criteria	Exam question	Number of correct answers*	Percentage
2	Q10	1	25%
3	Q7	2	50%
4	Midterm Q10	2	50%
5	Q14	1	25%

*Partial credit was applied. If 75% off all possible points were earned, the answer was counted as correct.

BS Biochemistry Major: 21 students

Criteria	Exam question	Number of correct answers*	Percentage
2	Q10	8	38%
3	Q7	11	52%
4	Midterm Q10	14	67%
5	Q14	12	57%

*Partial credit was applied. If 75% off all possible points were earned, the answer was counted as correct.

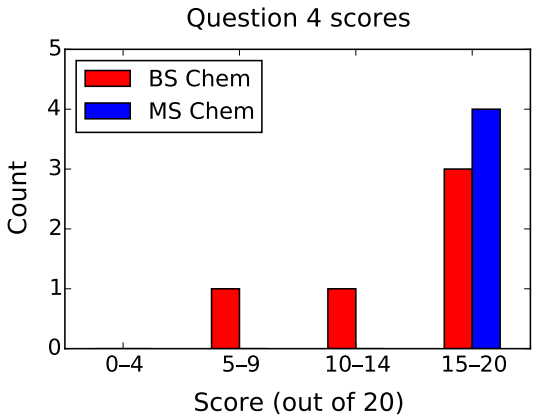
CHEM 4161/4162 Advanced Inorganic Chemistry

CHEM 4161/4162 is a two-quarter survey of inorganic chemistry. CHEM 4161 emphasizes main group inorganic compounds. Topics include: atomic structure, simple bonding models, symmetry and group theory, molecular orbital theory, acid-base and donor-acceptor chemistry, and solid state. CHEM 4162 covers the chemistry of coordination and organometallic complexes. Topics

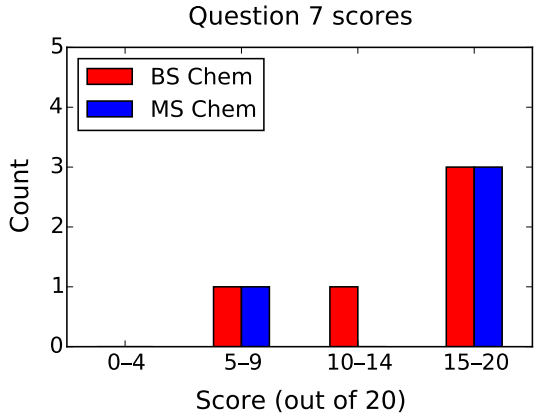
include: structure and isomerism, bonding theories (crystal field, ligand field, angular overlap method), electronic spectra, reactions and mechanisms.

This assessment focuses on the second quarter of the sequence, CHEM 4162, which builds on the foundation developed in the first quarter. The total course enrollment is 9 students: 5 B.S. Chemistry, 4 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, blue is 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.*



Analysis: For the 2016–17 academic year, we plan to introduce the regular use of in-class, active, cooperative learning activities. We will also explore the use of computational modeling and visualization tools as part of the curriculum.

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