Academic Program Review MS Chemistry

Table of Contents

APRC Recommendation to Faculty Senate
MS Chemistry

The Academic Program Review Committee (APRC) affirms that the Department of Chemistry has completed program review as per policy, including self-study, external review, internal review, and action plan submission for the MS Chemistry. APRC recommends that the next program review be scheduled for six years from Faculty Senate approval; or, should the College of Natural Sciences and Mathematics decide to schedule a college-wide program review, the next program review will occur at that time.

APRC Chair: Jeffrey Brodd, Professor of Humanities and Religious Studies

Chemistry Department Program Review Self-Study

Submitted February 1, 2022

Prepared by Susan Crawford, Chair and Professor Linda Roberts (former Chair).

Data for this Self-Study Report was obtained from a number of sources including the 2017 Chemistry Factbook department information, and available CSU and CSUS data bases.

MISSION AND CONTEXT

A. Mission Statement, Values, Visions and Goals

Sacramento State University Mission Statement: *"As California's Capital University, we transform lives by preparing students for leadership, service and success. Sacramento State will be a recognized leader in education, innovation and engagement."*

College of Natural Sciences and Mathematics Mission Statement: *"The College of Natural Sciences and Mathematics prepares students for future success, produces meaningful scholarship, and engages with broader communities to promote quantitative, scientific and spatial literacy."*

Chemistry Department Mission Statement: "*The Mission of the Chemistry Department is to inspire students' interest in chemistry and to facilitate the development of chemical knowledge and laboratory skills in a safe and inclusive environment."*

Chemistry Department Values:

- Technical Proficiency
- Safety
- Collaboration and Teamwork
- Quantitative Reasoning and Critical Thinking
- Equity and Inclusivity
- Student Success
- Professionalism and Ethics
- Professional development so that faculty and staff can keep up with developments in their field and contribute professionally to the scientific community.

Chemistry Department Goals:

- Reevaluate and Revise curriculum and programs to ensure that they best meet the needs of students and employers.
- Establish culture of safety in students, staff, and faculty associated with departmental activities.
- Improve connections and collaborations with regional employers hiring our graduates.
- Modernize scientific instrumentation in research and teaching laboratories to provide relevant training to students.
- Evaluate and improve the department environment to assure we are welcoming and encourage full participation of all students.
- Improve student success and reduce equity gaps where they exist in our courses and programs.
- Reduce graduation time.

- Improve facilities, opportunities and support for faculty/student research activities.
- Provide department staff with appropriate levels of help and professional development opportunities that enhance effectiveness and departmental service.

B. Degrees Offered and links to Catalog

The Chemistry department offers Bachelor of Science (BS) degrees in Chemistry and Biochemistry, and three BA degrees in chemistry, one in chemistry, one in biochemistry and one in chemistry with a concentration in forensic chemistry. The BS Chemistry is approved by the American Chemical Society (ACS) and undergoes annual and six-year reviews to maintain approval. ACS is a congressionally chartered professional organization with membership of scientists and educators in chemistry and chemistry-related fields. Departments seeking ACS approval must adhere to curricular, facilities, and workload requirements. The department additionally offers a Master's degree in Chemistry and a concentration in Biochemistry.

The catalog links to these degrees are provided below:
BS Chemistry Degree:
https://catalog.csus.edu/colleges/natural-sciences-mathematics/chemistry/bs-in-chemistry/
BS Biochemistry Degree:
https://catalog.csus.edu/colleges/natural-sciences-mathematics/chemistry/bs-in-biochemistry/
BA Chemistry Degree:
https://catalog.csus.edu/colleges/natural-sciences-mathematics/chemistry/ba-in-chemistry-general/
BA Chemistry Degree (Forensic Concentration):
https://catalog.csus.edu/colleges/natural-sciences-mathematics/chemistry/ba-in-chemistry-forensic-chemistry/
BA Biochemistry Degree:
https://catalog.csus.edu/colleges/natural-sciences-mathematics/chemistry/ba-in-chemistry-biochemistry/\
MS Chemistry Degree:
https://catalog.csus.edu/colleges/natural-sciences-mathematics/chemistry/ms-in-chemistry/
MS Chemistry Degree (Biochemistry Concentration):
https://catalog.csus.edu/colleges/natural-sciences-mathematics/chemistry/ms-in-chemistry-biochemistry/

Table 1. Student enrollment in Chemistry by program and concentration[1]

	Entering in Fall		
	2014	**2017**	**2021**
Undergraduate Students-BS			
Chemistry	105	109	81
Biochemistry	243	*242*	*162*
Sub-total	*348*	*351*	*243*
Undergraduate Students-BA			
No concentration	34	28	27
Biochemistry concentration	88	111	53
Forensic concentration	63	69	79
Sub-Total	*185*	*208*	*159*
Graduate Students-2nd BA			
Chemistry	1	0	0
Biochemistry	0	0	0
Forensic Chemistry	0	0	0
Sub-Total	*1*	*0*	*0*
Graduate Students-Masters			
Chemistry	21	21	21
Chemistry (Biochemistry)	14	8	11
Sub-Total	*35*	*29*	*31*
Department Total	**569**	**588**	**433**

[1]Data taken from the 2017 Chemistry Factbook and CSUS Enrollment Dashboard

Examination of the enrollment data shows a decline in total chemistry and biochemistry students since a peak enrollment in Fall 2017. A closer comparison of Fall 2017 enrollment with Fall 2021 shows a significant decrease in enrollment in the biochemistry degree seeking students and a significant, but smaller decrease in the chemistry degree seeking students. We currently do not have an explanation for this decline and cannot attribute it to the COVID pandemic since it began to manifest prior to fall 2020, the first semester fully impacted by the pandemic. The chemistry department will be watching this enrollment trend as it plans future course demand. In fact, the chemistry department was experiencing some significant impaction problems in upper division majors' chemistry and biochemistry courses with a subsequent impact on time to graduation for some students. The subtle enrollment decline may serve to help mitigate this impaction.

Enrollment in the master's degree programs is stable compared to the last program review period. However, the Covid pandemic saw applications down significantly for fall 2021 admissions where the department admitted only six new graduate students compared to the typical 10-15 new students per year. Currently, the master's degree in chemistry has approximately twice the number of students seeking the biochemistry concentration consistent with the past numbers. We are optimistic that applications will return to more normal levels as the pandemic is better controlled and we are able to move fully back to F2F operations.

C. Minors

The Chemistry department offers a minor degree. Over 90% of the ~80 students enrolled in this program are biological sciences majors, many of whom will earn the chemistry minor through completing chemistry courses required for their major. One sophomore level course required for the minor, Chem 31(Quantitative Analysis), is required in only a subset of the biological sciences concentrations (CLS, Forensics, Microbiology, Molecular Biology). These programs collectively enroll only about one-fourth of the biological sciences majors. The demand for the chemistry minor by the other three-fourths of biological sciences majors in the past created a significant bottleneck in Chem 31, which has been mitigated by enrollment management strategies. Chemistry 31 and the path to the Chemistry minor is much less problematic than in the last review cycle. The chemistry department is currently meeting demand in the course and minor access.

https://catalog.csus.edu/colleges/natural-sciences-mathematics/chemistry/minor-in-chemistry/

D. Service to/from Other Departments

The chemistry department provides service to multiple programs on campus. Chemistry is often referred to as the "Central Science" owing to the fact that many other majors require a solid foundation in chemistry as a critical element for their major courses. This often places foundation chemistry courses in gateway positions for these majors. The chemistry department has struggled with impaction in some of these gateway courses due to high demand and growth in other majors. Additionally, some of these courses are characterized by high DWF and equity gaps. The chemistry department is focusing energy on these courses to reduce the DWF rates and equity gaps. Some of these efforts are discussed below in the Strategic Initiatives Section. Foundation chemistry courses are required for biology, engineering, environmental science, geology, physics, family and consumer sciences, kinesiology, pre-nursing, and education. Table 2. Summarizes the chemistry courses that serve these other majors on campus.

Table 2. Lower Division Chemistry Courses and Majors Served

Major	Lower Division Chemistry labs required
Chemistry	Chem 4, Chem 1A, Chem 1B, Chem 24, Chem 25, Chem 31
Biology	Chem 4, Chem 1A, Chem 1B, Chem 24, Chem 25 Chem 20 and 20L, Chem 31
Engineering	Chem 4, Chem 1E
Geology	Chem 4, Chem 1A or 1E
Environmental Studies	Chem 6A or 1A
Physics	Chem 4, Chem 1A
Family & Consumer Sciences	Chem 4, Chem 6A or 1A, Chem 6B or 1B
Kinesiology	Chem 4, Chem 6A or 1A, Chem 6B or 1B, Chem 20L
Pre-nursing	Chem 6A
Health Science	Chem 6A, Chem 6B
Education	CHEM 106

The chemistry department also serves the biology department through the contribution of several upper division courses. Some of the biological science majors take the full organic chemistry series including Chem 124 (second semester organic chemistry). Biological science students also take upper division biochemistry lecture (Chem 161), and biochemistry lab (Chem 162). The size of the biological science department in terms of student population has at times caused enrollment impaction in some chemistry courses, particularly labs, that are also needed by chemistry majors. To address this demand, the chemistry department has expanded lab offerings to the extent possible and offers courses in summer. Additional enrollment management assures that both chemistry and biological science students have access to seats in these high demand chemistry courses.

The chemistry department offers several courses that contribute to the General Education requirements on campus. Table 3 summarizes chemistry course contribution to the GE requirements on campus. We recently added an upper division GE course to Area B5: Further Studies in Science and Quantitative Reasoning. CHEM 101, "Science in the Public Debate", was well received on its first offering during the 2020-2021 academic year, attracting enrollment over the initially set course capacity. The chemistry department additionally teaches NSM 21, Freshman Seminar ("Becoming an Educated Person"). This course is structured to help new freshman science majors acclimate and navigate the university environment.

Table 3. GE course taught by the chemistry department.

GE Area	Chemistry Courses
B1 Physical Science	CHEM 1A, CHEM 6A
B3 Lab	CHEM 1A, CHEM 1B, CHEM 6A, CHEM 6B
B5 Further Studies in Science and Quantitative Reasoning	CHEM 106, CHEM 125, CHEM 101 (New GE course for non-science majors, "Science in the Public Debate")
E Understanding Personal Development	NSM 21 Freshman Seminar "Becoming an Educated Person"

The chemistry department in turn relies on other stem departments to serve our students. Most notably, our students take math, physics and biological science courses (biochemistry majors). Both the BA and BS biochemistry degrees rely on upper division biological science courses to fill out the elective units for these majors. Students have a selection of several upper division biological science courses to select from including: microbiology, genetics, cell and molecular biology, systemic physiology, advanced molecular biology. Other biological science courses are considered on a case-by-case basis.

F. Major Structural Changes to Degrees and Programs

Honors Program

During this review period the chemistry department launched its Honors' Program. The purpose of the Chemistry Honors' Program is to recognize and support the department's highest achieving students through undergraduate research culminating in a chemistry honors thesis. Students at the junior standing must meet a minimum overall GPA and math/science GPA to be eligible for nomination to the program. A chemistry faculty member must nominate the student to the program. A department committee evaluates and approves the nominations. Students must complete a minimum of two semesters of research as part of the honors concentration, one being CHEM 198H. https://catalog.csus.edu/colleges/natural-sciences-mathematics/chemistry/chemistry-honors-program/

Other Undergraduate Degree Options.

The chemistry department is undergoing a review and analysis of its catalog description and undergraduate degree paths. We have not done a thorough review and updating in many years. We will be proposing changes to many of our degree paths as a result of this analysis. The chemistry department's curriculum committee is taking the lead on this project.

LEARNING OUTCOMES, STUDENT SUCCESS AND ASSESSMENT

1. Undergraduate Degrees

The chemistry department assesses its programs at the department level, so all five undergraduate degrees are included in a single assessment plan and share learning outcomes.

Table 4. Undergraduate Chemistry Learning Outcomes

Learning Outcome		Measurement tool	Evaluation
A. Laboratory Knowledge and Skills			
1. the basic analytical and technical skills to work effectively in the various fields of chemistry		Capstone project	Multiple faculty evaluation during department poster session
2. the ability to perform accurate quantitative measurements with an understanding of the theory and use of contemporary chemical instrumentation, interpret experimental results, perform calculations on these results and draw reasonable, accurate conclusions.		Capstone project	Multiple faculty evaluation during department poster session
3. the ability to synthesize, separate and characterize compounds using published reactions, protocols, standard laboratory equipment, and modern instrumentation.		Not assessed at program level	N/A
4. the ability to use information technology tools such as the Internet and computer-based literature searches as well as printed literature resources to locate and retrieve scientific information needed for laboratory or theoretical work.		Capstone project	Multiple faculty evaluation during department poster session
5. the ability to present scientific and technical information resulting from laboratory experimentation in both written and oral formats.		Capstone project	Multiple faculty evaluation during department poster session

6. knowledge and understanding of the issues of safety regulations in the use of chemicals in their laboratory work.		Not assessed at program level	N/A
B. Computer, Library and Information Skills			
1. the ability to make effective use of the library and other information resources in chemistry, including the primary literature, tabulated data, and secondary sources such as the Internet.		Capstone project	Multiple faculty evaluation during department poster session
2. the ability to make effective use of computers in chemistry applications using standard and chemistry specific software packages.		Capstone project	Multiple faculty evaluation during department poster session
3.the ability to perform and interpret simple molecular modeling or chemical computations using standard software		Not assessed at program level	N/A
C. Oral and Written Communication Skills in Chemistry			
1. adequate skills in technical writing and oral presentations.		Capstone project	Multiple faculty evaluation during department poster session
2. the ability to communicate scientific information in oral and written formats to both scientists and nonscientists.		Capstone project	Multiple faculty evaluation during department poster session
D. Quantitative Reasoning Skills			
1. ability to accurately collect and interpret numerical data.		Capstone project	Multiple faculty evaluation during department poster session
2.ability to solve problems competently using extrapolation, approximation, precision, accuracy, rational estimation and statistical validity.		Capstone project	Multiple faculty evaluation during department poster session

3.proficiency in the scientific method (formulating hypotheses and arriving at appropriate answers and conclusions)		Capstone project	Multiple faculty evaluation during department poster session
E. Knowledge of Chemical Principles and Facts			
1.a working knowledge of chemical principles appropriate to a chemistry degree program to include thermodynamics, equilibrium, kinetics, quantum mechanics, structures of materials, reactivities of substances, synthesis, isolation and identification of compounds.		ACS Standardized Exam[2]	Comparison to national scores
2. a mastery of a broad set of factual chemical knowledge concerning the properties of substances, molecules, and atoms.		ACS Standardized Exam	Comparison to national scores

The chemistry department utilizes two different measurement tools to assess student learning in its undergraduate programs:

1) Standardized ACS Exams
The American Chemical Society (ACS) is the predominant professional association for chemists in the United States. The ACS is committed to the education of future chemists and maintains guidelines for the preparation of students in university degree programs. Additionally, the ACS offers standardized exams in the different subdisciplines in chemistry that are associated with the standard sets of courses typical in most chemistry degrees. These standardized exams can be purchased for use as final exams in courses. An advantage of using a standardized ACS exam as a course final exam is that the results can then be compared to national averages for institutions of higher learning across the country. It permits us to evaluate how our students are performing compared to chemistry students across the country. It also permits a gauge on what important content should be included to keep courses modern. In our chemistry department, we have elected to administer the ACS exam in organic chemistry. This exam covers the content of the two semester course series in organic chemistry that students typically take in their sophomore year. The exam covers the material spanning both courses in the two-course series and is administered at the end of CHEM 124. We additionally administer the ACS exam in biochemistry that students take as a final exam at the end of the two-course series in biochemistry taken by all biochemistry students. The exam is administered as the final exam in CHEM 160B Students typically take these courses in their junior year. Finally, we offer the ACS exam in inorganic chemistry, CHEM 110, that BS chemistry students are required to take during their senior year.

2) Capstone Poster Project Assessment
The chemistry department's other main assessment tool is an assessment of student poster presentations at our end of semester departmental poster session. Many of the chemistry department's upper division lab courses have capstone projects that are equivalent to mini-research projects toward the end of the semester. The students in these courses prepare professional level posters on these

projects and present the posters at an end of semester joint poster session. Department faculty talk to students at this poster session, similar to a scientific conference, and then use a rubric to evaluate the poster. Ten poster features are evaluated on a scale from Strongly Agree (4) to Strongly Disagree (1). Question 10 relates to the overall impression of the poster. The areas evaluated cover the physical and content specific aspects of the poster, the scientific soundness of the presented material and analysis methods, use of the scientific literature, and the students' ability to explain their work and answer questions. Students demonstrate PLOA, *Laboratory Knowledge and Skills*, through design, implementation, and execution of an independent laboratory project. PLOB, *Computer, Library and Information Skills*, are demonstrated through extensive scientific literature review, computer-aided data analysis, and, in most cases, computer-interfaced instrumentation. *Oral and Written Communication Skills*, PLOC are demonstrated through oral presentations during the departmental poster session and written components of the poster. Most courses also incorporate a formal written report on the project and an oral presentation to the class. PLOD, *Quantitative Reasoning Skills,* are demonstrated through data reduction, analysis, and interpretation. *Knowledge of Chemical Principles and Facts,* PLOE*,* is demonstrated through extensive use of chemical facts (e.g. properties and reactivities of molecules) and nomenclature in the poster project. Courses participating in the poster session include: Chemistry 125 (advanced organic lab methods); CHEM 133 (instrumental analysis); CHEM 110L (inorganic chemistry lab); CHEM 141(physical chemistry lab); CHEM 164 (advanced biochemistry lab); and CHEM 198 (senior thesis research). The poster assessment rubric is shown in Figure 1 below.

Original Poster Project Assessment (Chemistry Department) PLEASE ASSESS 5 POSTERS

Course_________________ **Evaluator**______________________

Overall the student's presentation shows that the student:

1. demonstrates effective organization of their poster (shows effectively the problem and how problem was attacked and solved)

SD D A SA NA

2. demonstrates effective use of graphs and other visual aids

SD D A SA NA

3. uses effective writing (good grammar, spelling, coherent writing, clear exposition)

SD D A SA NA

4. shows an ability to use instrumentation useful in solving or doing problem

SD D A SA NA

5. collected reasonable data useful in solving or doing the problem

SD D A SA NA

6. uses literature properly in presentation

SD D A SA NA

7. supports their generalizations and conclusions with adequate and sound evidence

SD D A SA NA

8. uses technical vocabulary correctly

SD D A SA NA

9. demonstrates effective learning of several laboratory skills

SD D A SA NA

Key

SD: Strongly Disagree
D: Disagree
A: Agree
SA: Strongly Agree
NA: Not Applicable

10. Overall impression of the poster presentation. Please rate your overall impression

1 (poor) 2 (fair) 3 (average) 4 (good) 5 (outstanding)

Additional Comments:

Figure 1. Capstone Poster Presentation Rubric

<u>Impact of Covid on Undergraduate Assessment Practices</u>

The chemistry department assessment tools rely on face-to-face modality. The American Chemical Society will not permit its standardized exams to be administered online and as a result the exams were not administered after the pandemic pivot to virtual instruction. Similarly, the chemistry department shut-down all in person labs beginning in the spring 2020 semester. Courses that would have contained a capstone project transitioned to projects that were literature based, computational in nature, or replaced with a different type of assignment entirely. No posters were prepared and no poster session was held from Spring 2020-Fall 2021. As a result, program assessment was significantly disrupted during this time period.

2. Graduate MS Degrees

The assessment plan for our graduate programs has been the most recently developed and required by the university. As a result, this has been a recent activity in the department and remains a work in progress. Assessment tools are under development for the PLOs.

The chemistry department's master's degree program learning outcomes (PLO) for both chemistry MS degree options mapped on the university Graduate Learning Objectives are summarized in Table 5.

Table 5. Graduate Learning Objectives mapped on Chemistry Learning Outcomes.

Graduate Learning Objectives	Program Learning Outcomes
Disciplinary knowledge	Student demonstrates ability to describe and apply chemistry knowledge and skills.
Communication	Student demonstrates ability to communicate contemporary scientific research in chemistry including goals, methods, data, and conclusions.
Analysis and Synthesis	Student demonstrates ability to analyze original research data and to synthesize results and conclusions with regard to the relevant chemistry research literature.
Information literacy	Student demonstrates ability to obtain and evaluate information from a variety of scientific sources. Student demonstrates knowledge of different forms of plagiarism and how to avoid these.
Scientific integrity	Student demonstrates knowledge of safety practices and handling and disposal of hazardous materials in the area of the thesis research.

Table 6. Curriculum Map for Graduate PLOs for MS Chemistry Biochemistry Concentration

Course Work	PLO 1 – Disciplinary knowledge	PLO 2 - Communication	PLO 3 – Analysis and Synthesis	PLO 4 – Information literacy	PLO 5 – Scientific integrity
200 (C)		X		X	X
260 (C)	X				
261 (C)	X				
294 (C)		X		X	
299 (C)					X
500 (cul)		X	X	X	

Table 7. Curriculum Map for Graduate PLOs for MS Chemistry (No Concentration)

Course Work	PLO 1 – Disciplinary knowledge	PLO 2 - Communication	PLO 3 – Analysis and Synthesis	PLO 4 – Information literacy	PLO 5 – Scientific integrity
200 (C)		X		X	X
220 (C)	X				
230 (C)	X				
294 (C)		X		X	
299 (C)					X
500 (cul)		X	X	X	

The chemistry department's master's degree is a thesis-based program based upon thesis research performed in faculty member mentored labs. Students obtain program units for conducting this research (CHEM 299) and preparing a defendable research proposal on the project and then a defendable thesis on the results (CHEM 500). The students are also required to take discipline specific core courses (CHEM 220 and CHEM 230 for Chemistry MS students and CHEM 260 and CHEM 261 for Biochemistry MS students). The discipline specific assessment PLO1 will consist of questions on the course final exams that will be comparable from year to year. These questions are currently under development and faculty review. PLO2 is assessed in CHEM 200, "Introduction to Research", the course students take in their second semester in the program. In this course, students work on their literature seminar, and thesis proposal. There are considerable written and oral communication requirements embedded in this course. PLO4 and PLO 5 is additionally covered in this course. The department additionally requires students to prepare and deliver a 50-minute seminar on a literature topic outside of their thesis research area as a requirement for the master's degree. This is a departmental seminar with faculty, undergraduate, and graduate students invited. These seminars are assessed by all present faculty using a common rubric shown in Figure 2. A score of 3 or better is considered acceptable. Students who obtain scores of 2 or lower by two or more attending faculty are considered to have not successfully passed their seminar requirement. These cases are then reviewed by the department's graduate committee who identifies a remediation assignment which can include the preparation of a paper or re-presenting a portion or the entire seminar. The seminar assessment covers PLO2 and PLO4 in our assessment plan. The student's prepared master's thesis assesses PLO 2, PLO 3, and PLO4. The student's thesis committee, comprised of three faculty members, uses a common rubric for the thesis evaluation assessment tool.

Literature Seminar Evaluation Form

Presenter: ______________________________ Evaluator: ________________________

Presentation Style: 0 = unacceptable; 1 = poor; 2 = fair; 3 = good; 4 = outstanding

1. Were the slides acceptable? 0 1 2 3 4
   (font size, amount on slide, legible and clear, references, no errors, etc)
2. Was the quality of speaking acceptable? 0 1 2 3 4
   (well paced, projected voice, face audience, eye contact, confident, etc)
3. Was the seminar well organized? 0 1 2 3 4
   (outline, logical sequence, good transitions, easy to follow, etc)
4. Did the student keep the audience interested? 0 1 2 3 4
   (show enthusiasm, command attention, did you learn something new?)

Was the seminar between 40 and 55 minutes in length? Yes No
Start time:_________ End time:__________

Content: 0 = unacceptable; 1 = poor; 2 = fair; 3 = good; 4 = outstanding

1. Was the topic and literature cited current and chemistry based? 0 1 2 3 4
2. Did the student show an understanding of the research? 0 1 2 3 4
   (background, objectives and significance thoroughly explained?)
3. Did the student understand the methods used and data collected? 0 1 2 3 4
   (methods and data/results fully explained or simply restated?)
4. Did the student demonstrate an understanding of the overall contribution of the work presented to the field? 0 1 2 3 4
5. Did the seminar utilize cited studies to present a cohesive picture of the subject matter? 0 1 2 3 4
6. Did the student answer questions accurately and with confidence? 0 1 2 3 4
   (does student possess good understanding of topic based on answers?)

Overall Grade: 0 = unacceptable; 1 = poor; 2 = fair; 3 = good; 4 = outstanding (3 or higher is passing)

How would you score this seminar based on presentation (0 to 4)? ___________

How would you score this seminar based on content (0 to 4)? ___________

Additional comments may be provided on the reverse side of this evaluation form

Figure 2. Literature Seminar Assessment Form

B. Summary of Data for Learning Outcomes:

1. Undergraduate Degrees

PLO A-D Laboratory Knowledge and Skills, Computer, Library and Information Skills. Oral and Written Communication Skills in Chemistry, Quantitative Reasoning Skills

Table 8 summarizes the results for question 10 from the original poster assessment rubric. Question 10 shows the overall impression assessment. The data on the other remaining poster questions is not included for brevity. Again, we needed to cancel the capstone projects and poster sessions for several semesters due to the fires in northern California that closed down on-campus activities for several weeks toward the end of the semester and then the covid pandemic which shut down most campus activities for four semesters.

Table 8. Original Poster Project Assessment Summary for Rubric Question 10, Overall Impression. Rubric provided in Figure 1.

2018-2019	110L	125	133	141	164	Average
BS Chem	4.2	4.4	4.6	4.8		4.5
BS Biochem		4.4		4.1	4.3	4.2
BA Biochem					4.5	4.5
BA Forensic		3.5			3.8	3.6
BA Chem						NS
2016-2017	**110L**	**125**	**133**	**141**	**164**	**Average**
BS Chem	4.0	4.3	4.6	4.6		4.4
BS Biochem		4.2		4.1	3.5	3.9
BA Biochem					3.3	3.3
BA Forensic		4.0			4.0	4.0
BA Chem		4.3				4.3

Examination of the data in Table 8 shows that all of our degree paths in chemistry meet the PLOs assessed by the original poster capstone project. We are pleased with student performance on these capstone projects and are confident that these activities help to develop the technical, computer based, and communication skills that the department desires for its students. Despite our satisfaction with the overall outcomes, there are some trends worth deeper consideration. Close examination shows that BS Chem student posters more strongly meet the PLOs than the other major degree program posters. In contemplating some reasons for this, one must consider that the BS Chem curriculum contains some differences from the other degree programs that may give the BS Chem students fuller exposure and practice in the PLO areas. In explanation, the BS Chem degree students must take three semesters of calculus and three semesters of calculus-based physics for their degree. They must also take a full year of physical chemistry lecture. BS chem students are also required to take the largest number of capstone project lab courses and gain more project design/development experience through these courses. Although not included to maintain brevity, examination of the poster project rubric detailed results show that non-BS Chem and BS Biochem students consistently ranked lower on rubric questions 3,6, and 8. These questions are related to writing, use of scientific literature, and technical vocabulary. Although these skills are enhanced through the preparation of lab reports and oral presentation of scientific projects, these skills can be developed and enhanced in lecture-based courses. An additional consideration is to consider how participation in undergraduate research might impact this data. We have not evaluated the influence of research experience on capstone project and poster performance. However, it is reasonable to expect that research students have greater potential to meet all of the PLOs with significant undergraduate research experience. We have recently been incorporating a greater number of CURES (Curriculum Based Research Experiences) into our lab courses. It will be interesting to see the impact of these lab course redesigns on our assessment results. These are topics of discussion for a department retreat in the planning stages for early fall 2022.

PLO E. Knowledge of Chemical Principles and Facts

Tables 9 and 10 summarize the results of the standardized American Chemical Society Final Exams that we administer in our second semester organic lecture course (CHEM 124) and in our senior level inorganic chemistry course (CHEM 110). CHEM 124 is taken by all chemistry majors at the end of their second year or early in their third year. CHEM 110 is almost always taken by students in their senior year. The ACS exam is slated to be administered in our second semester biochemistry lecture course for biochemistry BS and BA students. However, the results of these exams were not provided in time include in this report.

Table 9. Results of Standardized Exam in Inorganic Chemistry (CHEM 110)

Section	Students	Average Score	Percentile (%)	National Average Score (2002 exam)
Fall 2016	16	31.2	66	28
Fall 2017	12	38.4	90	28
Fall 2018	14	34.3	80	28

Table 10. Results of Standardized Exam in Organic Chemistry (CHEM 124)

Date	Students	Average Score	Percentile	National Average
Fall 16	45	36	51	38
Fall 16	62	34	44	38
Spring 17	49	36	51	38
Spring 17	48	39	60	38
Summer 17	26	37	54	38
Fall 2017	54	35	40	38
Fall 2017	26	37	54	38
Spring 2018	59	35	40	38
Spring 2018	32	37	54	38
Fall 2018	65	37	54	38
Fall 2018	46	33	39	38
Spring 2019	60	34	44	38
Spring 2019	67	35	40	38
Summer 2019	39	32	38	38
Average		37(+/- 2)	47(+/-7)	38

ACS exam scores in 124 (Table 10) are close to the national average, as we've consistently observed for this course over the years. The variation observed over sections is fairly consistent and is not instructor dependent. Although one may consider a percentile of approximately 50% low, the department is pleased with this outcome. The students in CHEM 124 are frequently from significantly varied Organic Chemistry I backgrounds since many students transfer in with Organic Chemistry I completed at the community college. The level of these courses can vary considerably, and we often observe transfer students struggle in CHEM 124 after arriving on campus. In fact, we added Peer Assisted Learning Sections (PALS) to CHEM 124 to help students navigate this course specifically. Additionally, CHEM 124 is populated by a variety of majors, most notably chemistry and biology. Many institutions have a specific organic chemistry series for chemistry/biochemistry majors only and the standardized exam would only be administered to the major's o-chem series. As a result of this demographic mix in our course that serves multiple majors, the standardized organic exam is not currently assessment of solely our majors. It is worth consideration to analyze the data from this assessment considering chemistry and biochemistry major data only.

The standardized exam in CHEM 110, inorganic chemistry, is taken by senior chemistry and biochemistry majors only. It is frequently one of the last courses taken in these degrees. Our ACS exam class average in Chem 110 is generally much higher than the national norm. Chem 110, Inorganic Chemistry, is one of the final upper division courses the BS Chemistry /Biochemistry majors take. In fact, very few biochemistry students elect to take this course since it is not required for their degree and they have a larger set of elective options that more closely align with their biochemical interests. As a result, this course is mostly populated by BS CHEM students. For BS CHEM students to make it to this course, they must successfully pass three semesters of calculus and a year of physical chemistry. In addition to this rigorous preparation, Inorganic Chemistry integrates many of the concepts learned in previous courses. The department chair has asked students how they feel about this course and a common response is that students feel this is where they really understand why all of their previous learning was important. They feel they gain a deep appreciation for molecular structure and bonding in Chem 110.

Although data for Chem 160B was not provided to the department chair in time for this report, historically students in this course perform close to the national average.

2. Graduate Degrees.

As mentioned above, our graduate assessment plan is relatively new. We are still developing some of the assessment tools for these programs. However, our literature seminar assessment has been utilized for several years at this point and we can offer some qualitative information. Prior to the development of CHEM 200 and the implementation of our literature abstract approval process, the number of seminars evaluated to be unacceptable was approximately 25%. Our modified seminar topic and approval process reduced the number of seminars evaluated as unacceptable or marginal to approximately 10%.

STUDENT SUCCESS

A. Provide admission data disaggregated by gender and ethnicity for each degree

Data source: CSUS Enrollment Dashboard (https://www.csus.edu/president/institutional-research-effectiveness-planning/dashboards/enrollment.html).

1. <u>Current enrollment (F2021)</u>

The Department of Chemistry offers 7 major degrees and 1 minor degree. Undergraduate major degrees include BS Chemistry, no concentration (BS-NC); BS Biochemistry (BS-BC); BA Chemistry (BA-NC); BA Chemistry, forensic concentration (BA-FR); BA Chemistry, biochemistry concentration (BA-BC). There are two master's degrees, MS Chemistry, no concentration (MS-NC) and MS Chemistry, biochemistry concentration (MS-BC). There is also a Chemistry undergraduate minor degree (MN).

The current enrollment in all degrees is 410 students. This number does not include students who are enrolled in a chemistry degree as a secondary major. The BS Biochemistry degree is the most populated, followed by BA Chemistry (forensics concentration) and BS Chemistry (Figure 3A). The most populated ethnicity in most Chemistry degrees is Hispanic (both BS degrees, BA-NC, BA-FR) followed by Asian or White, depending on the degree (Figure 3B). Females outnumber males in all Bachelor's degrees whereas males outnumber females in both graduate degrees (Figure 3C).

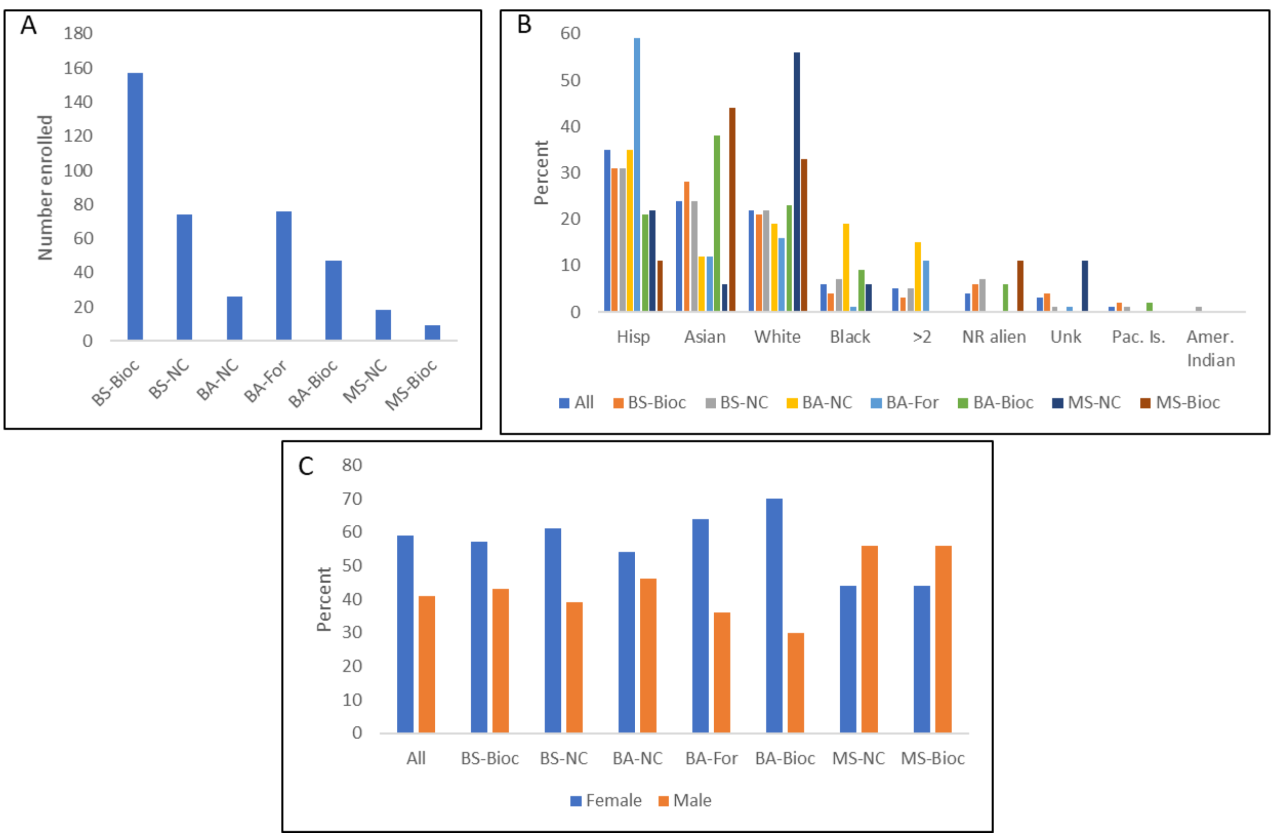

Figure 3. F2021 enrollment (panel A), ethnic representation (panel B), and gender representation (panel C) in Chemistry degrees.

2. <u>Trends in enrollment</u> (2012-2021)

a. <u>Degree enrollments</u>

Chemistry experienced a sharp increase in enrollment from 2012 to 2017 and an even sharper decline in enrollment from 2017 to 2021 (Figure 4A). Drop in 2021 could be explained by the Covid-19 pandemic. The largest drop in enrollment occurred between 2017 and 2018. The most popular degree in all years was BS-BC (Figure 4B). The next most popular degree is the BS-NC, which has experienced some decline since 2012. The BA-FR and BA-BC degrees have both experienced growth since 2021, although the BA-BC degree peaked in 2017-2018 and has since declined. There has been little change in the enrollment in BA-NC, the least populated undergraduate degree. Enrollment in both graduate degrees has been fairly constant, with more students consistently enrolled in the MS-NC than the MS-BC degree (Figure 4C).

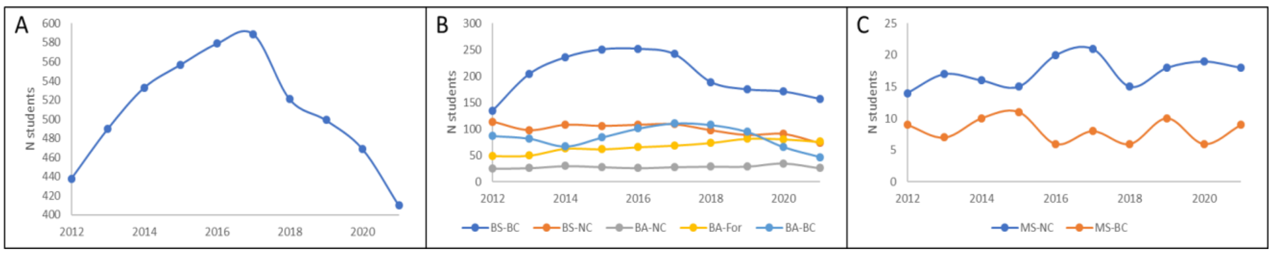

Figure 4. Enrollment trends in the Chemistry department from 2012 to 2021 for all (panel A), undergraduate (panel B), and graduate (panel C) degrees.

b. <u>Ethnic representation</u>

In 2012, Asian students comprised the highest ethnic representation (35%) in all Chemistry degrees whereas American Indian students had the lowest (0.1%) (Figure 5). White and Hispanic students had the second and third highest representation, respectively. Black students comprised 5% of the students in 2012 whereas Pacific Islander students comprised less than 1% of students in chemistry degrees. Just over 1% of students identified as non-resident alien while 8% were unknown. The enrollment of Hispanic students over all degrees increased from 15% in 2012 to 35% in 2021, the biggest change in ethnic representation, while enrollment of Asian students decreased by about 15% during this time period. The percent of white students remained largely the same. The percent of Black students increased up to 2019 and then decreased slightly in 2020 and 2021. There was a decline in Unknown students and an increase in non-resident alien students in 2020 and 2021. The percent of Pacific Islander and American Indians students experienced both slight increases and decreases; both categories remained the lowest represented ethnicities throughout the 2012-2021 time span.

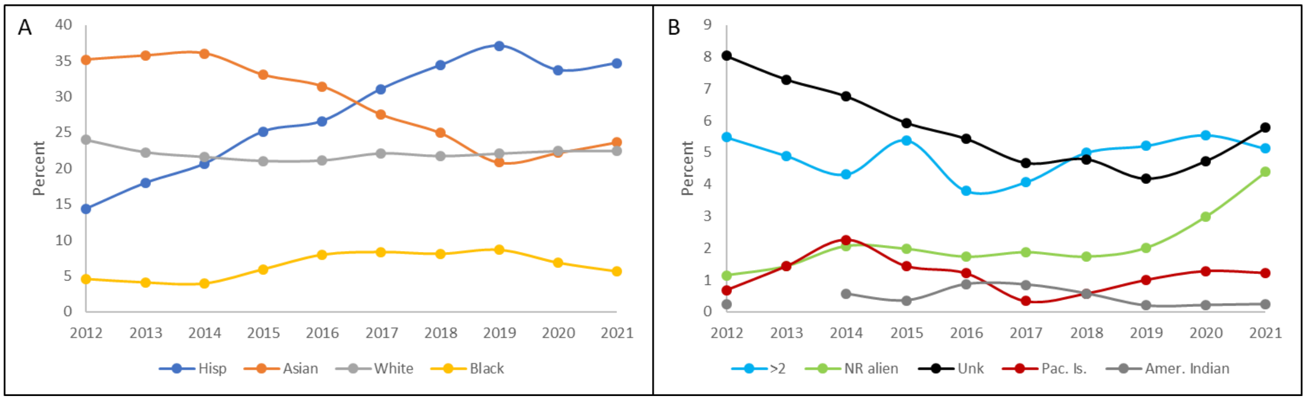

Figure 5. Ethnic representation over all chemistry degrees for Hispanic, Asian, White, Black (panel A) and non-resident alien, more than two races, unknown, Pacific Islander, and American Indian (panel B).

Trends in ethnic representation varied substantially among the individual undergraduate degrees. White students constituted the largest ethnic group in the BS Chem degree, until 2021 when there was a sharp decline (Figure 6, panel A). Hispanic representation increased throughout the time span, becoming the most populated group in 2021. The percent of Asian students remained steady, constituting about 25% of students. Students claiming “Unknown” decreased sharply in 2014 and remained very low thereafter. The percent of students indicating two or more races increased. Pacific Islander, American Indian, and non-resident alien were all very low, under 5%, except that non-resident alien students increased to about 6% in 2021.

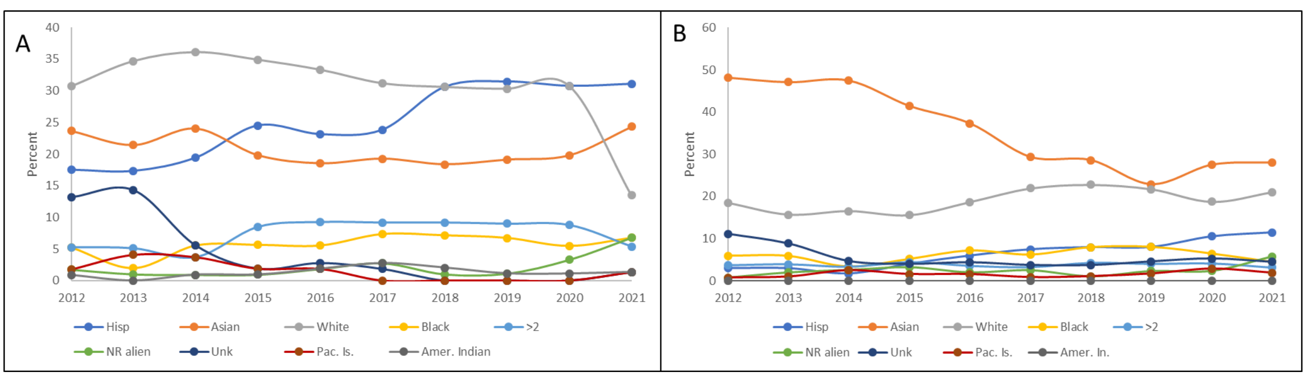

Figure 6. Ethnic representation in BS Chem (panel A) and BS Biochem (panel B).

The ethnic profile in the BS Biochem degree is markedly different than the BS Chem degree (Figure 6, panel B). Asian students constituted 50% of enrollment in 2021 vs 25% for BS-NC. This number declined overall but Asian students still had the highest representation in 2021 at 30%. White students had the second highest representation which increased slightly over the time period. The third largest category in 2012 was Unknown students at about 11%. This number declined over time to about 4%. Black students constituted about 7% of enrollment in this degree in both 2012 and 2021. The remaining categories all remained very low, generally less than 5%.

Marked differences in ethnic representation are also observed in the BA degrees (Figure 7). Similar to the BS-BC degrees, Asian students constituted about 50% of enrollment in the BA-BC degree, which declined slightly over time (Figure 7, panel C). In contrast, Asian students constituted only about 25% of enrollment in the BA-NC degree in 2021, which declined to 10% by 2021, and less than 20% of the BA-FR degree, also declining slightly over time (Figure 7, panels B and C). White students decreased in both BC-NC and BC-FR degrees to about 20% and 18%, respectively while this category increased in the BA-BC degree in 2020 and 2021 to 25%. Hispanic students increased in both BC-NC and BC-FR degrees, becoming the dominant enrollment in both degrees (35% and 60%, respectively). In contrast, Hispanic students, while experiencing an increase between 2012 and 2015, only constituted about 5% of the enrollment in BA-BC in 2021. Black student representation increased to nearly 20% in the BA-NC degree but remained low in BA-FR and BA-BC degrees, constituting 10% in 2021 of enrollment in the BA-BC degree and 0% in the BA-FR degree.

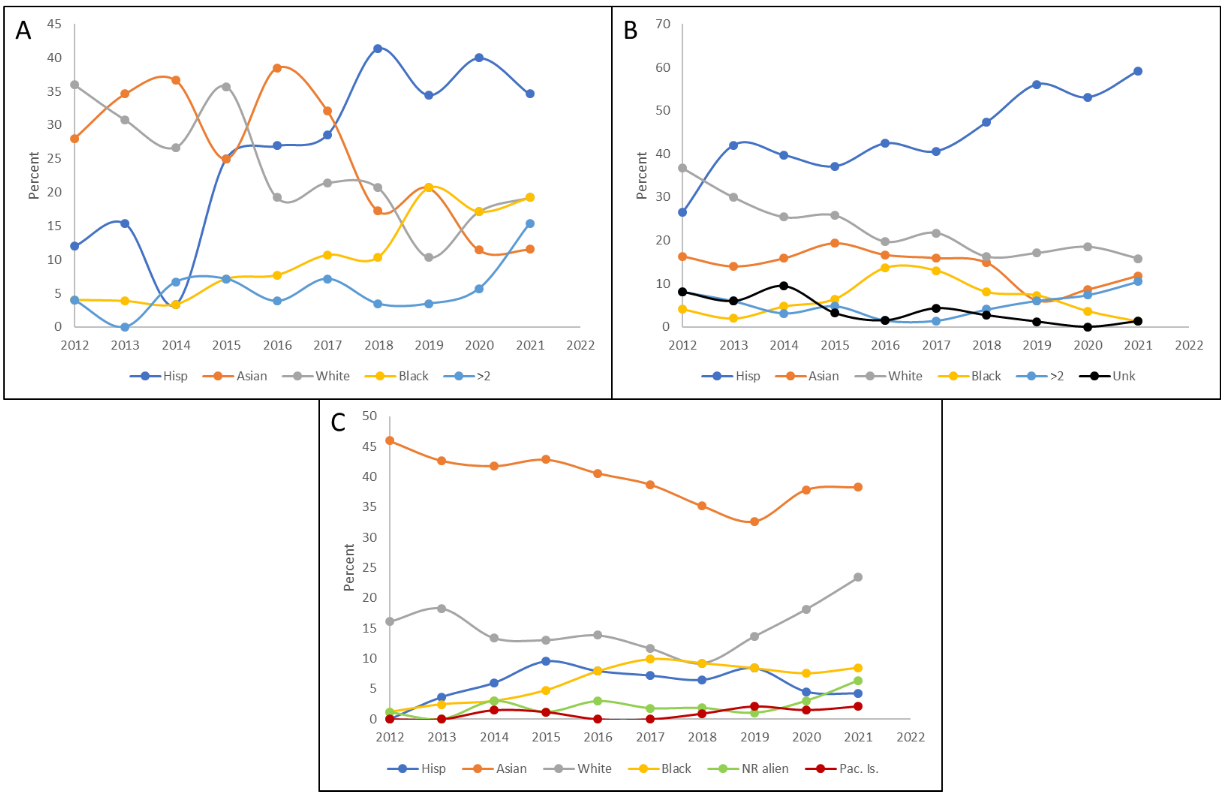

Figure 7. Ethnic representation in BA-NC (panel A), BA-FR (panel B), and BA-BC (panel C). Some categories are not shown because the number of students in those categories is zero.

Following the same trend as the undergraduate biochemistry degrees (BS-BC, BA-BC), there is a higher percentage of Asian students in the MS-BC degree compared to the MS-NC degree (Figure 8). The percentage of white and Asian students were both higher in the MS-BC degree than Hispanic students. In contrast, apart from “unknown”, Hispanic students constituted the highest enrollment in MS-NC until 2019, when the percent of white students increased and became the highest enrollment. Black students constituted 5-10% of enrollment in the MS-NC degree for most of the 2012-2021 time span. In contrast, there were no Black students enrolled in the MS-BC degree.

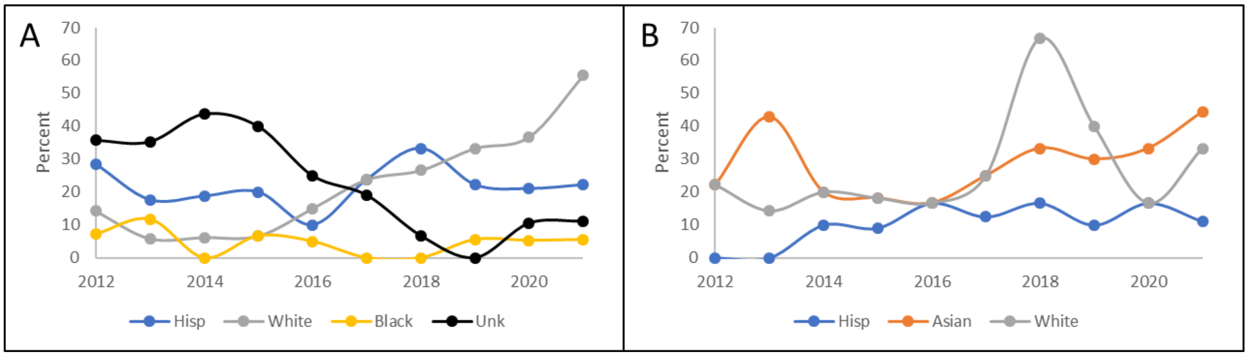

Figure 8. Ethnic representation in MS-NC (panel A) and MS-BC (panel B) degrees.

c. Gender distribution.

Females outnumber males over all degrees (Figure 9, panel A), with a gap that has increased over time. The distribution in 2012 was 55% female, 45% male versus about 60% female, 40% male in 2021. Differences in gender distribution occurred in the BS degrees with males outnumbering females in years prior to 2017 in the BS-NC degree. In contrast, females substantially outnumbered males in all years in the BS-BC degree, especially between 2015-2017 (~65% female, 35% male).

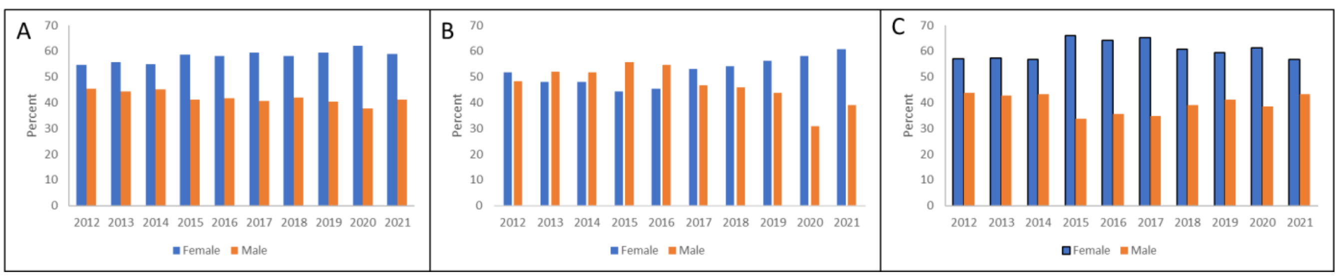

Figure 9. Gender distribution over all (panel A), BS-NC (panel B) and BS-BC (panel C) degrees.

Differences in gender distribution also occurred in the BA degrees (Figure 10). Males outnumbered females for most of the 2012-2021 time span in the BA-NC degree, especially between 2012-2017. Females significantly outnumber males in all years in the BA-FR degree by as much as 70 to 30%. Gender representation was pretty even in the first few years of the time span but there was a steady increase in the percent of females in the BA-BC degree with the greatest difference occurring in 2021 (70% female, 30% male).

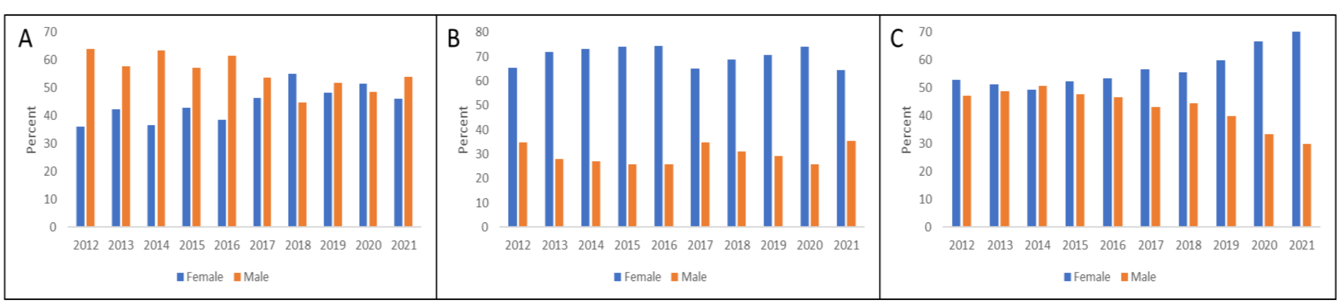

Figure 10. Gender distribution for BA-NC (panel A), BA-For (panel B) and BA-BC (panel C) degrees.

With a few exceptions, gender distribution was more even in the Master's degrees. Females initially outnumber males in the MS-NC degree until 2015 at which point males outnumbered females (55% male, 45% female in 2021). In the early years of the MS-BC degree, females outnumbered males substantially. The percent of males increased in 2015, was even in some years and culminated in 2021 with about 55% male, 45% female.

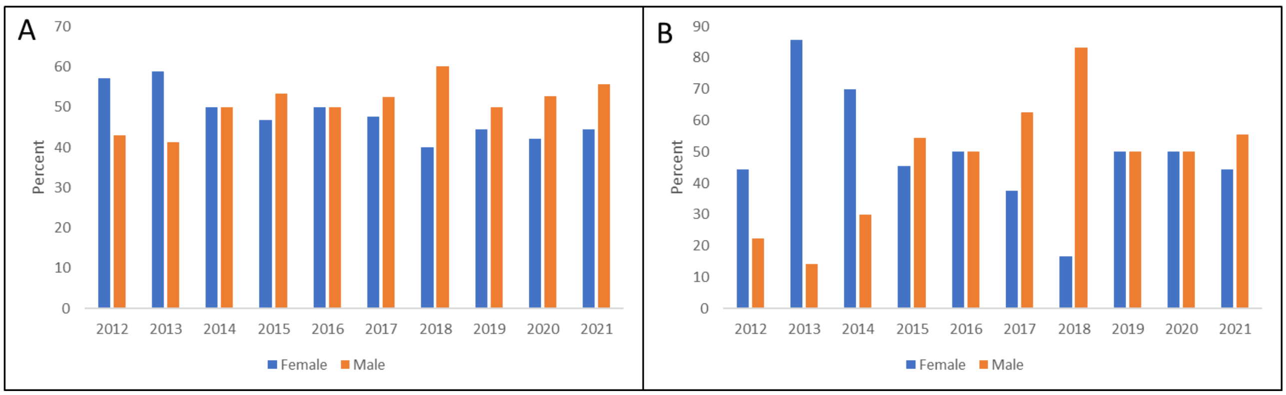

Figure 11. Gender distribution in MS-NC (panel A) and MS-BC (panel B) degrees.

B. Provide retention data disaggregated by gender and ethnicity for each degree.
Data source: Joel Schwartz, Office of the President, CSUS

Retention was evaluated from the fall 13 semester onward for the third and seventh terms, which provides information on 2nd and 4th year retention rates, respectively, for both first-year students (FYS) and transfers. Third term retention data includes cohorts from F13 to through F20 and seventh term retention data includes cohorts from F13 through F18. The retention data set for the department over this time period is very large and complicated by two factors. First, a lack of student enrollment in a particular gender or ethnicity for a particular degree in a particular cohort needs to be differentiated from a 0% retention rate. This is done by including an asterisk where the retention rate is 0% in the data presented in this section. Second, a small student enrollment (small N value) needs to be recognized in the retention rate. For example, a 100% retention looks very good but often reflects one student (N = 1). This is noted in the discussion below. Furthermore, the data were provided in Excel spreadsheet format and all data (in the absence of a department Factbook) had to be plotted individually. Due to the large amount of information, the need to generate plots for several variables, and the complicating factors of zero to very low numbers of students in some instances, we elected to streamline the data presentation by a. showing detailed data for one ethnic group (Hispanic) and b. showing data for all groups averaged over the cohort years. Hispanic student retention was chosen for detailed representation due to the high and growing enrollment of this group in the department. Finally, only undergraduate retention data are shown.

1. *Detailed data for Hispanic student retention*

First-year students

Third term retention of first-year Hispanic students is generally higher than seventh term retention (Figure 12). Retention overall was highest in the BS-NC degree and lowest in the BA-BC degree. Third-term retention in the BS-NC degree improved over time, and was 100% in F16 (N=7), F18 (N=10), F19 (N=7) and F20 (N=5) cohorts. The retention rate in the BS-BC degree was fairly constant, except for a dip in the F17 cohort, and steadily increased thereafter. The retention rate in F18, F19 and F20 cohorts, respectively, was 77.8% (N=9), 86.7% (N=15) and 90.0% (N=11). The BA-NC degree is the lowest enrolled of the undergraduate degrees (Figure 4B). There is a lot of fluctuation in the retention rate for this degree due to the low number of students in each cohort. For example, the retention rate in F14 (N=1) and F15 (N=2) cohorts was 100 and 50%, respectively, indicating that we retained the one student in this degree in the F14 cohort but lost one of two students enrolled in the F15 cohort. Retention rate in F18-F19 cohorts was 80.0 (N=5), 83.3 (N=6), and 66.7% (N=6). The BA-FR degree had pretty consistent third-term retention near 90% but declined in F19 and F20 cohorts to 70% (N=16 and 13, respectively). Third-term retention overall was lowest in all cohorts except F16. Retention in this degree between F18 and F20 cohorts was 50 (N=6), 77.8 (N=9), and 0% (N=3).

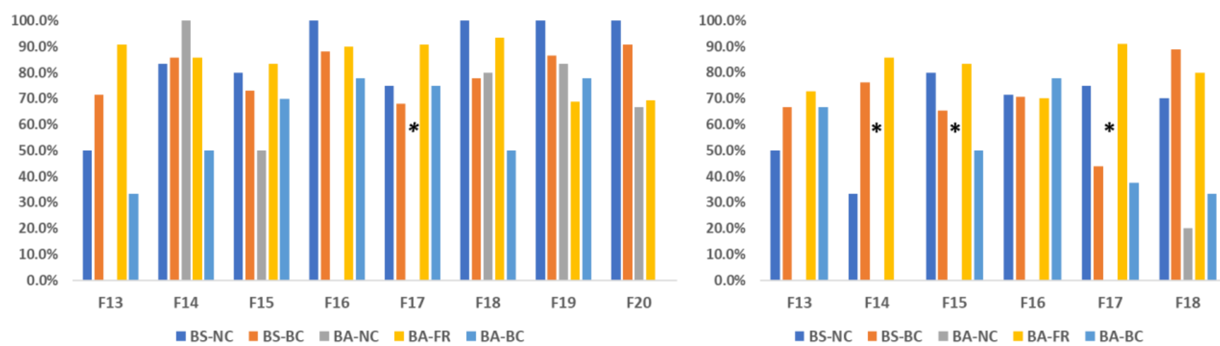

Figure 12. Third (left panel) and seventh (right panel) retention of first-year Hispanic students in undergraduate Chemistry degrees. Asterisks indicate 0% retention. Empty column areas without asterisks are due to no Hispanic students enrolled in the degree in that cohort.

The BA-FR degree had the highest overall seventh term retention of Hispanic students with 90.9% (N=11) and 80% (N=15) being retained in F17 and F18 cohorts, respectively (Figure 12, right panel). The BS-NC degree retention was about 50% in F13 (N=2) and about 70% in F18 (N=10) cohorts. The highest retention was in F15 (about 80%, N=5). Retention in the BS-BC degree ranged from 44% in F17 (N=25) to 89% in F18 (N=9). The BA-NC degree had very poor seventh term retention. Retention was 0% in F14 (N=1), F15 (N=2), and F17 (N=1) cohorts and 20% in the F18 cohort (N= 5). Seventh term retention in the BA-BC degree was highest in the F16 cohort (77.8%, N=9) and declined in the F17 (N=8) and F18 (N=6) cohorts to 37.5 and 33.3%, respectively.

In summary, the BS degrees had the highest third-year retention for FY Hispanic students while BA-FR had the highest seventh term retention. Retention was lowest in the BA-NC and BA-BC degrees, with the BA-NC degree retention being particularly low.

Transfer students

Third term retention of Hispanic transfer students, which had lower enrollment compared to FYS, was higher overall than FYS (Figure 13). BS-NC retention was 100% in F15 (N=3), F16 (N=5), F18 (N=3), F19 (N=3) but was 0% in the F17 (N=2) cohort and declined to 66.7% in the F20 cohort (N=3). BS-BC was similar to BS-NC with 100% retention in F15 (N=4), F16 (N=5), F18-F20 (N=4, 6, 4) but 71.4% in the F17 cohort (N=7). Third term retention was higher in the BA-NC degree for transfers than for FYS, with 100% retention in F13 (N=1), F15 (N=1), F16 (N=2), F17 (N=1), and F20 (N=1). Retention in BA-FR was 0% in F14 (N=2) but was 100% in all other cohorts where students were enrolled: F16, F17, F19, F20 (N=2 in each of these cohorts). Retention in BA-BC was 0% in two cohorts, F13 (N=1) and F19 (N=3), 66.7% in the F14 cohort (N=3) and 100% in F17 (N=1) and F18 (N=1) cohorts.

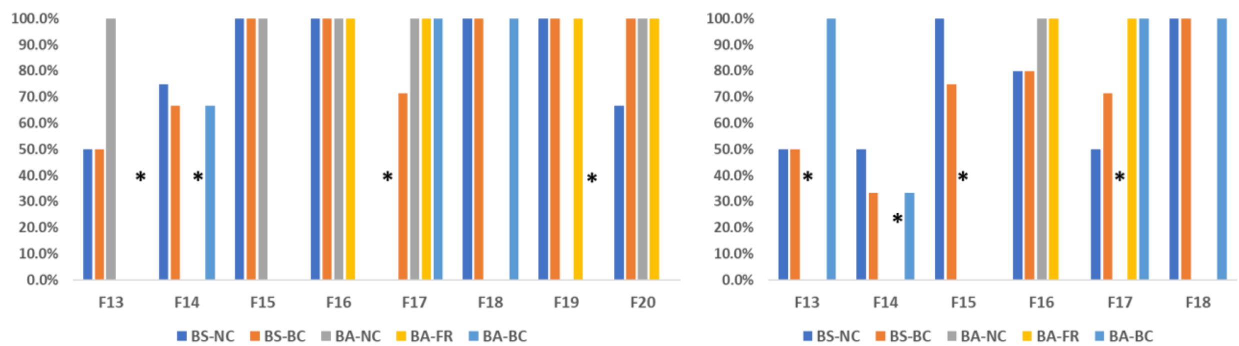

Figure 13. Third (left panel) and seventh (right panel) retention of transfer Hispanic students in undergraduate Chemistry degrees. Asterisks indicate 0% retention. Empty column areas without asterisks are due to no Hispanic students enrolled in the degree in that cohort.

Seventh term transfer retention was lower than third term (Figure 13, right panel). BS-NC retention of Hispanic students varied between 50 and 100%, with the F17 cohort (N=2) at 50% and the F18 cohort (N=3) at 100%. BS-BC retention varied from 33% in the F14 cohort (N=3) and 100% in the F18 cohort (N=4). The BA-NC degree was the lowest enrolled and also had lower retention with retention of F17 cohort at 100% (N=1) but retention of F13 (N=1), F15 (N=1) and F16 (N=2) cohorts at 0%. BA-FC had 0% retention of the F14 cohort (N=2) but 100% retention of the F16 (N=2) and F17 (N=2) cohorts. Finally, retention in the BA-BC degree had the best overall retention rate with 33.3% in the F14 cohort (N=3) but 100% in the F13 (N=1), F17 (N=3), and F18 (N=1) cohorts.

In summary, third term retention of transfers was overall higher than that of FYS with some cohorts having 100% retention in all degrees. Both BS and the BA-FR degrees had higher retention rates than BA-NC and BA-BC degrees. Seventh-term retention was lower overall and fluctuated among the cohorts with BA-BC having the highest retention rate.

2. *Averaged cohort data by ethnicity*

Third and seventh term retention rates were averaged over the cohorts. Third term cohorts were averaged for F13-F20, seventh term cohorts for F13-F18. Data are presented for FYS and transfer students by ethnicity and gender for each undergraduate degree. In some cases, enrollment in a particular degree was zero; this occurred most often with Pacific Islander and Native American students.

First-year students

Third-term retention of students in the BS-NC degree is at or above 80% for all ethnicities except Pacific Islander (PI, N=3 for this group) which was 50% (Figure 14). The averaged retention rate reflects the retention of one of two PI students enrolled in F13 and the retention of one PI student enrolled in F14. BS-BC was very similar to BS-NC but with a third term retention rate of 100% for PI students (N=5). BA-FR has the highest third term retention rate of the BA degrees for all ethnicities. The retention for BA-BC is around 80% for Asian and white students, less than 60% for Hispanic students, and 100% for PI students (N=1). BA-NC has somewhat lower retention with both Hispanic and white students having 60% retention. Retention of Asian and Black students is about 80%. There were no PI or Native American (NA) students enrolled in this degree.

Seventh term retention is overall lower than third-term retention ranging from 40 to 100% in most cases. Across degrees, seventh term retention is lowest for Black and white students. Seventh term retention decreases are generally between 10 to 20% with Hispanic and white students having a larger decrease in third to seventh term retention than Asian and Black students. Retention was 100% for NA students in the BS-NC degree (N=1). BS-BC shows similar 10-20% drops in retention except for Black students where the retention dropped from 88.3% to 50.3% (from 13 to 9 students between F13-F20). BA-FR shows 10-20% decreases in retention for Asian, Black, and white students. Retention of Hispanic students in this degree remained near 80%. BA-BC shows an overall smaller decrease in retention rate than the other degrees. The drop in retention was about 10% for Hispanic and Asian students, less than 4% for white students, and about 7% for Black students. The one PI student in this degree was retained in the seventh term. BA-NC has very poor retention of Hispanic students decreasing from 60 to 5%; almost all of this occurred in F19 and F20 cohorts. Each of these cohorts had 6 students enrolled in the BA-NC degree which dropped to zero for both cohorts in the seventh term. One explanation for this is that at least some of these students may have switched to a different chemistry degree.

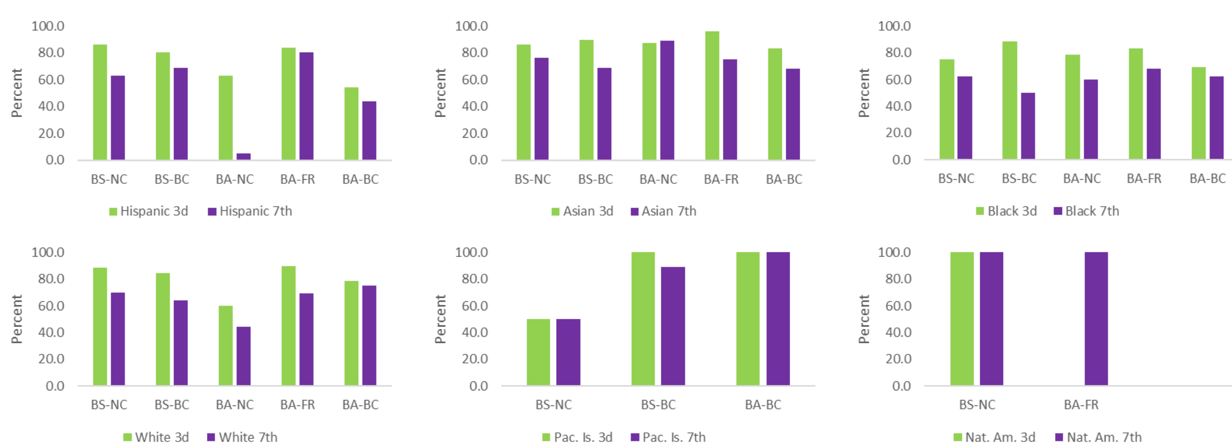

Figure 14. Third and seventh term retention of FYS by ethnicity. Data are averaged over the F13-F20 cohorts for third term and F13-F18 cohorts for seventh term.

Transfer students

Third term retention for all degrees for transfers is 100% for Black (N=13) and PI students (N=6) between F13 and F20 (Figure 15). Third term retention is also high for white students, above 80% for both BS degrees and 100% for the BA degrees. Third-term retention varies for Asian students between about 75 and 85% and for Hispanic students between about 55% (BA-BC) and 100% (BA-NC).

The decrease in retention from third to seventh term is greatest for Hispanic and Asian students in the BA-NC degree. In contrast, seventh term retention in this degree is 100% for Black, white, and PI students. Similar to FYS, in most other cases the drop in retention rate is between 10 and 20% except for a 100% drop in BS-NC for PI and BA-BC for white students.

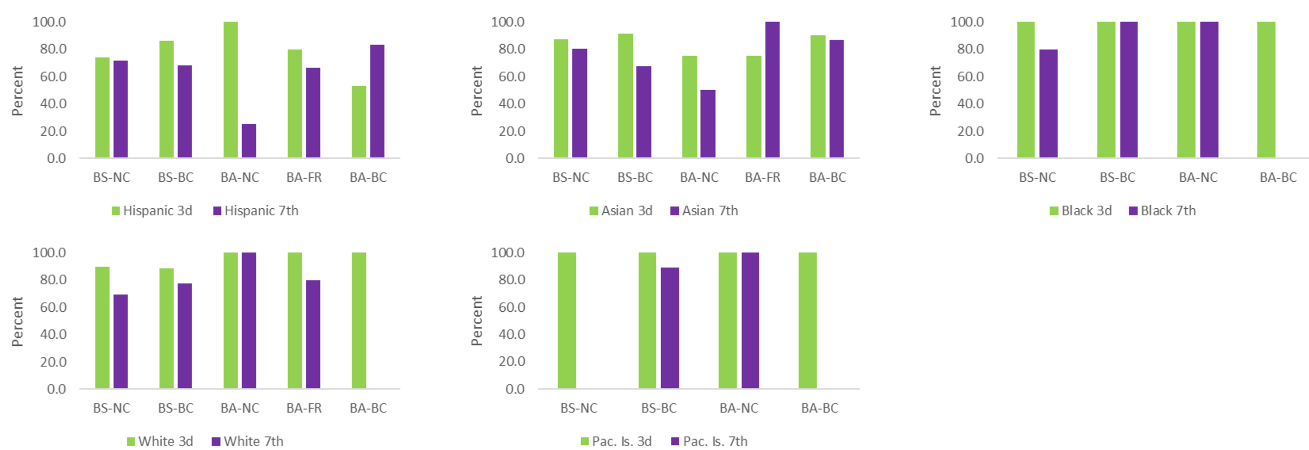

Figure 15. Third and seventh term retention of transfers by ethnicity. Data are averaged over the F13-F20 cohorts for third term and F13-F18 cohorts for seventh term. There were no Native American transfer students enrolled during the time period.

C. Provide 4-year and 6-year graduation data disaggregated by gender and ethnicity for each degree.
Data source: Joel Schwartz, Office of the President, CSUS

Data were not able to be completely processed in time for the program review. This analysis will continue in the chemistry department's Equity, Retention and Graduation committee.

D. Provide analysis on admission, retention, and graduation data, including how to maintain success and improve time to degree, and consider concentrations as needed.

Enrollment

The sharp increase in overall enrollment in the Chemistry department between F2012 and F2017 is due to an increased demand for STEM majors; a similar increase occurred in other STEM majors. The occurrence of the COVID-19 pandemic could explain the decline in enrollment between 2020 and 2021 but the reason for the decrease between 2017 and 2020 is less clear and will need to be examined going forward. The department should evaluate enrollment in other STEM majors during this period to determine whether the decline is specific to our department. The BS-BC degree is the highest enrolled degree in the department. The popularity of this degree is likely due to the wealth of career opportunities for students in biochemistry which includes employment in government, clinical, and biotechnology labs in the region, advancement to graduate programs (MS and PhD), and entry into medical, pharmacy and related school.

Ethnic representation varies among the degrees. White, Hispanic, and Asian students have the highest enrollment over all degrees. Hispanic student enrollment has increased over the years to become the dominant ethnicity in the BS-NC, BA-NC and BA-FR degrees. In contrast, Asian students have the highest enrollment in both the BS-BC and BA-BC degrees. The high enrollment of Asian students in biochemistry degrees may reflect the high interest of Asian, including Indian Asian, students in medical degrees, particularly pharmacy. We know anecdotally that the department has a lot of biochemistry students planning careers as pharmacists. We have found in advising meetings with students that the decision to pursue a pharmacy degree is often heavily influenced by the student's family.

Black student enrollment is generally less than 10%. Pacific Islander and Native American students enrollment is the lowest, 1% or less; there are frequently zero PI or NA students enrolled in some degrees in some cohorts. The department should consider how it can recruit an increased proportion of Black, PI and NA students into our majors. There is some effort in this direction through research engagement supported by Science Educational Equity (SEE) programs, which is further discussed below.

Females have higher representation in undergraduate degrees and lower representation in master's degrees, with females in some cases making up 70% of the undergraduate enrollment. A significant number of graduate students in our master's programs are students who completed their undergraduate degrees in our department. This suggests that male undergraduates from our department are more likely to enter our master's programs than female undergraduates. The department should do a more careful analysis of this issue and consider what factors might lead to a disproportionate entry of males vs females in our master's programs.

A few other enrollment trends may be Covid related. These include an increase in non-resident alien students in 2020 and 2021 over all degrees. A virtual environment may have made our courses more accessible. There was a big decrease in the enrollment of white students in BS Chem from 2020 to 2021. This may be due to students not wanting to spend money on a virtual chemistry education.

In summary, the department needs to examine the factors involved in the overall decrease in enrollment in chemistry degrees, increase recruitment of under-represented minority (URM) students in all degrees, and examine the apparent disproportionate entry of male undergraduates over female undergraduates in our master's programs.

Retention

Retention data, while variable among degrees and ethnicities, showed a few trends. Due to the small numbers of students involved in some of these trends, care needs to be taken to not over-interpret the data. One clear trend is that seventh term retention is lower than third term retention for all ethnicities. This is not a surprising result but analyzing the change in retention from one term to the next should be a priority for the department's ERG committee so we can develop and implement intervention strategies. We have retention data for the fifth and ninth terms and that will also be analyzed going forward.

Another trend is that the retention rate of a given ethnic group of students is different in different degrees. For example, retention of Hispanic students is highest in BS-NC and lowest in BA-BC. One possible explanation for this is that some students in the BA-BC degree may be moving into the BS-BC or into a Biological Sciences degree. We have communicated with Joel Schwartz about tracking entering chemistry majors through major changes and expect to be evaluating this data in the near future.

Retention of transfers seems to be better than that of first-year students. It is not uncommon for first-year students to change majors. However, the department needs to ensure that retention of FYS students is not negatively impacted by poor performance in entry level courses. This is addressed elsewhere in this document.

FY Asian students have the highest retention across degrees, especially in the seventh term. Hispanic and Black students have lower retention than Asian or White. Pacific Islander and Native American retention of FYS is high. Although the number of students in these latter two ethnic groups is low which could skew the rates, this is an encouraging result. The department needs to increase its efforts to retain Hispanic and Black students, which is discussed further in Section F.

Black and Pacific Islander transfer students have the highest retention across degrees. Although the N here is small, this is again an encouraging result. Seventh term retention is particularly low for transfers enrolled in the BA-NC degree. This degree generally serves students who are planning to pursue a high school teaching career. Although this rate is affected by a small enrollment, the department should still address this finding because the need for secondary teachers is high and students in this degree are likely to find employment easily after they graduate. One possible avenue for improving retention in the BA-NC degree is to encourage students with an interest in teaching to apply to be peer instructors for the PAL program.

The department is working directly with Joel Schwartz to track students who move to other majors or who, more importantly, drop out of the university. Preliminary data received just prior to the deadline for submitting this report is shown in Figure 16. This data clearly shows that retention of Black and Hispanic students is worse than that of Asian or white students and also shows the pattern of losing students over time (yellow bars with NE = “not enrolled”). Analysis of retention by semester will greatly assist us in applying strategic interventions.

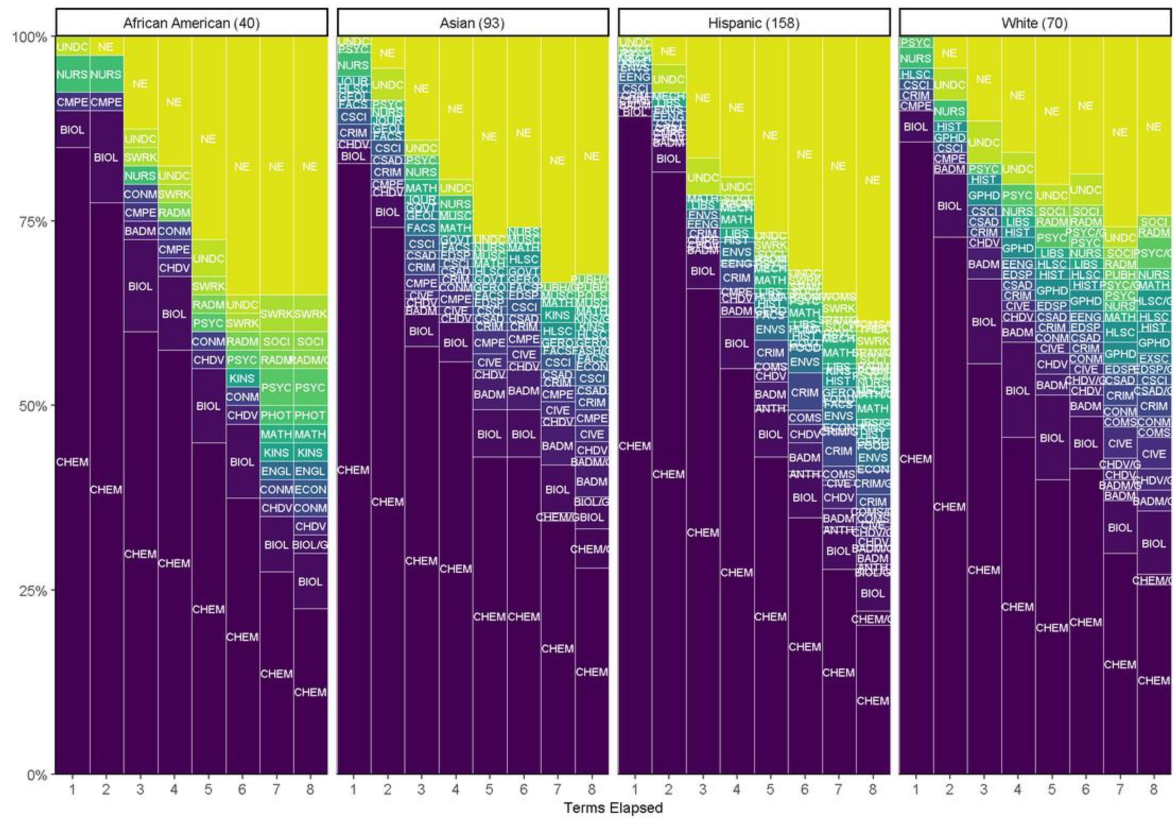

Figure 16. Eight term tracking of students through the Chemistry major. Yellow bars labeled "NE" indicate students who are no longer enrolled in the university. Source: Joel Schwartz.

In summary, the department needs to continue to examine the retention rates of FYS and transfers and institute measures to better retain URM students in our degrees. Such measures include further addressing the DFW rate and its equity gaps in entry level courses, creating a more welcoming environment for all students, and strategic interventions such as targeted advising practices to improve retention. The department is currently addressing the DFW rate and its equity gaps through reconstruction of the general chemistry sequence and has completed an environment survey submitted to all chemistry majors which will be analyzed this spring by the ERG committee. Further analysis of data we have collected will inform future advising efforts and suggest additional strategies for improving student retention.

E. Not applicable

F. Summarize current partnerships in success efforts (Advising, Writing Center, Library Student Success Center, internship sites, etc.) and consider ways to better work together to maintain success and improve time to degree.

The Chemistry department has numerous partnerships and programs that pertain to student success. These include the department's Equity, Retention, and Graduation committee, undergraduate research, the ACS Chemistry Club, and partnerships with Peer Assisted Learning, Science Educational Equity, Commit to Study, NSM Advising Center, and DEGREES project. Each of these is discussed below.

Department programs

1. *Equity, Retention and Graduation Committee*.

The ERG committee was formed in S2021. We considered whether to have separate equity/diversity and retention/graduation committees but we decided that equity issues are so intertwined with retention and graduation that these should be combined into one committee. The working mission of the ERG committee is as follows:

> *Student success it the core mission of the Department of Chemistry. The Equity, Retention and Graduation Committee is responsible for:*
>
> *1. Identifying factors that impact student success*
> *2. Identifying and obtaining student success data*
> *3. Evaluating and summarizing student success data for dissemination to the department*
>
> *The ERG Committee may make recommendations to the department, which can vote on whether to adopt or implement these recommendations.*

This mission statement has been presented to the department and needs to be approved. Current membership on the ERG committee includes faculty teaching general chemistry (Heidi Van Atta and Susan Crawford), faculty who work with student success programs on campus (Mary McCarthy and Linda Roberts) and our chemical education specialist (Yujuan Liu). The spring 2021 semester was focused on forming the committee, defining its mission, and establishing goals and action items. The fall 2021 semester was focused on creating and administering an environment survey to all chemistry majors and meeting with students in Chemistry Club. The focus of the spring 2022 semester will be to analyze the results of the environment survey and our meeting with Chemistry Club students. Our on-going role will be to continuously evaluate retention and graduation of students by ethnicity and gender, solicit student input on inclusion and environment in the department, and make recommendations to the department on how to improve the success of all students in our major and in our service courses to other majors.

2. *Undergraduate Research*

Undergraduate research is highly valued in the Chemistry department. Faculty mentored research with students is a requirement for tenure and promotion in our department. Research experiences our embedded in all of our upper division lab classes (Chem 110L, 125, 133, 141, 162, 164) and students additionally have the opportunity to conduct research with a faculty member in research classes (Chem 89, 189A-C, 198, 299, 500), in paid research opportunities (faculty grants, NIH-RISE, LSAMP), or on a volunteer basis. To determine the effect of undergraduate research on retention and graduation, we submitted a request to Institutional Research involving student success as it relates to enrollment in research courses but the data was not provided at the time of this program review. Once received, this data will be analyzed by the ERG committee.

3. *ACS Chemistry Club*

The department has a long-standing student affiliate group of the American Chemical Society (ACS) which is known as the Chemistry Club. Membership extends beyond the chemistry department and frequently includes students from other STEM majors and occasionally non-STEM majors. The Chemistry Club has won numerous awards from ACS for its work which includes community outreach, peer mentoring, and career development. The ERG committee is in the process of collecting data to evaluate the relationship between membership in Chemistry Club and student success.

<u>Partnerships</u>

1. *Peer-Assisted Learning*

PAL is a program that supplies peer instruction in supplementary courses for general chemistry (Chem 4, Chem 1A, Chem 1B) and organic chemistry (Chem 24, Chem 124). The program, which is led by Dr. Jennifer Lundmark in the department of Biological Sciences, was developed in 2012, with general chemistry courses among the first to implement the program. Data treated by propensity matched scoring from Drs. Lundmark and Corey Shanbrom in the department of Mathematics and Statistics show that PAL has increased the GPA in Chem 4, 1A, 1B, and 24 by 23, 34, 24 and 51%, respectively, for students who enroll in a PAL course (Lundmark, personal communication). Apart from this positive effect, the program is notable for the training it provides peer facilitators, many of whom are chemistry majors, URM, low income and/or first-generation students. We will be working with Institutional Research to determine whether the PAL benefit is specifically helping chemistry majors, particularly URM chemistry majors.

2. *Science Educational Equity* (SEE)

SEE is a long-standing program (30+ years) within the Center for Science and Mathematics Success. SEE supports URM students in education and research through a variety of programs, several of which are funded by external grants such as NIH-RISE and LSAMP. Chemistry has long been involved with SEE through faculty mentored research and advising. Four faculty, James Miranda, Jackie Houston, Linda Roberts and Mary McCarthy, have served as SEE advisors; Dr. Roberts has been a SEE advisor for more than 20 years. Dr. Mary McCarthy, who is a tireless champion of educational equity and inclusion, became the co-director of SEE along with Dr. Enid Gonzales-Orta of the department of Biological Sciences about ten years ago. Nearly all chemistry faculty have mentored SEE students in their research labs. Although its involvement with SEE is strong, the department should work toward involving more of its faculty in SEE advising. The department's ERG committee will work with Institutional Research to evaluate the relationship between involvement in SEE and graduation and retention of chemistry majors.

3. *Commit to Study* (C2S)

C2S is a program within the Center for Science and Mathematics Success that was started by chemistry faculty member Dr. Jeff Paradis. C2S provides tools to students to help them with time management, understanding their learning styles, and developing successful study strategies. The ERG committee will be evaluating the efficacy of C2S involvement in course performance and graduation and retention of chemistry majors.

5. *NSM Advising Center*

Chemistry works closely with the NSM Advising Center which now advises all first and second year chemistry majors. Dr. Ben Gherman has been serving as the chemistry faculty representative to the Advising Center for the past two years.

6. *DEGREES Project*

The DEGREES Project is part of SASEEP (Student Academic Success and Equity Educational Equity Programs). The DEGREES Project is focused on improving retention and graduation for URM, low-income, and first-generation students through peer and faculty advising, workshops, and other support programs. Linda Roberts has been the NSM faculty advisor for DEGREES for the past four years. Drs. Miranda and McCarthy have also served as DEGREES advisors. In addition to extensive advising of NSM students (which has a caseload of ~1800 students), Dr. Roberts has recently joined with NSM Associate Dean Yinfa Ma, Mary Kober of the Career Center, Jennifer Navarro from Advancement and Biological Sciences major Krystal Jackson (now graduated) to create the NSM Career speaker series "What's Your Next Step?". This series has run for the past two years and has included building relationships with alumni and industry partners to foster the career preparation of students in NSM. The series will continue again in fall 2022. Going forward, Dr. Roberts is working closely with faculty, staff and students of DEGREES Project to develop holistic advising practices to ensure all DEGREES students receive the support, information, and advice they need to graduate in a timely fashion.

In summary, the department of Chemistry is highly active in student support services, particularly those directed towards URM, low-income, and first-generation students. The main focus for the near future is for the department's ERG committee to evaluate the efficacy of these services in the success of chemistry majors. This will inform future activities regarding student success.

DEVELOPING RESOURCES TO ENSURE SUSTAINABILITY

A. Strategic Initiatives.

1. Safety

During this review period, the chemistry department focused considerable energy evaluating and improving the safety policies and practices in the department. The college hired a new NSM Safety Manager that oversees safety in the college departments. Brittany Anderson-Steele also serves as a conduit to EH&S. The department safety culture has improved enormously in the past few years through this important work. Currently most safety training has been converted to online training that is easily accessible to faculty, staff, and students who need training to work in the lab. We have an updated chemical hygiene plan, https://www.csus.edu/campus-safety/environmental-health-safety/_internal/_documents/chemical_hygiene_plan.pdf , that is regularly updated and revised to reflect the current practices in the department. Research students, faculty, staff, and student assistants are required to complete extensive safety training prior to any work in the lab. Faculty must do personal safety inspections of their research spaces each semester and submit a signed checklist that appropriate items have been evaluated in their lab spaces. Each lab course section is given safety training at the beginning of the semester. Every student must sign a form that they understand the safety rules of the lab and agree to abide by the department's safety policies. Professor Cindy Kellen-Yuen produced a safety video for use in course safety training. She utilized student actors in the production of this video.

The schedule of department training, inspections, and inventory reconciliation are tracked and maintained by Janee' Hardman, our ISTIII lead stockroom staff member. Janee' is responsible for coordinating, documenting, and tracking training in the chemistry department. All teaching assistants, instructional student assistants, student assistants, and new adjunct faculty must attend a special safety training offered at the beginning of each semester. Janee' Hardman helped to develop this training and delivers it at the beginning of each semester. This training focuses on instructor responsibilities, liabilities, safe handling of chemicals in a teaching lab setting, hazardous waste generation and handling, good housekeeping practices, and what to do in case of an accident or emergency.

Chemistry Safety Committee

The chemistry department has a standing safety committee with the following members: Janee' Hardman Chemistry ISTIII (Chair), Professor Cindy Kellen-Yuen-Organic (Secretary), Professor Roy Dixon (Member)- Analytical, Laurel Ward (Member) Stockroom ISTII, Professor John Spence -Organic (Member), Professor Johannes Bauer- Biochemistry (Member), Professor Justin Miller-Schulze-Analytical (Member) Brittany Anderson-Steele- NSM Safety Manager (Member) and Tom Scarry EH&S (Member). The Chemistry Safety Committee is charged with the oversight of safety issues associated with the curriculum and operations within the department. The committee serves as a conduit of information between the departmental-level safety committee and higher-level committees to develop policies and practices to ensure a safe environment for our students, staff, and faculty. The committee meets roughly once a month during the spring and fall semesters. The focus of the Chemistry Safety Committee has been to continue to establish department wide safety policies and to address safety concerns within the college. Recent meetings have focused upon safety items related to the ongoing pandemic, discussion on safety incidents that occurred and preventative measures, and the department lab supervisory policy for students and graduate students working in the lab environment.

2. Reduction of DWF Rates in Introductory Chemistry Courses

Our chemistry department, like most chemistry departments, teaches multiple courses plagued with high DWF rates. CHEM 1A, the first course in the general chemistry series is characterized by DWF rates ranging from 25-40%. The fact that students must obtain a minimum of a "C" and not a "C-" to move on to CHEM 1B makes the student success rates even lower. Just as troubling as these poor student success rates is the fact that approximately 35% of students from URM groups are unsuccessful in the CHEM 1A. These statistics are deeply concerning to our department, and we strive to identify ways to improve student success in general chemistry and reduce the equity gap. Over the years, we have implemented multiple strategies to provide student support in CHEM 1A with the hope of improving student success. Out initial attempts included adding discussion sections to the course, establishing the HELP! Office where students can obtain up to 20 hours/week of help with general chemistry, the addition of PALS (peer assisted learning sections), and most recently the introduction of CARA (Chemistry ALEKS Review and Assessment) which is an online individualized review and assessment program for students to prepare for CHEM 1A/CHEM 1E. Since we have been using CARA now for two years, we will be assessing its impact on student success with a comparison of how students perform who enter CHEM 1A through the CHEM 4 route. However, since we are still currently observing very high DWF rates, we know that we have more to do. We believe that some students are just not ready to enter a course like CHEM 1A when they arrive on campus, independent of the extra resources we can provide associated with the course. For these students, we have CHEM 4. CHEM 4, Chemical Calculations, is a preparatory course with the sole purpose of preparing students for success in CHEM 1A or CHEM 1E. Unfortunately, we observed similarly high DWF rates in CHEM 4 and an equally large equity gap. The DWF rate in CHEM 4 over the past four semesters averages 32% with URM students failing at an average of 38%. African American students are observed to fail at a rate averaging 50%. This is particularly troubling since CHEM 4 is intended to be a preparatory course.

CHEM 4 sections have in recent semesters served as many as 400 students/semester. We recently have been funded to redesign CHEM 4 in an attempt to improve student success and to reduce the observed equity gap. The redesigned course will be taught for the first time this summer and pivots some large lecture time to smaller group active learning, shifts some assessment away from large point exams, and reduces the content of the course to include only topics essential to the preparation of CHEM 1A/CHEM 1E.

We then have plans to implement a stretch CHEM 1A that will be taught over two semesters instead of one. The idea is that some students can be successful in stretch CHEM 1A instead of taking CHEM 4 and then CHEM 1A. Of course, some students are prepared to be successful in CHEM 1A from the moment they walk on campus and we will continue to offer the traditional one semester course for those students. Students will need to place in the one-semester version through some type of diagnostic. We merely need to focus on the students who struggle with that path and identify ways that they can be successful. We have similar issues with student success in organic chemistry. We are beginning discussions in that area as well. The message we wish to convey is that poor student success and accompanying high DWF rates in chemistry courses that impact student paths in their majors is of serious concern to us. We are working toward ways to help identify and implement solutions to this ongoing crisis.

3. <u>Tracking and Strengthening Ties with Alumni</u>

The chemistry department has been fortunate to have some alumni who regularly check-in with us through visits and emails. However, this is only a subset of alumni. We plan to embark on activities to better track where our students' professional paths lead them after graduation and provide them regular updates on the department. Our planned activities include:

i). Participation in an electronic event on February 11 , 2022, "Chemistry Insider Update". This is a one-hour zoom event that invites donors and alumni to an interactive presentation on news in the department. This event is co-sponsored by the campus development office.

ii) We are in the initial planning stages of an annual electronic newsletter that will update alumni on department news.

iii) We are developing a survey that will be administered electronically one year following graduation and then three years after graduation to see where our students' paths have led them professionally. We will query how these alumni feel that their chemistry degree served them on their career path and ask for suggestions for improvement. We may then include a follow-up survey at five years post-graduation. The strategic planning committee will begin work on this project this spring.

4. Implementing Expanded Internship Opportunities for CHEM Forensic Students

Although many of our majors participate in undergraduate research in faculty labs, we currently do not have a faculty member with research in the area of forensic chemistry. We are exploring the implementation of internship programs for our forensic chemistry students to gain hands-on experience in regional crime labs. This experience can enhance our students' competitiveness for jobs in this highly competitive field. Professor Roy Dixon, Assistant Chair, obtained a campus grant that will allow us to host working meetings with regional crime labs to develop these internship program guidelines. The grant will also sponsor student field trips to the crime labs and information sessions. The development of this fuller internship program will benefit our students and strengthen departmental ties with the regional crime labs. This also may catalyze department consideration of fuller internship expansion for our other chemistry degree programs.

5. Analysis and Updating of Our Major Programs

The chemistry department has not done a thorough analysis of our degree program requirements and recommended courses for a very long time. It is time to take a look and identify changes or modifications that will better serve our students. Additionally, the growth in our majors, particularly the biochemistry BS degree, has resulted in some impaction in our upper division lab courses. Although our major numbers are on a slight decline recently, we are still seeing large demand for these lab courses since they are required for BS students and electives for many of our BA degrees. Some degrees may be better served by courses that are different that those required or suggested in their current degree paths. With the addition of new faculty, we have the opportunity to consider a larger breath of course offerings at the upper division level. It is a good time for us to review and update our degree requirements.

6. Assessment

The chemistry department has program assessment plans that we believe measure the learning outcomes that are important for our different degree paths. We utilize assessment tools that measure these learning outcomes. However, we currently only collect the data and have not done much in the way of analyzing the results and identifying changes that may increase our degree effectiveness. The department needs to work on "closing the loop" on our assessment practices.

B. Faculty and Staff Hiring Needs

1. Faculty

The chemistry department currently has 16 full-time faculty. We have 2 physical chemists (a new physical chemist will join our department spring 2022 which will bring this number to 3. Susan Crawford is chair and does not teach), 1 inorganic chemist, 1 chemical education faculty member, 4 organic chemists, 6 biochemists (1 will begin FERP fall 2022 but will not teach), and 2 analytical chemists. The number of FT faculty members has not increased in over 20 years even with the significant increased number of majors and service course students. The chemistry department currently teaches over 2000 students in courses per semester. In order to manage our teaching needs, the department currently hires approximately 30 lecturer/part-time faculty and approximately 6-8 teaching assistants per semester. Examination of our teaching shows that FT faculty teach approximately 33% of the course sections with the remaining 66% taught by a combination of lecture/part-time faculty and teaching assistants.

Analyzing the breakdown of lower division and upper division courses shows that approximately 80% of our lower division and service (non-major courses) are taught by adjunct faculty or teaching assistants. These courses often exhibit some of the highest DWF and equity gap rates and lowest student success. These courses are often gate-way courses in student majors. It is difficult to work on changes and improvements in these courses without full-time faculty consistently teaching them from semester to semester. Our lecturers/part-time faculty are highly valued and appreciated in the department, but they are not paid to work on programmatic changes. We need FT tenure-track faculty to play larger roles in these lower division gate-way courses.

The reality is that we also need our FT tenure-track faculty teaching our upper division majors, service, specialty, and graduate courses due to their unique focus and the difficulty hiring adjunct faculty with the appropriate background to teach these courses. Many of our adjunct faculty have master's degrees and lack the background to teach in upper division and graduate courses. It is obvious that we need to hire more tenure-track faculty to meet our teaching and curricular redesign needs.

We recently saw the retirement of one of our biochemists in the fall 21 semester along with one of our chemical education faculty members. These both leave holes in some of our largest lower division courses. Another biochemistry faculty member very recently declared their intention to enter the FERP program beginning fall 2022. This faculty member is extremely active in the campus SEE program and will not teach at all during her semesters on campus. We will clearly need another biochemistry faculty member to replace the loss of the retired and FERP faculty member.

Additionally, the increased need to offer more organic chemistry sections has required us to begin utilizing adjunct faculty in courses which have traditionally been taught by our tenure-track faculty. The department needs an additional organic faculty member. We are proposing an organic polymer or materials chemist to fill out our breath of specialties for this hire.

Finally, we need to consider the teaching replacement of our retired education faculty member who taught extensively in introductory chemistry. This teaching could be covered by a new chemical education faculty, an additional physical chemist, inorganic chemist, or interdisciplinary chemist. A hire in one of these areas could also contribute to upper division teaching in areas of need. Since one of the retirement announcements and one of the FERP intentions were only recently announced, the department has not had the chance to reformulate its hiring plan taking these into account. This will be the topic of discussion in an upcoming department meeting. However, we would like to stress that the chemistry department is behind in its hiring. It is inappropriate that over two thirds of our courses are being taught by non-tenure track faculty and teaching assistants. Our low number of tenure-track faculty relative to the student numbers served additionally generates a heavy advising and committee work assignment level in the department.

We anticipate requesting two faculty hires next year and likely one or two in the 2023-2024 academic year. The age distribution of the department faculty is likely to result in a steady stream of retirements or faculty entering the FERP program over the next five years. The department will need to prepare for this with a well-designed hiring plan.

2. Department Chair.

The chemistry department elected a new department chair that would have begun the position in August 2020. However, the hiring freeze in 2020 required cancellation of a visiting professor position and made it impossible for the new chair to take over the position until January 2021. This is the first time the department has had a full-time chair which was a needed change from the 0.6 time chair of the past. The department additionally gained a partial assistant chair for three units per semester. The department is still determining a policy to identify or elect the assistant chair, how long they will serve, and the exact role of the position. The department policy committee will work on the assistant chair policy this semester. Currently, the assistant chair works mostly on scheduling, although the chair also participates in scheduling since it is a large job. It is clear that the chemistry department needed a full-time chair designation. Very few faculty have expressed interest in serving as department chair due to the extremely heavy workload. In fact, it could be argued that a 0.5 time base assistant chair is appropriate for the department. A recent survey by academic affairs querying workload issues of department chairs suggests this is university wide issue of concern. Rapid turnover of department chairs does not serve the department well since it takes over a year to even begin to learn the facets of the position and to begin to function effectively on behalf of the department. The chemistry department's last chair lasted only one three-year term.

3. Staff

The Chemistry department has faced significant instability in department staffing since the last program review. We suffered the resignation of our lead ISTIII stockroom lead just as the move into the new science building was set to begin. We also lost two stockroom ISTIIs near the same time. We also lost our long-term equipment technical staff member (EQIII) and anoher ISTII to retirement. At the beginning of Covid, we lost our long time ASCII (over 20 years in the department) due to a promotion to the Dean's office. Another ISTII left for a job in private industry a year ago. In all, we have needed to replace six out of eight of our department staff members since the last program review. In fact, due to the hiring freeze, we were only able to fill three of those positions during the last year. We were getting by with borrowed and temporary help in several areas. It was a challenging time. Becoming a staff member in the chemistry department requires considerable training and a steep learning curve. The need to rely on borrowed and temporary staff over the past few years has had a definite impact on the chemistry department's ability to function and progress as usual. Many projects and initiatives were put on hold since maintaining basic operations, particularly under the changing conditions of the covid pandemic that continually required modified protocols, made things particularly challenging. During the past year, it has been necessary for the new staff members to have time to learn and acclimate to the university and department protocols and procedures. It has not been an easy time, but we are finally beginning to see some stability.

Office Staff

The chemistry department has two office staff members, an ASCII and ASC I. Despite our increase in students served, we have not had an increase in office staff in over 20 years. These staff members run the office, handle student office traffic, handle faculty requests, maintain the time cards for student assistants, organize department events, help with college and other department requests, check student prerequisites, add students to courses when difficulties arise in automated registration, and cover basic office tasks such as answering the phone, photocopying, and handling mail. The ASCII has additional duties that include the large job of preparing the course schedule, preparing contracts and workload reports, hiring teaching assistants, taking and preparing department meeting minutes, assisting with the hiring of faculty, and assisting the chair with projects and reports. Our ASCII also works with faculty and other staff members for assorted needs, such as travel requests, seminar speaker arrangement, graduate program needs, and student research packet processing. The department office often hires one work study student to assist with some basic office tasks such as photocopying and sorting mail. Although the department office manages to complete the necessary work for the department, the beginning, registration time, and end of semester periods become excessively stressful.

Stockroom Staff

The chemistry department has five stockroom staff members. Janee' Hardman, our ISTIII, is the stockroom lead and oversees, organizes and supervises the stockroom operations. She is also the chair of our department safety committee. Additionally, due to the large workload associated with class lab preps, she also spends considerable time prepping for labs. The stockroom is also staffed with four ISTII employees. Three of these ISTII's spend the vast majority of their time prepping for lab courses, maintaining waste, keeping chemical inventory, ordering, lab set-up and maintenance, management of student assistants, filling cryogens on NMR spectrometers, maintaining course lab lockers, performing safety related tasks and enormous amounts of dishes. Rachel Blackeye, ISTII, additionally spends a good portion of her time maintaining the department budget and ordering specialty items. Except for Rachel, the entire stockroom staff has been here less than two years. The department also attempts to hire between 9 and 12 student stockroom assistants, some of them work-study students, to help with lab course prep work and to help staff the stockroom windows.

Historical data shown in Figure 17 shows a dramatic and continual increase in chemistry lab course sections since Fall 2010. The department offerings have grown from 42 total lab sections to 85 sections in Fall 2021. This represents a factor of two, over a 100% increase, in the number of lab sections. Much of this increase has been observed in service courses for other majors. However, growth in our own majors has also contributed to the need to offer more sections of upper division lab courses. During this time, we have not had an increase in stockroom staff. In order to schedule and run these lab sections, we begin labs at 7:30 am and run labs until 8:30 pm. This amounts to over a 12-hour day on some days. Scheduling our staff to have stockroom coverage over all of these hours and remain in a 40-hour work week is very challenging. We need to have stockroom coverage to service these courses and to maintain safety since labs should not be running without someone in the stockroom in the event of a situation. Additionally, the opening of our second science building with its own stockroom has increased the department's stockrooms from two in one building to three over two buildings. This situation has become unmanageable. Although student assistants can help offset some of the work, they need close supervision and direction. They cannot work alone. The department is in dire need of an additional ISTII position.

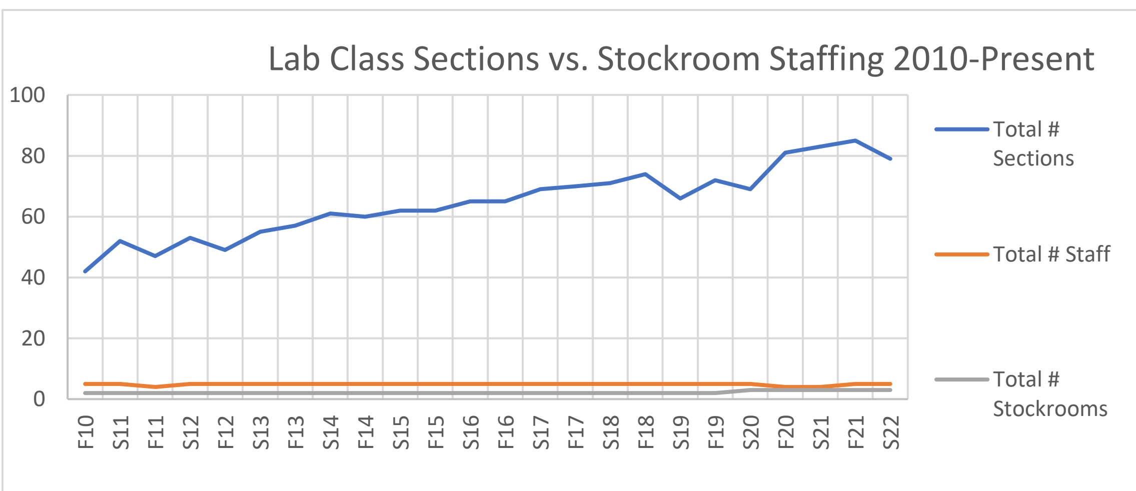

Figure 17. Number of lab sections as a function of time from 2010 to present.

Table 10. Data of Stockroom Staffing, Students and Lab Sections

Total Lab Class Sections SP 22	79
TSC lab sections	17
TSC supported students in labs	330
TSC staff	2
SQU 4th floor lab sections	40
SQU supported students in labs	936
SQU 4th floor staff	1
SQU 5th floor lab sections	22
SQU supported students in labs	328
SQU 5th floor staff	2

Equipment Technician

We have one Equipment Tech III (EQIII). Our current EQIII, Stephen Disher, is new since the last program review. He replaced an EQIII that was with the department for over 15 years. This position is instrumental to the smooth operations in the department. As a lab and equipment-based discipline, having a staff member who can maintain, troubleshoot, and repair both our basic and increasingly sophisticated instrumentation is critical to our daily operations. This position is responsible for keeping the lab equipment and associated facilities (not associated with the building infrastructure) running and functional. This position is also responsible for servicing and maintaining the computers associated with instrumentation. These computers alone number well over 50. With addition of our new building and large increase in lab sections, our equipment and instrumentation holdings have increased significantly. Some of this instrumentation is very specialized, delicate, and sophisticated. They can also be extremely expensive, up to $700K in some cases. It is extremely important to train students on modern instrumentation they will see and use in their professional lives after graduation. In order to be cost conscious, we have needed to accept considerable donated equipment from state/local agencies and regional companies. Although we greatly appreciate these donations since they can provide instrumentation that we would not be able to afford to purchase new, these donations add extra workload and demands on the EQIII. Merely navigating the process to accept, move, and set-up donated equipment is a significant undertaking. The installation of this sophisticated instrumentation is often not funded and falls upon the EQIII who is not a trained installation engineer for the equipment. The learning curve can be steep. Additionally, these donated instruments often come with existing problems that must be repaired upon installation. Parts are not always readily available and can be challenging to locate if the instrument is no longer supported by the manufacturer. It is important for the university to understand that these donations, although able to offset the cost of new equipment, are not free and often take funding to make operational on campus. The chemistry department has recently accepted major donated pieces of sophisticated equipment such as a super conducting NMR spectrometer, mass spectrometers, particle analyzer and others. We are currently considering accepting an ICP/MS. This will be a multi-department instrument, will require modification of the room prior to installation, and training to be able to maintain and service it. As department chair, I feel that

Stephen Disher's position has grown in complexity and scope significantly over the past few years with the addition of the new science building, the extra equipment, and the sophisticated nature of the equipment. A recommendation is that Stephen's position description needs to be revised and updated to reflect the change in work scope, responsibility level, and magnitude. The department has recently been attempting to hire a student assistant to help manage Stephen's lower level work, but hiring a student with the appropriate skill set is challenging. Training and supervising the student can take almost as much time as they may save Stephen.

Summary of Hiring Needs

1. Request the addition of an ISTII stockroom position. Immediate need.
2. Chemistry office student assistant Spring 2022
3. 2 faculty positions 2022-2023 academic year
4. Review and update EQIII position description
5. 1-2 faculty positions 2023-2025 academic year.

4. Budget

The chemistry department obtains an annual operating allocation from the college each year. The department must cover the cost of its lab classes, office supplies, equipment maintenance and upkeep, and all other needs out of this allocation. The salaries of faculty and staff are paid at the college level. The chemistry department offsets some of the cost associated with instructional lab expendables through charging student lab fees. For many years, we have been charging lab fees at the rate of $18/ student in general chemistry labs and $30/student in organic, quantitative analysis, and most upper division labs. Unfortunately, increases in our budget allocation and lab fee accrual have not kept up with the increase the cost of materials needed to teach chemistry labs. A comparison of our 2018 budget allocation compared to our allocation in 2021 showed less than a 5% increase in allocation. When comparing this to the increase in costs of basic materials such as solvents, gases and coolants, a shortfall gap is observed and is increasing as the prices of these items increase.

Table 11. Representative increases of some common costs observed.

Solvents Year	**Acetone**	**EtOAc**	**IPA**	**Hexane**	**MeOH**	**EtOH 190**	**EtOH 200**
2018	$48.44	$58.72	$52.41	$44.93	$33.82	$34.12	$34.12
2022	$57.93	$62.66	$113.38	$51.30	$43.02	$63.44	$63.44
Percent Increase	19.6%	6.7%	116.3%	14.2%	27.2%	85.9%	85.9%
Gases /Coolants/dry ice/ demurge							
2018	$31,301.06						
2021	$34,982.21						
Percent increase	11.8%						

Examination of the percent increases for some common items in Table 11 illustrate that an OE allocation increase of 5% is not keeping up with the increases in prices we are observing. Additionally, the addition of instrumentation and donated instrumentation increases our need for maintenance and repair part costs. The Dean's office has generously provided us with extra funding for instrument repair when needed.

Table 12. Summary of the current lab fee deficit per chemistry lab course. This is the deficit based upon cost analyses performed for our lab fee increase request. It is expected that with the increase in prices recently, this deficit is larger at this point. General chemistry courses are not included since there is no discernable deficit in those lab courses.

Lab Fee Deficit Per Course		
Class	**2-Year Net Loss**	**1-Year Net Loss**
25	-$2,423.10	-$1,211.55
31	-$66.52	-$33.26
110L	-$2,499.84	-$1,249.92
125	-$2,133.40	-$1,066.70
133	-$5,495.28	-$2,747.64
141	-$4,179.96	-$2,089.98
162	-$1,675.52	-$837.76
164	-$2,486.48	-$1,243.24
		-$10,480.05

The chemistry department recently submitted (pre-covid) a request to increase student lab fees in order to help cover the increased material costs of teaching our chemistry labs. We have not requested a lab fee increase in many years. We did not request an increase to the general chemistry lab fees since our cost analysis showed that current lab fees were adequately covering the cost for these lab courses. For some other labs, we requested an increase to $45 or $60 / student depending on the cost of expendable materials for the course. Many of the courses requested to be charged the $60/student are courses that contain capstone semi-independent experiences which are considered one of the strongest attributes of our majors' courses and are the cornerstone of our program assessment. This charge is either equal or less than the lab fee charged for many project centered courses offered in different departments such as biology, art, and engineering. Our lab fee increase request was recommended consistently until the last approval stage where it was denied. Since most of our lab classes have been virtual for the past two years, this denial has not impacted us significantly yet. However, as we pivot back to face-to-face lab instruction with materials costs increasing yet further, the deficit shown in Table 12 will result in unsustainable student projects in our labs. We need either a budget augmentation or approval of our lab fee increase resubmission to keep our lab activities and independent projects funded sustainably.

5. <u>Space</u>

Since the last review, the chemistry department has moved half of the department into the new Tschannen Science Complex. This expansion permitted us to move many of our upper division lab courses to new and more modern facilities. A significant portion of lower division labs were also moved. New instrumentation and donated instrumentation in this space permits us to offer courses during the same time block that previously would not have been possible due to overlapping need of facilities and equipment. This has allowed us to expand offerings of upper division lab course that have been impacted and causing delays in graduation for some of our majors. Research lab space was also increased to some degree. Most of our organic faculty now occupy a sizable shared research space that has improved safety. We gained 10 faculty offices and a stockroom that serves the building lab courses.

The remaining half of the department remained in Sequoia Hall, the original building. The department office also remained in the original building. Space in Sequoia was reallocated and divided based on other department moves. Chemistry lost a significant portion of its space in Sequoia due to the move of half of the department. We also lost multiple faculty offices due to the safety hazard associated with faculty offices located at the back of labs, requiring students to walk through labs in progress to reach faculty offices. Chemistry lost 14 of these offices (shared) and needed to relocate faculty into single offices on the main hallway or in the new building. We currently have 20 total offices for 16 faculty (soon to become 17 with a new hire) and approximately 30 adjunct faculty. Adjunct faculty are assigned office space at an occupancy level of 3 or more per office. We make every attempt to assign adjunct faculty to offices according to a schedule that minimizes occupant overlap. However, this is not always possible since we have a considerable number of adjunct faculty with teaching loads at or near full-time status. As the department hires new faculty according to its projected hiring plan, our assigned office space will quickly become an unworkable. There are some limited creative solutions in Sequoia Hall that would generate some usable office space, but would require the installation of doors to the main hallway so that the generated offices would not share an entry with a working lab. In any case, the chemistry department will soon face an office space crisis.

Limited research space for new faculty is currently available as long as some renovation funds can be secured in the start-up packages. These spaces would be needed in cases where the new faculty member is an expansion and not replacing a retired faculty member. We have one organic chemistry research space available in the new science building. Any other new faculty research space would need to be located in Sequoia Hall. We have been able to make this work so far, but funds for some level of renovation need to be heavily considered in these cases. Including the organic space in the new science building, the department estimates the ability to accommodate research lab space for a maximum of three expansion positions. The department will soon be limited by available research space which could inhibit FT faculty expansion.

6. Equipment

The chemistry department is currently well equipped with most of the standard laboratory equipment and some higher-level instruments. All of our instrumentation serves a teaching and research use. Some of this instrumentation was purchased new, while some of it has come to the department through donations. We have also obtained instrumentation though successful grant applications, the LC mass spectrometer for example. We do have some concern over the age of some of our current instrumentation, such as the fluorescence spectrometer. Some of these pieces of equipment are approaching 20 years in age and cannot be expected to last indefinitely. These aging instruments will need to be replaced and the annual equipment calls often do not have sufficient funds for more expensive equipment. Many of these instruments are heavily used in teaching.

Our largest current concern is the loss of one of our super conducting NMR spectrometers. The magnet on our 300MHz NMR quenched last winter. Since the spectrometer was having significant issues and the system was over 20 years old, we decided not to attempt to re-energize the magnet at that point and instead attempt to fund the purchase of a new spectrometer and magnet. The loss of this spectrometer will negatively impact organic chemistry teaching in Sequoia Hall once we return to F2F lab instruction in the organic labs next week. This instrument was heavily used in organic teaching and would have served 120 students in courses this semester, four days per week. It was outfitted with an autosampler which made it possible to run the instrument around the clock and obtain significant data sets for students in CHEM 25 (organic chemistry lab) and CHEM 125 (advanced organic chemistry lab). CHEM 125 students will have some limited time on the 500MHz instrument that is also used for research, but having CHEM 25 also use this instrument is not feasible since it does not have an autosampler. We also have the 400MHz donated instrument in TSC that CHEM 125 will also use on a limited basis. The 400MZ instrument is also used for courses in TSC and is not available at all CHEM 125 lab times. The largest concern is that both liquid state NMR spectrometers are of the same generation approximately and likely to begin experiencing significant problems and repair costs. The department needs to work with the college and university to form a replacement plan. Both Sequoia instruments were obtained through successful NSF grants. It is not clear that we could request MRI funding for a mostly teaching instrument. We may request an autosampler for the 500MHz instrument to assure that it is being used as efficiently as possible while we navigate this issue. This is an issue of significant worry in the department since NMR spectroscopy is central to our curriculum.

PLANNING TO MAINTAIN SUCCESS AND ENGAGE IN CONTINUOUS IMPROVEMENT

<u>Summary of Areas of Concern and Means of Improving</u>

The chemistry department has detailed in the previous text some of its current initiatives and challenges. A summary of the highlights includes:

1. Analyze and identify contributors to the high DWF rates in courses. Implement curricular changes to attempt to improve student success.

2. Examine student success and inequity issues in our courses and programs. Implement changes to increase student success. Improve the experiences we offer to provide a more welcoming environment for all students.

3. Work with the college to implement our hiring plans for faculty and staff. Examine staff position descriptions to assure they accurately reflect the work performed.

4. Work with the college to cover our budget and space needs as we move forward in our growth as a department.

5. Work with the college to identify mechanisms to maintain and obtain the modern equipment and instrumentation we need to continue to offer the high-quality educational experiences that have been the hallmark of our programs.

6. Strengthen ties with alumni through outreach efforts.

7. Strengthen ties with community partners to foster increased support for our department and students seeking jobs. Increase internship opportunities.

8. Examine our programs to assure they are modern and adequately reflect the learning outcomes desired. Implement changes where appropriate.

An external evaluation of Sacramento State University's Chemistry Department undertaken by Dr. Blake Gillespie and Dr. Alam Hasson in April 2022.

Blake Gillespie, Ph.D.
Professor and Chair
Chemistry Department
CSU Channel Islands

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Interim Vice Provost
Professor of Chemistry
CSU Fresno

ELEMENT ONE: DEPARTMENT MISSION AND INSTITUTIONAL CONTEXT

Does the department have a mission statement or statement of program goals that is appropriate?

Is the department mission and its programs aligned with CSUS and college missions and strategic priorities?

Is the department supportive of the CSUS general education program and/or general graduate learning outcomes?

Does the department engage key constituencies and campus partners in academic and strategic planning, including faculty, professional colleagues, current and prospective students, and the community?

Does the program have policies and procedures that facilitate articulation with community colleges and/or other external educational partners?

Comments:

Mission statement and goals The department's self study clearly articulates a set of University, College, and departmental mission statements. Chemistry's mission boils down to igniting interest, building knowledge and skills, and safety and inclusion. These latter mission elements are reiterated in the department's values statement, pointing to their importance to departmental culture.

Recommendations The mission, values, and goals provide an important context for addressing the department's most serious challenges. Lecturer faculty and staff are critical to the department's responsibility to students but often face significant challenges in performing their work. Equipment updates are absolutely vital to the continued success of students and faculty, both in terms of practical, technical experience and the development of higher order research skills. Likewise, curricular revision is essential to the furthering of their inclusion objectives; training in, and incorporation of, updated pedagogies could drive closure of equity gaps and improvement of graduation rates. Department- and administration-level change and development projects should be motivated by understanding these departmental requirements for Chemistry student success in the context of the mission.

ELEMENT TWO: LEARNING OUTCOMES AND ASSESSMENT TO MAINTAIN SUCCESS AND ENGAGE IN CONTINUOUS IMPROVEMENT

Does each degree program have appropriate and measurable learning outcomes that reflect current standards in the discipline?

Does each course have appropriate and measurable learning outcomes that allow students to achieve program learning outcomes?

Are the curriculum and graduation requirements for each degree reflective of current standards in the discipline?

Does each degree's curriculum and graduation requirements appropriate for the degree level and reflect high expectations of students?
Is the assessment loop regularly being closed for each of the degree's program learning outcomes?

Is the learning assessment data being used to make maintain Success and Engage in Continuous Improvement?

Do students feel connected to academic support services (writing, math, tutoring, library, etc.)?

Comments:

Learning Outcomes Assessment The department has a very clear set of high-level Undergraduate Learning Outcomes and an assessment plan for reviewing how the program is meeting these goals. There are 16 assessable dimensions ranging from facts, to skills, to application. Most of these are accessed through capstone projects in a set of upper division classes. The two lowest-level outcomes, basic knowledge acquisition, are measured using standardized ACS exams. Three others are not assessed. It is notable that the learning outcomes are not degree-specific; though the degrees serve different goals, these goals are not represented in a specific subset of outcomes.

This assessment strategy provides several points of contact: organic chemistry, biochemistry, and capstone. While the ACS exam probes basic knowledge acquisition and the capstone project gives insight into high-order skills, neither tool provides insight into the *approaches* and outcomes of the curriculum as a whole. How does introductory classwork prepare students for critical and analytical problem solving, or the development of research skills? How are potential equity gaps captured in these assessments?

A more comprehensive assessment strategy might take a developmental framework. The Department could consider whether/how the programmatic learning outcomes are addressed by each class or during each year of the degree. Ideally, such a plan is conceived simultaneously with a broad curricular and pedagogical review. Thus, equity-based approaches, student learning expectations, and assessment are all created in concert. As it considers developing a new assessment framework, this department is in a position to develop such a more comprehensive - and meaningful - approach to measuring their instructional strategies.

The assessment plan for the graduate program is a reasonable model: the role each course plays in meeting the program learning outcomes is clear; though here, too, these outcomes are not presented as a developmental process with milestones, but more as standalone elements that any given class addresses itself to. This observation was repeated by faculty who mentioned that assessment was more a matter of checking boxes that aimed at program improvement.

Continuous Improvement The assessment data presented in the self-study not always connected in a meaningful way to a change and improvement cycle. Though it is reported that General Chemistry is undergoing an equity-based revision, that series is not part of the overall learning outcome assessment plan. A comprehensive review of program learning outcomes that is connected to a plan for change is warranted. Linking the goal and process to the Departmental values and broad University objectives such as improved equity gaps could provide a starting point.

Recommendations While a well-defined assessment plan exists, it seems oriented toward compliance less than development. The department is in an excellent position to develop a new and much more meaningful assessment of student learning. The department should develop a new assessment plan for addressing student learning across *all* courses, using a range of assessment objects. Simultaneously - and especially critical to achieving University and departmental equity objectives - this new plan should encompass not just outcomes but pedagogies since it is well understood that culturally sustaining pedagogies will be central to improving equity gaps in, *e.g.*, introductory courses. In this scenario, the assessment will be informative and will allow the subsequent development of a coherent and comprehensive curricular update.

Broad goals require broad participation, and the administration should consider carefully how to support this project. It is recommended that department and administration work together to find a way to allocate faculty workload in a way that supports a meaningful outcome.

ELEMENT THREE: STUDENT SUCCESS AND ASSESSMENT TO MAINTAIN SUCCESS AND ENGAGE IN CONTINUOUS IMPROVEMENT

Does each degree program use aggregated and disaggregated data to understand admission trends and manage enrollment with an eye to diversity, impaction, or address program specific concerns?

Does each degree program use aggregated and disaggregated data to consider ways to improve retention?

Does each degree program use aggregated and disaggregated data to consider ways to improve time to degree or close graduation gaps?

Does the program provide or partner with other entities to provide appropriate co-curricular activities for its students, such as clubs, field trips, lectures, and professional experiences?

Does the program provide adequate student advising?

Do students feel connected to student success support services?

Comments:

Student data: enrollment and student success The self-study presents a wealth of disaggregated data on student enrollment and retention. Two key items emerge from these data. The first is the growth in Latinx students from 15-35% over the last decade. Among all the datapoints presented, this one points out a key challenge the department faces: how are data being used to develop a response to the changing needs of the community? Additionally, the marked shift in gender distribution from bachelor's to masters suggests a target for making adjustments in recruiting students.

It seems that the institution provides ample resources for the collection of these data, but little guidance on coherent and evidence-based responses. The report dedicates several pages to data, but only a couple of sentences to consideration of ways to improve outcomes. This suggests that the department needs to create the space for faculty to think and plan together what their response to changes should be. The current effort at assessing the learning environment in General Chemistry is laudable, but what training has the faculty had on best practices for closing equity gaps, for example? And what time are they allotted to consider different approaches? All these data point to the real need for a curricular review/redesign process that is driven by disaggregated assessment data, but supported with the tools necessary to make effective changes.

Co-Curricular Activities. In our meetings with faculty and students, there was consensus that the Chemistry Club is a key component of the department community, and that faculty are engaged with and supportive of club activities. Research opportunities for students are also well supported by the department, and are enhanced by participation in externally funded programs that promote research experiences such as NIH-RISE and LSAMP. Students commented that internship opportunities were communicated to them, but busy schedules could make it difficult to take advantage of these. Some students said that they were initially unaware of some of the opportunities available to them and only learned of them after several semesters on campus.

Advising. All students are advised centrally during their freshman and sophomore years. They are assigned a faculty advisor at matriculation but are not required to meet with them until the end of the second year unless the student is on academic probation. Current students and alumni noted that mentoring and support from faculty is a signature strength of the program, although several commented that initially approaching faculty was initially intimidating and was a barrier to making that connection.

Student Success Support Services. The self-study report details that department faculty are engaged with a number of student success support programs including Peer-Assisted Learning (PAL), Commit to Study, and the DEGREES project. Data indicate that students participating in PAL have better outcomes in General Chemistry classes, but impacts of other programs are still being evaluated. The department has established an Equity, Retention and Graduation committee to better understand student success and equity issues, and to make recommendations to the department to improve student outcomes.

Recommendations:

We encourage the department to continue to evaluate data on co-curricular and support programs to ensure that effort and resources are used efficiently. The department may wish to consider if the most impactful and scalable programs could be mandatory or opt-out, rather than opt-in.

We encourage the department to work with communications specialists in the College or University on ways to better engage students with programs and activities. Current students commented that Instagram and Slack might be good mechanisms to connect with them.

ELEMENT FOUR: DEVELOPING RESOURCES TO ENSURE SUSTAINABILITY

Does the program have faculty in sufficient numbers and with appropriate rank, qualification, and diversity to allow students to meet the program learning outcomes and deliver the curriculum for each degree program?

Does the program employ professional staff and/or appropriately partner with campus partners (e.g., graduate studies or College of Continuing Education) to support each degree program?

Are the program's facilities, including offices, labs, and practice and performance spaces, adequate to support the program?

Does the program have access to information resources, technology, and expertise sufficient to deliver its academic offerings and advance the scholarship of its faculty?

Does the program seek and receive extramural support at the appropriate level, including grants, gifts, contracts, and alumni funding?

Has the program identified other concerns that impact budget and resource planning?

Comments:

Personnel

Tenured/Tenure-Track Faculty. The department currently has 16 T/TT faculty. The self-study notes that the number of faculty has not changed in the last 20 years while the size of the program has increased significantly. T/TT faculty only teach about 1/3 of classes and mostly staff upper-division courses where qualified lecturers are generally not available. This means that General Chemistry courses, which have high-failure rates that require constant attention to address institutional student success efforts, are taught primarily by part-time instructors who may have teaching loads and time-commitments that could affect their ability to participate in professional development and course redesign.

Part-Time Faculty. In our meeting with lecturers, there was initial consensus that they are treated with respect by faculty, and have good relationships with the chair and the department. Many expressed concern and frustration, however, with the university. Some concerns over issues such as office space, pay, and teaching priorities are perennial challenges with non-TT faculty and are beyond the control of the department, or even the university. However, other concerns did emerge that are within the department's purview. Some faculty said that they only received their teaching schedules a few days before instruction began, and that they were concerned about retaliation if they declined some assignments. One faculty member noted that they learned that they were being reassigned to a different office not from the department, but from the faculty member that the room was being reassigned to. In general, morale is very low and the lecturers that we spoke with felt undervalued and taken for granted.

Professional Staff. We were able to meet with most of the department staff, including the five instructional support techs and the instrument support tech. All staff were proud of their department and clearly committed to the success of their students. It was also clear to the review team that collectively the staff were stressed and felt overwhelmed. While five stockroom technicians should be sufficient for a department of this size, the distribution of operations across two buildings requires three separate stockrooms, which seems unsustainable in the long term with current staffing. The lone instrument support tech is also clearly struggling to provide the support needed with the physical separation of the department between two locations.

Resources

Space. Half of the department is located in the new Tschannen Science Complex and half remains in Sequoia Hall, its original home. Decisions on space assignments in the new building are inevitably complex and require compromise. The division of the department across the two buildings is not aligned with programmatic needs and operational efficiency. These include the separation of General Chemistry I and II, the separation of some organic chemistry labs, and the separation of teaching and research labs from equipment needed by students and researchers. This has inevitably created stresses on personnel and resources, with some duplication of services and support needed as a result of the division. Some students located in Sequoia Hall felt 'left behind' with new equipment and resources going to the new building.

Primary space concerns in the department were over office availability, with only two or three offices for a large number of part-time faculty. Administrators expressed some concerns over teaching lab utilization, noting that some spaces are only used for one class each year. While recognizing that chemical safety and other factors impact room utilization, they also noted that making a case for additional space to upper administration is challenging with spaces that are perceived as underutilized. It appears that the consequences of the compromises are manifesting, with no plan for addressing the challenges they place in the way of students, faculty, and staff.

Equipment/Technology. Concerns over equipment and instrumentation were raised in every meeting during our virtual visit. These included the age and reliability of shared research instruments (e.g., NMR) through to basic equipment, such as glassware, needed for introductory courses. While it is inevitable that resource-intensive programs at a publicly funded institution may feel that they are under-resourced, the concerns expressed here seemed to go far beyond this. Current students and alumni expressed that this issue impacted their learning experience and progress to degree completion. Faculty noted that their ability to train students in a program that emphasizes hands-on skills and conduct research is adversely impacted by lack of access to reliable equipment. Staff articulated the workload challenge in maintaining aging and often unreliable equipment. The Dean's office acknowledged that - while more funding has been provided to support instructional costs of more course sections - the supply, equipment, and technical support costs of additional lab sections have not been funded. The precarity of the department's instructional effectiveness cannot be stated in starker terms: without a renewal process, the students' training will degrade.

External Funding. The self-study does not directly address this issue, but from our meetings, our understanding is that only one faculty member currently has external funding. If correct, this is an area where the department could grow.

Graduate Student Support. A theme that emerged from meetings with faculty, students, and alumni was the lack of financial support opportunities for graduate students. Students were frustrated that they were required to maintain enrollment in their program during Covid while they were unable to make progress towards their degrees because their research labs were shut down, and felt overlooked and ignored when it came to financial support. Current and former students commented that their progress towards degree completion was slowed by the lack of support for graduate students.

Recommendations

We recognize that recommendations requiring additional investments are often unhelpful given the limited resources available, but we encourage the university to look closely at several areas of high need/concern. The deep stress felt by staff, and the impacts on faculty productivity and student success should be factored into resource allocation decisions.

We encourage a close look at the division of department operations across Tschannen Science Complex and Sequoia Hall as Covid impacts (hopefully) recede and the campus operates more normally. There may be adjustments possible that could reduce the need to replicate services and facilities in both buildings.

We strongly encourage hiring an additional instructional support technician position for the department. With the current division of operations and current staffing, we have serious concerns about the sustainability of current services, and the safety of faculty, staff, and students, without an additional staff member to cover three stockrooms.

We strongly encourage a review of equipment and lab supply/consumable costs and budgeting. Budget changes must be aligned with increases in supply costs and number of sections to meet GI 2025 goals.

The department might consider a mechanism to engage regularly with non-TT faculty in a safe space. This would help them to feel heard by the institution and would provide an opportunity to address any misconceptions they might have.

ELEMENT FIVE: PLANNING TO MAINTAIN SUCCESS AND ENGAGE IN CONTINUOUS IMPROVEMENT

Does the academic unit engage in planning activities which identify its academic priorities and their alignment with those of the college and the university?

If appropriate, does the program have an advisory board or other links to community members and professionals? Does the program use community professional input for program improvement? Does the program maintain a relationship with its alumni?

Does the academic unit have a strategic plan, and other long term plans (5-year hiring, facilities, etc.)?

Does the academic unit have regular processes to revise plans and timelines?

Do plans include engagement with needed campus partnership and external entities to accomplish goals?

Comments:

The department has identified eight priorities to maintain success and engage in continuous improvement that span programmatic improvements, student success and equity, resource concerns, and strategic partnerships. These seem well-aligned with college and institutional goals, but the scope of these is very ambitious.

Student success and program development efforts should be guided by data and the department is either still waiting for this data (for example, graduation rate data were not provided in the self-study), or is still in the analysis phase. They have established an Equity, Retention and Graduation Committee that will help with this process. The department has a multi-year faculty hiring plan built around the current curriculum and anticipated teaching needs in the coming years, but priorities may change as a result of the ongoing planning and evaluation process.

Department faculty noted that several major issues have required attention in recent years and have inhibited the department's ability to reflect and make long-term plans. These are the changes required to address health and safety issues raised by Cal-OSHA audits; the department's move to the new Tschannen Science Complex; and Covid.

Our meeting with alumni was well attended and included graduates working across sectors (education, public agencies, and private industry). Most noted that their connection to the campus is an informal one via their faculty advisor.

Recommendations:

The department might think about a smaller set of priorities that may be achievable with limited resources. The most important and impactful actions may naturally emerge from the analysis and discussion that is planned/in progress.

The department has alumni that are passionate supporters of the program, and there may be value in establishing an alumni group led by graduates. There is potential for this group to provide professional development opportunities for current students, a structure for input to improve programs, and philanthropy to support the department. The department could work with the university's alumni association on this.

SUMMARY

Commendations:

Faculty and staff are clearly dedicated to the success of their students and show pride in the quality of their programs. Department faculty and staff seem genuinely supportive of each other and aligned in working towards fulfilling the department mission and goals. Current students and alumni comments reflect the transformative impact that department faculty have on their academic and professional success. Many expressed their gratitude to the department for providing them with an environment that they could grow and thrive, and that they did not think that they would have been successful without such supportive faculty. Alumni were unanimous in their praise for the quality of the program and how well it had prepared them for their professional careers. The department can be very proud of the quality of their programs and the graduates that they produce.

Recommendations and Specific Considerations to Improve Learning and Student Success for Each Degree:

Undergraduate programs. The department will benefit from an in-depth collection and analysis of student/alumni outcome data and curriculum planning. This should include a much broader assessment of pedagogical approaches and learning outcomes in their courses, using a wider range of assessment tools. The assessment should be linked directly to comprehensive curriculum planning, design, and revision efforts. The department should review the goals of each of their programs and develop program-specific learning outcomes that align with these.

Graduate programs. Efforts to provide additional financial support for graduate students would allow them to focus more on their studies and shorten time to degree. Some CSU campuses provide full or partial tuition waivers for TAs. Given the typical salary difference between a TA and a lecturer, this could lead to cost savings if this incentivizes more graduate students to teach. Graduate scholarships could also be a priority for development efforts. For many campuses with graduate programs, external grants support students in the research lab, and increased faculty activity in pursuing grants and contracts should be encouraged.

Recommendations and Specific Considerations to Develop Resources to Ensure Sustainability:

A review of staffing levels and needs is urgently needed. Beyond staff workload and ability to support programs, we have concerns with the ability to maintain a safe environment in all three stockrooms.

Equipment maintenance and lab supply budgets must be realistic and sustainable. General Fund support for increases to the number of lab/activity sections should include budget to cover increased equipment maintenance, supplies, and staff support costs. We recognize the challenges of state funding and limited general funds, but the basic operational needs to educate students cannot be met if teaching labs do not have basic equipment and glassware. Lower division chemistry courses are high DFW gateway courses for many majors, and additional support from GI 2025 funds would be a worthwhile investment. The department had proposed raising course fees to offset funding gaps, and while it is not an ideal solution, this should be supported by the university in the absence of other funding. Development funds for basic department operations is challenging, but philanthropy should be explored to support efforts that overlap with these needs (for example, course-based undergraduate research courses, and research areas). Faculty should explore external grant opportunities for high-end equipment needs, but the institution must recognize that funding agencies will not support equipment for routine operations, that maintenance and support expenses are an institutional responsibility, and that funding is highly competitive, and a successful application may require several rounds of applications.

Recommendations and Specific Considerations to Improve Academic Unit Planning:

The department does not appear to have had an opportunity for reflection and planning in recent years due to a combination of external factors. This presents an opportunity to reflect on how to update their approach to planning, and how to link this approach to a granular assessment of methods, outcomes, and needs. To ensure sufficient time and focus for a deep discussion without the distraction of immediate issues and concerns, this may be best achieved at a department retreat.

Internal Review Report

Internal Review Report:	Department of Chemistry
College:	Natural Sciences and Mathematics
Chemistry Degree Programs:	BA in Chemistry BS in Chemistry BS in Biochemistry MS in Chemistry
Internal Reviewers:	Jeffrey Brodd, Department of Humanities and Religious Studies, College of A&L Julie Fogarty, Department of Civil Engineering, College of ECS
Date Submitted:	May 13, 2022

I. Self-Study:

The Department of Chemistry submitted its self-study on February 1, 2022. It consists of just over 43 pages and mostly conforms structurally to the self-study template provided in the *Academic Program Review Guide*. The presentation of data and analysis in the section featuring Student Success is especially rich in detail. The self-study concludes with eight "current initiatives and challenges" under the heading, Areas of Concern and Means of Improving, that correlate quite closely with the Department's "Values" and "Goals" (p. 1) and help form the core of recommendations offered in the concluding section of this internal review report. This list indicates the sort of self-reflection that is also manifested in more subtle ways at various points in the report. Authorship of the self-study is credited to only two faculty members, departmental chair Susan Crawford and former chair Linda Roberts, which suggests the self-reflection might not have been undertaken by a large contingent of the faculty; or it might simply result from credit for the bulk of the work being fairly given to those to whom credit is due.

The self-study begins by clearly setting forth the Department's mission statement, values, and goals, demonstrating how these correlate with the missions of our University and the College of Natural Sciences and Mathematics. The Department offers three bachelor's degrees and a master's degree, with various concentration options (with Fall 2021 enrollments, per Table 1, p. 3): BS Chemistry (81); BS Biochemistry (162); BA Chemistry with Biochemistry and Forensics options (159); and MS Chemistry with Biochemistry option (31). The Department also offers a minor that currently enrolls approximately 80 students (p. 4). Statistics presented in Table 1 (p. 3) indicate decline in the numbers of students enrolled in the three BA programs, regarding which the report is candidly states: "We currently do not have an explanation for this decline…" (p. 3). CHEM 101, "Science in the Public Debate," is a "well received" new offering (p. 5). The Department has recently launched its Honors Program.

<u>Student learning</u>:

The self-study readily admits that the Department's assessment of student learning at the undergraduate level currently does not disaggregate per degree: "The chemistry department assesses its programs at the department level, so all five undergraduate degrees are included in a single assessment plan and share learning outcomes" (p. 6). (The self-study speaks of five degrees, but there are only three distinct degrees that appear on graduating students' diplomas; the three variations of the BA degree involve concentration options as opposed to separate bachelor's degrees.) This situation presents a good opportunity for improvement, as this report's concluding section will detail. Table 4 (pp. 6-8) charts the undergraduate Learning Outcomes: five primary outcomes with two to six sub-outcomes connecting to each of the main LOs (e.g., under Learning Outcome A, "Laboratory Knowledge and Skills," there are six specific outcomes, such as "1. the basic analytical and technical skills to work effectively in the various fields of chemistry."). The Table clarifies the tool and means of evaluation by which each of the sub-outcomes is assessed, noting when appropriate that certain sub-outcomes are "not assessed at the program level." All but two of the assessed sub-outcomes are measured via the capstone project; the other two are measured via the ACS Standardized Exam. The capstone project involves an end-of-semester poster session, in which six courses participate (CHEM 110L, 125, 133, 141, 164, and 198). Tables 5, 6, and 7 (pp. 11-12) set forth the assessment system applied to the MS degree program, demonstrating correlation between our University's Graduate Learning Objectives and the MS program's Program Learning Objectives, and mapping the PLOs with (Table 6) the MS Chemistry Biochemistry Concentration and (Table 7) MS Chemistry without concentration. The ensuing section provides helpfully self-reflective analysis on assessment data acquired from 2016 through 2019.

Student Success:

The Self-Study contains an impressive amount of data—filling nearly 16 pages—regarding student demographics and retention rates, that facilitates analysis of trends. Percentages regarding the ethnicity of students pursuing BA or BS degrees in Chemistry, for example, show a marked increase in the number of Hispanic students, from 15% in 2012 to 35% in 2021 (p. 18). As the self-study straightforwardly notes, data on graduation rates are not included in the self-study, as they "were not able to be completely processed in time for the program review." This admission is followed by the promise that this "analysis will continue in the chemistry department's Equity, Retention and Graduation committee" (p. 26). Data also reveal that a relatively high percentage of male undergraduates enter the master's degree program, prompting a call for "a more careful analysis of this issue" (p. 27). The fact that males make up only 30% of the undergraduate enrollment would seem similarly to call for further analysis, but no mention is made of this. The remaining two and one-half pages of this section describes six impressive programs and projects designed to help foster student success.

Developing Resources to Ensure Sustainability:

The self-study in this section highlights six main concerns: safety, reduction of DFW rates in introductory courses, tracking and strengthening ties with alumni, enhancing internship opportunities, analyzing and updating degree programs, and assessment. The latter section is brief but helpfully candid, making clear the Department's opportunity now to shore up its assessment systems and, in so doing, analyze and update its programs. This section proceeds to spell out perceived hiring needs, noting that the "department currently teaches over 2000 students in courses per semester" (p. 35), and that the 16 full-time faculty "teach approximately 33% of the course sections" with the rest taught by temporary faculty or teaching assistants (pp. 35-36). The remainder of this section describes issues involving staffing, maintaining adequate equipment, and challenges brought about by occupying space in two buildings (the Tschannen Science Complex and Sequoia Hall). This section does not address the *Academic Program Review Guide* template's Element Four D ("Summarize revenue opportunities [grants, gifts, partnerships, etc.]"), a fact noted in the external review report (p. 8).

Planning to Maintain Success and Engage in Continuous Improvement:

The self-study concludes with a concise list of eight "current initiatives and challenges," as noted above.

II. External Review:

The external reviewers were Dr. Blake Gillespie, Professor and Chair of the Chemistry Department, CSU Channel Islands, and Dr. Alam Hasson, Interim Vice Provost and Professor of Chemistry, CSU Fresno. It would seem that they were appropriate choices, especially given that both of these campuses offer both the BA and BS in Chemistry, including Biochemistry options, and CSU Fresno also offers the MS in Chemistry. They undertook their virtual visit on March 10 and 11, 2022 and submitted the report in mid-April. They met separately with departmental Chair Susan Crawford, departmental Graduate Coordinator Katherine McReynolds, faculty, (specifically) probationary faculty, (specifically) lecturers and temporary faculty, staff, College of NSM Dean Lisa Hammersley and Associate Dean Shannon Datwyler, undergraduate students, graduate students, and alumni. Although ideally the visit would have included a meeting with the Dean or Assistant Dean of Graduate Studies, this is an impressively extensive list. Email addresses were also provided to facilitate contact with Michelle Hladik, Research Chemist for the U.S. Geological Survey; Poonam Chandra, Senior Environmental Scientist with the California Department of Food and Agriculture, and Michael Payne, chair of the Chemistry Department at American River College, where several MS students teach. The report responds to most but not all of the questions set forth in the five-element template for the External Review Report in the *Academic Program Review Guide*. The report's failure to disaggregate comments and recommendations per each of the four degree programs is a shortcoming, given that our program review process is supposed to be degree-specific. The report also fails to consider the nature of specific courses or overall curricular design, despite the self-study having included among its eight "current initiatives and challenges" this one (#8): "Examine our programs to assure they are modern and adequately reflect the learning outcomes desired. Implement changes where appropriate" (p. 44). That said, the report offers thoughtful comments and recommendations on a number of topics, aligning closely with the self-study's emphasis on, for example, need to hire more staff and to update equipment. The report on one hand praises the department for its "very clear set of high-level Undergraduate Learning Outcomes and an assessment plan for reviewing how the program is meeting these goals," while on the other hand noting that three of the outcomes are not assessed, and observing (as noted above in review of the self-study) that "the learning outcomes are not degree-specific" (p. 2). The report is critical of dependence on the ACS exam and review of the capstone project as assessment tools, as "neither tool provides insight into the *approaches* and outcomes of the curriculum as a whole" (p. 2). The report is more positive regarding assessment of the graduate program, but still calls for more attention to "developmental process" (p. 3). Such feedback regarding Element Two on learning outcomes and assessment tends to be relatively critical, while comment on Elements Three through Five on student success, development of resources, and planning to maintain success notes various strengths and concurs for the most part with the Department on such issues as need to enhance staffing and acquisition of equipment. The report does, however, urge better financial support for graduate students and addressing concern over low morale among non-tenured/tenure-track faculty.

III. Internal Review Recommendations:

Based on the self-study and external review report the internal reviewers offer the following recommendations for consideration when drafting the Action Plan. We also wish to acknowledge a number of especially notable strengths that the reports make apparent. The external reviewers include in their summary section praise for the faculty and staff for their dedication to student success, pride in their programs, and supportive approach to accomplishing the Department's mission and goals. Ongoing efforts, as explained in the self-study (p. 34), to redesign CHEM 4 and to implement a two-semester version of CHEM 1A indicate commitment to addressing DFW rates and equity issues. The external reviewers also make clear the very positive perspective shared by current students and alumni. Also as noted in the external review report, the Department offers excellent support services for students, with a vibrant Chemistry Club and such programs as Peer-Assisted Learning and the DEGREES project. Departmental commitment to providing effective advising also appears to deserve commendation, although analysis of graduation rates and time-to-degree data would facilitate a more precise appraisal.

When commenting on the Department's list of eight "current initiatives and challenges," the external review report recommends thinking about "a smaller set of priorities that may be achievable with limited resources" (p. 10). Our internal review considers this to be an important overarching recommendation, and urges careful consideration of priorities when determining the Action Plan for this program review cycle. With this overarching consideration in mind, we offer the following twelve recommendations, roughly in order of priority per our perceptions (but again, we urge the Department and the College to determine priorities and to be realistic with regard to the extent of improvements to be attempted during the forthcoming review cycle).

1. Revise the BA/BS Assessment Plan to disaggregate the three bachelor's degrees and revise programs accordingly. The Department's "current initiatives and challenges" #8 (henceforth these items are referred to simply by number) states: "Examine our programs to assure they are modern and adequately reflect the learning outcomes desired. Implement changes where appropriate" (p. 44). The self-study addresses this initiative in more detail elsewhere (pp. 6 and 35). We suggest that the most effective means of examining the programs, while at the same time significantly enhancing the Department's Assessment Plan for purposes of ongoing assessment of student learning, will be to revise to establish specific sets of learning outcomes pertaining to each bachelor's degree. Without such specific sets, one must ask (as indeed the Chancellor's Office would ask, were this to involve an attempt to launch a new degree program), Why should this specific degree be offered by our University? Lumping all three bachelor's degree programs into one set of learning outcomes belies the need for more than one degree program. Perhaps most significantly, by engaging in this pursuit, the Department will naturally engage in thoughtful analysis of the extent to which each degree is "modern" and will be in a position to make responsible alterations if necessary. The self-study's Table 8 and accompanying analysis (p. 14) represent good steps in this direction and demonstrate headway and the value of disaggregation. The internal reviewers further recommend that this revised Assessment Plan incorporate the common approach of designating courses as intended to facilitate Introduction, Development, or Mastery (I, D, M) of learning necessary to succeed in attaining the degree. We also fully endorse the external reviewer report's recommendation to effect "developmental framework" (p. 2) as a sound assessment strategy. As the external reviewers' report notes, assessing by means of the ACS Standardized Exam and review of the capstone project—which seems to involve a sizeable group of faculty—have advantages, but they do not provide much by way of useful information for purposes of improvement throughout the curricular path to degree. For example, as stated in the self-study, and much to the credit of the Department and its students, the "exam class average in Chem 110 is generally much higher than the national norm" (p.

16). Consider the benefits of assessing the developmental learning through the various degrees' curricula that lead to this impressive extent of mastery.

2. Revise the MS Assessment Plan to augment good progress already made. This should prove to be an easy step, taken in concert with the steps suggested in our first recommendation. The approach to assessing the MS already benefits from clear mapping of correspondence with our University's Graduate Learning Goals, curricular mapping, five clearly articulated programmatic learning outcomes, and a rubric. Along with development of assessment tools, noted in the self-study (p. 11), there is room for improvement with regard to the correlation between the ten rubric categories and specific course content.

3. Follow through on the good work in producing the self-study by accessing and analyzing graduation rate and time-to-degree data. As noted above, the self-study straightforwardly confesses that data on graduation rates are not included in the self-study. It is imperative that such data be accessed and analyzed now in order to proceed to establish a sound Action Plan.

4. Address concerns regarding DFW rates and inequity issues. The Department's items #1 and #2 appropriately address these concerns. The external review report helpfully suggests connections between these concerns and allocation of general funds (p. 11). We also suggest assigning one tenured/tenure-track faculty person to teach more lower-division sections and to serve, at least informally, as a coordinator of the teaching of these courses, activities to include the review of syllabi, meetings with faculty, and so forth. The self-study cites the need of "FT tenure-track faculty teaching our upper division majors, service, specialty, and graduate courses" (p. 36). But offering optimal opportunities for student learning in the lower-division courses seems of paramount importance, for purposes of addressing the concerns over DFW rates and inequity issues, and for achieving other worthy objectives.

5. Strengthen ties with alumni through outreach efforts and involve alumni in strategic planning. The first portion of this recommendation is addressed directly in the Department's item #6. Notably, some STEM accreditation bodies *require* that program advisory committees include alumni among their members. It would seem that the Department could benefit greatly by paralleling such an approach.

6. Work with the College of NSM to implement a sound hiring plan to fortify faculty and staff and to ensure optimal space allocation. The self-study helpfully sets forth a summary of hiring needs (p. 40), and item #3 aligns with this recommendation while also including the practical step, "Examine staff position descriptions to assure they accurately reflect the work performed" (p. 43). The external review report strongly advocates for the hiring of additional staff to help ensure safe operations: "A review of staffing levels and needs is urgently needed. Beyond staff workload and ability to support programs, we have concerns with the ability to maintain a safe environment in all three stockrooms" (p. 11). With regard to hiring more faculty, recognizing the ongoing reality that *every* department likely can make a fairly strong case for needing more tenure-track faculty, we suggest that an evidence-based approach to requesting new hires is the most viable approach. For the Department of Chemistry, this might involve needing to balance the recent decrease in the number of majors with its strong contributions to serving other degree programs and General Education.

7. Strive to ensure appropriately modern equipment. The Department's item #5 calls for identifying "mechanisms to maintain and obtain the modern equipment and instrumentation…" (p. 43). The

external review report puts this bluntly: "The precarity of the department's instructional effectiveness cannot be stated in starker terms: without a renewal process, the students' training will degrade" (p. 7). Near the conclusion of their report, the external reviewers cite the desirability of faculty exploring grant opportunities to fulfill these needs, but set forth cautionary advice in this regard (p. 11). One way or another (or, more likely, through a combination of ways), it seems clear that responding to this recommendation constitutes a vital need.

<u>8. Work to develop community partnerships to increase internship and grant opportunities.</u> The Department's item #7 includes: "Increase internship opportunities." Following through on strengthening ties with alumni (recommendation #5 above, and the Department's item #6) surely has potential. As noted in our review of the self-study, the report does not attempt to address the *Academic Program Review Guide* template's Element Four D ("Summarize revenue opportunities [grants, gifts, partnerships, etc.]"), but it's certainly not too late to consider this prior to developing the Action Plan.

<u>9. Attend to concerns regarding morale among non-tenured/tenure-track faculty.</u> This issue is not mentioned in the self-study's list of "Chemistry Department Goals" (pp. 1-2) or in its list of eight items, but it drew the attention of the external reviewers (pp. 6 and 8 of their report). The Department and College should consider ways to make things better for these members of the faculty, perhaps by inviting fuller participation in departmental meetings and decision-making and, presumably on the part of the College, attempting to provide earlier offers of employment.

<u>10. Consider means of fortifying financial support for MS students</u>. This is suggested in the external review report, citing a "theme that emerged from meetings with faculty, students, and alumni"(p. 10). It is quite possible that these concerns have arisen primarily as a result of the Covid pandemic; but if they are in some way attributable to long-term circumstances, the Department should consider means of alleviating them. One method to address this concern that ties in with Department item #6 and our internal reviewers' Recommendations #4, #5, and #9, is to create a program that cultivates MS students as future temporary faculty by providing TA opportunities as described by the external reviewers. Creating and drawing faculty from this pool might also bridge the disparity in demographics between students and faculty to help address diversity, equity, and inclusion.

<u>11. Analyze decline in enrollment post-2017 and strategize means to address.</u> The self-study openly acknowledges this decline and the need to examine it (pp. 3 and 36), and helpfully disaggregates enrollment figures per degrees and concentrations via Table 1 and accompanying analysis (p. 3) and, with focus on ethnic and gender representation, in the Student Success section. Perhaps it will prove helpful to compare to the situations in other STEM degree programs, especially given the Department's perspective on the reason for the increase from 2012 to 2017.

<u>12. Consider the "big picture" with regard to concern over relatively low enrollment of female undergraduates in the MS program.</u> The concern noted in the self-study (p. 27), together with the low percentage (30%) of male undergraduate students, which is not noted as a concern, seems to involve various interrelated issues in STEM degree programs that would be worth investigating. For example, do female undergraduates, regardless of relative demonstrated accomplishment, tend to enter the workforce with the bachelor's degree in hand rather than going on to graduate studies relative to male students? Regarding our CSUS Chemistry majors in particular, how many of the female students are going on to graduate or professional programs at other institutions? Such investigations obviously would benefit from ascertaining sound data through exit interviews or alumni surveys.

Program: MS Chemistry and MS Chemistry with Biochemistry concentration
College: NSM

Date: 9/27/2022 Program Review 2YR Update 4YR Update 6YR Update

Program Review Finding Cite self-study, external review, internal review, and/or accreditation documentation	**2 YR** List goal, success indicator, responsible parties, and resource implications.	**4 YR** List goal, success indicator, responsible parties, and resource implications.	**6 YR** List goal, success indicator, responsible parties, and resource implications.
To Maintain Success			
Faculty are staff are clearly dedicated to the success of their students and show pride in the quality of their programs. The department will benefit from an in-depth college and analysis of student/alumni data and curriculum planning.	Collect and analyze student/alumni data. Identify careers and post-graduation goals of MS chemistry and biochemistry students. Identify program strengths and potential areas for improvement to support these professional paths.	Revise MS curriculum to maintain currency and support student success post-graduation.	Program review examines updated assessment data and focuses future curriculum planning for the MS Chemistry and Biochemistry.
Current student and alumni comments reflect the transformative impact the department faculty have on their academic and professional development. Work with the college to identify mechanisms to maintain and obtain	MS students in chemistry and biochemistry typically have post-degree plans that require enhanced technical and research skills. The thesis-based MS degree programs support these student goals. Identify facility	Re-evaluate equipment needs and update facilities plan.	Re-evaluate equipment needs and update facilities plan.

the modern equipment and instrumentation needed to continue to offer the high-quality educational experiences that have been the hallmark of the MS program.	and equipment needs that support these program goals and work with college dean to identify potential funding sources to maintain and acquire equipment.		
To Improve Student Learning (consider university/college goals on learning, research/scholarship, diversity)			
The assessment plan for the graduate program is a reasonable model: the role each course plays in meeting the program learning outcomes is clear. However, the learning outcomes are not presented as a developmental process with milestones.	Examine and revise the MS Chemistry PLOs for each concentration. Revise to assess the developmental process sought for students progressing through the MS programs.	Develop assessment tools that provide data that the PLOs are being met to inform developmental progress throughout the degree path.	Reexamine goals and PLOs in light of assessment data.
To Improve Student Success (consider university/college goals on recruitment, retention, graduation, diversity, engagement)			
The number of MS applicants has declined since the onset of covid. Female graduate students are less represented in the program.	Analyze decline in enrollment post-covid and strategize means to address. Create new recruitment materials that encourage female and diverse applicants.	Evaluate enrollment for changes.	

Efforts to provide additional financial support for graduate students would allow them to focus more on their studies and shorten time to degree. Some CSU campuses provide full or partial tuition waivers for TAs.	Encourage department graduate coordinator to bring this issue to university graduate coordinator meeting for discussion. Encourage faculty to write external grants that provide financial support for MS students.		
Many current MS students in the program began as undergraduate majors in chemistry at CSUS.	Explore the idea of a BS+MS program that has been implemented on other campuses and has been recently approved for development on CSU campuses		
To Build Partnerships and Resource Development to Enhance the Student Experience (consider university/college goals on university as place, university experience, community engagement)			
Ties and collaborations with regional industries and agencies can support the department's mission.	Identify and make a list of regional agencies and industries that would benefit from closer interactions with the department and graduate program through collaborations and recruitment.	Make contact with individuals from list to identify possible collaborative ventures that benefit MS students.	

Work to develop community partnerships to increase internship and grant opportunities.	Recruit alumni and regional employers to form a program advisor committee.	Analyze impact of increased interaction with community and alumni on student engagement in outside opportunities.	
To Improve Strategic & Budget and Operational Effectiveness and to Ensure Sustainability (consider university/college goals on innovative teaching, scholarship, research, university as place, university experience)			
Work with the College of NSM to implement a sound hiring plan to fortify faculty and staff.	Create a five-year hiring plan that aligns with MS student success, PLOs and faculty workload.		Re-evaluate hiring plan in context of program assessment and any curriculum changes that may have occurred.

Department Chair Name/Signature Susan Crawford Susan M. Crawford

College Dean Name/Signature Lisa Hammersley