Chemistry BS

Goal 1: Establishing a Robust Foundation in Core Chemistry Principles and Techniques

Goal Description:

In our Chemistry program at Sam Houston State University, we are committed to ensuring that students not only gain but also retain comprehensive foundational knowledge and practical skills in key areas of chemistry, essential for both academic and professional success. This goal encompasses a deep understanding of General Chemistry, Organic Chemistry, and Quantitative Analysis, as these areas form the cornerstone of chemical education and are vital for a wide range of scientific careers. These courses are required in the Chemistry and Forensic Chemistry majors and are normally taken in the first two years (for full descriptions see http://catalog.shsu.edu/undergraduate/course-descriptions/chem/ and for the main degree plans see http://catalog.shsu.edu/undergraduate/colleges-academic-departments/science-and-engineering-technology/chemistry/#programstext):

- CHEM 1411 General Chemistry I
- CHEM 1412 General Chemistry II
- CHEM 2323+2123 Organic Chemistry I Lecture and Laboratory
- CHEM 2325+2125 Organic Chemistry II Lecture and Laboratory
- CHEM 2401 Quantitative Analysis

General Chemistry lays the foundational bedrock, providing students with an in-depth understanding of chemical reactions, atomic and molecular structures, and thermodynamics. It serves as the gateway for appreciating the complexity and beauty of chemistry.

Organic Chemistry advances this knowledge by delving into the intricate world of carbon-based compounds, fostering skills in molecular synthesis, and understanding chemical properties and reactions that are central to biological, pharmaceutical, and industrial applications.

Quantitative Analysis equips students with crucial analytical and data interpretation skills, emphasizing accuracy, precision, and problem-solving techniques. These skills are not only fundamental in chemistry but also translate across various scientific disciplines, enhancing the students' ability to tackle complex real-world problems.

Additionally, this goal stresses the importance of integrating theoretical knowledge with practical applications. Through laboratory courses and research opportunities, students apply concepts learned in the classroom to real-life scenarios, thus solidifying their understanding and preparing them for the challenges of scientific careers and advanced study.

Our curriculum aligns with the highest standards set by professional bodies like the American Chemical Society, ensuring that our graduates are well-prepared for the demands of the job market and further academic pursuits. We also emphasize the development of critical thinking and analytical skills, fostering a culture of inquiry and innovation.

Furthermore, we recognize the interdisciplinary nature of modern scientific problems. Our program encourages students to understand and apply chemistry principles to fields such as biochemistry, environmental science, forensic chemistry, and material science, reflecting the versatile and interconnected nature of the discipline.

Finally, we aim to instill in our students a commitment to continuous learning and professional development. In an ever-evolving scientific landscape, the ability to adapt and grow is crucial. We prepare our students to be lifelong learners, ready to contribute meaningfully to the scientific community and

society at large. The foundational knowledge obtained in this set of courses allows students to form a solid common foundation in the field of chemistry from which to launch into specialized fields like biochemistry, physical chemistry, inorganic chemistry, and polymer chemistry in their advanced undergraduate studies.

Providing Department: Chemistry BS

Progress: Completed

RELATED ITEMS/ELEMENTS

RELATED ITEM LEVEL 1

Achieve Proficient Comprehension in Fundamental Organic Chemistry Concepts and Skills

Learning Objective Description:

Students will achieve a proficient comprehension of fundamental concepts in Organic Chemistry, a crucial subfield of chemistry. This objective is centered around the knowledge and skills acquired in the second-year series of Organic Chemistry courses (CHEM 2323/2123/2325/2125). Key components of this learning objective include:

1. **Understanding of Core Organic Chemistry Principles**: Students will develop a thorough understanding of fundamental organic chemistry concepts, including molecular structure, bonding theories, stereochemistry, and the properties of various organic compounds.
2. **Mechanisms of Organic Reactions**: Mastery in comprehending and predicting the mechanisms of organic reactions is essential. This includes understanding reaction kinetics, reaction types, and the factors influencing these reactions.
3. **Synthesis and Analysis of Organic Compounds**: Students will learn the principles and techniques for the synthesis of organic compounds. This includes knowledge of reagents, reaction conditions, and purification methods, along with skills in analyzing and identifying compounds using spectroscopic techniques.
4. **Application of Organic Chemistry in Real-World Contexts**: Students should be able to apply their knowledge to solve practical problems in organic chemistry. This could include case studies, laboratory experiments, or problem-solving exercises that demonstrate their ability to apply organic chemistry concepts in practical scenarios.
5. **Safety and Best Practices in Organic Laboratory Work**: An understanding of and adherence to safety protocols and best practices in handling organic compounds and conducting experiments is crucial.
6. **Integration of Theoretical Knowledge and Practical Skills**: Students are expected to integrate theoretical knowledge from lectures with practical laboratory skills. This includes performing experiments, analyzing results, and understanding the practical implications of theoretical concepts.

Through achieving these outcomes, students will not only grasp the fundamental concepts of Organic Chemistry but also be able to apply this knowledge effectively in both academic and professional settings. This solid foundation in Organic Chemistry is crucial for their success in advanced studies and various careers in the chemical sciences.

RELATED ITEM LEVEL 2

Proficiency Assessment in Organic Chemistry for CHEM 3438 Biochemistry I

Indicator Description:

In the initial weeks of the CHEM 3438 Biochemistry I course, all students will participate in a specialized Organic Chemistry test. This assessment, authored by Dr. Haines who teaches Biochemistry and used to teach Organic Chemistry II regularly, is specifically designed to focus on

aspects of Organic Chemistry that are most relevant to the Biochemistry curriculum. The test will be administered during laboratory sessions within the first two weeks of the course. A copy of the test to be given is attached.

The primary objectives of this assessment are:

1. **Diagnosis of Prerequisite Knowledge**: Given that Organic Chemistry I and II are prerequisites for Biochemistry I, the test will serve as an essential tool to evaluate students' foundational knowledge in Organic Chemistry. This is particularly crucial as a strong understanding of Organic Chemistry is imperative for grasping the chemistry and properties of biological molecules, a key component in Biochemistry.

2. **Assessment of Knowledge Retention**: This test will also measure the retention of Organic Chemistry concepts learned in the second year of the students' chemistry coursework. It aims to identify the extent to which key concepts have been retained and understood, which is vital for the successful study of Biochemistry.

The test content will encompass critical areas of Organic Chemistry such as molecular structure, reaction mechanisms, synthesis, and analysis of organic compounds, ensuring a comprehensive review of the subject matter. The results from this test will provide valuable insights into the students' preparedness for advanced biochemical studies and will help identify areas where additional instructional support or review is necessary.

Attached Files

CHEM3438 F2023 Prereq Test Organic Chemistry.pdf

Criterion Description:

In the previous year an American Chemical Society standardized test was employed with the criterion that seventy-five percent of chemistry majors are expected to score within one standard deviation of the mean or higher than one standard deviation above the national mean on the ACS standardized organic chemistry examination. The nationally normed mean on the ACS Organic test used was 36.6 +/- 11.4 questions correct, so the threshold used was 36.6-11.4 = 25.2 questions correct. The nearest whole number above 25.2 is 26, so that was the required score students had to achieve. Of the three sections of Biochemistry Lab in Spring 2023, 6/16, 8/23, and 1/22 students scored 26 or higher out of 50 for a total of 15/71 students. Only 21% of students earned the expected score, so the criterion was far from being met. Two issues were observed: 1) Students may not have taken the exam seriously, as it did not directly calculate as part of their grade, but a low score triggered mandatory review activities. 2) Students who took some prerequisite chemistry (Organic Chem) at community college appear to score particularly low on the exam.

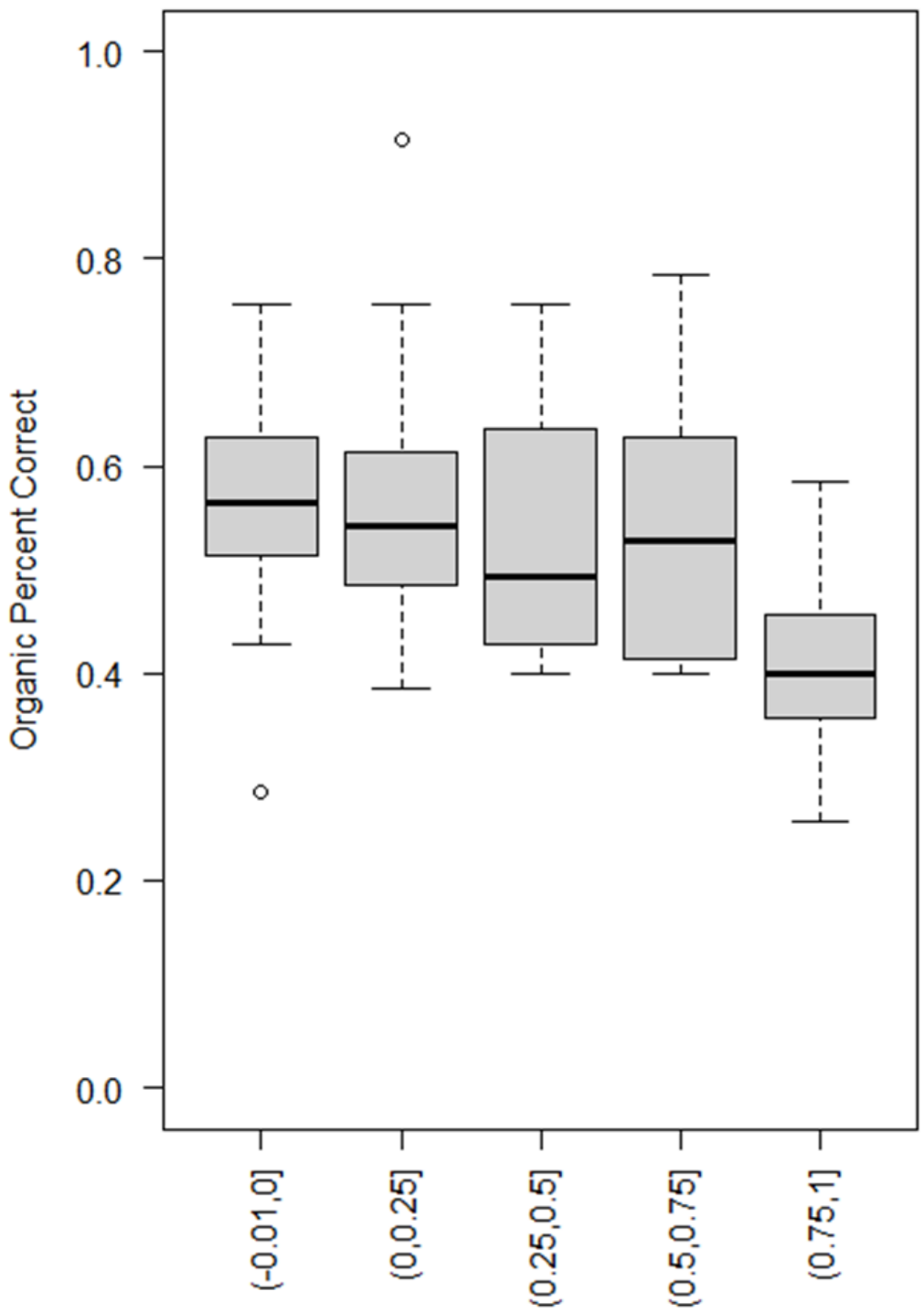
For the current year, an exam that focused more on the part of Organic Chemistry most relevant to Biochemistry was desired for reasons having to do with course pedagogy. This new custom-written exam has not been normed. Therefore, the criterion will be that at least 75% of students score a 'passing' grade of at least a C, designated by a numerical score of at least 70 out of 100 points on the exam. Due to the transfer issues noted above, only students that took at least 3 of 4 prerequisite chemistry lecture courses at SHSU will be included in the analysis this year, with other students (including transfer students) left to assess in a later cycle.

Findings Description:

For the exam given in Fall 2023, 78 students were assessed. Of those, 24 had taken all prerequisites at SHSU, and 13 had taken 3 of 4 prerequisites at SHSU. The statistical distribution of scores (as a quantile analysis in the statistical package R) was:

Percent of Prereqs at SHSU	minimum score	25-percentile	median	mean	standard deviation	75-percentile	maximum score	count
100%	28.6%	51.4%	56.4%	56.1%	9.9%	62.9%	75.7%	24
75%-99%	38.6%	48.6%	54.3%	57.0%	15.3%	61.4%	91.4%	13
50%-74%	40.0%	42.9%	49.3%	52.7%	11.3%	63.2%	75.7%	20
25%-49%	40.0%	41.4%	52.9%	54.0%	13.0%	62.9%	78.6%	10
0%-24%	25.7%	35.7%	40.0%	40.5%	9.4%	45.7%	58.6%	11

A boxplot of the data shows a clear trend downward as percent of prereqs taken elsewhere increases:



From this data, it can be seen that

- Even if only the students with 75% and 100% of prereqs at SHSU are considered, the median score was only around 56% which is well short of the 70% criterion. Even considering the 75%-ile (top 25% of students), the scores only reach about 62%, but considering the top 3/4 of students as indicated in the criterion results in an exam score of only about 50%. Therefore, the findings are not even close to the criterion.
- As predicted, there is a major difference in score when comparing students who took all or most prerequisites at SHSU to those who took all or most prerequisites at other schools (almost always at community college). The median score is 56% for those from SHSU versus 40% for

those who took all prerequisites elsewhere, and the 25th-percentile scores (3/4 of students) for the two groups are 51% versus 36%. There is a consistent difference of roughly 16% between the two groups.

RELATED ITEM LEVEL 3

Action - Proficiency Assessment in Organic Chemistry for CHEM 3438 Biochemistry I

Action Description:

The criterion was not met, it wasn't even close. For all student groups examined, knowledge of Organic Chemistry in this post-Organic course severely lags behind the expected knowledge level. This assessment alone cannot determine if the issue is that students never learned the material or if they originally learned it and then lost that knowledge. Both components are likely at play.

To address this serious problem, the following actions will be taken:

1. Dr. Haines, the CHEM 3438 lab instructor, will Increase the required review of Organic Chemistry at the beginning of CHEM 3438 lab where this assessment is carried out. These reviews are carried out in Blackboard Modules. These modules will be expanded for Fall 2024.
2. Results will be discussed with Organic instructors and our support partners (Academic Success Center tutor leaders, etc.) to raise awareness of the issue and discuss what supports may be useful.
3. Dr. Haines will lead a faculty and staff discussion of the issue in Fall 2024 to determine if additional assessment and correction are appropriate. For example, a mandatory 1 credit hour course for majors in the department could be added during the junior year that more thoroughly assesses this knowledge (along with knowledge of General Chemistry) followed by mandatory corrective actions for those that whose knowledge and skills do not meet standards. The pedagogical benefit must be weighed against the increased credit hours and cost, as well as consideration of what happens to students that fail to reach those standards even by the end of the course.

RELATED ITEM LEVEL 2

American Chemical Society Standardized Organic Chemistry Final Examination in CHEM 2325

Indicator Description:

t the conclusion of the CHEM 2325 Organic Chemistry II course at Sam Houston State University, all chemistry majors will undertake the ACS Organic Chemistry Test. This test, developed by the American Chemical Society Division of Chemical Education Examinations Institute, is a nationally standardized assessment and will serve as the final examination for the course.

The primary purpose of this assessment is:

1. **Comprehensive Evaluation of Organic Chemistry Knowledge**: The test is designed to comprehensively evaluate the students' understanding and mastery of Organic Chemistry. It covers a broad range of topics integral to the subject, ensuring a thorough assessment of the students' knowledge and skills acquired throughout the course.
2. **Standardized Benchmarking**: By using a nationally standardized test, the examination provides a reliable benchmark to measure students' performance against national standards. This helps in evaluating the effectiveness of the Organic Chemistry II course at Sam Houston State University in comparison to similar programs nationwide.

3. **Identification of Learning Outcomes**: The results from this test will offer valuable insights into the areas where students excel and where they may need further improvement. This information is critical for curriculum development and instructional strategies, aiming to enhance the overall quality of the Organic Chemistry program.
4. **Preparation for Advanced Studies and Professional Exams**: This standardized test also serves to prepare students for future professional and academic pursuits that require a solid foundation in Organic Chemistry, including advanced studies and professional certification exams.

The content of the test encompasses key topics in Organic Chemistry such as reaction mechanisms, synthesis, identification and analysis of organic compounds, and molecular structure, among others. The results will be analyzed to understand the efficacy of the teaching methods and the curriculum in imparting the necessary knowledge and skills in Organic Chemistry.

Criterion Description:

In the previous year, the criterion was that seventy-five percent of chemistry majors are expected to score within one standard deviation of the mean or higher than one standard deviation above the national mean on the ACS standardized organic chemistry examination. The ACS Organic exam had a normed average of 36.6 +/- 11.4 out of 70 questions (scores ranged from 17-57), so one standard deviation below the mean was 25.2 and a student score of 26 or higher would be above that threshold. Of 45 students reaching the end of CHEM 2325 with Dr. Hobbs in Spring 2023, 35 scored above the threshold. This was 78% of students, so the criterion was met.

There is currently a lot of concern about increasing learning loss and decreased student engagement and performance in college classes, especially difficult classes like Organic Chemistry. Therefore we will use the same threshold this year, not increase it.

Note: We are not legally allowed to reproduce these exams, so a sample is not attached. However, the normalization data is available and is attached.

Attached Files

OR16_Norm_Sheet_Final_post.pdf

Findings Description:

[Note: As of 5-31-24, the results have not yet been collated but are expected to be analyzed before the assessment cycle is over.]

RELATED ITEM LEVEL 3

Action - ACS Organic Chemistry Test at end of CHEM 2325 Organic Chem II

Action Description:

[Results still being collated and analyzed as of 5-31-24 so no action can be assigned yet.]

RELATED ITEM LEVEL 1

Students Grasp and Can Apply Foundational Chemistry Concepts and Skills

Learning Objective Description:

A great deal of what chemists learn is built on a foundation of general chemistry principals laid out in first-year chemistry courses, and learning that foundational material well greatly improves a student's ability to learn more complex knowledge and skills later on in their development. Students will demonstrate a profound grasp of foundational chemistry concepts and skills, as laid out in the first-year courses CHEM 1411 and 1412 General Chemistry I and II. This objective underscores the importance of

these fundamental principles as they form the bedrock upon which all advanced chemistry education is built. Mastery of these topics is crucial for students' success in their subsequent years of study in chemistry. Key components of this learning objective include:

1. **Understanding of Measurement and Analysis**: Students will comprehend the significance of uncertainty in measurement and be adept at dimensional analysis. This forms the basis for accuracy and precision in chemical experimentation and data interpretation.
2. **Atomic and Electronic Structure**: Students will gain a thorough understanding of atomic theory, including atomic structure and electron configuration. This knowledge is fundamental to understanding chemical reactions and properties.
3. **Molecular Formulas and Nomenclature**: Mastery of ionic and molecular formulas, as well as chemical nomenclature, is essential for clear communication and understanding in chemistry.
4. **Stoichiometry**: Students will develop proficiency in stoichiometry, a vital skill for quantifying substances in reactions and understanding chemical relationships.
5. **Thermochemistry and Chemical Thermodynamics**: An understanding of thermochemistry and the principles of chemical thermodynamics, including heat transfer and energy changes in chemical reactions, is crucial.
6. **Bonding Theories and VSEPR Theory**: Students will learn bonding theories and Valence Shell Electron Pair Repulsion (VSEPR) theory to predict molecular shapes and bond angles, which are key in determining molecular properties and behavior.
7. **Properties of Gases and Solutions**: Comprehensive knowledge of the properties of gases and solutions, including gas laws and solution concentrations, is important for understanding many chemical processes.
8. **Intermolecular Forces**: Understanding intermolecular forces enables students to predict and explain physical properties and phase changes of substances.
9. **Chemical Kinetics and Equilibrium**: Students will grasp the principles of kinetics and equilibrium, essential for understanding the rate of reactions and the balance between reactants and products.
10. **Acid-Base and Oxidation-Reduction Chemistry**: Mastery of acid-base concepts and oxidation-reduction reactions is fundamental to various chemical processes and applications.
11. **Electrochemistry**: Knowledge of electrochemistry, including galvanic and electrolytic cells, is critical for understanding energy production and material synthesis.

Through achieving these outcomes, students will not only establish a strong foundation in chemistry but also be well-prepared for advanced studies in the field. This deep understanding of fundamental concepts and skills is vital for their academic growth and future success in various chemistry-related careers.

RELATED ITEM LEVEL 2

ACS General Chemistry Test at Beginning of CHEM 3438 Biochemistry I
Indicator Description:
At the onset of the CHEM 3438 Biochemistry I course, all enrolled students will undertake the ACS General Chemistry Test, a nationally standardized assessment developed by the American Chemical Society Division of Chemical Education Examinations Institute. This test will be administered during laboratory sessions early in the course. The primary objectives of this assessment are twofold:

1. **Diagnosis of Prerequisite Knowledge**: Since CHEM 1411 and 1412 General Chemistry I and II are prerequisites for CHEM 3438, the test will serve as a diagnostic tool to identify any deficiencies in students' foundational knowledge. This will enable instructors to tailor their teaching strategies accordingly to address these gaps.
2. **Measurement of Concept Retention**: The test will also provide valuable data on students' retention of General Chemistry concepts over an extended period, typically between the first or second year and the third or fourth year of their college education. This longitudinal measure will help in evaluating the effectiveness of the General Chemistry courses in imparting and sustaining key chemistry knowledge.

The test will include questions covering a range of topics from General Chemistry, including atomic structure, stoichiometry, thermochemistry, bonding theories, and others as outlined in the General Chemistry I and II syllabi. The results from this test will be analyzed to gauge students' preparedness for advanced biochemistry topics and to identify areas where additional review or instructional support may be required.

Note: We cannot legally reproduce these exams, but the normalization data is available and is attached (this is the 2006 ACS General Chemistry 2nd Term Form).

Dr. Haines will give the exam in Fall and Spring Biochemistry I Laboratory and collate the results.

Attached Files

General-Chemistry-Brief-Year-Form-2006.pdf

Criterion Description:

From last year, the target was that seventy-five percent of chemistry majors are expected to score within one standard deviation of the mean or higher than one standard deviation above the national mean on the ACS standardized General Chemistry examination. The nationally normed mean on the ACS exam was 27.5 +/- 8.1 questions correct, so the threshold of 75% will be that students should have answered at least 20 (the next whole number above 19.4) questions or more correct. Of the three lab sections in the spring 2023, the number of students meeting this threshold was 7/16, 5/23, and 6/22 student met the threshold for a total of 18/71 students achieving at least 20 questions correct out of 50. That is only 25% of students meeting the criterion, the criterion was not met (the value is 1/3rd of the expected criterion).

It was observed that 1) students may not be taking the exam very seriously, the score does not count toward their grade but a low score does trigger a mandatory review module and 2) transfer students appear to lag students who took their General Chemistry at SHSU by a lot. It may be reasonable to disaggregate this data in the future into the two populations. Corrective action is needed, students are not able to answer questions about General Chemistry correctly in a later course, even though all students passed the course with a C or higher to reach Biochemistry I.

This year a more complex and nuanced criteria will be used, that 75% of department majors that took at least 3 of the 4 prerequisite chemistry steps at SHSU will score within one standard deviation of the mean or higher than one standard deviation above the national mean on the ACS standardized General Chemistry examination. Department majors not in this group will be the focus of a future ICF once we characterize this group that received more of their chemistry education at SHSU.

Findings Description:

The threshold score remains at least 20 questions correct out of 50, or 40% correct. In Fall 2023, 79 students took the exam (regardless of where they took the prerequisite) and the 75th percentile score was 22 questions correct.

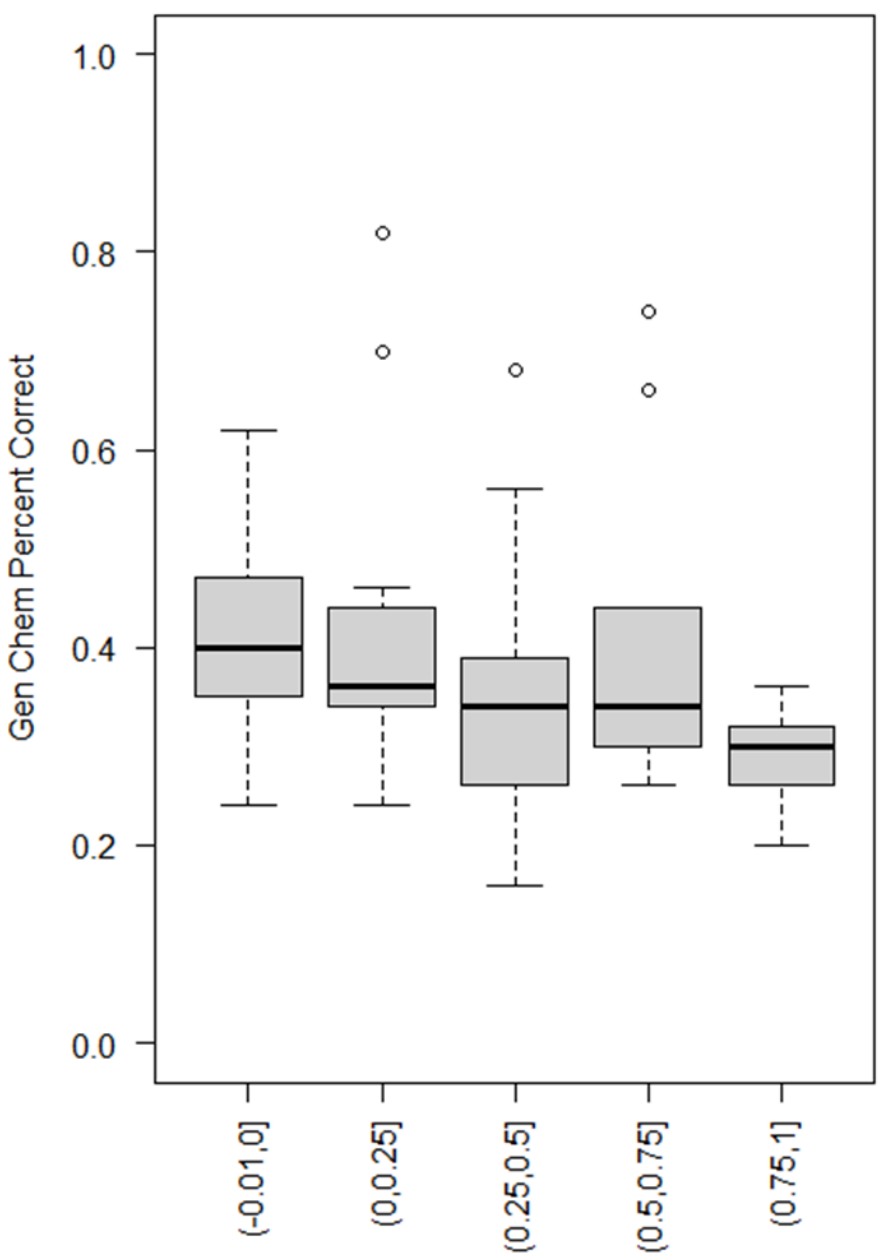
The results broken out by what fraction of prerequisites were taken at SHSU were as follows:

Percent Correct on ACS Exam

Fraction of Prereqs at SHSU	minimum	25th percentile	median	mean	std.dev	75th percentile	max	count
100%	24%	35%	40%	41%	11%	47%	62%	24
75%-99%	24%	30%	37%	40%	16%	43%	70%	6
50%-74%	20%	30%	36%	39%	16%	43%	82%	14
25%-49%	16%	26%	34%	36%	17%	41%	68%	7
0%-24%	24%	29%	33%	34%	9%	39%	48%	6

As can be seen in the table, for every level above 25% of prerreqs taken at SHSU, the 75th percentile of the test takers scored over 40%, so the criteria was met. For those who took their prereqs at other institutions, the score was just under 40%.

A very clear trend is apparent with the score distributions as shown on this boxplot (note: the x-axis on this graph is fraction of courses taken *elsewhere*, reverse of the above table; the 75% percentile is the top of each rectangular box):



There appears to be a very clear dose-response-type relationship, the more prereqs taken at SHSU the higher the student scores on this Gen Chem exam in CHEM 3438, which comes after both General Chem courses and both Organic Chemistry courses.

Although the criterion was met, and in fact would have been met with all students pooled together, the data clearly show students taking prereqs elsewhere are at a significant disadvantage. Mechanisms for helping those students reach a similar level of knowledge to those who took it at SHSU should be explored. In future years, the criteria for all students could be raised, as this threshold is still lower than we would like to achieve eventually.

RELATED ITEM LEVEL 3

Increase Review of General Chemistry in Biochemistry I

Action Description:

To increase student retention of General Chemistry knowledge (or fill it in where it was never learned), the review modules in CHEM 3438 should continue to be expanded and enhanced. Further, the department Chair will lead discussions with instructors in Fall 2024 in Faculty and Staff meetings to identify mechanisms to specifically support students that take General Chemistry or Organic Chemistry elsewhere (which includes transfer students, but also SHSU students who struggle to pass here and then take it at community college where it is generally easier to pass).

RELATED ITEM LEVEL 2

American Chemical Society (ACS) General Chemistry Test at end of CHEM 1412 Gen Chem II

Indicator Description:

Upon nearing the completion of the CHEM 1412 General Chemistry II course, all chemistry majors at Sam Houston State University are be invited to participate in the ACS General Chemistry Test. This nationally standardized assessment, crafted by the American Chemical Society Division of Chemical Education Examinations Institute, is designed to evaluate the comprehensive understanding of general chemistry concepts.

Key aspects of this assessment include:

1. **Comprehensive Evaluation of General Chemistry Knowledge**: The test aims to assess students' grasp of fundamental concepts covered in General Chemistry I and II, including atomic structure, stoichiometry, thermochemistry, bonding theories, and more. This provides a measure of the students' learning outcomes and the effectiveness of the course curriculum.
2. **Incentivization and Engagement**: To encourage participation and acknowledge excellence, the student achieving the highest score on this test will be awarded scholarship funds for a future semester. Additional scholarships will be distributed based on percentile performance, creating a motivating environment for students to perform to the best of their abilities.
3. **Benchmarking and Improvement**: The results from this standardized test offer valuable data for benchmarking our students' performance against national standards. This information is crucial for continually improving our teaching methodologies and course content.
4. **Preparation for Advanced Courses**: By participating in this assessment, students will also gain experience in taking standardized tests, which is beneficial for their future academic and professional pursuits, especially if they involve further chemistry education or certification exams.

The content of the test is aligned with the comprehensive topics taught in General Chemistry II, ensuring a holistic evaluation of the students’ knowledge and understanding in general chemistry.

Note: We cannot legally reproduce these exams, but the normalization data is available and is attached (this is the 2006 ACS General Chemistry 2nd Term Form).

Attached Files

General-Chemistry-Brief-Year-Form-2006.pdf

Criterion Description:

Last year, the criterion was that seventy-five percent of chemistry majors are expected to score within one standard deviation of the mean or higher than one standard deviation above the national mean on the ACS standardized General Chemistry examination. In the Fall term, only two students took the exam. One met the threshold, one did not, so 50% of students met the threshold which is short of the criterion. In the Spring term, the Chair forgot to actually ask students to take the test so no data was collected. The criterion was technically not met, but with only 2 students taking the exam the only possible outcomes were 0%, 50%, or 100% meeting the threshold. That wasn't enough students for meaningful assessment.

For this year the exam needs to be better managed and communicated. We will only give the exam in the spring term, and will invite students who took CHEM 1412 either semester with better communication about the scholarships that can be won (still with separate fall and spring student pools to ensure fairness). The criterion was that seventy-five percent of chemistry majors are expected to score within one standard deviation of the mean or higher than one standard deviation above the national mean on the ACS standardized General Chemistry examination.

Findings Description:

In part due to weather disruptions at the Spring 2024 term, and in part due to the low value of the assessment due to the low number of students taking the exam, we did not end up giving this exam in Spring 2024. Therefore there are no findings.

RELATED ITEM LEVEL 3

Action - American Chemical Society (ACS) General Chem Test at end of CHEM 1412 Gen Chem II

Action Description:

The assessment itself did not happen, and has always been problematic (never attracting a significant number of students). In Fall 2024, Chair Haines will lead the faculty and staff in a discussion of alternate ways to asses the range of knowledge this test was meant to asses for inclusion in next year's assessment plan.

Goal 2: Mastery and Integration of Advanced Concepts in Key Chemistry Disciplines

Goal Description:

In the Chemistry program at Sam Houston State University, our objective is to ensure that students acquire and master advanced knowledge and skills in the principal subfields of chemistry, preparing them for successful careers and significant contributions to scientific research. This goal encompasses an in-depth study of Physical Chemistry, Biochemistry, Inorganic Chemistry, and Instrumental Analytical Chemistry, each integral to the diverse and evolving landscape of chemical sciences.

Physical Chemistry forms the core of our understanding of chemical systems, providing insights into thermodynamics, kinetics, and quantum mechanics. Mastery in this area is pivotal for innovations in material and drug design, contributing to advancements in healthcare and technology.

Biochemistry offers a window into the chemical processes within living organisms. Our program emphasizes the importance of understanding biochemical pathways, which is crucial for drug development and medical breakthroughs. This knowledge is fundamental in addressing global health challenges.

Inorganic Chemistry is vital for advancements in science and technology, given the broad applications of inorganic compounds in energy production, catalysis, medicine, agriculture, and electronics. Our curriculum focuses on equipping students with the skills to innovate in these fields, addressing societal needs and environmental concerns.

Instrumental Analytical Chemistry is essential for developing analytical skills crucial in identifying and solving complex societal problems. Our students learn to analyze chemical compositions, which is key in industrial quality control, environmental studies, forensic science, and material science, emphasizing the role of chemistry in sustainable development.

Each of these advanced courses — CHEM 4448 Physical Chemistry I, CHEM 3438 Biochemistry I, CHEM 4440 Instrumental Analytical Chemistry, and CHEM 4367 Advanced Inorganic Chemistry — not only provides comprehensive knowledge but also encourages critical thinking, problem-solving, and practical application. Our program ensures that students are not just recipients of information but active participants in research and innovation, ready to tackle contemporary challenges in science and technology.

Furthermore, we emphasize the importance of interdisciplinary collaboration, recognizing that the most pressing scientific problems often require a multifaceted approach. Students are encouraged to apply their chemical knowledge in cross-disciplinary contexts, fostering a broader understanding and adaptability in a rapidly changing scientific landscape.

Through this goal, we aim to produce graduates who are not only well-versed in advanced chemical concepts but also skilled in applying this knowledge creatively and effectively in a variety of professional and research contexts. We are committed to nurturing the next generation of chemists who are equipped to drive scientific innovation and contribute positively to society.

Providing Department: Chemistry BS

Progress: Completed

RELATED ITEMS/ELEMENTS

RELATED ITEM LEVEL 1

Demonstrate In-Depth Knowledge and Application of Fundamental Biochemistry Concepts

Learning Objective Description:

Students will showcase a comprehensive understanding of biochemistry, which encompasses the study of the chemical processes and substances in living organisms. This objective focuses on several key areas of biochemistry, taught in the required first-semester course:

1. **Classification and Analysis of Biological Molecules**: Students will be able to identify and differentiate between various classes of biological molecules, such as carbohydrates, lipids, proteins, and nucleic acids. They should demonstrate an understanding of the physical and chemical properties of these molecules and their roles in biological systems.

2. **Protein Structure and Function**: A detailed understanding of protein structure, including primary, secondary, tertiary, and quaternary structures, is required. Students should be able to relate these structures to the functions of proteins, with a particular emphasis on enzyme action.

3. **Enzymatic Activity and Regulation**: Students will gain knowledge of enzyme kinetics, mechanisms of enzyme action, and factors affecting enzyme activity. They should understand the principles of enzyme regulation, including allosteric regulation and feedback mechanisms.

4. **Methods of Biochemical Study**: Students should be familiar with the techniques and methods used in the study of biochemistry. This includes understanding experimental approaches for the isolation, purification, and characterization of biological molecules, as well as the use of spectroscopy, chromatography, and electrophoresis.

5. **Application of Biochemical Concepts**: Beyond theoretical understanding, students are expected to apply these concepts to analyze and solve problems related to biochemical processes. This could include case studies, laboratory experiments, or problem-solving exercises that demonstrate their ability to apply biochemistry knowledge in practical scenarios.

Through achieving these outcomes, students will not only have a strong foundation in biochemistry but also the ability to apply this knowledge in various scientific contexts, preparing them for advanced study or professional careers in chemistry and related fields.

RELATED ITEM LEVEL 2

Assessment of Enzymatic Function Understanding in CHEM 3438 Biochemistry I

Indicator Description:

In CHEM 3438 Biochemistry I, a crucial learning outcome is for students to demonstrate a comprehensive understanding of enzymes – their nature and mechanism of action. To assess this, a specific free-response question will be included in the final exam of the course.

The assessment criteria and structure are as follows:

1. **Question Context and Content**: Students will be asked to explain what an enzyme is and how it works. The question is designed to be answered in a way that would be understandable to a student who has just completed Organic Chemistry II. This context requires students to articulate their answer in a clear, concise, and accurate manner, suitable for an audience with foundational chemistry knowledge but not necessarily specialized in biochemistry.
2. **Key Components of the Answer**: The expected response should cover:
    - **Basic Definition of Enzymes**: A clear and concise definition of enzymes as biological catalysts, including their proteinaceous nature.
    - **Mechanism of Action**: An explanation of how enzymes catalyze biochemical reactions, including concepts like the active site, substrate specificity, and the lowering of activation energy.
    - **Examples and Relevance**: Where appropriate, inclusion of examples to illustrate how enzymes function and their significance in biological processes.
3. **Evaluation Criteria**: The free-response question will be evaluated based on the accuracy of the content, the clarity of the explanation, the ability to communicate complex concepts in an accessible manner, and the completeness of the answer.
4. **Objective of the Assessment**: This question aims to assess students' ability to not only understand the biochemical principles of enzymatic action but also their skill in effectively communicating these concepts. It is a critical indicator of their grasp of fundamental biochemistry concepts and their ability to apply this knowledge in an explanatory context.

Through this assessment in CHEM 3438, students demonstrate their mastery of a key concept in biochemistry – the nature and function of enzymes. The results of this question provide valuable insights into the effectiveness of the teaching methods and the students' understanding of enzymatic mechanisms.

Criterion Description:

Last year the criterion was that at least 90% of students (set high as this knowledge is very fundamental to understanding of biochemistry) can achieve a score of at least three out of four points on the question. The instructor forgot to put the question on the final exam, so the data was not collected. Therefore, the same criterion (90% of students scoring at least 75% on the question) will be used again this year.

Findings Description:

The instructor forgot when writing the exam that this question was planned for assessment again. Therefore, the data is unavailable to evaluate and should be re-examined next year.

RELATED ITEM LEVEL 3

Action - Students can explain what an enzyme is and how it works

Action Description:

There are two actions needed:

1. Instructor Haines will put the exam question on a Biochemistry final exam in Fall 2024.
2. He will try to find a better method to remind instructors of planned assessments when they need to remember - which is in the mad rush near the end of the semester when they are writing their final exams. This is not a trivial problem.

RELATED ITEM LEVEL 2

Students Can Accurately Represent The Structure Of A Simple Protein

Indicator Description:

In CHEM 3438 Biochemistry I, a key skill for students to master is the accurate representation of protein structures, an essential aspect of understanding protein biochemistry. To assess this competency, a question will be included in the first exam of the course that tests students' ability to draw the chemical structure of a peptide given its amino acid sequence.

The assessment criteria are as follows:

1. **Representation of Peptide Structure**: Students will be provided with a specific amino acid sequence (for example, WERSAMH) and asked to draw the corresponding peptide structure. The sequence and contextual story may vary each semester to maintain the test's integrity.
2. **Contextual and Creative Question Setting**: To engage students and add an element of real-world application, the question will be framed in a creative and relatable context. For instance, a scenario where a friend wishes to get a peptide sequence tattoo representing school spirit for SHSU:
    - "A friend of yours is really weird, and not just because they like biochemistry so much (nearly as much as OChem). They are truly, madly in love with with SHSU and the Sammy Bearkat mascot. They decided they are going to get a tattoo that says ‘We R Sam H’, since everyone chanted ‘We are Sam Houston’ at the new student convocation, but written out as a peptide structure. Yes, really. You try to explain to them that they may want to put a little more thought into this, or maybe at least come up with a better phrase since everyone that can read peptide structures will wonder what ‘We R Sam H’ is about, but they are set on doing it. Write the structure for the peptide with the sequence WERSAMH in the correct ionization state at physiological pH (pH 7.4). Be sure to get it correct, as your friend clearly has enough problems without having to wear your mistake on their skin for the next couple of decades."
3. **Accuracy and Detail**: The drawing must accurately represent the peptide structure, including correct peptide bonding, side chain structures for each amino acid, and the overall peptide conformation. Special attention should be given to the ionization state of the peptide at physiological pH (7.4).
4. **Prerequisite Knowledge**: This question relies heavily on prerequisite knowledge of Organic Chemistry. A new assessment of knowledge of Organic Chemistry and review module for reviewing Organic Chemistry were implemented this year in the associated lab to help improve prerequisite knowledge in that area.

5. **Assessment of Understanding**: This question not only tests the students' ability to draw a peptide structure but also assesses their understanding of amino acid properties, peptide bond formation, and the behavior of peptides at physiological pH.

6. **Scoring Criteria**: The question will be scored by the instructor (Dr. Haines) on the accuracy of the peptide structure, the correct representation of ionization states, and the overall completeness of the drawing. Points will be allocated for each aspect of the peptide structure, ensuring a comprehensive assessment of the students' understanding and representation skills.

Through this assessment, students in CHEM 3438 demonstrate their proficiency in a fundamental aspect of biochemistry – the ability to accurately visualize and represent protein structures. The results of this question provide valuable insights into the students' grasp of protein biochemistry and their ability to apply this knowledge in a practical context.

Criterion Description:

Last year's criterion was that at least 80% of students would score at least 10/12 on the question, which is scored by the instructor of record. For Dr. Haines' Fall 2022 Biochemistry I section, 27 students took the exam and of those 13 scored 10 or higher and 14 did not. That is only 48% of students meeting the threshold that was set, well short of the goal of 80%. The criterion was not met, and action to improve student understanding of protein structure is needed. A lot of students were not far below the 10 point threshold, though a subset were. If those that weren't can be gain a bit more knowledge to score better, this criterion is reasonable and can be met in the future.

This year a similar criterion will be used, that at least 80% of students will score at least 80% of the points on the question on exam one. This will allow us to see if changes requiring student to review prerequisite knowledge of Organic Chemistry at the start of the course improve student skill attainment.

Findings Description:

For Dr. Haines' Fall 2023 Biochemistry I section, 33 students took the exam. Of those, 17 scored 10 or higher and 16 did not. That is only 52% of students meeting the threshold that was set, well short of the goal of 80%. The criterion was not met, and action to improve student understanding of protein structure is needed. A lot of students were not far below the 10 point threshold, though a subset were. If those that weren't can be gain a bit more knowledge to score better, this criterion is reasonable and can be met in the future. It appears that efforts in the past year may have improved student knowledge a little, but there is a lot more to be done.

RELATED ITEM LEVEL 3

Action - Students can Accurately Represent the Structure of a Simple Protein

Action Description:

For Fall 2024, Dr. Haines will add a new activity to the class exam review. The activity will specifically have groups of students build a peptide structure from a sequence. This addition should help.

RELATED ITEM LEVEL 2

Students Will Self-Report That They Learned A Lot in CHEM 3438 Biochemistry I

Indicator Description:

In addition to traditional exam question assessments in CHEM 3438 Biochemistry I, students' perception of their learning will be evaluated through a post-course Qualtrics survey. This survey serves as a complement to objective assessments, offering insights into students' subjective evaluation of their learning experience.

Key features of this survey include:

1. **Survey Timing and Distribution**: The survey will be distributed to students approximately one week before the last day of class by Dr Haines in Fall 2023 Biochemistry I, ensuring that they have experienced the full extent of the course content before reflecting on their learning.
2. **Survey Question Structure**: Students will be asked to respond to the statement 'I learned a lot this semester' using a numerical scale. This question is aimed at gauging students' self-assessment of the overall learning they achieved during the course.
3. **Rating Scale**: The response will be on a scale from 1 to 100, with 1 indicating strong disagreement and 100 indicating strong agreement with the statement. The scale defaults to a neutral score of 50, allowing students to indicate their level of agreement or disagreement with the statement effectively.
4. **Objective of the Survey**: The primary aim of this self-assessment is to capture students' subjective perceptions of the amount of learning they have experienced in the course. It serves as an indirect measure of the course's effectiveness from the students' perspective.
5. **Analysis and Interpretation of Results**: The collected data will be analyzed to understand the perceived effectiveness of the course in facilitating student learning. The average scores, distribution of responses, and any trends identified will provide valuable insights into students' self-perceived learning outcomes.
6. **Continuous Course Improvement**: The survey results will inform continuous improvement efforts for CHEM 3438 Biochemistry I. Insights gained will be used to modify and enhance the course structure, content, and teaching methodologies, aiming to maximize student learning and engagement.

Through this self-reported learning assessment, students in CHEM 3438 provide feedback on their own learning experiences, contributing to a comprehensive evaluation of the course's effectiveness in teaching biochemistry.

Criterion Description:

Last year, the criterion was that 80% of students give an agreement rating of 75% or more. A total of 14 students responded to the survey and gave an average score of 90 +/- 6 on the question (scores ranged from 80.0-100.0). Since all students gave scores of 80 or higher, 100% of students gave an agreement rating of 75% or more and the criterion is met.

This year, the criterion will be raised to 90% of students giving a rating of 75% or more to try to maintain that high standard of student self-assessment of their learning in the area of biochemistry.

Findings Description:

In Fall 2023, 15 students responded to the question. The average was 87.6, and the standard deviation was 18.6. Only 1 student rated their agreement a score below 75 (they gave it a 25), and 7 students (nearly half the respondees) rated it a perfect 100. The criterion is met.

RELATED ITEM LEVEL 3

Action - Student Self-Assessment of Knowledge Learned

Action Description:

The criterion was met, and students feel like the learn a lot in Biochemistry I. The main action is to continue to work hard for students in the course to maintain this high student evaluation of learning.

RELATED ITEM LEVEL 1

Mastery of Instrumental Analytical Methods and Their Application in Chemistry

Learning Objective Description:

Students will achieve in-depth proficiency in understanding and applying instrumental analytical methods, with a focus on mastering advanced scientific instrumentation and data analysis. This objective is integral to the curriculum of our Instrumental Analytical Chemistry course (CHEM 4440), and includes the following key aspects:

1. **Comprehensive Understanding of Instrumentation**: Students will develop an extensive knowledge of advanced scientific instruments used in spectrophotometry, chromatography, and mass spectrometry. This includes understanding the operational principles, components, and functionalities of these instruments, as well as the types of analyses they are best suited for.
2. **Hands-On Instrument Operation**: Proficiency in the practical operation of these instruments is essential. Students must be able to set up and calibrate instruments correctly, perform routine maintenance, troubleshoot common issues, and conduct experiments with a high level of precision and accuracy.
3. **Advanced Data Analysis Skills**: Students will cultivate advanced skills in analyzing and interpreting data generated from these instruments. This involves using sophisticated statistical and computational methods to process data, identify patterns, quantify substances, and validate results.
4. **Critical Evaluation of Instrumental Methods**: Students are expected to critically evaluate the strengths, limitations, and appropriate applications of different instrumental methods. This includes understanding the sensitivity, accuracy, and precision of different techniques and choosing the appropriate method for specific analytical challenges.
5. **Integration of Computers in Instrumentation**: Mastery in utilizing computers for data acquisition, processing, and interpretation is a critical component. Students must be proficient in the use of software and digital tools that are integral to modern analytical instrumentation.
6. **Effective Communication of Analytical Results**: The ability to communicate complex data and analyses clearly and effectively through complex technical writing and presentations is paramount. Students should be adept at preparing detailed reports, graphs, and presentations that accurately convey their findings and methodologies.
7. **Use of Scientific Literature and Current Trends**: Students should be capable of engaging with current scientific literature to inform their understanding and application of instrumental methods. This includes staying abreast of emerging technologies and advancements in the field of analytical instrumentation.
8. **Laboratory Safety and Ethics**: Adherence to safety protocols and ethical standards in the operation of advanced instrumentation and handling of samples is crucial for responsible scientific practice.

Through this learning objective, students will not only gain a thorough understanding of modern analytical instruments but also develop the critical skills needed to analyze and interpret complex scientific data. This comprehensive proficiency is fundamental for their future roles in scientific research, industrial applications, environmental monitoring, and other fields where advanced analytical skills are essential.

RELATED ITEM LEVEL 2

Examinations In Instrumental Analytical Chemistry

Indicator Description:

In the CHEM 4440 Instrumental Analytical Chemistry course, a crucial component of the assessment process is a series of structured examinations designed to evaluate students' mastery of the fundamentals of modern analytical instrumentation. These examinations are essential in

determining the students' understanding and application of electronic, sampling, schematic, and computational principles in analytical chemistry.

Key features of these examinations include:

1. **Exam Structure and Content**: The course includes three 80-minute tests and a comprehensive final examination. Each test consists of essay questions, laboratory data evaluation, and calculator-based computations, offering a multifaceted approach to assess students' knowledge and analytical skills.
2. **Evaluation of Core Competencies**: The exams are designed to rigorously evaluate students' proficiency in the key areas of Instrumental Analytical Chemistry, including understanding of instrument operation, data interpretation, problem-solving, and computational analysis.
3. **Standardization Across Sections**: The testing methodology and content are standardized across all sections of the course within the department, ensuring consistency and fairness in assessment.
4. **Performance Expectations**: The department sets a high standard for student performance, expecting that at least 82.5% of chemistry majors will score within one standard deviation of the mean or higher on these examinations. This benchmark reflects the department's commitment to academic excellence and mastery of the subject matter.
5. **Analysis of Results for Continuous Improvement**: The department recognizes the importance of statistical variability in assessment results. Analysis of test scores, including variations across tests and year-to-year trends, is conducted to continually refine teaching methods and course content. This process is crucial for maintaining the high quality of the Instrumental Analytical Chemistry program and ensuring that it effectively meets the learning needs of students.

Through these comprehensive examinations, the CHEM 4440 course aims to rigorously assess and confirm students’ mastery of instrumental analytical techniques, preparing them for advanced study and professional work in the field of chemistry.

Criterion Description:

Eighty two and one half percent of chemistry majors are expected to score within one standard deviation of the mean or higher than one standard deviation above the mean on the four examinations in this class. We expect statistical variability from test to test and from year to year.

Last year, this criterion was used and met with each exam having at least 84% of students score within one standard deviation of the mean or higher.

Findings Description:

On exam one, 49 of 55 students scored at the required level, or 89% of students who took the exam.

On exam 2, 47 of 55 students scored at the required level, or 85% of students who took the exam.

On exam 3, 49 of 55 students, for 89%.

On the final exam, 52 out of 55, for 95%.

Since all are above 82.5% of students, and the total is 197 out of 220, or 90% of scores meeting the criterion, the criterion is met.

RELATED ITEM LEVEL 3

Action - Examinations in Instrumental Analytical Chemistry

Action Description:

The criterion was met, but this measure of student success is pretty broad. In the future, more granular assessments should be used.

RELATED ITEM LEVEL 1

Proficient Understanding and Application of Thermodynamics and Spectroscopy in Physical Chemistry

Learning Objective Description:

Students will demonstrate a proficient understanding and application of key concepts in Thermodynamics and Spectroscopy within Physical Chemistry, as taught in Physical Chemistry I (CHEM 4448). This objective encompasses mastering advanced topics and applying them to various spectroscopic techniques. Key components of this learning objective include:

1. **Advanced Thermodynamics Concepts**: Students will develop a deep understanding of thermodynamic principles, including the laws of thermodynamics, enthalpy, entropy, Gibbs free energy, and their applications in chemical systems.
2. **Quantum Theory and Wave Functions**: Mastery of quantum theory fundamentals and the behavior of wave functions is essential. This includes understanding the Schrödinger equation, quantum numbers, and the interpretation of wave functions in chemical contexts.
3. **Molecular Structure and Orbital Theory**: Students will gain comprehensive knowledge in molecular orbital theory, electronic configuration, and molecular structure. This includes understanding the formation of chemical bonds, molecular orbital diagrams, and the role of electron configurations in determining molecular properties.
4. **Symmetry and Group Theory**: An understanding of symmetry elements and group theory in chemistry is critical. Students should be able to analyze molecular symmetry and apply group theory to predict molecular vibrations and electronic transitions.
5. **Spectroscopic Techniques and Applications**: Students will learn the principles and applications of various spectroscopic techniques, including X-ray, ultraviolet (UV), visible, infrared (IR), Raman, and magnetic resonance spectroscopy. They should understand how these techniques are used to deduce molecular structure, dynamics, and chemical environments.
6. **Integration of Theoretical and Practical Knowledge**: Students are expected to integrate theoretical knowledge with practical applications. This includes solving problems and analyzing data from spectroscopic experiments to elucidate chemical phenomena.
7. **Critical Analysis and Problem-Solving Skills**: Development of critical analysis and problem-solving skills is crucial. Students should be able to apply their knowledge to interpret experimental results and solve complex problems in physical chemistry.

Through achieving these outcomes, students will not only have a solid foundation in the theoretical aspects of thermodynamics and spectroscopy but also be proficient in applying these concepts to practical scenarios. This comprehensive understanding is vital for their future academic and professional endeavors in the field of chemistry, where thermodynamics and spectroscopy play a pivotal role.

RELATED ITEM LEVEL 2

CHEM 4448 Physical Chemistry I Final Examination

Indicator Description:

CHEM 4448 is required of all chemistry majors. The final examination in Physical Chemistry I (CHEM 4448), written by Dr. Darren Williams, is recognized by the faculty of the Department of Chemistry as being comprehensive and covers all of the advanced topics listed in the objective statement. Dr. Williams is the sole instructor of CHEM 4448 at SHSU having taught all sections of CHEM 4448 since his arrival on campus in 2004, although in the Spring 2023 term a new professor Dr. Schaugaard will teach a spring offering of the course. All students are required to complete the final examination. Examples of final exams are on file and secured within the Department of Chemistry and may be viewed by contacting Dr. Williams directly at williams@shsu.edu.

Criterion Description:

Seventy-five percent of chemistry majors are expected to demonstrate a mastery of at least sixty percent of the material (score 60%) on the comprehensive final examination.

Findings Description:

In Fall 2023, the final exam was taken by 20 students with a low score of 34% and high score of 82%. Of the 20 scores, 14 students scored 60% or higher on the exam. That is 70% of students, slightly short (one student short) of the 75% in the criterion.

An examination of the background of students scoring low on the exam (and in the course) when a separate analysis was done suggested the scores vary surprising strongly with a student's grade in Calculus II, one of the prerequisites for the course. Calculus skills may be a factor (though it maybe that the issue is a factor that correlates to both Calc II grades and Physical Chemistry grades, not directly an issue of insufficient Calculus II skills).

RELATED ITEM LEVEL 3

Action - CHEM 4448 Physical Chemistry I Final Examination

Action Description:

Dr. Haines will discuss the observed Calc II dependence of student performance with the Physical Chemistry instructors in Spring 2024 and Fall 2024. Together, they will determine how best to support or enhance that background knowledge for students entering Physical Chemistry.

It was further observed that of the six students that scored less than 60%, all but one had C grades in Calculus II. The other student had an A, but had the top score of the group. Therefore, the Faculty should also discuss whether it is feasible and/or desirable to raise the prerequisite from a C or higher in that course to a B or higher.

Goal 3: Students Develop Expertise and Proficiency in Highly Specialized Chemistry and Can Apply The Breadth of Chemistry to Solving Problems

Goal Description:

In our Chemistry program at Sam Houston State University, we are dedicated to providing our students with a profound and practical understanding of specialized topics in chemistry, essential for a well-rounded and advanced education in the field. This goal focuses on the development of highly specialized knowledge in courses that offer deep dives into specific, high-level areas of chemistry, paired with extensive laboratory and research experience.

The CHEM 4327 Polymer Chemistry course is central to this goal, as it explores the complex chemical properties and diverse applications of polymers, which are integral to numerous industries including plastics, textiles, and electronics. This course not only provides theoretical knowledge but also emphasizes practical applications and current research trends in polymer science.

Physical Chemistry II (CHEM 4449) builds upon the foundational principles learned in earlier courses. It delves into advanced topics of thermodynamics, phase diagrams, equilibria, and kinetics, which are traced from the statistical mechanics of quantum states to the macroscopic observations of thermodynamics. This course is essential for students to comprehend and predict chemical behavior at a molecular level.

CHEM 4395 Undergraduate Research is another cornerstone of this goal, offering students the unique opportunity to engage in independent research projects under the mentorship of experienced faculty. This hands-on experience is crucial for developing critical research skills, fostering innovation, and potentially leading to significant discoveries and publications.

Lastly, CHEM 4260 Advanced Integrated Lab represents the culmination of the students' learning journey. In this lab, students apply the comprehensive knowledge and skills they have acquired to tackle complex, real-world challenges. This course is designed to simulate a professional scientific environment, preparing students for their future careers in the field. It is a major challenge that requires them to apply with their own hands all of the fundamental and advanced chemical expertise that they have developed to solve detailed problems.

Overall, these courses are not only pivotal for acquiring advanced knowledge in chemistry but also for developing the practical skills and innovative thinking necessary for success in the rapidly evolving field of chemistry. Through these specialized subjects, our students are equipped to contribute meaningfully to scientific research and the broader scientific community.

Providing Department: Chemistry BS

Progress: Completed

RELATED ITEMS/ELEMENTS

RELATED ITEM LEVEL 1

Expertise in Conducting and Analyzing Advanced Chemistry Laboratory Experiments

Learning Objective Description:

Students will demonstrate expertise in conducting and analyzing advanced laboratory experiments in chemistry, showcasing an array of skills honed through their coursework. This objective focuses on several key areas of laboratory proficiency. Key components of this learning objective include:

1. **Experimental Design and Execution**: Students will be adept at designing experiments to test hypotheses or investigate chemical phenomena. This includes selecting appropriate methods, setting up experimental apparatus, and conducting experiments safely and effectively.
2. **Technical Skills and Instrumentation**: Mastery of a range of technical skills and the use of advanced laboratory equipment is essential. Students should be proficient in handling various instruments and tools, performing accurate measurements, and executing complex experimental procedures.
3. **Data Collection and Management**: Students will efficiently collect, organize, and manage experimental data. This includes using proper techniques to ensure the accuracy and reliability of data collected during laboratory experiments.
4. **Analytical and Critical Thinking in Data Analysis**: Students should demonstrate analytical skills in interpreting experimental results, applying statistical methods where appropriate, and drawing informed conclusions based on their data.
5. **Problem-Solving and Troubleshooting**: The ability to identify and troubleshoot experimental problems is crucial. Students should be able to make adjustments and think critically to overcome challenges encountered during laboratory work.

6. **Understanding of Chemical Safety and Ethics**: Knowledge and adherence to laboratory safety protocols and ethical guidelines in conducting experiments are mandatory. Students should be aware of potential hazards and conduct all laboratory work in a safe and responsible manner.

7. **Effective Communication of Experimental Findings**: Students must be able to clearly and effectively communicate their experimental findings. This includes preparing detailed lab reports, presenting data in a clear and organized manner, and discussing their results and methodologies.

8. **Collaboration and Teamwork**: Often, advanced laboratory work involves teamwork. Students should demonstrate the ability to work collaboratively, contributing effectively to group projects and respecting the diverse roles and perspectives within a team.

Through achieving these outcomes, students will not only refine their laboratory skills but also develop a comprehensive understanding of the scientific process. This expertise is fundamental for their future roles in scientific research, industry, or academia, where the ability to conduct and analyze complex experiments is critical.

RELATED ITEM LEVEL 2

Faculty Evaluate Undergraduate Student Research Project Work
Indicator Description:
Indicator Description:

In the CHEM 4395 undergraduate research course, which is a requirement for Chemistry majors at least once (and up to three times for those seeking Academic Distinction or engaged in an honors thesis), the evaluation of students' research projects is conducted directly by their faculty research advisors. This process is crucial for ensuring the quality and rigor of student research work.

Key aspects of this evaluation process include:

1. **Evaluation Criteria**: Faculty research advisors assess students based on several criteria, including the level of participation in the research project, adherence to safety protocols in the laboratory, and the overall achievement and quality of the research work. These criteria are designed to evaluate both the process and the outcome of the research efforts.

2. **Grading System**: The course grading reflects the faculty advisor's assessment of the student's performance. By tradition, a grade of 'A' is awarded to students who meet a baseline level of participation, safe work practices, and research achievement. Grades lower than 'A' indicate varying degrees of lack of engagement or achievement in the research project.

3. **Communication with the Department Chair**: The faculty research advisor communicates the proposed grade to the Department Chair, who serves as the instructor of record for the course. This ensures that the evaluation and grading process is consistent and transparent within the department.

4. **Direct Indicator of Student Performance**: The grade assigned in CHEM 4395 is a direct result of the faculty member's evaluation of the student's research performance. As such, it serves as a reliable indicator of the student's proficiency in conducting undergraduate research, reflecting their ability to engage in scientific inquiry, maintain laboratory safety, and achieve meaningful research outcomes.

5. **Continuous Improvement and Feedback**: This evaluation process not only provides an indicator of individual student performance but also offers valuable feedback for continuous improvement in teaching, research supervision, and curriculum development in the Chemistry program.

Through this structured assessment process, the faculty's evaluation in CHEM 4395 serves as a critical indicator of students' ability to conduct research effectively, safely, and successfully, preparing them for future academic and professional pursuits in the field of chemistry.

Criterion Description:

Of the undergraduate chemistry students graduating each year, 100% will have at least one CHEM 4395 course that received a grade of 'A'. This same criterion was used last year and was successful.

Findings Description:

In Spring 2024, 11 students graduated with majors in Chemistry according to CampusConnect. Of those 100% had at least one CHEM 4395 course with a grade of A. In fact, the number of courses taken by each student were:

4 students with one attempt, all A's

6 students with 3 attempts, all A's (note: multiple attempts useful for earning the honor 'Academic Distinction')

1 student with 4 attempts, all A's

Since all students had a least one attempt with a grade of A, the criterion is met.

RELATED ITEM LEVEL 3

Action - Faculty Evaluate Undergraduate Student Research Project Work as Appropriate

Action Description:

The criterion was met, so continue to support student research efforts and maintain the high performance.

RELATED ITEM LEVEL 2

Proficiency in Chemometrics for Species Concentration Analysis in Advanced Integrated Laboratory

Indicator Description:

In the Advanced Integrated Laboratory course, typically taken in the final semester of the BS Chemistry degree, students engage in a sophisticated 'Chemometrics Lab' experiment. This experiment is designed to assess their ability to apply chemometric techniques for determining the concentration of various species in an unknown mixture using UV-vis spectroscopy.

Key elements of the experiment include:

1. **Theoretical Foundation**: Students receive a detailed handout that covers the fundamentals of chemometric analysis. This includes the principles of Linear-Least-Squares Minimization of residuals, along with basic statistical concepts like variance, covariance, and deviation.
2. **Preparation of Standard Solutions**: Students must meticulously prepare solutions of at least three different UV-vis active metals in water. This process tests their skills in accurate solution preparation and dilution techniques, which are critical for reliable chemometric analysis.
3. **Determination of Molar Absorptivity**: For each standard solution, students are required to determine the molar absorptivity at a series of wavelengths. This step is crucial for establishing the calibration data necessary for subsequent analysis.
4. **Analysis of an Unknown Mixture**: Students are tasked with determining the concentrations of each species in an unknown mixture using at least two different methods developed in the handout. This analysis must be based on data obtained from a single UV-vis spectrum of the mixture.

5. **Spectral Data Acquisition and Processing**: Proper acquisition of UV-vis spectra, using appropriate parameters and setup, is essential. Students must demonstrate their ability to collect and correctly input spectral data into a spreadsheet for analysis.
6. **Evaluation Criteria**: The experiment is assessed based on the accuracy and precision of the solution preparation, the quality of the spectral data obtained, the correct application of chemometric methods, and the accuracy of the concentration determinations.
7. **Objective of the Assessment**: This experiment aims to evaluate students' proficiency in applying chemometric techniques in a practical laboratory setting. It tests their understanding of the theoretical aspects of chemometrics and their ability to accurately prepare solutions, obtain and process spectral data, and apply statistical methods to analyze complex mixtures.

Through this comprehensive chemometrics experiment in the Advanced Integrated Laboratory course, students demonstrate their capability to integrate theoretical knowledge with practical laboratory skills in the field of analytical chemistry. The results of this assessment provide valuable insights into the students' readiness for professional practice in chemical analysis.

Criterion Description:

The target is that 75% of students will be able to accurately determine the concentrations of the species based on UV-vis spectrum using chemometrics in a properly set-up spreadsheet as judged by the instructor of the lab.

Findings Description:

[This data has not been aggregated, and the instructor has been out of town through the second half of May. We will try to add it over the summer.]

RELATED ITEM LEVEL 3

Action - Using Chemometrics to Determine Concentration

Action Description:

[This data has not been aggregated, and the instructor has been out of town through the second half of May. We will try to add it over the summer.]

RELATED ITEM LEVEL 1

Master and Apply Advanced Concepts in Physical Chemistry Focusing on Quantum Mechanics

Learning Objective Description:

Students will master and effectively apply advanced concepts in Physical Chemistry, with a special emphasis on Quantum Mechanics. This learning objective is rooted in the deep understanding of the relationship between quantum states and macroscopic thermodynamic phenomena. Key components of this learning objective include:

1. **Thermochemistry and Thermodynamics**: Students will gain an in-depth understanding of thermochemistry and the fundamental principles of thermodynamics. This includes studying the laws of thermodynamics, energy transfer, heat capacity, and the thermodynamic properties of systems.
2. **Phase Diagrams and Equilibria**: Mastery in interpreting and analyzing phase diagrams is essential. Students should understand phase transitions, phase equilibrium, and the application of these concepts in different chemical systems.
3. **Chemical Kinetics and Reaction Dynamics**: Students will learn the principles of chemical kinetics and reaction dynamics, including rate laws, reaction mechanisms, and factors affecting reaction rates. This also involves understanding the connection between microscopic quantum states and macroscopic reaction rates.

4. **Statistical Mechanics and Quantum States**: A critical component is the understanding of statistical mechanics and its role in explaining the behavior of quantum states. Students should be able to relate quantum mechanical models to observable thermodynamic properties.

5. **Application of Quantum Mechanics in Chemistry**: Students will apply quantum mechanical concepts to solve problems in physical chemistry. This includes the use of mathematical models and computational methods to predict chemical behavior based on quantum mechanics.

6. **Integration of Theory and Practice**: Students are expected to integrate theoretical knowledge with practical application, demonstrating their understanding through problem-solving exercises, laboratory experiments, or computational simulations.

7. **Critical Thinking and Analytical Skills**: Development of critical thinking and analytical skills is crucial, enabling students to analyze complex data, draw conclusions, and apply quantum mechanical principles to broader chemical phenomena.

Through achieving these outcomes, students will not only develop a comprehensive understanding of advanced concepts in Physical Chemistry, particularly Quantum Mechanics, but also be adept in applying these principles to real-world chemical problems. This knowledge is fundamental for their academic growth and future careers in scientific research and industry, where advanced physical chemistry knowledge is essential.

RELATED ITEM LEVEL 2

Comprehensive Final Examination in CHEM 4449 Physical Chemistry II

Indicator Description:

The CHEM 4449 Physical Chemistry II course, a requirement for all chemistry majors at Sam Houston State University, culminates in a comprehensive final examination. This examination, meticulously crafted by Dr. Darren Williams, is a critical component in assessing the students' understanding and mastery of the advanced topics covered in the course.

Key features of this final examination include:

1. **Coverage of Advanced Physical Chemistry Topics**: The exam thoroughly covers all advanced topics outlined in the course's objective statement, such as quantum mechanics, spectroscopy, statistical mechanics, and thermodynamics. This ensures a complete evaluation of the students' knowledge and comprehension of the subject matter.

2. **Comprehensive Assessment of Student Learning**: Recognized by the Department of Chemistry faculty for its rigor, the final exam serves as a definitive measure of the students' grasp of complex physical chemistry concepts. It tests not only their theoretical understanding but also their ability to apply these concepts to solve advanced problems.

3. **Benchmark for Academic Standards**: The exam sets a high benchmark for academic excellence in physical chemistry, aligning with the department's standards for knowledge and expertise in the field. It is a vital tool for gauging the effectiveness of the teaching and learning processes in CHEM 4449.

4. **Feedback for Continuous Improvement**: The results of this final examination provide valuable feedback to both students and faculty. For students, it highlights areas of strength and opportunities for further growth in physical chemistry. For faculty, it offers insights into how effectively the course material is being taught and understood, guiding potential curriculum enhancements.

The final exam in CHEM 4449 Physical Chemistry II, through its comprehensive and rigorous nature, plays a pivotal role in the academic journey of chemistry majors, preparing them for advanced studies and professional pursuits in the field of chemistry.

Dr. Williams is the sole instructor of CHEM 4449 at SHSU having taught all sections of CHEM 4449 since his arrival on campus in 2004. All students are required to complete the final examination. Examples of final exams are on file and secured within the Department of Chemistry and may be viewed by contacting Dr. Williams directly at williams@shsu.edu.

Criterion Description:

Last year, the criterion was that seventy-five percent of chemistry majors are expected to demonstrate a mastery of at least sixty percent of the material (score 60%) on the comprehensive final examination. Seven students took the course in Spring 2023. Of those, all seven scored above 60% so the criterion was met (far exceeded).

This year, a criterion of at least 90% of majors scoring at least sixty percent on the exam.

Findings Description:

In Spring 2024, 9 students took the exam. Of those, 7 scored 60 or higher and 2 scored below 60 (46 & 58). That is 78% of students, so the criterion is not met.

Note that the number of students makes this assessment noisy.

RELATED ITEM LEVEL 3

Action - CHEM 4449 Physical Chemistry II Final Exam

Action Description:

The issue appears to be more about student effort and engagement than a specific pedagogical problem and it passed easily last year. As such, it will be re-assessed next year.

Goal 4: Excellence in Scientific Communication: Oral and Written Skills Mastery

Goal Description:

In the field of science, effective communication is a cornerstone skill that supports long-term success across all career paths. Recognizing this, our Bachelor of Science in Chemistry program places a significant emphasis on developing robust oral and written presentation skills. Scientific topics, known for their complexity and nuanced details, require a clear and articulate mode of communication to be understood accurately by diverse audiences.

Oral Communication: Our program offers multiple platforms for students to develop and refine their oral communication skills. This includes presenting research findings and scientific concepts in various settings - from classroom discussions to academic conferences. Students learn to convey complex scientific information in a clear, concise, and engaging manner, adapting their presentations for both technical and non-technical audiences. This skill is critical in settings such as academic symposiums, industry meetings, and public outreach programs.

Written Communication: Similarly, the program places a strong emphasis on developing written communication skills. Through assignments like lab reports, research papers, and literature reviews, students learn to articulate scientific ideas, methodologies, and findings with precision and clarity. This training is invaluable for preparing manuscripts for scientific journals, grant proposals, and technical documentation in research and industrial settings.

Interdisciplinary Communication: Moreover, the program recognizes the growing importance of interdisciplinary communication. Students are encouraged to develop skills to communicate chemical concepts to colleagues in related fields like biology, physics, and engineering, fostering collaborative research and innovation.

Real-World Applications: To ensure that our graduates are well-prepared for their future careers, whether in academia, research, or industry, the program provides real-world communication scenarios. This includes collaborations with industry partners, participation in research projects, and engagement in community science outreach programs.

Feedback and Continuous Improvement: Throughout their studies, students receive constructive feedback on their communication skills. This feedback mechanism, coupled with numerous opportunities for practice, ensures continuous improvement and mastery of scientific communication.

This goal is dedicated to nurturing well-rounded chemists who are not only experts in their field but also exceptional communicators. This dual competency is essential for advancing in the modern scientific landscape, where the ability to effectively share knowledge and ideas is as important as the knowledge itself.

Providing Department: Chemistry BS

Progress: Completed

RELATED ITEMS/ELEMENTS

RELATED ITEM LEVEL 1

Demonstrate Proficiency in Scientific Oral Communication

Learning Objective Description:

Students will showcase their proficiency in oral communication skills by effectively presenting a seminar to their peers, based on either their own research or research reported in the scientific literature. This skill is crucial in the field of chemistry for several key reasons:

1. **Clarity of Content**: Students must articulate their research topic, objectives, methodology, findings, and conclusions with clarity. This is vital as clear communication of complex chemical concepts and data ensures accurate understanding and facilitates scientific discourse.
2. **Organization**: The presentation should be logically structured with a defined introduction, body, and conclusion. Good organization is essential for effectively conveying research findings and theories in chemistry, which often involve complex processes and data.
3. **Engagement and Delivery**: Engaging the audience is critical in chemistry, where presentations often involve data-heavy or abstract concepts. Effective voice modulation, body language, and visual aids help in making the content more accessible and interesting.
4. **Critical Thinking and Understanding**: Demonstrating a deep understanding of the research topic and being able to engage in discussions reflect the ability to apply critical thinking – a key skill in experimental sciences like chemistry.
5. **Adherence to Time Constraints**: Managing presentation time effectively is crucial in scientific conferences and meetings, where chemists must present their findings succinctly and clearly within limited time frames.
6. **Use of Visual Aids**: In chemistry, visual aids like graphs, charts, and molecular models are essential tools for illustrating complex ideas and data. Effective use of these aids can significantly enhance understanding and retention of the presented information.

The development of oral presentation skills is not just about effective communication; it is also about developing the ability to think critically, organize complex information, and present it in an engaging and understandable manner. These skills are essential for chemists who often need to present their

findings to diverse audiences, including fellow scientists, funding bodies, and the general public. Proficiency in oral communication thus prepares students for a range of professional scenarios in academia, industry, and beyond, making it an indispensable part of their education in chemistry.

RELATED ITEM LEVEL 2

Chemistry Seminar Presentation

Indicator Description:

All chemistry majors are required to take CHEM 4100 "Chemical Literature Seminar". Students typically do so in their senior year. One of the requirements of this course is to give an oral PowerPoint presentation on either their research or research from the published chemical literature to the other students in the class. As part of the Fall 2023 and Spring 2024 semesters, students were tasked with completing a seminar topic form, including two supporting references and a reason why they were chosen.

Attached Files

Syllabus CHEM 4100 Spring 2022.pdf

Criterion Description:

Success was defined by submission of two supporting references by at least 80% of students and overall improvement in introductory and background slides as evaluated by the instructor.

Findings Description:

All students submitted a topic selection form that included at least two additional references. So that part of the criterion was met. Improvement in the presentation introductions seems to be occurring but could not be easily measured without a baseline presentation to compare it to. The additional references were cited on the slides in many cases.

RELATED ITEM LEVEL 3

Action - Chemistry Seminar Presentation

Action Description:

[The results from Spring 2024 are still being tallied as of 5-31-24 and action will be added at that point]

RELATED ITEM LEVEL 1

Develop Effective Written Communication Skills

Learning Objective Description:

Students will master the art of professional scientific writing, adhering to the high standards and conventions outlined in 'The ACS Guide to Scholarly Communication.' (This style guide is available at https://pubs.acs.org/doi/book/10.1021/acsguide.) This objective aims to equip students with the skills necessary to effectively communicate scientific information to a professional audience in the field of chemistry. Key aspects of this learning objective include:

1. **Understanding of ACS Writing Standards**: Students will become thoroughly familiar with the guidelines and standards for scientific writing as documented in 'The ACS Guide to Scholarly Communication.' This includes understanding the structure, style, and format of various types of scientific documents.
2. **Application of Professional Writing Techniques**: Students will apply these standards in creating well-structured, clear, and concise scientific documents. This includes writing lab reports, research papers, literature reviews, and grant proposals.
3. **Critical Analysis and Synthesis of Information**: Students will demonstrate the ability to critically analyze scientific literature and synthesize this information in their writing. This involves evaluating existing research, drawing conclusions, and effectively integrating these insights into

their written work.

4. **Effective Use of Language and Terminology**: Mastery in the use of scientific language and terminology appropriate to the field of chemistry is essential. Students should be able to convey complex scientific concepts accurately and understandably.

5. **Citation and Referencing Proficiency**: Students will exhibit proficiency in citing sources and referencing literature following the ACS guidelines, demonstrating academic integrity and respect for intellectual property.

6. **Revision and Peer Review Skills**: Students will engage in the process of revising and editing their written work, incorporating feedback from peer reviews. This process is crucial for achieving clarity, coherence, and adherence to professional standards.

7. **Effective Communication of Research Findings**: Students will learn to effectively communicate their research findings, including the use of appropriate graphs, tables, and figures to complement and clarify the text.

8. **Adaptability to Various Formats**: Students will be able to adapt their writing to different formats and purposes, such as journal articles, conference presentations, and public science communication.

Through achieving these outcomes, students will not only develop effective written communication skills but also gain an appreciation for the importance of professional standards in scientific discourse. Mastery of these skills is vital for their future careers in academia, research, industry, or any field where precise and impactful scientific communication is required.

RELATED ITEM LEVEL 2

Chemistry Majors Will Self-evaluate That Their Writing Has Improved as a Result of Their Writing-Enhanced Courses

Indicator Description:

To evaluate the effectiveness of writing-enhanced courses in improving writing skills among Chemistry majors, a targeted self-assessment survey will be developed and administered. This survey is designed to gauge students' perceptions of their writing skill development as a direct result of their coursework.

Key aspects of the survey include:

1. **Focused Survey Question**: The primary question of the survey will be centered around the statement, 'My writing has improved as a result of writing-enhanced chemistry courses.' This question aims to directly assess the students' self-perceived improvement in writing skills.

2. **Quantitative Scoring Scale**: Students will be asked to rate their agreement with the statement on a scale from 0 (strongly disagree) to 100 (strongly agree). This numeric scale provides a quantifiable measure of their perceived improvement, allowing for precise analysis of the survey results.

3. **Targeted Audience**: While the survey will be distributed to a broader group that includes all students that take a chemistry course this year, the results pertinent to this Indicator will be filtered specifically for responses from Chemistry majors. This ensures that the data accurately reflects the impact of writing-enhanced courses on the target student population.

4. **Data Analysis and Interpretation**: The collected data will be analyzed to determine the overall perception of writing skill improvement among Chemistry majors. The average scores, distribution of responses, and any provided qualitative feedback will be evaluated to gain insights into the effectiveness of writing instruction within the department.

5. **Actionable Insights for Curriculum Development**: The findings from this survey will inform the department about the effectiveness of current writing-enhanced courses and highlight areas for potential improvement. This feedback is crucial for curriculum development and enhancing the overall quality of writing instruction in the Chemistry program.

By utilizing this self-assessment survey, the Department of Chemistry aims to gather valuable student feedback on the impact of writing-enhanced courses, ensuring that these courses effectively support the development of critical writing skills in their majors.

Criterion Description:

The criterion last year was that at least 80% of Chemistry majors responding will give agree with a score of 51 or higher (since 51 would be minimal agreement). Twelve students responded to the question giving an average score of 83 +/- 12. The lowest score given was 69, so the criterion was exceeded by a significant margin. The criterion was significantly exceeded.

The ICF is being employed again this year, but with the new more stringent criteria of 80% of Chemistry majors responding with a score of at least 80 or higher. This should help ensure our major success in this area doesn't erode with time.

Findings Description:

As of 6-1-24, the survey is still open but 10 students responded to the survey question. Due to an issue with updated major concentrations in the curriculum not being updated in the survey questions (which had them select a major but specified the different concentrations using an outdated list), student self-identification as different chemistry majors was not reliable, so the results were analyzed using all respondees, not just chemistry majors.

Of the ten responses, 6 scored 51 or higher, so the criterion is not met. The median score was 71 and the average score was 58..

A different question may provide some insight into the lower results for this question. Students were asked to rate agreement with "I get detailed and appropriate feedback on my writing" and the average score was only 36. This suggests a lack of timely feedback on written work may be a factor, and should be worked on.

RELATED ITEM LEVEL 3

Action - Chemistry Major Self-Evaluation

Action Description:

Dr. Haines will lead faculty and staff discussions at the beginning of Fall 2024 about what challenges are causing slow feedback on written work in writing-enhanced classes and how they can be addressed. The discussion will include more broad coverage of how to improve student writing, as well.

RELATED ITEM LEVEL 2

Lab Assistant Evaluation of Student Writing Proficiency in CHEM 3438W Biochemistry I Laboratory Will Demonstrate Student Improvement to a Passing Level

Indicator Description:

In the CHEM 3438W Biochemistry I Laboratory, which is a writing-enhanced course, students engage in extensive scientific writing, a skill critical for their professional development. The course requires students to produce multiple large 'Formal Reports' and preliminary 'Results and Discussion' sections, emulating the format and standards of professional scientific research reports.

The assessment process involves several key steps:

1. **Sequential Writing and Feedback**: Students first submit the 'Results and Discussion' sections, which are drafts of parts of the larger Formal Reports [described in attachment]. These drafts receive feedback from undergraduate and graduate lab assistants, enabling students to refine their writing based on this input before submitting the complete Formal Report.

2. **Role of Lab Assistants**: The lab assistants, who have expertise in both the subject matter and scientific writing, play a crucial role in evaluating the students' writing. They provide detailed feedback aimed at improving the students' ability to communicate scientific information effectively and professionally.

3. **Evaluation Criteria and Rubric**: The writing artifacts are assessed using a specific rubric, which is detailed and implemented in Blackboard/Turn-it-In. Although the rubric cannot be exported as a text table, it includes criteria such as clarity of expression, accuracy of content, structure and organization, and adherence to scientific writing conventions. [See attachments.]

4. **Demonstration of Improvement**: The primary goal of this assessment is to ensure that students demonstrate significant improvement in their writing skills over the course of the semester. The lab assistants' evaluations are geared toward helping students reach a passing level or higher in their writing proficiency, reflecting the standards expected of professional scientists. The indicator will be the quality of their final large Formal Report.

5. **Documentation and Analysis**: While the specific rubric details are not available in text format, the attached two-part picture from the lab manual provides an overview. Analysis of the lab assistants' evaluations and student writing artifacts helps in understanding the efficacy of the writing-enhanced curriculum and in identifying areas for further improvement in teaching scientific writing.

Through this structured assessment process, the CHEM 3438W Biochemistry I Laboratory aims to cultivate advanced writing skills in students, preparing them for the rigors of scientific communication in their future academic and professional endeavors.

Attached Files

Report Pages from Biochemistry Lab Manual 2021-22.pdf

Rubric1.JPG

Rubric2.JPG

Criterion Description:

Last year, the criterion was that at least 90% of students will be evaluated to write an acceptable final Formal Report as indicated by a score of 70% or higher in the evaluation of the report. The number of students achieving the successful outcome for their report in three sections was 16/16, 23/23, and 22/22. All students reaching the end of the course were evaluated to have successfully written an acceptable final report. The criterion was met (exceeded).

There is ongoing concern about increasing learning loss and lack of student engagement, but we feel that the criterion can be increased slightly this year to 90% of students being evaluated to write an acceptable final Formal Report as indicated by a score of 80% or higher in the evaluation of the report.

Findings Description:

Fall 2023 Section 11: 11/15 scored 80% or higher

Fall 2023 Section 12: 20/24 scored 80% or higher

Fall 2023 Section 13: 11/14 scored 80% or higher

Fall 2023 Section 14: 20/24 scored 80% or higher

[Fall total: 62/77 students scored 80% or higher, or 80.5% of students]

Spring 2024 Section 11: 8/8 scored 80% or higher

Spring 2024 Section 12: 3/8 scored 80% or higher

Spring 2024 Section 13: 3/9 scored 80% or higher

Spring 2024 Section 14: 8/22 scored 80% or higher

[Spring Total: 22 of 47 students, or 46.8% of students]

Overall total: 84 of 124 students, or 67.7% of students.

The criterion was not met either semester nor was it met by the overall total. The data falls well short. Note that there is a significant difference between the two semesters. The same two lab assistants were used in the lab and spring and had two sections each, so variation in grading between lab assistants does not seem to be a major factor. Different populations of students take the course in spring versus fall (the distribution of majors is different, for example).

Especially in the spring term, students often did not get their feedback on their written drafts for many weeks and felt that impacted their later writing adversely.

RELATED ITEM LEVEL 3

Action - Lab-assistant Assessment of Student Writing
Action Description:
In future semester, try to shorten the time it takes to provide written feedback on Results and Discussion sections (which are basically drafts of those sections of the Formal Reports) and of Formal Report #1. Dr. Haines will work with the lab assistants to try to close the feedback loop in a more timely fashion.

RELATED ITEM LEVEL 2

Student Self-Assessment of Writing Improvement in CHEM 3438W Biochemistry I
Indicator Description:
In the writing-enhanced course CHEM 3438W Biochemistry I Laboratory, taught by Dr. Haines in Fall 2023 and Spring 2024, students' perception of their writing skill development will be evaluated through a post-course survey. This survey is designed to gauge the effectiveness of the course in enhancing students’ writing abilities, a critical skill in scientific communication.

Key aspects of the survey include:

1. **Specific Survey Question**: Students will be asked to respond to the statement 'My writing has improved as a result of taking this course.' This question directly addresses the course's impact on their writing skills.

2. **Quantitative Response Scale**: Students will rate their agreement with the statement on a scale from 0 (disagree strongly) to 100 (agree strongly). This numerical scale allows for quantifiable measurement of students' self-perceived improvement in writing.

3. **Objective of the Survey**: The primary aim of this self-assessment is to understand students' own perceptions of their progress in writing skills throughout the course. It serves as an indirect measure of the effectiveness of the writing-enhanced curriculum and instruction in developing these skills.

4. **Analysis and Application of Results**: The survey results will be analyzed to determine the overall effectiveness of the course in improving students' writing abilities. The distribution of responses and average scores will provide insights into the course's impact and areas where further enhancement might be needed.

5. **Continuous Improvement of Writing Instruction**: Feedback from this survey will inform future course developments and teaching strategies in CHEM 3438W. It will help in tailoring the course content and writing assignments to better meet students' needs and to strengthen their writing proficiency.

Through this self-assessment survey, students reflect on their own development in writing skills, providing valuable feedback to the instructor and the department on the effectiveness of the writing-enhanced approach in CHEM 3438W Biochemistry I Laboratory.

Criterion Description:

Last year the criterion was that at least 80% of students responding will agree that their writing improved at a level of 51 or higher on the scale of 0-100. The survey was given in Dr. Haines' Fall 2022 Biochemistry I lecture. Of the 14 students responding to the question, an average score of 83 +/- 13 was received (scores ranged from 50.0 to 100.0). Only one student gave a score of 50, the other 13 gave scores of 70 or higher. This is 93% so the criterion is met (significantly exceeded).

This year the criterion will be raised to more challenging target that 90% of students agreeing at a level of 70 or higher so we can try to maintain that level of self-assessed writing improvement.

Findings Description:

At the end of the Fall 2023 semester, 48 students responded to the question, with a mean rating of 74 and standard deviation of 25.

Of the 48 responses, 16 were below 70, and 32 were at 70 or higher, so only 67% of students agreed at a level of 70 or higher. This fails to meet the criterion and, in fact, would have failed to meet the lower criterion last year.

Students this year felt that feedback on their written work took too long (often many weeks) to get back and that it hurt their ability to to improve their writing. Perhaps that underlies the survey results.

RELATED ITEM LEVEL 3

Action - Student Self-Assessment of Writing

Action Description:

Dr. Haines will work the the lab assistants for Fall 2024 and Spring 2025 to try to return feedback in a more timely fashion. This should give students a better chance to learn from the feedback and improve over the course of the semester.

Update to Previous Cycle's Plan for Continuous Improvement Item

Previous Cycle's Plan For Continuous Improvement (Do Not Modify):

Closing Summary

In the big picture, the findings suggested most things assessed were on track, but a few spots revealed areas that needed attention:

- A major challenge is that retention of material from one course to another was very poor, with assessment of both General Chemistry (1st year chemistry) and Organic Chemistry (2nd year chemistry) in Biochemistry (taken by 3rd and 4th year students) revealing that most students could not meet the very low threshold that was set as our expectation (only around 25% of students met expectations).
    - This is likely at least partly aggravated by post-COVID issues with learning loss generally. This effect will likely improve with time.
    - A major fraction, though, is likely not due to COVID. To address this fraction:
        - Additional review of General Chemistry will occur in CHEM 3438 Biochemistry I, and the faculty and staff will discuss additional places reinforcement activities can occur. [Dr. Haines]
        - Additional review of Organic Chemistry will occur in CHEM 3438 Biochemistry I, and the faculty and staff will discuss additional places reinforcement activities can occur [Dr. Haines]
        - Additional supplemental information will be collected from students to obtain their perspectives on why retention is low. This will involve surveys of students in CHEM 3438 (likely added to the normal custom end-of-semester survey) [Dr. Haines]
- Knowledge and skills at the advanced course level were more of a mixed bag. In general, most items tested revealed students were developing the appropriate knowledge and skills. A few items that need attention, though, are:
    - The students' ability to analyze enzyme kinetics was not assessed properly (the graduate course assessment was reported not the undergraduate course that should have been). The data exists for the undergraduate course, so this assessment can still be completed. [Dr. Haines]
    - Students generally met the criteria for inorganic chemistry, learning to analyze inorganic catalysis and inorganic electronic structure and spectroscopy. However, as the criteria were not exceeded by much, additional efforts will be made to engage students not meeting the threshold. Further, the connection between empirical properties of inorganic complexes and conceptual properties that explain them (like donor properties of ligands) will be emphasized in future CHEM 4367 offerings. [Dr. Zall]
- Students were found to meet expectations for specific knowledge and skills in professional chemistry.
    - Evaluation of student research projects by their faculty mentors demonstrated that all met the requirements for at least a baseline level of success in the project (the research outcome did not have to be successful, but the student had to engage in the research enough for the experience itself was deemed successful). No action needed other than to maintain high-quality research training.
    - Assessment of students' chemometric skills in CHEM 4260 is ongoing (being analyzed) and will be completed. [Dr. Arney]
- Student written and oral communication has been an ongoing focus of department assessment and improvement for several years. As a result, current assessments of student communication all came out favorably, some by a significant margin. Changes are not required at this time, but we will work to maintain this strength. [Drs. Gross, Haines, Thompson, and Williams]

Update of Progress to the Previous Cycle's PCI:

Most, but not all, items were completed:

- Additional review of General Chemistry was added in CHEM 3438 Biochemistry I, and the faculty and staff discussed additional places reinforcement activities can occur. Some thought an additional required course would be useful, but the consensus is that we are not ready to do that (and may never reach consensus that it is wise).

- Additional review of Organic Chemistry was similarly added in CHEM 3438 Biochemistry I
- The survey asking students about their learning loss was not carried out and remains something that should be done.
- Students generally met the criteria for inorganic chemistry, learning to analyze inorganic catalysis and inorganic electronic structure and spectroscopy. However, as the criteria were not exceeded by much, additional efforts were made to engage students not meeting the threshold. Further, the connection between empirical properties of inorganic complexes and conceptual properties that explain them (like donor properties of ligands) was emphasized in the Spring 2024 CHEM 4367 offering by Dr. Zall.
- Students were found to meet expectations for specific knowledge and skills in professional chemistry.
- Assessment of students' chemometric skills in CHEM 4260 was not completed, and was used again this year with results again pending.
- Student written and oral communication has been an ongoing focus of department assessment and improvement for several years. Last year, assessments of student communication all came out favorably, some by a significant margin. Changes were not required at this time, but we worked to maintain this strength (with mixed results according to the new assessments).

New Plan for Continuous Improvement (BS Chem)

Closing Summary:

As last year, one major issue requiring action is the retention of knowledge from one class to another, especially the retention of foundational knowledge from General Chemistry and Organic Chemistry. Although slight improvement was observed over last year, it is still nowhere near where we think it should be. Therefore, we will carry out the following actions:

1. To increase student retention of General Chemistry knowledge (or fill it in where it was never learned), the review modules in CHEM 3438 should continue to be expanded and enhanced. Further, the department Chair will lead discussions with instructors in Fall 2024 in Faculty and Staff meetings to identify mechanisms to specifically support students who take General Chemistry or Organic Chemistry elsewhere (which includes transfer students, but also SHSU students who struggle to pass here and then take it at community college where it is generally easier to pass).
2. Discuss ways to increase the assessment of General Chemistry at the end of the course CHEM 1412, and how to more consistently use the ACS Gen Chem test (and measure more students). The Gen Chem instructors will be tasked with developing a plan during Fall 2024.
3. Dr. Haines, the CHEM 3438 lab instructor, will Increase the required review of Organic Chemistry at the beginning of the CHEM 3438 lab, where this assessment is carried out. These reviews are carried out in Blackboard Modules, which will be expanded for Fall 2024.
4. Results will be discussed with Organic instructors and our support partners (Academic Success Center tutor leaders, etc.) to raise awareness of the issue and discuss useful supports.
5. Dr. Haines will lead a faculty and staff discussion of the issue in Fall 2024 to determine if additional assessment and correction are appropriate. For example, a mandatory 1 credit hour course for majors in the department could be added during the junior year that more thoroughly assesses this knowledge (along with knowledge of General Chemistry), followed by mandatory corrective actions for those whose knowledge and skills do not meet standards. The pedagogical benefit must be weighed against the increased credit hours and cost, as well as consideration of what happens to students who fail to reach those standards even by the end of the course.

Knowledge in advanced classes required some help as well:

1. Dr. Haines will add an activity to CHEM 3438 to help students perform better writing protein structures, which is a task that depends heavily on organic chemistry knowledge combined with new understanding of amino acids developed in CHEM 3438.

2. Dr. Haines will discuss the observed dependence of Physical Chemistry grades on pre-requisite Calculus II grades, and the Physical Chemistry faculty will make a plan in Fall 2024 to help better support student knowledge/retention of calculus.

In recent years, student writing assessments have been very successful in our department, underscoring a heavy emphasis on developing writing skills. We increased the criteria due to the success, but multiple measures of student writing decreased this year. Therefore, we will:

1. Dr. Haines will work with his lab assistants in CHEM 3438 to speed up the grading so students get feedback in a more timely manner. It is believed that very slow feedback disrupted student learning and skill development this year.

Through this combination of activities, we hope to improve the efficacy of the education process, and help students achieve their goals.