WSU Five-Year Program Review
Self-Study

Cover Page

Department/Program: Chemistry and Biochemistry

- Chemistry – ACS Certified (BS)
- Biochemistry – ACS Certified (BS)
- Chemistry Teaching (BS)
- Chemical Technician (AAS)

Semester Submitted: Fall 2019

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Brief Introductory Statement

The Department of Chemistry and Biochemistry is part of the College of Science (COS) and supports the range of programs the COS offers. As an American Chemical Society (ACS) approved department we offer flexible ACS Certified Chemistry (BS) and Biochemistry (BS) programs that prepare students for productive careers in industry, research and graduate studies, and medical professional studies. The Chemistry Teaching (BS) prepares students for State of Utah secondary education licensure requirements. The two-year Chemical Technician Program (AAS) emphasizes skills required for employment as a technician in chemical laboratories and provides a valuable path to a career for students from many majors. The chemistry faculty's range of expertise includes Analytical Chemistry, Biochemistry, Inorganic Chemistry, Organic Chemistry, and Physical Chemistry. To better accomplish the mission of the Chemistry and Biochemistry Department, we will focus on the following strategic initiatives:

1. Review current teaching practices and identify new high-impact practices that enhance educational excellence and improve progress toward degree for our majors and those we serve.

   Since revising the Chemistry program and adding the Biochemistry program in 2016, the Department is experiencing significant growth in numbers of majors enrolled in upper-division courses. Dashboard numbers reflect an average annual growth of almost 5% for the most recent five-year period with some courses serving two or three times the number of students that they served five years ago. Because of the robust numbers of progressing majors in sophomore and junior level courses, we expect these trends to continue for the next three years. This expected continued growth will require changes in how we schedule and teach courses within the program. Items to consider include:

   A. Are students being slowed in their progress toward their degrees because of a lack of available seats in classes, a need for more course sections—perhaps taught at different times, or a need for more effective program advising?
   B. Is the current research requirement sustainable and appropriately serving student needs? What changes will improve student research experiences?
   C. What changes can the department initiate to make our courses and labs more sustainable while minimizing the need for significant additional resources? Because the department serves many students in majors besides our own we must also consider our service courses and the progress of students from outside our programs that are required to take our courses in support of their own programs of study.

2. Work with departments across the College of Science to develop a new interdisciplinary Environmental Science program.

   The Department supports the college-wide initiative to develop an interdisciplinary Environmental Science (BS) program. Chemistry and biochemistry play a significant role in similar programs across the nation. Designing the new program will require thoughtful review of these other programs and consideration of the faculty expertise within the College and Department. Chemistry and Biochemistry courses spanning all areas of chemistry will potentially play significant roles in support of the new program with analytical chemistry likely to be crucial. Questions to answer include:

A. What existing courses can be utilized to support the new program.
B. What additional courses are required?
C. What additional chemistry expertise is necessary to help make the program and its students successful?

3. Review need for and develop stackable credentials to encourage and enhance student achievement and success.

    The Chemical Technician (AAS) has seen tremendous growth during the last three years as it has provided a stackable credential supporting programs within chemistry and across the college and university. College-wide efforts are underway to create associates degree programs in the life and physical sciences. These programs include support courses in chemistry that are required of majors in both areas. In addition to providing support for these broader college initiatives, the Department is reaching out to employers in the region to determine if additional certificates of proficiency would be helpful in preparing existing and future employees to fill needed roles in their businesses. Preliminary feedback indicates general interest in such certifications.

4. Update the Chemistry Teaching major to increase science education teaching graduates and support alternate routes to licensure programs across our service area.

    The State of Utah is experiencing a severe shortage of secondary-education chemistry and science teachers and has implemented guidelines for alternate routes to licensure to address this shortage. The State licensure requirements for chemistry and science education broadly have also been updated recently and it is time to realign the program with the latest requirements. To address the high school chemistry teacher shortage in Utah, we are streamlining the Chemistry Teaching B.S. Major to mirror the Utah Secondary Science Endorsement. We will also put greater effort into increasing the visibility of the Chemistry Teaching Major and of advertising the need for chemistry teachings. This effort will involve other departments in the College of Science and with the College of Education to promote and advertise science teaching programs.

Alignment of Initiatives to Academic Affairs Objectives:

1) **Value/Quality:** All the initiatives are primarily focused on the quality of education and student success at WSU. The Department adheres closely to the guidelines set forth by American Chemical Society. We also maintain close ties with local chemistry and natural-products related businesses and respond to their feedback, ensuring that we offer robust and relevant programs that meet and exceed national standards. These relationships provide support for our students seeking internship and research opportunities. The Department has made excellent progress with the recent revisions of our programs but the success of these programs prompts review and identification of further needed changes. Streamlining our programs is also necessary to help faculty have the time to engage in their responsibilities in teaching, scholarship, and service. Development of the new Environmental Science (BS) program at WSU is timely and supports the campus-wide initiative to create a greener, more sustainable campus by

raising awareness of the possibilities, both locally and worldwide. Development of specialized certificate programs support student progress to credentials that can help them progress in their education and careers. Finally, improving the experience that K12 public education students have through developing and supporting outstanding science teachers will ultimately improve the opportunities those students have when they attend WSU. Our support of a streamlined Chemistry Teaching B.S. degree, teacher career information dissemination events, and HIEE relevant to pre-service teachers will secure WSU a leadership role in supplying Utah with high school chemistry teachers.

2) **AFFORDABILITY**: The Department is committed to finding ways to decrease the cost and effort associated with the growing number of Chemistry and Biochemistry majors while sustaining the quality of our programs. Affordability is a central consideration in all the Department's initiatives. Instructional and direct costs to students have been lowered with the streamlined Chemistry, Biochemistry and Teaching Majors curriculum. Additionally, more students enrolled in chemistry classes can help decrease the per student cost of each class.

3) **ACCESS/GROWTH**: Identifying and addressing where students are being delayed in the Department's existing programs will improve access for students by decreasing the time required to complete their programs of study. The initiative to develop an Environmental Science program is specifically focused on an urgent growth area with local and worldwide demand. Development of certificate programs helps prepare students and the workforce with currently needed expertise. Improving support of public education science teaching is key to our future. The department is committed to supporting quality public science education.

RESOURCES REQUIRED: The intent of the Department's first initiative is to increase efficiency by achieving more with current resources. However, limiting or cutting fees that offset laboratory costs will negatively impact the programs that we support. Continued strong support for campus infrastructure is also required to sustain our programs. For example, cutting the availability of campus supported vehicles and busses will severely impact our ability to offer fieldtrips related to the Chemical Technician (AAS) program. Finally, we have been fortunate to have obtained several significant new instruments that support our growing biochemistry program during the last few years but the cost of maintenance and replacement for these instruments will render them unusable in a short time if continued support is not available.

While the Environmental Sciences program described in the second initiative is still being formulated, the department lacks faculty with expertise in field measurement and the associated analytical techniques. The department and college does not have any faculty trained in atmospheric chemistry and air quality, which is recognized to be an area of particular importance in northern Utah. If such expertise is determined to be necessary, then an additional faculty line supporting at least in part the Environmental Science program is needed.

We do not anticipate significant additional costs associated with the Department's third and fourth initiatives.

Standard A - Mission Statement

The mission of the Department of Chemistry and Biochemistry is to equip our students with the conceptual and experimental foundation to support their goals. Such a foundation is achieved through deep understanding of the chemical basis of matter, in combination with current hands-on practical laboratory skills. The Department provides a personalized and accessible learning environment to encourage critical thought, maintain safe and ethical practices, and develop the ability to communicate effectively. First, our mission is to engage chemistry majors seeking thorough technical knowledge and advanced skills that will enable them to pursue post-graduate studies or employment. Our degree programs include an Applied Associates Chemical Technician degree, ACS Certified Bachelor's degrees (Chemistry and Biochemistry), and a Chemistry Teaching Bachelor's degree. Our students take on undergraduate research opportunities under the direct mentorship of faculty members. The relationships between the faculty and local businesses allow for real-world internship opportunities. Second, our mission supports students in other scientific majors including pre-professional students by providing molecular context interdisciplinary to life science or other physical sciences. Third, our mission enables non-science majors (general education credit) to attain a basic understanding of chemistry and the scientific method, growing the community's ability to evaluate critically and make informed decisions on issues relating to science, technology, and society. We share our enthusiasm with the wider community through outreach activities, and through concurrent education opportunities.

Standard B - Curriculum

The curriculum and programs housed in the Department of Chemistry and Biochemistry have all undergone significant revision during the past five years. The Department now houses two ACS certified BS programs, one in Chemistry and one in Biochemistry, that comply with recent changes in the ACS Guidelines and Evaluation Procedures for Bachelor's Degree Programs. These changes introduce significantly increased flexibility for the student to make choices that will best serve their educational and professional interests. Significant changes have also been incorporated into the Chemical Technician (AAS) and Chemistry Teaching (BS) programs. New courses that have been added to the curriculum include, CHEM 3610, Foundation in Inorganic Chemistry, CHEM 4150, Nuclear Magnetic Resonance, CHEM 4250, Medicinal Chemistry, and CHEM 4630, Materials Chemistry. The topics that were previously taught in CHEM 3400, Symmetry and Applied Mathematics for Physical Chemistry have been distributed across other courses that that course has been discontinued. A course in each of the central disciplines of chemistry has been identified and adjustments made to satisfy the requirements of the ACS for foundational training in the areas of Analytical Chemistry, Biochemistry, Inorganic Chemistry Organic Chemistry and Physical Chemistry. These courses, which are required for all Chemistry (BS) and Biochemistry (BS) majors ensure that our students have the breath of training in each of these fields to create chemists that are well rounded with training in each area of chemistry and biochemistry. We continue to develop in-depth coursework offerings that will allow our students to focus on their interests and pursue their goals. Additionally, specific chemistry related courses from programs such as Physics, Earth and Environmental Sciences, Zoology, Microbiology, Botany and Mathematics, can also fulfill elective requirements.

<u>Curriculum Map</u>

Courses in Department/Program	Department/Program Learning Outcomes				
	Knowledge & Comprehension of the core	Problem Solving Skills	Laboratory Skills	Presentation Skills	Computer Skills
CHEM 1210 Principles of Chemistry I (5)	3	2	2	1	1
CHEM 1220 Principles of Chemistry II (5)	3	2	2	1	1
CHEM 2310/2315 Organic Chemistry I (4/1)	3	2	2	1	1
CHEM 2320/2325 Organic Chemistry II (4/1)	3	2	2	1	1
CHEM 2990 Chemical Technician Seminar (1)					
CHEM 3000 Quantitative Analysis (4)	3	3	3	2	2
CHEM 3020 Computer Applications in Chemistry (1)	3	3	1	1	3
CHEM 3050 Instrumental Analysis (4)	3	3	3	2	2
CHEM 3070/3075 Biochemistry I (4)	3	3	3	1	1

CHEM 3080 Biochemistry II (3)	3	3	1	1	1
CHEM 3090 Biochemistry Techniques (1)	3	3	3	2	2
CHEM 3410 Physical Chemistry I (4)	3	3	3	2	2
CHEM 3610 Foundations in Inorganic Chemistry (4)	3	3	2	1	1
CHEM 4150 Nuclear Magnetic Resonance Spectroscopy (2)	3	3	3	3	3
CHEM 4250 Medicinal Chemistry (3)	3	3	3	3	3
CHEM 4420 Quantum Chemistry (4)	3	3	3	3	3
CHEM 4540 Spectrometric and Separation Methods (4)	3	3	3	2	2
CHEM 4550 Geochemistry (3)					
CHEM 4620 Advanced Inorganic Chemistry (4)	3	3	3	3	1
CHEM 4630 Materials Chemistry (3)	3	3	3	3	1
CHEM 4700 Special Topics in Chemistry (1)	3	1	1	1	1
CHEM 4800 Research and Independent (1)	3	3	2	1	1
CHEM 4990 Senior seminar (1)	3	2	1	3	3

Note: The scale of one to three indicates the extent that the course curriculum is intended to address each Student Learning Outcome. One = minimal, Three = significant. Learning-outcomes will be assessed in courses rated 3 and for some rated 2.

The following table outlines the department's strategy for assessing learning outcomes over the past five years.

Learning Outcome	**Assessment Measure**	**When Assessed**
1. Knowledge & Comprehension of the core concepts of Chemistry and Biochemistry	i. Quizzes, exams, graded homework assignments and laboratory reports. ii. ACS Chemistry Standardized Exam National Scores iii. GRE, DAT, & MCAT Science Scores iv. Graduation Exit Survey	i. Throughout the curriculum ii. End of organic series iii. at graduation iv. at graduation
2. Problem Solving Skills	i. Quizzes, exams, graded homework assignments and laboratory reports. ii. ACS Chemistry Standardized Exam National Scores iii. GRE, DAT, & MCAT Science Scores iv. Graduation Exit Survey	i. Assessed in courses rated 2 or 3 for problem solving skills ii. End of organic series iii. At graduation iv. At graduation
3. Laboratory Skills	i. Laboratory technique, notebook, and reports. ii. GRE, DAT, & MCAT Science Scores iii. Graduation Exit Survey	i. Assessed in courses rated 2 or 3 for problem solving skills ii. At graduation iii. At graduation
4. Communications Skills	i. Oral presentations and written reports ii. Graduation Exit Survey	i. Assessed in courses rated 2 or 3 for presentation skills ii. At Graduation

5. Computer Skills	i. Quizzes, assignments, and laboratory reports requiring computerized data organization, analysis, and presentation. ii. Graduation Exit Survey	i. Assessed in courses rated 2 or 3 for presentation skills ii. At Graduation

Major courses are evaluated using traditional methods with specific questions on quizzes and exams and focused graded homework assignments and laboratory reports. The American Chemical Society provides exams covering the range of chemistry courses across the undergraduate curriculum. ACS National Exams, where they exist, are administered for most courses.

Standard C - Student Learning Outcomes and Assessment

Program Student Learning Outcomes focus on the areas of the 1) Core Concepts of Chemistry and Biochemistry, 2) Problem Solving Skills, 3) Laboratory Skills, 4) Communications Skills, and 5) Computer Skills. Core concepts and problem solving skills are evaluated throughout the curriculum using traditional methods with specific questions on quizzes and exams and focused graded homework assignments and laboratory reports. The American Chemical Society provides exams covering the range of chemistry courses across the undergraduate curriculum. These exams are administered for the Principles of Chemistry series, the Organic Chemistry series, Quantitative Analysis, Biochemistry, Inorganic Chemistry, and Physical Chemistry. Performance varies significantly from student to student but typical class averages place our students above the national averages, with a few students placing in the 90th percentile and higher. Laboratory skills are measured based on practical and theoretical formative and summative laboratory assessments. Written and oral laboratory and project reports provide a basis to evaluate communication skills. Computer and related skills are developed and assessed through laboratory and homework assignments. Finally, graduating students meet with the department chair for an exit interview during their final semester before graduation. The feedback received during these interviews provides some of the most candid and useful information that we obtain regarding what is working within the program and where improvements need to be made.

We find that student retention is very good when our students have progressed to taking junior level courses (>90% completion rates for the last five years) but we are concerned about our students that fail to complete introductory level courses, especially Chemistry Principles and Organic Chemistry. Completion rates for these lower division courses have hovered around 75% for the last five years. This number does not capture students that drop the course before the drop date, which would lower the completion rate still further. While many of our students are doing very well in their studies, The Department has become aware that an apparently growing number of students are choosing to complete their lower-division chemistry coursework at other institutions then transfer those courses back to Weber State for credit toward their majors, apparently because of the perception that it is easier to obtain a higher grade in those courses elsewhere. We have not been able to determine how many students are choosing this approach but it is a significant concern as we consider how we can better serve and retain our students. While most of the upper-division major's courses that are taught in the department have smaller enrollments, usually under 24 students, introductory courses tend to have much large enrollments often of 100 or more. It is felt that smaller class sizes would allow faculty to work with students on a more individual basis, which would help improve retention and student success.

A. Measurable Program Learning Outcomes

At the end of their study at WSU, students in this program will have knowledge and comprehension of the core concepts of chemistry. Additionally, students will have developed:

1. Problem-solving skills. Chemistry majors should be competent problem-solvers. They should be able to identify the essential parts of a problem and formulate a strategy for solving the problem. They should be able to estimate the solution to a problem, apply appropriate techniques to arrive at a solution, test the validity of their solution, interpret their result and connect it to related areas of chemistry.
2. Laboratory skills. Chemistry majors should be competent experimentalists. They should be able to design and set up an experiment, collect and analyze data, identify sources of error, interpret their result and connect it to related areas of chemistry.
3. Presentation skills. Chemistry majors should be able to express (orally and in writing) their understanding of core chemical principles, the results of experiments, the analysis of problems and their conclusions.
4. Computer skills. Chemistry majors should be competent users of basic software, such as word processing, spreadsheet, and graphing programs. Strong presentation and organizing skills are complimented with computer knowledge in graphing and spreadsheets.

In the most recent ACS Guidelines and Evaluation Procedures for Bachelor's Degree Programs, the ACS further defines learning outcomes for certified chemistry programs as follows.

1. Problem Solving Skills - Students should be taught how to define problems clearly, develop testable hypotheses, design and execute experiments, analyze data using appropriate statistical methods, understand the fundamental uncertainties in experimental measurements, and draw appropriate conclusions.

2. Chemical Literature and Information Management Skills - Essential student skills include the ability to retrieve information efficiently and effectively by searching the chemical literature, evaluate technical articles critically, and manage many types of chemical information.

3. Laboratory Safety Skills - Programs must instruct students in the aspects of modern chemical safety appropriate to their educational level and scientific needs.

4. Communication Skills - The chemistry curriculum should include critically evaluated writing and speaking opportunities so students learn to present information in a clear and organized manner, write well-organized and concise reports in a scientifically appropriate style, and use relevant technology in their communications.

5. Team Skills - Programs should incorporate team experiences into classroom and laboratory components of the chemistry curriculum, thus providing opportunities for students to learn to interact effectively in a group to solve scientific problems and work productively with a diverse group of peers.

6. Ethics - Students should be trained in the responsible treatment of data, proper citation of others' work, and the standards related to plagiarism and the publication of scientific results. The curriculum should expose students to the role of chemistry in contemporary societal and global issues, including areas such as sustainability and green chemistry.

B. Other programs
   a. General Education Outcomes (if applicable)

   This program supports General Education in the following area(s)

☐ AI ☐ Comp ☐ IL ☐ QL

☐ CA ☐ HU ☐ LS ☐x PS ☐ SS

☐ WSU ☐ DV

Measureable Learning Outcomes – Physical Science General Education

The Chemistry Department offers multiple chemistry courses that satisfy the requirements for the Weber State University General Education Breadth Requirements for Physical Sciences:

CHEM PS1010 – Introduction to Chemistry
CHEM PS1050 – Introduction to General, Organic, & Biochemistry
CHEM PS1110 – Elementary Chemistry
CHEM PS1210 – Principles of Chemistry
CHEM PS1360 – Principles of Physical Science

These courses satisfy all the University General Education Learning Outcomes and the Breadth Area Learning Outcomes for the Natural Sciences and Physical Sciences:

WSU General Education Learning Outcomes

Content Knowledge - This outcome addresses students' understanding of the worlds in which they live and disciplinary approaches for analyzing those worlds. The knowledge is well defined in R470 and further refined by Core and Breadth area committees.

Intellectual Tools - This outcome focuses on students' use of and facility with skills necessary for them to construct knowledge, evaluate claims, solve problems, and communicate effectively. [Students will provide evidence of their ability to construct knowledge, evaluate claims, solve problems, and/or communicate effectively.]

Responsibility to Self and Others - This outcome highlights students' relationship with, obligations to, and sustainable stewardship of themselves, others, and the world to promote diversity, social justice, and personal and community well-being. [Students will provide evidence of their ability to relate course content to issues of responsibility in the context of a signature assignment requiring them to bring to bear course content to broader issues connected to the Big Question.]

Connected & Applied Learning - This outcome emphasizes how students' learning in general education classes can be connected and applied in meaningful ways to new settings and complex problems. [Students will demonstrate the integration and application of course content via a signature assignment that promotes meaningful use of the course content.]

<u>Foundations of the Natural Sciences Learning Outcomes</u>

After completing the natural sciences general education requirements, students will demonstrate their understanding of general principles of science:

1. <u>Nature of science</u>. Scientific knowledge is based on evidence that is repeatedly examined, and can change with new information. Scientific explanations differ fundamentally from those that are nor scientific.
2. <u>Integration of science</u>. All natural phenomena are interrelated and shared basic organizational principles. Scientific explanations obtained from different disciplines should be cohesive and integrated.
3. <u>Science and society</u>. The study of science provides explanations that have significant impact on society, including technological advancements, improvement of human life, and better understanding of human and other influences on the earth's environment.
4. <u>Problem solving and data analysis</u>. Science relies on empirical data, and such data must be analyzed, interpreted, and generalized in a rigorous manner.

<u>The Physical Sciences Learning Outcomes</u>

Students will demonstrate their understanding of the following features of the physical world:

1. <u>Organization of systems</u>**:** The universe is scientifically understandable in terms of interconnected systems. The systems evolve over time according to basic physical law.

2. Matter**:** Matter comprises an important component of the universe, and has physical properties that can be described over a range of scales.
3. Energy**:** Interactions within the universe can be described in terms of energy exchange and conservation.
4. Forces**:** Equilibrium and change are determined by forces acting at all organizational levels.

Provide a brief summary of the program's contribution to supporting, improving, and/or revitalizing the General Education program at WSU:

Under the recently adopted requirements proposed by the General Education Improvement and Assessment Committee (GEIAC) and adopted by the Faculty Senate, each General Education course at Weber State University will incorporate a "Big Question" (BQ) as a central theme and include a Signature Assignment (SA) to assess student learning related to the BQ. Instructors in some sections of Chemistry Physical Science General Education course have already implemented BQ and SA while the remaining instructors are implementing these for the first time during Fall Semester 2019.

b. Concurrent Enrollment (if applicable)

The Department of Chemistry and Biochemistry continues to support concurrent enrollment CHEM 1110 courses in Davis County and Weber County school districts. Department faculty oversee these courses to ensure that content and assessment are consistent with sections of similar courses offered on campus. Curriculum and learning outcomes are shared and coordinated across all sections concurrent enrollment CHEM 1110 and a common set of exams is used for assessment. Instructors that teach concurrent enrollment sections are held to the same standards as other adjunct faculty that teach in the department of Chemistry and Biochemistry. In addition to CHEM 1110, a few sections of concurrent enrollment CHEM 1120 have been offered. However, the Department has since discontinued support of CHEM 1120 in the high schools because of inadequate resources to appropriately support the sections of the added course, concerns of consistency of instruction and instructor preparation across all sections being taught, and the ability to deliver a rich student experience consistent with the on-campus offering.

c. Other interdisciplinary

The Department of Chemistry and Biochemistry provides support courses that benefit many other disciplines in the sciences and across the university. Additionally, the Department houses the Chemistry minor that many students earn while pursuing majors across the college and university. Chemistry also supports the University's Bachelor of Integrated Studies (BIS) program with an emphasis that allows students to develop significant chemistry expertise that combines with and complements two other academic emphases and supports a senior project and thesis. Finally, chemistry and biochemistry coursework are central in the design of a new Environmental Science (BS) program that is currently in the proposal stage and is anticipated to begin in Fall semester 2020.

C. Five-year Assessment Summary

Assessment of Classes

The following are reflective statements about the development of individual courses based on assessment findings and actions since the last program review. The most recent assessment data is included in the appendix.

CHEM 1010 - Introductory Chemistry

During the past few years the Weber State University faculty have made significant changes to the delivery and implementation of the programs related to the introductory chemistry courses. Textbooks are being used that address fundamental concepts as well as teaching chemistry in context. There are a variety of instructors teaching the courses. Each instructor has been adopting the essential question and/or signature assignments for the course with good success in student response. Some instructors are using the traditional text while others have embraced the on-line text. Instructors have created curriculum in delivery systems which include the flipped classroom, integrated or blended learning. Hybrid and on-line formats are used as well as the traditional face to face teaching. These diverse teaching methods provide opportunities for all students to identify with an instructor that meets their individual learning style. Testing methods are also diverse. In some courses, testing is traditional with the Chi Testing program administered in the University testing center. Some assessment is accomplished on-line through organized learning platform such as Learn Smart, Connect, and CANVAS. Test questions are traditional multiple choice, short answer, work out and essay. Project work is encouraged. Activities are designed to enhance the concepts being taught and to teach teamwork skills.

CHEM 1050 PS - Introduction to General, Organic & Biochemistry

CHEM 1050 is an introduction to general, organic and biochemistry designed primarily for students of nursing and other majors that require no more than one semester of chemistry. Key aspects of the curriculum continue to focus on health and medical chemistry. During the past five years, more emphasis has been placed on problem-solving skills in both lab and lecture. Students are being challenged to solve problems using creative approaches. One example is counting the number of protons on mono-, di-, and tri-protic acids by titrations with sodium hydroxide. By analyzing data they collect in lab, they learn to differentiate between and identify these acids. This activity then leads into a discussion of moles versus equivalents. Equivalents is a term focused on counting electrons or individual elements, as opposed to entire molecular formulas. Many medical laboratory test results are reported in terms of "equivalents" per volume of solution (e.g., sodium, potassium, and chloride electrolytes in blood serum.) Students have improved dramatically in their understanding of this important concept and related topics. Another enhancement to this course's curriculum is the addition of a major assignment to write a paper that discusses their own views about a "Big Question." Each student must study and determine their own answer to a controversial question dealing with a topic in the course. For example, this term (Fall, 2019), students are writing their response to the Big Question, "*Is it good or bad that we burn* *ethanol as a fuel?*" In the past, student learned the chemical structure of ethanol, its properties, reactions, and biological effects. However, this new dimension to the course is asking students to apply their new knowledge and consider their own feelings as to the ethical aspects of converting food into automobile fuel. Enhanced personal student involvement in the study of renewable fuels is proving to be a fun, new learning tool in the course. It has increased student discussions, stimulated students to do more independent readings, and offered an opportunity for them to support and formally express their own views on a chemistry-oriented topic.

<u>CHEM 1110 PS Elementary Chemistry</u>

CHEM 1110 is the first semester of general, organic, and biological chemistry, primarily focused on general chemistry and the beginning concepts of organic chemistry. The course is for non-chemistry majors, and supports the college of science, nursing and medical lab science, engineering, and criminal justice students. The course has an associated lab with activities that support the chapter topics. The course textbook has changed three times, and currently uses the same text as several other major universities in Utah. The laboratory book has been used continuously. The format for the course includes chapter reading assignments/quizzes, chapter homework, and chapter exams that are given at the end of each chapter (13 chapters). The final exam is comprehensive. Reading/quizzes and homework are completed online. Exams are given in Weber State Testing Centers. Students attend one lab per week, and complete prelab assignments, and post lab reports. The lab grade is rolled into the lecture grade; students must pass the lab to pass the class. Some students are required to only complete CHEM 1110, while others must go on to complete CHEM 1120, depending on the requirements of their major.

<u>CHEM 1120 Elementary Organic and Biochemistry</u>

CHEM 1120 is the second semester of general, organic, and biological chemistry, primarily focused on organic and biochemistry. The course is for non-chemistry majors, and supports the college of science, nursing and medical lab science, engineering, and criminal justice students. The course has an associated lab with activities that support the chapter topics. The course textbook has changed three times, and currently uses the same text as several other major universities in Utah. The laboratory book has been used continuously. The format for the course includes chapter reading assignments/quizzes, chapter homework, and chapter exams that are given at the end of each chapter (13 chapters). The final exam is comprehensive. Reading/quizzes and homework are completed online. Exams are given in Weber State Testing Centers. Students attend one lab per week, and complete prelab assignments, and post lab reports. The lab grade is rolled into the lecture grade; students must pass the lab to pass the class.

CHEM 1210/1220 Principles of Chemistry I and II

CHEM 1210/1220 are the foundational chemistry classes that have undergone many iterative improvements in the past decade. The topics of the course have been standardized across all instructors to make sure that core content is well covered per the ACS guidelines. We also standardize our text across all sections to save students money in case they switch sections between semesters. Classes have become more interactive, with sections of CHEM 1210/1220 using POGIL and other sections using a partial flip methodology. In all cases, students are actively engaged in the classroom. Homework is adaptive, allowing for multiple attempts to understand content. We have made big strides in testing, with many sections opting into an iterative testing schedule. Within this schedule, tests are treated as formative assessments, instead of summative. Students take the exam for a first time alone in a traditional setting. Their first attempt is graded, and then they are given class time to take the exam again in a group setting, where they can learn from each other and work in groups to answer the questions. The final score for the exam is the average of the two attempts. We have preliminary data showing that this is particularly helpful to ebb anxiety with our female students. Our labs have become more inquiry based, first teaching students a skill or technique, then presenting them with a problem and allowing them to create an experiment as a group to solve the problem. This has helped with a deeper understanding of the lab techniques, and the connection with class content.

CHEM 2310 Organic Chemistry I

Students majoring in Chemistry or who are pursuing a health profession field (medical, dental, pharmacy, etc…) generally take CHEM 2310 Organic Chemistry 1 their sophomore year of college, and after having completed CHEM 1220 Principles of Chemistry 1. It is a pre-requisite for and provides a foundation for Biochemistry. Although, the course is officially listed by course number as being lower division, it has the reputation of being very challenging and is widely used to evaluate the quality of students seeking advanced training in a health profession field. In nature, it is very different from principles of chemistry in that it is much more visual and conceptual than quantitative. Students are challenged with applying their knowledge to new systems and differentiating concepts. In addition to problem solving, students are challenged to pay meticulous attention to details. The main textbook used for this course has been “Organic Chemistry” by Leroy Wade, and more recently accompanied by Jan Simek. CHEM 2310 has been taught every semester, including summer semesters, for at least the past 20 years. In fall semesters, two sections are taught, while in the spring semester, only one section is taught. The format of the course and the number of exams administered varies with the course instructor. Assessment measures include weekly quizzes, multiple midterm exams, and a comprehensive final exam. For some sections the final exam is the first-semester organic chemistry ACS standardized national exam. Average student performance on the ACS exam typically falls around the 50^{th} – 70^{th} percentile nationally. Enrollment in sections of this course typically range from 30 to 80 students.

CHEM 2315 Organic Chemistry I Laboratory

CHEM 2315 is the accompanying lab to CHEM 2310 Organic Chemistry 1. This course is mainly focused on learning fundamental laboratory techniques in organic chemistry, including recrystallization, simple, fractional, and steam distillation, extractions, and collections of melting points. Students are also exposed to basic instrumentation and equipment including specialized glassware, refractometers, polarimeters, Meltemp apparatus, sand baths, and infrared spectroscopy. In addition to learning techniques and the use of equipment, students also conduct reactions including radical halogenation, reduction of a ketone, oxidation of an alcohol, and dehydration of an alcohol. The sequence of experiments is designed to reinforce concepts taught in the lecture, and is a co-requisite with the lecture. Students who pass the lab but not the lecture, may re-take the lecture without the lab.

CHEM 2320 Organic Chemistry II

CHEM 2320 Organic Chemistry 2 is a continuation of CHEM 2310. Like CHEM 2310, Organic Chemistry 2 has been offered every semester for at least the last 20 years, including summer semesters. In the fall semester, only 1 section of the class is offered, while 2 sections are offered in the spring semester. Since many graduate schools and professional programs only require the first semester of organic chemistry, and due to attrition, enrollment in CHEM 2320 is significantly less than that of CHEM 2310, ranging from as low as 15 when it is taught in the fall to around 40 when taught in the spring. In addition to being a continuation of concepts taught in Organic Chemistry 1, spectroscopy (IR, MS, NMR, uv/vis) is taught at the beginning of the semester. The format of the course varies depending on the instructor. Assessment measures include weekly quizzes, multiple midterm exams. The final for the course is the American Chemical Society (ACS) organic chemistry exam, which covers material from both semesters of organic chemistry, providing a type of summation of what the student will take away from the course. Generally, 20 to 30 percent of the class will score in the 90+ national percentile and the average in the 40^{th} – 70^{th} percentile in the nation.

CHEM 2325 Organic Chemistry II Laboratory

CHEM 2325 is the accompanying lab for CHEM 2320 lecture. Having learned most of the basic techniques in CHEM 2315, students are now able to apply them in several reactions and synthesis. Students make aspirin, soap, dibenzalacetone (component of some sunscreens) and luminol (an example of chemiluminescence). Additionally, students perform both thin-layer and column chromatography, and do ^{1}H NMR spectroscopy. As with CHEM 2315, an attempt is made to align concepts taught in lecture with experiment conducted in the lab to reinforce the learning of these concepts.

CHEM 3000 Quantitative Analysis

Until the adoption of the new ACS guidelines, chemistry majors were required to complete two semesters of analytical coursework, CHEM 3000-Quantitative Analysis and CHEM 3050-Instrumental Analysis. This original arrangement allowed for an in-depth coverage of classical analytical topics including analytical process measurements, experimental error in measurements, statistical methods, quality assurance, calibration, gravimetry, the systematic treatment of equilibrium, monoprotic and polyprotic acid-base equilibria, acid-base titrations, and complex solubility. In addition, the course gave an introduction into the fundamentals of electrochemistry, potentiometry, and spectrophotometry. The original laboratory portion of the course consisted of eight experiments that were completed individually. The concepts taught in these experiments focused on building laboratory problem solving skills and reinforcing the topics discussed in lectures, such as glassware calibration, sample preparation and making measurements for gravimetric and volumetric analyses, performing potentiometric and photometric titrations, as well as an introduction to using serial dilutions. Students usually performed all measurements in triplicates and reported their average results with relative standard deviations.

In fall 2017, CHEM 3000 became the foundation course in analytical chemistry, the only required analytical course for chemistry or biochemistry majors. Consequently, the coverage of the original course topics became less rigorous to allow for the inclusion of more concepts in spectroscopy and an introduction to chromatography. Holding lectures in the multi-purpose labs of the new science building allows seamless transitions during the lecture into demonstrations of laboratory techniques and "show-and tell" of instrumentation. The written problem-solving skills of the students are assessed by regular homework assignments using Chi Tester. The number of midterm exams has been increased from three to four. The comprehensive final has been replaced by an Analytical Chemistry Exam of the American Chemical Society. The laboratory portion of the course has been changed significantly. Students still perform five of the original experiments individually. Five additional experiments intended to give students hands-on experience with the topics added to the lecture content are done in small groups (2-3 students). Working on experiments in teams provides students with the opportunity to learn how to effectively interact as a group to solve scientific problems and how to communicate and generate a report. Additionally, the procedure of all original experiments has been modified to include the analysis of control samples. The results of the control analyses are shared among all students. Students analyze all data for unknowns and controls statistically. Using their own data and the pooled class data allows them to gauge random and systematic error in their own measurements and to draw appropriate conclusions. Students are expected to use the skills they learned in CHEM 3020-Computer Applications to generate pertinent graphs and reports.

With all these changes, some constants remain. Cleanliness and safety in the laboratory are stressed on a regular basis. The keeping of a laboratory notebook with an accurate record of procedures, observations, measurements, and conclusions is paramount. Students are required to submit their notebook weekly. Doing some experiments individually and some as a group helps students distinguish between their own work and that of others. An open-book laboratory notebook exam at the end of the semester gives students an incentive to develop this essential skill and to be honest in their recording. 84 of 86 students who completed CHEM 3000 in the last three years passed the course. The average student performance was 84%. The average performance (27.0/50) of the students on the ACS exam was slightly above the national average (26.1/50).

CHEM 3020 Computer Applications in Chemistry

The problem-solving and communication skills of the students are assessed by weekly homework assignments that are submitted through Canvas file upload. The homework problems apply the word processing and spreadsheet concepts taught during the weekly lecture to a chemical problem. The final is a comprehensive take-home examination that tests student's mastery in the various computer skills introduced during the course.

CHEM 3050 Instrumental Analysis

Until the adoption of the new ACS guidelines, chemistry majors were required to complete two semesters of analytical coursework, CHEM 3000-Quantitative Analysis and CHEM 3050-Instrumental Analysis. In this original arrangement, CHEM 3050 expanded on the in-depth coverage of classical analytical topics and the introduction to electrochemistry, potentiometry, and spectrophotometry given in CHEM 3000. CHEM 3050 added the analytically important concept of figures of merit to the discussion of error with respect to instrumentation and then applied this topic to many of the laboratory experiments. The original CHEM 3050 curriculum also introduced atomic spectroscopy, mass spectrometry, and column chromatography.

When CHEM 3000-Quantitative Analysis became the foundation course in analytical chemistry, several adjustments to CHEM 3050 became necessary. Instead of offering the course during both semesters, the department now only offers the class during the spring. This, coupled with the flexibility to choose from many different courses under the new ACS guidelines, often means that fewer than half of the students who enroll in CHEM 3050 do so immediately after they have completed CHEM 3000. While some of the topics that were originally associated with CHEM 3050 are now introduced in the foundation course, many students who come back to analytical chemistry after a while seem to struggle remembering or demonstrating a mastery of these concepts. Consequently, the lectures include a refresher on the fundamentals of electrochemistry, spectroscopy, and analytical separations before discussing applications and the principles of operation for a variety of instruments used in a modern analytical laboratory. Holding lectures in the multi-purpose labs of the new science building allows seamless transitions during the lecture into demonstrations of laboratory techniques and "show-and tell" of instrumentation. The written problem-solving skills of the students are assessed by regular homework assignments, two midterm exams, and a comprehensive final. The laboratory portion of the course consists of twelve experiments that are performed in small groups (2-3 students). The experiments are designed to help students gain hands-on experience to reinforce many of the lecture topics, such as separations, qualitative and quantitative measurements, the calibration of instrumentation, the determination of sensitivity and detection limits, and the effect of matrix interference. Working on experiments in teams provides students with the opportunity to learn how to effectively interact as a group to solve scientific problems and how to communicate and generate a report. Many experiments require the use of standards to determine the presence and concentration of species in unknown samples. Students analyze all data for unknowns and controls statistically. Using their own data, pooling data with other groups, and analyzing unknowns and standards by multiple methods allows each team to gauge random and systematic error in their own measurements and to draw appropriate conclusions. Students are expected to use the skills they learned in CHEM 3020-Computer Applications to generate pertinent graphs and reports.

Despite a few changes to CHEM 3050 since the department's adoption of the new ACS guidelines, much that is at the heart of analytical chemistry has remained constant in CHEM 3050. Cleanliness and safety in the laboratory are stressed on a regular basis. Maintenance and proper care of instrumentation is emphasized. The keeping of a laboratory notebook with an accurate record of procedures, observations, measurements, and conclusions is paramount. Each week, students are required to submit their notebook with a written report of the experiment performed the prior week. Performing each experiment with a group but being responsible for an individual report helps students to distinguish between their own work and that of others. It also encourages discussions about data, the execution of an experiment, uncertainty in measurements, and what conclusions may be drawn from the experiment. An open-book laboratory notebook exam at the end of the semester gives students an incentive to develop this essential skill and to be honest in their recording. All 32 students who completed CHEM 3050 in the last three years passed the course. The average student performance was 86%.

<u>CHEM 3070 Biochemistry I</u>

CHEM 3070 is the foundational chemistry course in Biochemistry. CHEM 3070 is required by all Chemistry and Biochemistry majors, in addition to being a support course for other biological majors and pre-professional students. Biochemistry is the study of reactions and chemical interactions that occur within living systems. This course is a detailed study of amino acids, proteins, enzymes, nucleic acids, lipids, carbohydrates, and metabolism. The influence of biochemistry over the understanding of biology, medicine and numerous other fields is presented and discussed in the course. Students in this course are encouraged to cultivate critical thinking and analytical analysis skills while applying biochemical knowledge to solve problems. CHEM 3070 is accompanied by CHEM 3075 biochemistry laboratory course. CHEM 3070 used to be a 4-credit course including lab, but the lecture and lab were separated to better serve the students taking the course (lab is not required by everyone) and thereby conserve lab space and resources. Over the last 5 years, methods of assessing Biochemistry have been tested. Two assessment resources for biochemistry that have been used are the ACS 1-semester Biochemistry exam and the Biochemical Concept Inventory (Loertscher et. Al, CBE Life Sci Edu. 2014 Fall; 13(3); 516-528). Use of the assessments are to better understand what students know and can be used in future course revisions. CHEM 3075 has been improved over the last 5 years to include better equipment including spectrometric plate readers, micropipettes, incubators, etc.

Individual labs have been updated to use this equipment including protein quantitation and a new lactase kinetic lab.

CHEM 3080 Biochemistry II

Biochemistry II is an extension of the concepts taught in Biochemistry I. The course focuses on the study of chemical reactions, signaling events, and regulation of biochemical processes that occur within living systems. These complex systems combine to support, sustain and perpetuate life here on this earth. This course is a detailed study of the metabolism of amino acids, complex and simple lipids, DNA and RNA nucleotides. This course also presents the structure and function of cellular receptors, ion channels and pumping systems along with signal transduction relay systems and the role of oncogenes in humans. There is a detailed discussion of different disease states and the underlying cause of these diseases along with a discussion of the latest technological scientific advances, instrumentation, and methods used to advance our understanding biochemistry and medicine. The immediate goals of the course are to:

1. Build upon the fundamental biochemical concepts learned in biochemistry I.
2. Cultivate critical thinking and analytical analysis skills.
3. Apply the knowledge learned in this course to problem solving.
4. Effectively communicate advanced biochemical concepts through oral and written communication.
5. Develop the student's ability to read and understand the scientific literature.

Changes: The number of students taking CHEM 3080 continues to grow. Before adding a biochemistry degree at WSU, we had about 4 to 5 students taking this course each year. Now that we have a full biochemistry program, the number of students taking this class has increased to 24 per year – this represents a full class. If this number continues to rise, we will need additional faculty to serve the growth in the biochemistry degree.

CHEM 3090 Biochemical Techniques

This course covers advanced biochemical laboratory techniques required for students seeking advanced degrees in biochemistry or those seeking employment in biochemically related industries. The course material has not changed in the last 5 years but the number of students enrolling in this course has more than doubled. Due to limitation of students working in a teaching laboratory and equipment, we can only handle 12 students per section. We are now forced to offer 2 sections of CHEM 3090 to handle the increased demand for this course. Currently there is only one faculty member who teaches this course. We will not be able to continue adding more sections of this course without additional faculty.

CHEM 3410 Foundations of Physical Chemistry

CHEM 3410 is a course in physical chemistry that has undergone tremendous change since the Chemistry department adopted the new ACS guidelines. The course topics originally were thermodynamics and kinetics. The course evolved to be a survey course that still included thermodynamics and kinetics, but now it includes quantum mechanics. The textbook has changed three times with the in-depth course, CHEM 3420 Quantum Chemistry, adopting the same text each year. The format for the course has also evolved from straight lectures to interactive lectures with group work. Daily class quizzes, to review homework problems, have been replaced with weekly quizzes in the Tracy Hall Testing Center. The order of the course content has changed from thermodynamics then kinetics to quantum mechanics has changed by leading with quantum mechanics. This new ordering has emphasized using calculus and partial derivatives when students are still fresh instead of asking them to do more of more advanced math at the end of the semester. The topics have been trimmed to avoid mere memorizing of materials and instead a deeper understanding of less material is demanded, especially in quantum mechanics. Exams have been increased to three midterms and one comprehensive final. The lab portion of the class has evolved to concentrate on laboratory work that reinforces the topics covered in class, a change much appreciated by students. Additionally, peer review of formal lab reports with more time given to make corrections has been incorporated to help students with formal lab report writing; more math review. Lab homework covering calculus and partial derivatives has been front-loaded to help students with error-analysis. All students who have taken the course have passed and many have taken the following more in-depth class, CHEM 4420 Quantum Chemistry.

<u>CHEM 3610 Foundations of Inorganic Chemistry</u>

As of 2014, we had only one Inorganic Chemistry course at Weber State. It was a senior level course (CHEM 4600) that had many prerequisites and, as a result, students usually did not get to experience this content until the last semester of their senior year. This limited their exposure to Inorganic Chemistry during their time at Weber State and did not allow them to give inorganic chemistry full consideration in choosing their future path (many students have already applied to graduate school before the Spring semester of their senior year). The American Chemical Society, our accrediting body, updated their guidelines for ACS approved programs in 2014. Their new guidelines provided increased flexibility and earlier access to the variety of disciplines of chemistry. This included a requirement for foundation level courses that could be taken without many prerequisites beyond General Chemistry. As part of our efforts to develop a Foundations in Inorganic Chemistry course, we created an exploratory CHEM 4700 Special Topics course in Inorganic Chemistry in 2014. This had only General Chemistry as a prerequisite. After this successful course, we developed a full Foundations in Inorganic Chemistry course with a laboratory. This class was designed with only General Chemistry as a prerequisite and, thus, significant time is spent on foundational topics before advanced topics are studied or instrumentation is used in the laboratory. In cases where there is content overlap with other foundational classes like Organic Chemistry or Physical Chemistry, we provide significant scaffolding and resources for students who haven't taken those courses yet so that there is a even playing field. Both faculty who teach this class use guided inquiry activities in small student groups. There is agreement on core topics and assessment methods including semester exams and the American Chemical Society Final Exam. The ACS Final exam provides us with a way to compare our student outcomes with other programs around the US. In 5 semesters of running this course, our students have consistently scored at or above the national average. Also, in those 5 semesters, we have had 78 students start the class and 75 students finish the class with grades of C or higher. In our previous paradigm before 2014, we had 5-10 students per year exposed to Inorganic Chemistry. In our new paradigm, this class provides access to this core topic area of chemistry to more than 30 students per year. CHEM 3610 is now a prerequisite course for 3 of our upper division courses (CHEM 4620- Advanced Inorganic Chemistry, CHEM 4420- Quantum Chemistry, and CHEM 4630-Materials Chemistry).

<u>CHEM 4250 Medicinal Chemistry</u>

CHEM4250 is a newly developed, 3-credit course that is required by Biochemistry majors and an elective for Chemistry majors. In this course, students demonstrate a proficiency in understanding major medicinal chemistry topics including how drugs are designed, how to evaluate a drug's mode of action, how to make a better drug, and how a drug acts in the body. The material in the course is presented in a way to cultivate critical thinking and analytical analysis skills. Students apply the information learned in this course in a final project where they use foundational course knowledge and computer-aided drug design resources to propose an improved drug. Projects include molecular modeling of a drug target, pharmacophore development, and docking of proposed drug structure. With its emphasis on a student project, this course currently serves the capstone course for Biochemistry majors.

<u>CHEM 4420 Quantum Chemistry (</u>previously CHEM 3420 – Physical Chemistry II)

With the introduction of the new ACS Certified Biochemistry (BS) degree program, the significant changes in the ACS Certified Chemistry (BS) degree program, and other changes related to the adopting the 2008 and subsequent 2015 ACS Guidelines and Evaluation Procedures for Bachelor's Degree Program, the two semesters of Physical Chemistry courses, CHEM 3410 & 3420 have undergone numerous modifications. CHEM 3410 has seen the greatest impact as elements of Quantum Chemistry are now introduced in that course. The CHEM 3400 Symmetry and Applied Math for Physical Chemistry has also been discontinued. While students are now being introduced to quantum chemistry in the foundations course, requiring less time introducing quantum mechanics in the Quantum Chemistry course, students are not as well prepared mathematically as they were previously, requiring additional emphasis on mathematical concepts and applications, especially differential equations and linear algebra related to quantum mechanics, in both CHEM 3410 and 4420 courses. CHEM 4420 lectures use a group-work and discussion format with brief lectures used as needed to emphasize certain concepts and ideas. Student understanding related to lecture topics is assessed with hand-in homework sets, group-work classroom reporting out, weekly quizzes, an end-of-semester take-home exam, and a comprehensive ACS National Physical Chemistry Exam covering both CHEM 3410 and 4420 topics. Quizzes and exams emphasize conceptual understanding and problem solving ability and are closely linked to homework assignments. The average ACS exam scores place our students at or near the 50th percentile nationally with some students scoring much high and some lower. Laboratory consists of ten weeks of assigned laboratory work with associated laboratory reports, followed by a four-week laboratory project of each student's choosing with a formal report required upon completion of the project. Three chemistry labs with informal reports introduce students to computational approaches to quantum mechanical and thermodynamic properties of substances. Four spectroscopy labs with associated formal lab reports utilize spectroscopy to understand both quantum mechanical and statistical mechanical properties of substances. Laboratory reports are graded with an emphasis on correct calculations, conceptual understanding, and clear and complete writing. Since the last review many changes have been implemented related to lecture and lab in response to reorganization of the physical chemistry courses into foundational and in-depth course, dropping the applied math course, new ACS requirements for computational chemistry instruction, student performance, and instructor interaction with other physical chemistry faculty from across the nation. Marked improvement has been observed in student ability to use computational chemistry to address laboratory and theoretical questions. At the same time, students comfort and ability to apply calculus and linear algebra concepts to solve physical chemistry problems has decreased somewhat with the loss of the applied math course. Quiz and exam questions that previously required 5-10 minutes to complete now typically require 25 minutes or more with no significant improvement in results. Students have become more accustomed to working in groups but this is sometimes at the cost of taking personal ownership and responsibility for their own work and performance. About 90% of students successfully complete the course. Most of those that do not complete the course withdraw.

<u>CHEM 4540 Spectrometric and Separation Methods</u>

Until the adoption of the new ACS guidelines, chemistry majors were required to complete both CHEM 3000-Quantitative Analysis and CHEM 3050-Instrumental Analysis prior to enrolling in CHEM 4540-Specrometric and Separation Methods. Unfortunately, a loophole was unintentionally created when CHEM 3000-Quantitative Analysis became the foundation course in analytical chemistry. Instead of offering CHEM 4540 during the spring semesters, as had been done for many years, the course was moved to the fall semester. The intent was to help students benefit from the flexibility of course selection permitted under the new ACS guidelines by removing scheduling conflicts and competition between CHEM 4540 and other foundation and in-depth course work. However, in the past two years nearly 20% of the students petitioned to be permitted to enroll without having taken CHEM 3050. Creating the foundation classes makes it necessary to re-evaluate and clarify the pre-requisites for in-depth courses.

The lecture topics for CHEM 4540 build on concepts students encountered in CHEM 3000 and CHEM 3050 but much emphasis is on how different kinds of spectrometers and chromatographs work and how these instruments are used to solve problems in chemical analysis. Of interest are how noise and matrix affect measurements and how various analytical techniques and/or instruments are used to deal with sensitivity and/or selectivity issues. Holding lectures in the multi-purpose labs of the new science building allows seamless transitions during the lecture into demonstrations of laboratory techniques and "show-and tell" of instrumentation. Since the adoption of the new ACS guidelines, the written problems-solving skills of the students have been assessed by two midterm exams and a comprehensive final, which consists of the Instrumental Methods Exam of the American Chemical Society. The laboratory portion of the course consists of nine experiments that are performed in small groups (2-3 students). The experiments are designed to help students gain hands-on experiences to reinforce many of the lecture topics. Rather than just giving students detailed procedures on how to obtain data from the instruments, they are expected to draw on prior knowledge and on information they must seek in the chemical literature to propose an approach to solve an analytical problem by using the instrumentation available to them. Many experiments require the use of standards to determine the presence and concentration of species in unknown samples. Students analyze all data for unknowns and controls statistically. Using their own data, pooling data with other groups, and analyzing unknowns and standards by multiple methods allows each team to gauge random and systematic error in their own measurements and to draw appropriate conclusions. Working on experiments in teams provides students with the opportunity to learn how to effectively interact as a group to solve scientific problems and how to communicate and generate a report. Five of the nine laboratory reports are written up as a team, thus enforcing the idea of peer review in writing. The remaining reports are written up individually. Students are expected to use the skills they learned in CHEM 3020-Computer Applications for all graphs and reports they generate.

Cleanliness and safety in the laboratory are stressed on a regular basis. Maintenance and proper care of instrumentation is emphasized. The keeping of a laboratory notebook with an accurate record of procedures, observations, measurements, and conclusions is paramount. Students are required to submit their notebook each time they finalize a written report for one of the experiments. All 15 students who completed CHEM 4540 in the last three years passed the course. The average student performance was 84%. The average performance (26.6/50) of the students on the ACS exam was slightly above the national average (24.1/50).

<u>CHEM 4620 Advanced Inorganic Chemistry</u>

Inorganic Chemistry is one of 5 core disciplines in Chemistry. Prior to 2016, we had only one Inorganic Chemistry course, CHEM 4600. This was a senior level course which required two semesters of Physical Chemistry as a prerequisite. Thus, most students took this class in their final spring semester before they graduated. Prior to 2016, CHEM 4600 was a required course in our Option 1 ACS certified major. As our department adapted to the new American Chemical Society guidelines for accredited programs (published in 2014), we developed a foundation level inorganic chemistry course CHEM 3610 Foundations in Inorganic Chemistry which was first offered in 2016. Thus, we changed the prerequisites for CHEM 4600 such that CHEM 3610 was the only prerequisite. In the last 5 years, the laboratory has incorporated more research experiences for students with cutting edge equipment and instrumentation. 2 years ago, we changed the name of this course to CHEM 4620 Advanced Inorganic Chemistry to better fit into our overall course numbering scheme of x6xx to represent Inorganic and 4x2x to represent an in depth upper division course.

The assessment of learning in this course is carried out through regular exams, laboratory reports, presentations, and a 7-week research project. The ultimate evidence of learning comes from students who work on novel research projects where they develop their own approaches to solve real world problems and share their results with each other in a final presentation. There is also a reflection assignment where students reflect on their learning and progress in the research project. We also use the American Chemical Society Final exam for senior level Inorganic Chemistry. This exam has the potential to help us understand student learning relative to the rest of the country, but the total number of students taking this exam is still relatively small sot the normative data is still limited. Based on the limited data that we have; our student results are in the normal range for students in this course at other universities.

<u>CHEM 4630 Materials Chemistry</u>

CHEM 4630 is a senior level investigation of solids and materials. It was designed to match with PHYS 4200 "The Physics of Materials". While PHYS 4200 focuses much on materials properties and analysis, CHEM 4630 focuses on synthesizing materials. After we cover many of the fundamentals of solid state chemistry and crystalline solids, we discuss, and use, many solid state analytical tools including XRD, SEM, AFM, DSC, Ellipsometry, ICP, and UV/Vis. We then dive deep into different types of materials, including semiconductors, superconductors, nanomaterials, thin films, ceramics, polymers, and metals/alloys. We engage during class with class activities, ranging from making physical and computer models of crystalline systems, creating liquid crystals, using candy to discuss glass transition temperatures, making YBCuO superconductors, and making Metal-Organic Frameworks. These activities allow students to get first-hand experience with synthetic, analytical, and modeling techniques that will be helpful in a career in materials science. Students are asked to read through recent journal articles to understand techniques, motivations, and discussion of fundamentals in solids. Students also present on a different material/analytical tool that was not covered in class.

<u>CHEM 4990 Senior Seminar</u>

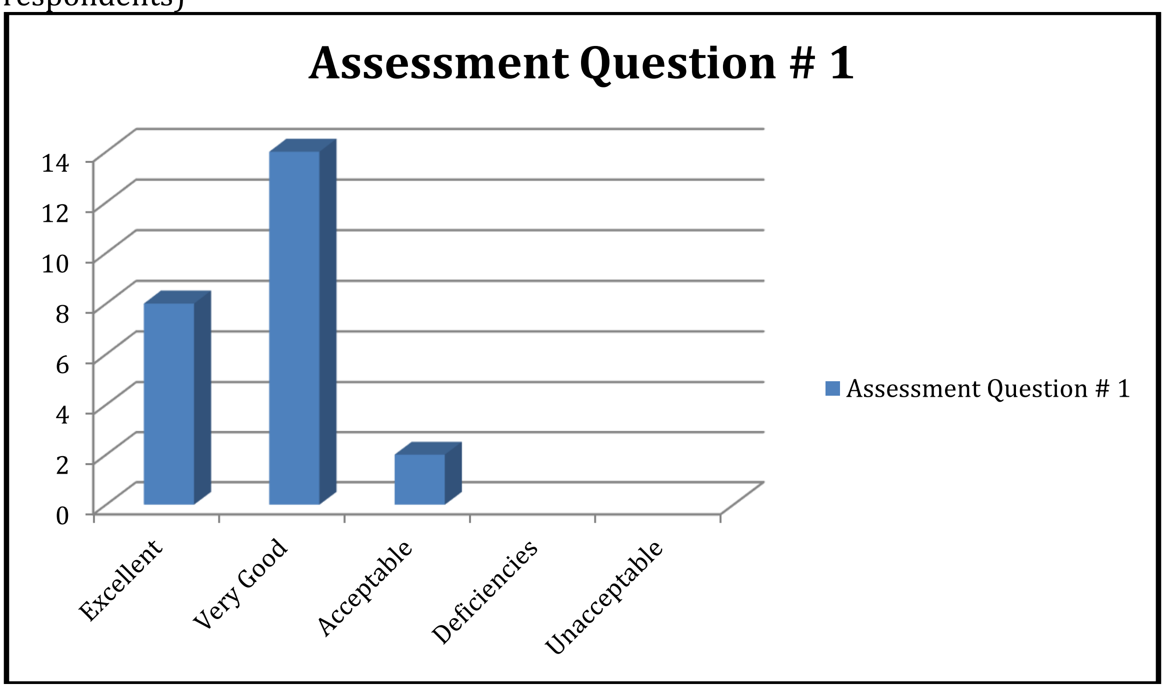
CHEM 4990 is a capstone course for students seeking to earn upper-division credit for CHEM 4800 as a chemistry elective. In the course students prepare a manuscript suitable for publication in a scientific journal and a poster suitable for presentation at a scientific conference. This class has changed to include more detailed rubrics and instructions for writing the manuscript and creating the poster. Peer review of work has continued to be a tool for improving student writing and poster creation. The latest version of the course also requires students seek input from their research adviser for most assignments to ensure that students understand their research projects. All students who have taken this course passed with a B- or better.

Assessment of Graduating Students
A narrative describing assessment processes for graduating students (at the associate, bachelor, and/or graduate level) should be provided.

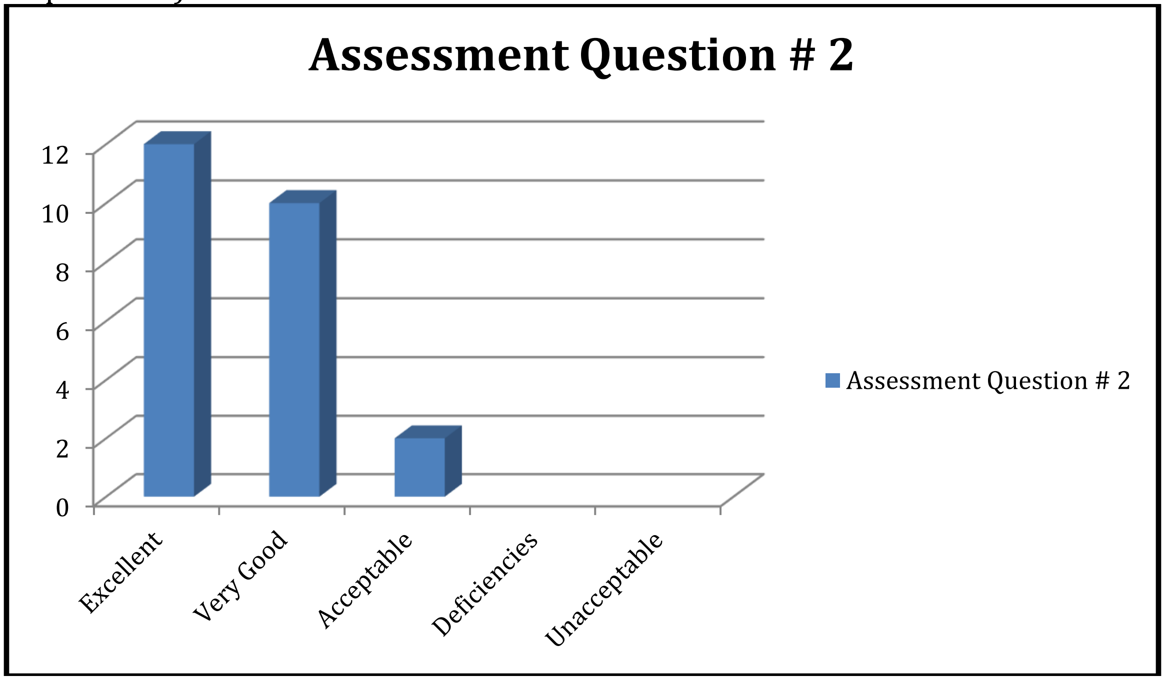
CHEM 4990, described above serves as a capstone course within the Chemistry (BS) program. It also serves many students in the Biochemistry (BS) program who have chosen to pursue undergraduate research to fulfill elective credits within the major. Additionally, as described in several of the course descriptions in the previous section, many courses utilize the ACS National Exam for that sub-discipline to track and compare student mastery relative to national norms. No separate exit exam is administered in the Chemistry and Biochemistry programs.

Graduating students meet with the department chair for an exit interview during their final semester before graduation. While the feedback received during these interviews is admittedly subjective, it provides some of the most candid and useful information that we obtain regarding what is working within the program and where improvements need to be made. In preparation for the exit interview, students complete a short questionnaire that include a Likert scale self-evaluation of their own success in the specific learning outcome areas and other aspects related to their experience while at Weber State University. This is followed by a short answer section focusing on each of the learning outcome areas that invites students to reflect on what courses and experiences have been most effective in developing skills in each of the learning outcome areas. The following bar charts summarize the Likert scale results for the 2018-19 school year.

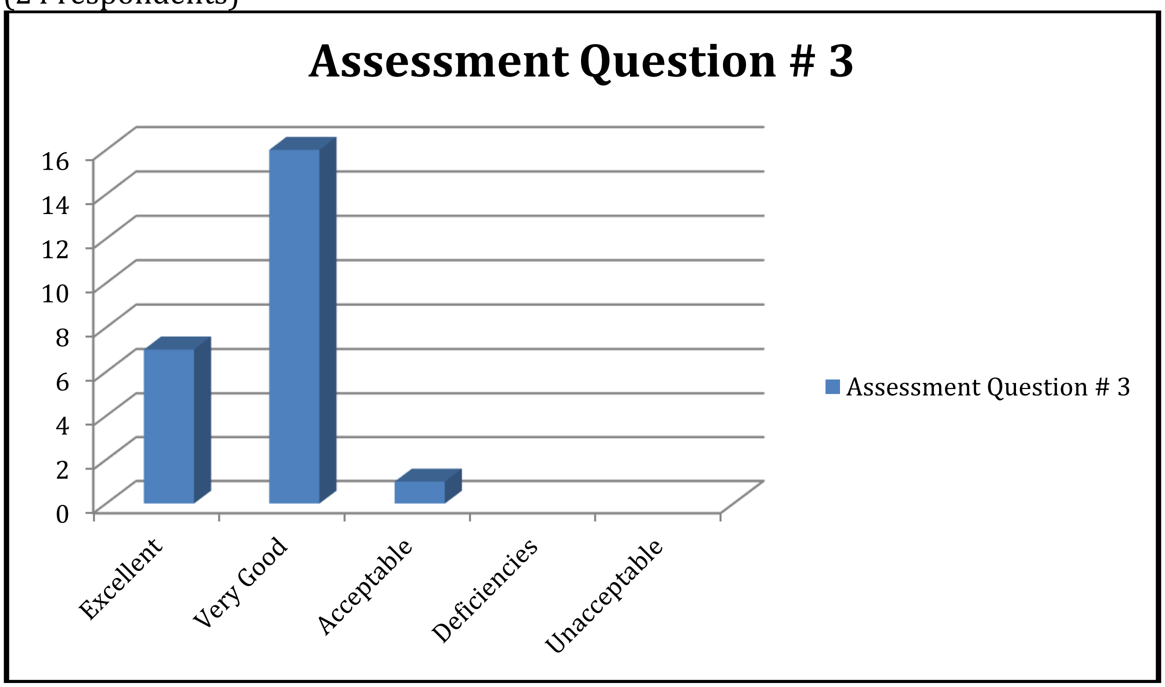
Question 1: Ability to apply chemistry knowledge in a professional position: (24 respondents)



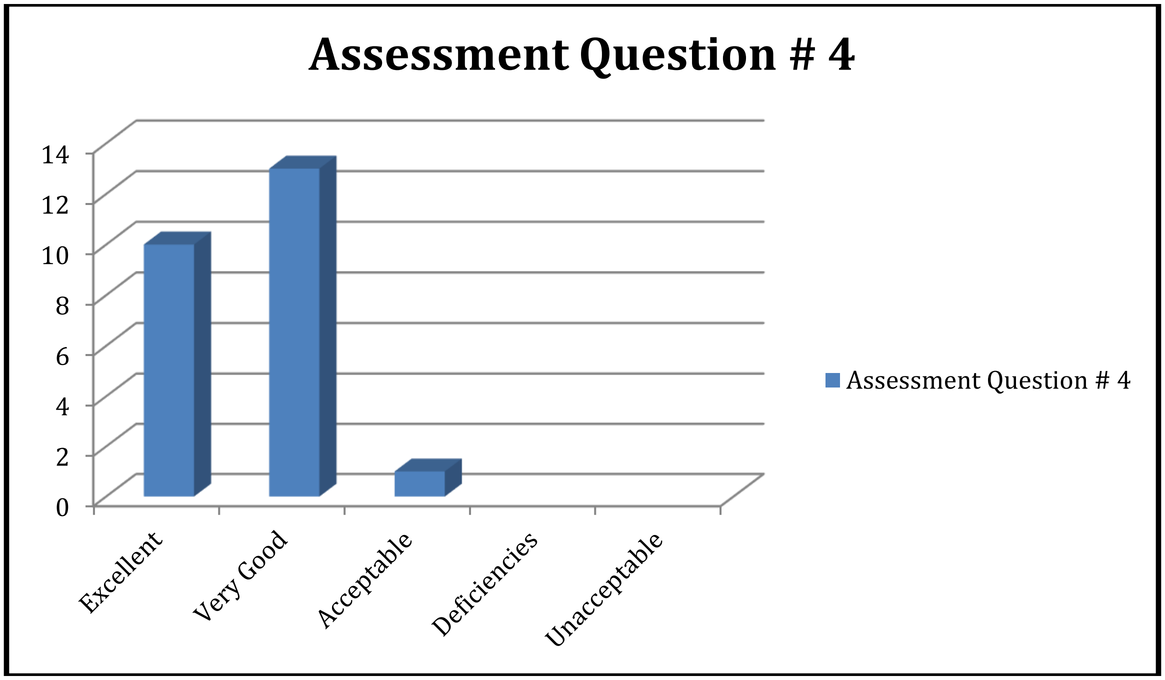
Question 2: Ability to identify, formulate and solve chemical problems: (24 respondents)



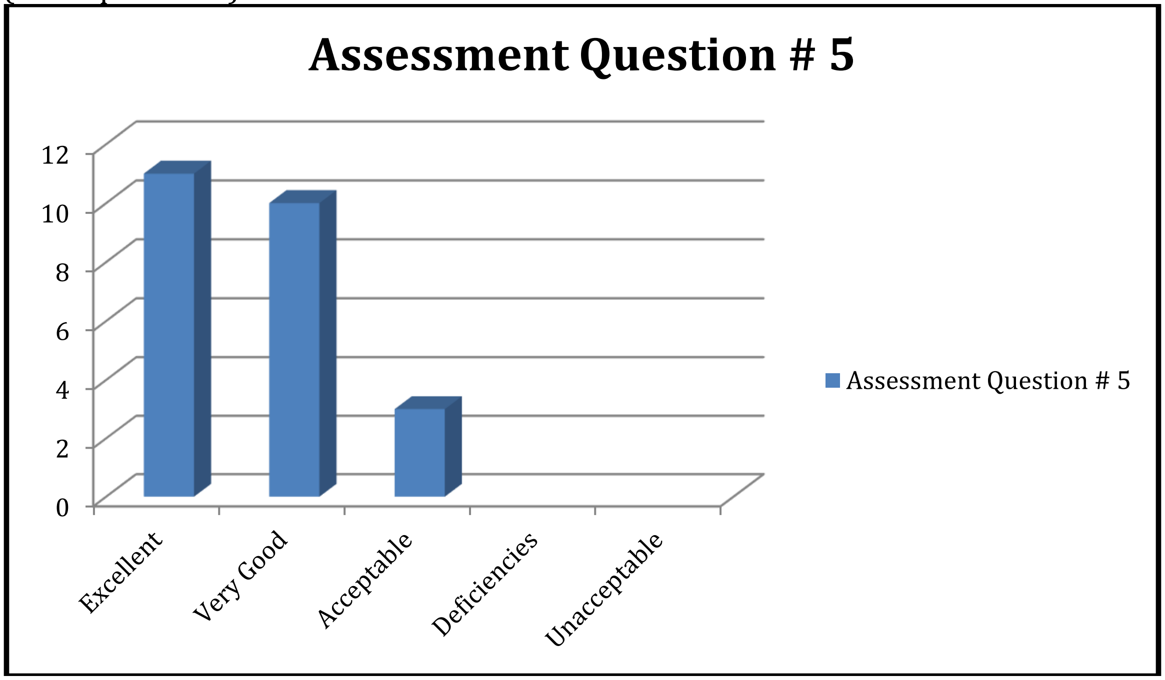
Question 3: Ability to design and conduct experiments:
(24 respondents)



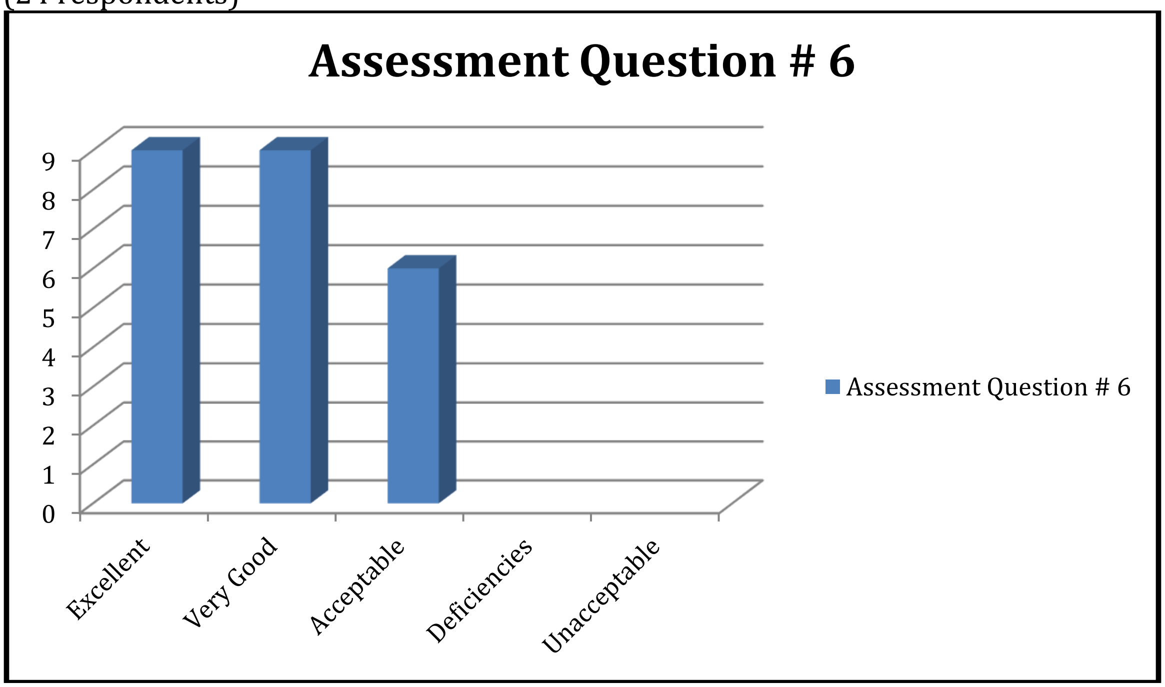
Question 4: Ability to Analyze and interpret data:
(24 respondents)


Assessment Question # 4
14
12
10
8
6
4
2
0
Excellent
Very Good
Acceptable
Deficiencies
Unacceptable
Assessment Question # 4

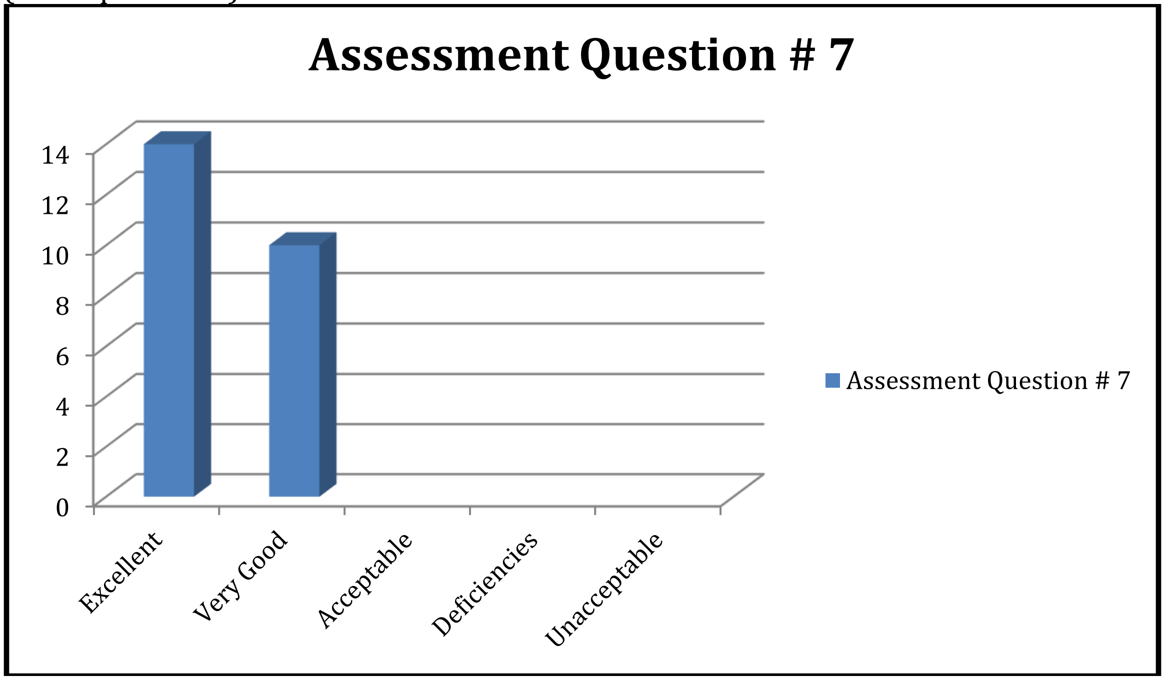
Question 5: Ability to effectively communicate in writing:
(24 respondents)



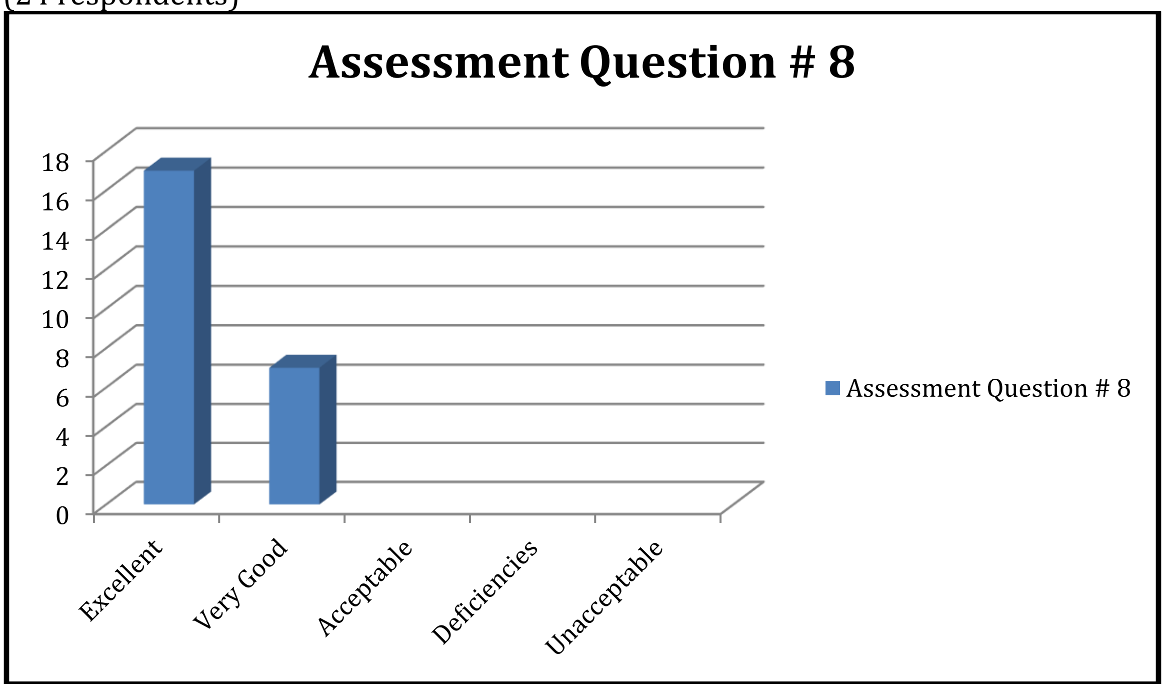
Question 6: Ability to effectively communicate orally:
(24 respondents)



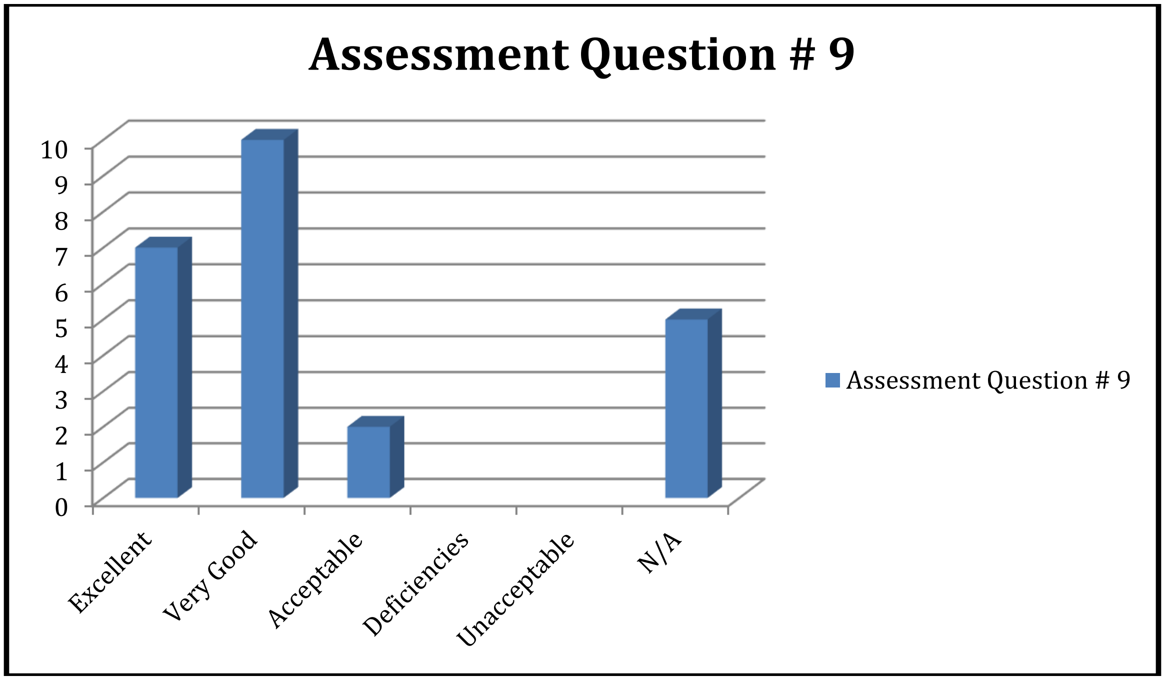
Question 7: Ability to use common graphing, data-analysis and presentation software:
(24 respondents)



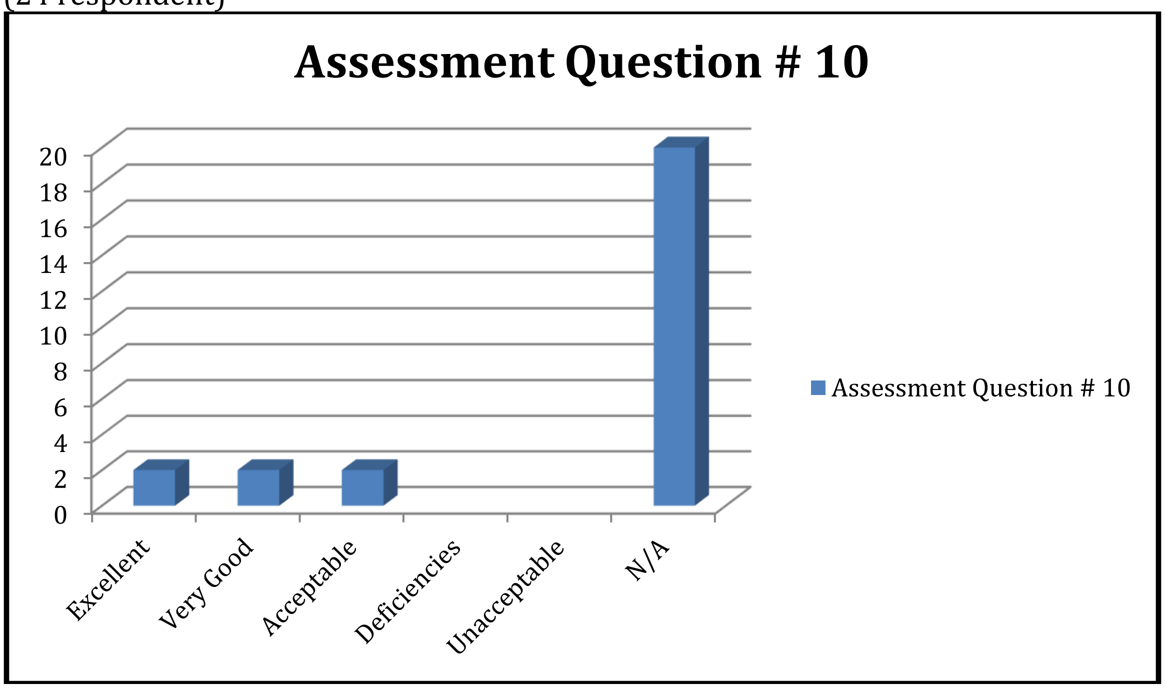
Question 8: Overall, how do you feel about your educational experience at Weber State University?
(24 respondents)



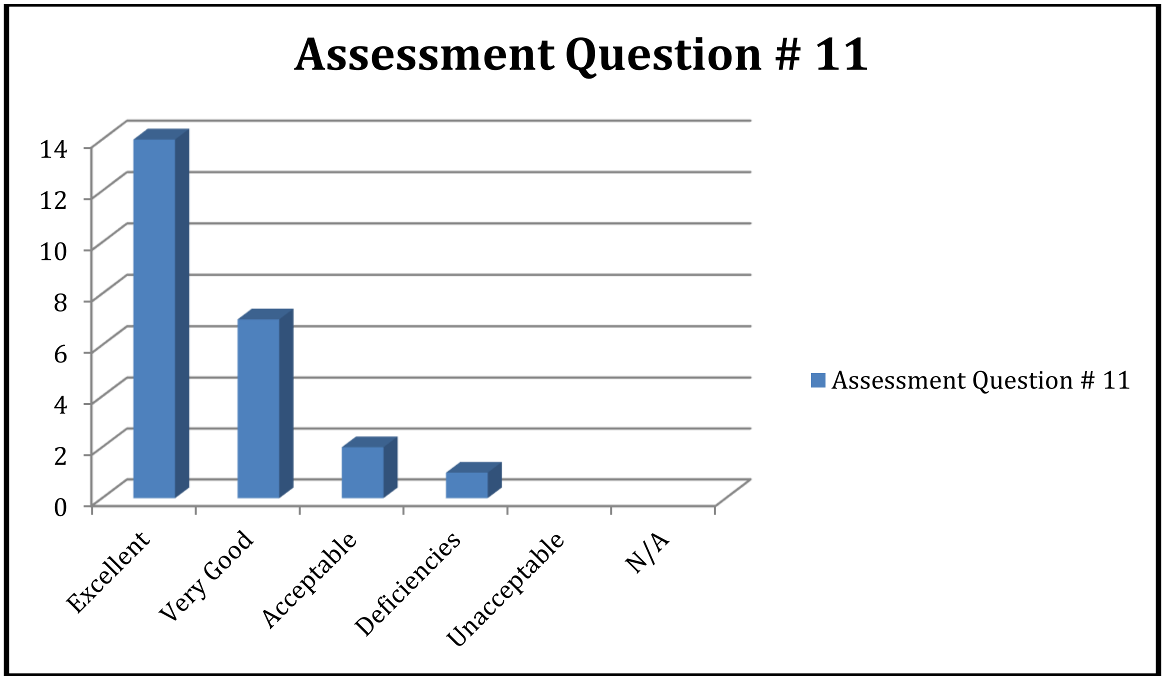
Question 9: For students continuing their education - Ability to compete for graduate or professional school.
(24 respondents)



Question 10: For teaching certificate majors: Did the curriculum help you gain acceptable laboratory skills for teaching?
(24 respondent)



Question 11: Assess the effectiveness of the academic advising throughout your academic career here at WSU.
(24 respondent)



Assessment Question # 11
14
12
10
8
6
4
2
0
Excellent
Very Good
Acceptable
Deficiencies
Unacceptable
N/A
Assessment Question # 11

Standard D - Academic Advising

Advising Strategy and Process

Advising of chemistry and biochemistry majors has changed significantly since the last program review was completed. The added flexibility introduced by the changes in the Chemistry (BS) program and addition of the new Biochemistry (BS) program make effective advising even more important than it was previously. Advising is a shared responsibility of the entire Chemistry and Biochemistry Department faculty. The department chair meets with each student that wishes to declare a Chemistry (BS) or Biochemistry (BS) or BIS major for initial advising answer student questions about the major and ensure the student knows what classes to take next. A member of the faculty will be assigned to advise specifically for the Chemistry Teaching (BS) major and another for the Chemical Technician (AAS). As part of the initial advising visit, each student is assigned a member of the faculty as act as their faculty advisor with the intention that the student will meet at least annually with their faculty advisor to ensure they are on-track and know what courses to enroll in during the coming year. Where possible, faculty advisors are chosen to complement each student's interests. For example, a biochemistry major would usually be assigned to one of the biochemistry faculty. In addition to assisting the student to find a path that leads to graduation in an efficient and timely manner, it is felt that faculty taking the time to advise students helps to develop relationships that positively influence retention, degree completion and lasting connections.

To assist faculty in providing accurate information about course advisement, a flow chart mapping out all of the courses within the major and indicates the pre-requisites of each course has been created. Additionally, the current graduation map provides a recommended schedule for the completion of these courses in a 4-year time frime.

Effectiveness of Advising

Quantitative measures of the effectiveness of advising are difficult to identify. "Time to Baccalaureate Degree for 90 Credit Hour" reports provide one source of information that might reflect advising effectiveness but is convoluted with many other effects, including the fact that a large fraction of majors do not declare their Chemistry or Biochemistry major until they already have 60 to 90 credit hours of coursework complete that does not include many required chemistry courses. No clear trend is obvious in the departmental data since the last program review in 2012. Approximately 50-60% of students with 90 Credit hours or more have not graduated after three more years. This compares poorly with the university average of about 25-30% that have not graduated after the same time period. One possible cause it that many of our majors began as majors in other programs before declaring a Chemistry or Biochemistry major and so have a significant number of credits before starting their chemistry and biochemistry coursework. We do not have enough information to determine the impact of this effect and what other factors play a role. We are seeking to better understand this statistic as we strive to improve the programs offered by the Department of Chemistry and Biochemistry.

The most useful feedback on advising continues to come from student exit interviews. Unfortunately, these interviews capture information only about students that are successfully completing their degrees, but based on trends in their feedback, advising changes that have been implemented since the last review cycle have produced a marked improvement in the student's perception of the quality of advising. Prior to implementing the current advising model, about half of students would comment on the desire for better program advising. That number has fallen to about 10% of students making similar comments, with most being very satisfied with their program advising experience in Chemistry and Biochemistry.

Most of our majors do not avail themselves of the many advising opportunities the department strives to provide. The department administrative assistant sends out invitations to the students to meet with their faculty advisor each fall. In spite of the invitation, most students do not meet with their faculty advisor. Instead, they solicit informal input from the department chair or a faculty members teaching their current classes.

Past Changes and Future Recommendations

As we move forward, it is envisioned that there will be three tiers for student advising. Primary advising or introductory advising will continue to be done by the department chair. In the initial advising meeting, a record of the student and their interests will be initiated and added to as they progress toward their degree. The department chair will welcome the student into our program and find out about their interests to help match them with a faculty advisor. Secondary advising or general advising will be done by a faculty member assigned to each if the major programs. This is a change from the current departmental advising model and will be recognized as service to the department. Most tracking of student progress and course advisement is conducted at this level. Faculty advisors email students to come and visit them to personalize the invitation for advising. The College of Science pre-medical senior advisor, currently Jane Stout, and other pre-health advisors appointed at the college level will assist in this endeavor. If this general advising is effective at reaching students, these faculty advisors will experience a significant time commitment related to their advising responsibilities and the department may need to offset that time commitment with a somewhat reduced teaching load or other compensation. Tertiary advising or specialist advising will be done by all faculty members as needed and will be recommended by the general program advisors. Advising at this level will inform students of the work experiences and specialization skills individual faculty members have developed. All faculty will support this level of advising by addressing student questions related to their specific training and knowledge.

Standard E - Faculty

The strength of the Department of Chemistry & Biochemistry lies in the dedication and expertise of both the faculty and staff. The Department currently has eleven full-time faculty and two full-time instructors. All tenured or tenure-track faculty members within the Chemistry Department hold terminal degrees with unique talents and technical expertise. The academic preparation required of faculty in the Department generally includes an earned Ph.D. or equivalent in one of the recognized areas of chemistry (analytical, biochemistry, inorganic, organic or physical) or in a closely related area such as metallurgy, chemical engineering, material science, or geochemistry. The Department places priority on hiring and supporting qualified and experienced faculty who complement the design, goals and mission of the program. While some improvement has been made in achieving a diverse and representative faculty, this remains a challenge with improvement to be made in gender and especially race demographics that more closely match the populations we serve.

The Department supports a total of about 17,000 student credit hours each year. We are experiencing significant growth in numbers of progressing declared majors (+8.5% annual increase for the last five years), numbers of baccalaureate degree graduates (+15.6% annual increase for the last five years) and numbers of associate degree graduates (+56.5% annual growth for the last five years). We have over 300 declared progressing majors across each of the department's programs. We also see significant improvements in the numbers of majors from underrepresented populations (+11.5% annual growth for the last five years among students identifying as Hispanic and Latino). There are over 200 declared progressing majors in Department bachelor of science programs with about half of those declared as Biochemistry (BS) majors, half as Chemistry (BS) majors, with six Chemistry Teaching (BS) majors. We have seen remarkable growth in Chemical Technician (AAS) graduates during the last five years, with about 10 graduates per year five years ago and graduating about 60 each of the last two years. There are currently over 100 declared Chemistry Technician (AAS) majors enrolled and progressing in that program. These numbers confirm that the department is experiencing healthy growth across our programs but they also point toward challenges that lie ahead as we strive to serve increasing numbers of students with increasingly time and effort intensive teaching pedagogies. This growth has occurred while the number of tenured and tenure-track faculty have remained constant and the number of support staff has decreased. Our ability to support our own programs and many others for which our courses provide support depends on maintaining sufficient numbers of faculty with diverse backgrounds in chemistry.

A multidisciplinary Environmental Sciences program is being developed in the College of Science. While chemistry plays a central role in similar programs, the Department lacks faculty with expertise in field measurement and the associated analytical techniques. Specifically, the Department and College do not have faculty trained in atmospheric chemistry and air quality, which is recognized to be an area of particular importance in northern Utah. At least one additional faculty line supporting in part the Environmental Science program is needed to help fill this void.

Faculty loads remain a significant concern. The university policy regarding faculty loads is based on antiquated teaching techniques, especially for laboratory course and undergraduate research. Modern pedagogical approaches to teaching lectures and labs require much more effort that was typical for labs ten to twenty years ago. Laboratory teaching load assignments presume that the faculty member will have half of their lab time available to grade and do other preparatory work while students work individually collecting their laboratory data. Modern active-learning pedagogies require faculty's continuously attention as students develop experimental methods and gather data. Time in lab is as all-consuming as time in lecture. Teaching load credit needs to be give faculty based on contact hours rather than the teaching load credit provided for in university policy. Similarly, faculty are increasingly involved as mentors in undergraduate research projects with students. University policy needs to be developed to better recognize the real effort that faculty are called upon to provide in these activities.

<u>Programmatic/Departmental Teaching Standards</u>

The chemistry curriculum is consistent with the American Chemical Society's Committee on Professional Training, ACS-CPT, guidelines for *Undergraduate Professional Education in Chemistry.* These guidelines are revised periodically, most recently in 2015. ACS-CPT standards for approved departments include the adoption and use of current textbooks and lab manuals, the preparation and administration of appropriate examinations and other materials used in student grading, and the use of appropriate laboratory equipment and experiments. Faculty members are expected to maintain teaching standards that meet the requirements of approved departments. Faculty are made aware of the departmental teaching standards in initial orientation sessions conducted by the department chair after faculty are hired, and by a continuing dialogue with experienced faculty of the department.

A range of teaching pedagogies are employed in the various chemistry courses. Lecture sessions take on many forms depending on the instructor, the number of students in the section, and the subject being taught. Active learning pedagogies such as POGIL are widely used across the faculty and curriculum. Some faculty place emphasis on lecture demonstrations in which students participate while others treat lecture sessions as discussions with an emphasis on student involvement. Many use technology in various forms to present material and assess learning. Student performance in lectures is typically evaluated using examinations, quizzes, and reports.

In addition to lecture sessions, most chemistry courses also have a laboratory component in which students experience typical chemistry laboratory procedures, equipment and instrumentation, and the application of the scientific method to solving problems. Evaluation of student performance is done using laboratory report sheets, formal laboratory reports and notebooks.

<u>Faculty Qualifications</u>

The academic preparation required of faculty in the chemistry department generally includes an earned Ph.D. in one of the recognized areas of chemistry (analytical, biochemistry, inorganic, organic or physical) or in a closely related area such as metallurgy, chemical engineering, material science, or geochemistry. Key qualities related to the potential success of a new faculty member are intellect, work ethic, collegiality, innovation, and communication skills. Previous teaching experience and/or postdoctoral work, while not necessary, are considered in hiring decisions for both tenure track and adjunct faculty. See Appendix A.

Faculty Scholarship

Most departmental faculty work with students on undergraduate research projects each year. Additionally, faculty are involved in various scholarly pursuits ranging from basic and/or applied research in Chemistry and Biochemistry to pedagogical research and development and textbook writing. Specific research activities are cited in the appendix in each faculty member's CV. The department maintains a small fund supported by donations to provide for some faculty research expenses. Faculty are also expected to pursue other campus sources of research funding such as grants administered by the Research, Scholarship, and Professional Growth committee. Some faculty have successfully pursued nationally funded grants through the NSF and other national agencies.

Mentoring Activities

The department chair carries primary responsibility for mentoring tenure track faculty through the tenure process and in their teaching, research, and service responsibilities. This occurs formally upon hire, during the second-year review, during the third-year review and during the sixth-year review. It also occurs much more frequently on an informal basis as the chair and other faculty members interact with tenure track faculty providing support and encouragement to improve teaching, research, and service in the university.

The College and University also provide mentoring support for tenure track faculty in the form of seminars and information sessions related to preparation of the professional file and other aspects related to the tenure process. The College has recently appointed a senior faculty member to act as a resource and guide for new faculty on the tenure track.

Mentoring and support of tenure track faculty was identified by the previous review team as an area where the department and college needs to improve. In particular, mentoring and support related to ongoing scholarship was strongly recommended. The chemistry faculty remain very supportive of fellow tenure-track faculty but are also frustrated by the lack of time available to support significant chemical research.

Diversity of Faculty

Individuals of diverse backgrounds are specifically encouraged to apply for positions when available. Human Resources at WSU specifically promotes diversity through provisions in the applicant rating system that allow favoring otherwise equally qualified applicants based on various diversity-related characteristics that applicants may self-select. Some progress has been made since the last program review, however the department remains homogeneous based on race and gender with all tenured and tenure track faculty members being white and nine of eleven being male. Two instructor level faculty have been added since the last program review, both of which are female. The challenges associated with achieving a fully diverse faculty representative of the broader community is due to at least two factors that are separate from hiring bias alone. The first is that hiring new faculty members is a rare event so changing the departmental profile requires time. The second factor is attrition. Over the past twenty-five years, two female and eight male faculty members have left the department, which represents proportionally a greater loss of female faculty members than male. One of the female losses was due to retirement and the other was due to family relocation. In addition to ensuring fair and equal hiring practices, it is important that existing faculty feel the support and encouragement of the department to avoid bias in attrition. Emphasis on developing a diverse faculty will continue to be emphasized and addressed as new faculty hires are made and we will consult with the University's chief diversity officer to help us develop a strategy to generate a more diverse candidate pool.

Ongoing Review and Professional Development

The full-time faculty provide an update of activities beyond teaching loads that include areas of service and professional growth or scholarship during each annual review. All contract faculty serve on at least one committee at the department, college or university level and most serve on several committees spread across all levels. The service rendered promotes the business of the department, college or university. Along with service all contract faculty are required to participate in professional growth or scholarship activities which may include: book writing, research, participation in national science societies, grant writing, seminars etc. The tenure-track faculty, undergo tenure reviews at the 2nd, 3rd, and 6th year of employment. These ongoing reviews of teaching, service and scholarship are designed to help the faculty member achieve tenure. Samples of teaching evaluations are included with each faculty member's professional file. The professional file is reviewed by the Department's Promotion and Tenure Committee, the College of Science Promotion and Tenure Committee, the Dean of the College of Science and the Provost if necessary.

All faculty members (including tenured faculty) are reviewed annually by the Department Chair. The annual review examines a faculty member's efforts and achievements in the areas of teaching, service, and scholarship. The annual review of teaching includes student course evaluations from at least two courses that the faculty member has taught during the previous year. Untenured faculty (including adjuncts) are required to have all courses evaluated, as required by PPM 8-11.

Faculty Senate adopted a post-tenure review policy that requires that all faculty undergo a post-tenure review every five years. The College of Science has implemented a post-tenure review process that is consistent with the policy adopted by the Faculty Senate. All faculty of the college undergo post-tenure review every five years following achieving tenure. Post-tenure review consists of a summary and review of the previous five annual reports, highlighting achievements in the areas of teaching, scholarship, and service. The Department Chair and Dean each prepare written responses with ratings of the faculty member's performance. The results of these reviews are shared with the Provost. Where performance concerns exist, plans are developed in consultation with the individual faculty member, their Chair, and the Dean to bring performance in line with university expectations of tenured faculty.

Faculty are expected to remain active and current in their fields through attendance at scientific conferences, monitoring the scientific literature, and active scholarship. The expectation extends beyond completion of the tenure process. Significant teaching and service loads make this very challenging for faculty. Limited funding is available to support development related travel for faculty. This funding is often supplemented by other funding from within the college and university as well as external source to make faculty attendance at meetings and workshops possible. Faculty are encouraged to present their work where appropriate at these events.

Evidence of Effective Instruction

Teaching effectiveness within the Department is reviewed by both direct and indirect means. Section D above outlines assessment of student learning. The structured nature of the chemistry curriculum provides a further measure of instruction effect. Each chemistry course prepares students in many aspects for subsequent courses. The first instructor in a series of chemistry courses must prepare students who take the series so that they can successfully step into the second semester of the series. The coordinated efforts of both instructors are invaluable to the student's progress. For example, all instructors teaching a series class are required to use the same book and cover the same core topics. In this way teaching effectiveness in the first course of the series can be assessed by student performance in the second semester of the series. Similarly, the overall sequential nature of chemistry course work allows an evaluation of student performance to be made continually by faculty who instruct students previously taught by other faculty members. This constitutes an ongoing, though unofficial, peer review of teaching effectiveness.

Quality of teaching (and student learning) in the Chemistry Department is determined in part by the traditional methods of formal peer review, scrutiny of exams, syllabi, and professional files, classroom visits and student evaluations. Standardized American Chemical Society exams are administered and used both to evaluate student performance and compare that performance to national norms. Those results are listed in Section D above.

i. <u>Regular Faculty</u>

All courses taught by faculty within the department are evaluated by students each year. Consistent with university requirements, all courses taught by tenure track faculty members and at least two courses taught by tenured faculty are considered in the annual faculty review process. Student evaluations are discussed with the department chair. The annual review is a College of Science requirement and includes an interview between the faculty member and the department chair. Teaching and other expected activities are discussed and goals are set for the coming year to improve in the various areas of faculty responsibility. More frequent review of teaching occurs with the department chair when problems related to a faculty member's teaching are noted. During the tenure review process each faculty member forms a Peer Review Committee that formally observes and evaluates the tenure track faculty's teaching, then identifies strengths and recommends improvements in its report.

ii. <u>Adjunct Faculty</u>

All courses taught by adjunct faculty are evaluated by students each year. These student evaluations are reviewed by the department chair and any problems related to teaching are discussed with the adjunct faculty. No official university review process exists for adjunct faculty that is similar to the annual review required in the College of Science.

Standard F – Program Support
Support Staff, Administration, Facilities, Equipment, and Library

Adequacy of Staff

The number of support staff has decreased since the last program review – 7 years ago. We currently have one full-time secretary and one lab manager who also serves as manager of the science store. A full-time science store manager was cut from the department in early 2015 and was never replaced. The science store manager's responsibilities were added to those of the laboratory manager, who now functions approximately half-time as the lab manager for all chemistry teaching labs and half-time as the manager of the science store for the College of Science. The lab manager position requires someone who is capable of organizing, coordinating, and managing all logistical and safety aspects associated with running multiple teaching laboratories each day of the semester. The lab manager directs room, equipment, and chemical preparation for all labs on campus and at the Davis center. The science store manager responsibilities involve purchasing and maintaining the chemical inventory for Chemistry as well as all other departments in the College of Science. The decrease in support staff coincides with a significant increase in managerial responsibilities. Students have been recruited to assist in both the chemistry stockroom and in the science store, but the help is not sufficient to support all teaching labs, especially the upper division courses. Presently, two portable dishwashers are needed to reduce student menial activities, so they can concentrate on material preparation and lab set-up.

We have one full-time administrative specialist to support all full-time and part-time adjunct faculty and handles most of the department's business, including student registration and graduation issues. She also provides significant support college-wide due to her expertise. Her work load continues to increase with an ever-increasing number of students served by the Department of Chemistry and Biochemistry and its programs.

The Tracy Hall Science Center (THSC) came online in 2016. The THSC provides excellent modern facilities. However, it was built for the current need and finding space for classes and research is increasingly difficult as enrollments grow. As we continue to experience growth in the number of majors and the faculty needed to teach them, we will face increasing challenges with available teaching and research space. The THSC provides adequate safety equipment that is easily accessed by faculty, staff and students. All equipment such as fire alarms and eyewash stations is checked regularly and is certified by the university to be in working order. We have many new fume hoods in both the teaching and research labs. Organic chemistry students now are far less likely to inhale noxious fumes. There is a College of Science Safety Committee that is tasked with identifying and resolving safety issues and making recommendations to the Dean for needed repairs or the purchase of additional safety equipment. The committee has not met for an extend period. There seems to be little support from the university and we currently have limited active safety support staff. Waste handling and disposal requires better coordination with university facilities and the Environmental, Health, and Safety group. Overall, there have been significant improvements in safety over the past several years, including the development of a uniform laboratory safety policy, frequent review of specific lab safety issues as they are identified, and course and lab specific emphasis on experimental safety. The chemistry department is committed to making safety a priority in all labs.

i. Ongoing Staff Development

The two departmental administrative staff members regularly participate in university and other professional training and development programs. The university provides frequent training for staff related to their various responsibilities. Additional specific training support is provided where possible for stockroom and science store staff. Additionally, staff personnel are encouraged to attend professional meetings and other external training events to help them develop and improve skills related to their job requirements.

Adequacy of Administrative Support

The university supplies a number of support organizations that provide support for grant writing, budget management, facilities, etc.

Adequacy of Facilities and Equipment

The Tracy Hall Science Center that houses the College of Science is new with improved teaching and laboratory spaces. Research laboratory spaces remain barely adequate to accommodate increasing numbers of undergraduate research students. Little teaching or research laboratory space was allocated for growth in the new building. The number of teaching lab stations is essentially the same is it was in the old building. Our classroom space in the new building is extremely limited and we must to use the other buildings across campus for many different classes. Many of these rooms do not have adequate facilities, or even running water, for presenting chemistry demonstration in the classroom. We have added a new biochemistry degree to the program and the number of chemistry majors is increasing every year. However, faculty are stretched-thin trying to accommodate teaching loads with an ever-increasing push to expand our research here on campus. Of great concern is that the College of Science tenure document requires research for promotion and tenure but there is little space or start-up funding provided to faculty to meet this requirement. Faculty members are largely left on their own to find funds to purchase reagents and equipment to start research. The University Research and Professional Growth Committee (RS&PG) and the Office of Undergraduate Research provide $1,000 to $4,000 one-time money through an increasingly competitive granting process. Even when awarded, an RS&PG grant is typically small, providing only enough support for small research projects, which only marginally helps establish a quality research program at Weber State. The Dean of the College of Science is very supportive of faculty that wish to pursue external funding but obtaining funding through external organizations is difficult due of the lack of support for research from the State of Utah. We have been fortunate to obtain funding from a few private donors and from the Dean to purchase new equipment for the college of science but along with new equipment comes equipment maintenance issues. We currently have the following instruments on campus:

- 1-90 MHz Fourier Transform NMR Spectrometer which is capable of analyzing multiple different nuclei.
- 2-functioning classroom Agilent GCs -- a 5890 and a 6890.
- 1-research Agilent GC-7890
- 1-research and class Agilent GC-MS with mass hunter software
- 1-research Agilent 1100 HPLC with multiple analytical columns (mostly donated)
- 1-research Thermo Scientific – Vanquish UHPLC – TSQ Endura triple quad MS
- 1-research Thermo Scientific – ICP-MS
- 1-research Thermo Scientific – ICP-OES
- 2-Classroom Thermo Scientific FT/IR spectrometer
- 2-research Thermo Scientific FT/IF Raman spectrometer
- Several UV/Vis spectrophotometers
- 1-research UV/Vis/Fluorescence 96-well plate reader
- 1-Applied biosystems capillary electrophoresis
- 2-classroom Vis 96-well plate readers
- 1-classroom and research AA with multiple lamps and NO2 capability.
- 1-tube furnace, kiln and multiple ovens

Needed for chemistry and biochemistry programs:

- New Ion Chromatograph
- multiple ion electrodes for classroom
- 2-Tissue culture incubators
- Deli refrigerator
- Table-top centrifuge
- Real-time PCR
- DNA sequencer
- Speed Vac
- High field Fourier Transform NMR spectrometer
- Preparative gas chromatograph
- Preparative liquid chromatograph

Presently we have some nice serviceable equipment and instruments available for teaching and research. Sophisticated instruments require much faculty time, instruction, training, and practice to learn safety, operation, and routine maintenance procedures. Instruments sometimes stand idle for extended periods due to extensive faculty workload. Most instruments in the department are heavily used by students and require frequent maintenance and repair. A small equipment budget is maintained for instruments related to laboratory courses by requiring a lab fee for those courses. However, some of the lab fees for different courses have been removed and money for equipment maintenance and repair is limited. All of the instruments listed above (with the exception of the ICPs) do not carry maintenance contracts and sometimes become unusable for months and potentially years when they are in need of major repair. Faculty members can do some instrument maintenance but often problems are beyond our expertise or available time. Money for maintenance and repair is very tight. The department is fortunate to have had several donated instruments, but these donated items are usually in disrepair or no longer supported and it is very difficult to find parts to remedy the situation. As a result, some equipment is passed on to surplus for disposal.

High-field NMR instruments are becoming increasing common at primarily undergraduate teaching institutions like Weber State University. Faculty members requiring routine NMR analysis of compound related to their research must contract with the University of Utah to have spectra run on their 300 MHz instruments and pay an instrument usage fee. Faculty who want to do research find themselves in a vicious cycle of inadequate facilities and funding and are often obligated to seek help from outside sources such as the University of Utah or Utah State University. Faculty members in the Chemistry Department have continued to work through the process because they are dedicated researchers. Consequently, progress continues at a rather slow pace using equipment and instruments that are designed for teaching rather than research.

Supporting a state-of-the-art undergraduate research program in chemistry requires significant investment continue acquiring, implementing, and maintaining more research quality instruments and equipment. Eventually, new spaces will be needed.

<u>Adequacy of Library Resources</u>

The Chemistry Department meets the minimal library ACS accreditation requirements, which specifies that fourteen current journals from the CPT list of recommended journals be available in print or electronic form. Maintaining this minimum requirement demands constant vigilance. The library is in a constant dilemma of trying to decide which journals should be kept, which should be added and which should be terminated. The decision is often based on student and faculty journal use. Attempts are made to weed-out non-used journals and save money. The decision several years ago to cancel ACS print journals and replace them with a larger number of online journals worked briefly but the department was again faced with cutting access further the following year. Unlike print journals, which remain available on library shelves even when a subscription is dropped, electronic journals become inaccessible when the subscription is dropped, even for volumes printed during the period of the active subscription. Students and faculty therefore rely extensively on larger universities because the WSU library does not carry many important journals in either bound or online versions. The ease with which articles can be obtained online and via

Interlibrary Loan is improving. However, Chemical Abstracts are no longer available through the Science and Technology Network (STN), which is a serious problem for researchers. We anticipate an ongoing need for these resources as the department, university, and the ACS increasingly emphasize undergraduate research.

Standard G - Relationships with External Communities

<u>Description of Role in External Communities</u>

The Department of Chemistry and Biochemistry enjoys excellent relationships with commercial and government laboratories in northern Utah. Each year, we take our chemistry students to visit some of the local corporate, government and university laboratories. These include the only Occupational Safety and Health Administration (OSHA) laboratory in the nation, Wasatch Labs, Balchem-Albion, Systemic Formulas, Frontier Scientific, ARUP, Nutraceutical Corp., Northrop Grumman (Orbital-ATK), Fresenius, Capstone Laboratories, Compass Minerals, Water treatment plants, Big West Oil, Purity Technologies, RJ Analytical, Western Zirconium, Utah Crime Lab, Advanced Laboratories, AMT Laboratories, Utah State University, and many others. Keeping these connections alive and nurturing those pays big dividends to the Chemistry and Biochemistry Department and to the University.

While it requires much time and effort to coordinate travel to these places with students, these site visits always result in very meaningful discussions, both on site and in the lecture hall afterwards. Furthermore, when our department is pressed for favors or lacking resources, we can turn to these off-campus laboratories for support and they are often very eager to help (e.g., internships, new degree programs, lobbying efforts, student tours, donations of instruments, access to instruments, etc.). Many of our chemistry students gain extra experience by working with these local companies, both as interns and as employees. In addition, our students apply chemistry techniques they are learning to “real-world” problems encountered by these outside labs, including unique techniques of sampling and testing, quality control and method validation. All of this adds tremendous value to our students’ education.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Summary of External Advisory Committee Minutes

The Department of Chemistry and Biochemistry formed an advisory council in 2017 and has meet annually with that body. Current members of the council are listed in Appendix E. Below are the minutes of the most recent council meeting on November 30, 2018.

Advisory Council Agenda
Weber State University
Wildcat Store - WSU Downtown - Conference Room
2314 Washington Blvd.

5:00 to 6:30 p.m.
November 30, 2018

Present: Allan Guymon, Ben Prall, Debra Titmus, Louis Cannizzo, Vince Hansen, Danette Pulley, Michelle Paustenbaugh, Tim Herzog, Brandon Burnett, Laine Berghout
Phone In: Stephen Wise
Dinner: Carson Cole, Tyler Browning, Nick Eccles, Megan Gull
Excused: Betty Yamashita, Yoon Mi Hamrick
Welcome: Laine Berghout, Department Chair
Danette Pulley, Development Director, College of Science

Program Updates:

- Significant growth in numbers of majors, especially in Biochemistry.
- Record number (12) of December graduates.
- Full classes and added foundation classes.

Business:

1. Opportunities for Students – Michelle Paustenbaugh
    - Discussed internships and mentoring. Allan Guymon shared some details of the U. Iowa chemical engineering mentoring model.
    - Discussed value of undergraduate research. Vince Hansen commented on the value of undergraduate research experiences, particularly involving scholarly publication for students interested in careers in medicine. There was general agreement about the value of undergraduate research
    - Question arose about student destinations following graduation: ~50% of students seek employment with BS, 20-25% professional schooling, 25-30% graduate schooling.
    - Expect increase especially in professional schooling due to availability of biochemistry program.
    - Interested in ways to attract new majors, especially in Chemistry Teaching. Ben Prall suggested that community outreach could be required for students in chemistry to encourage K-12 students to consider the sciences.
2. Program Support Opportunities – Brandon Burnett
    - Interest in members of the chemistry community to provide seminars. Committee felt that associates would value the opportunity.
    - Interest in field trip opportunities, especially for ChemTech program.
3. Program Outcome Discussion – Tim Herzog
    - How can we develop programs to better prepare students with locally needed technical and soft skills?

- How can we best emphasize laboratory safety and create culture of safety?
- How can we better assess skills?

4. Action Items – Laine Berghout
    - Create 2-4 subcommittees to work on some of these efforts and perhaps some others by early January.
        - Each member of council to respond on interest in working on items above in subcommittee.
        - Organize subcommittees in early January to report at next meeting.
    - Suggest additional members of council and background/expertise to fill gaps in advisory council.
        - Chemistry Department will consider adding other members to the advisory council, targeting individuals in the natural products and pharmaceutical industries.
    - Plan for next meeting in mid-April.
        - Graduating student research poster presentation.
        - Subcommittee Reports

Adjourn: Dinner with students at Union Grill, 315 24th Street, 6:30 PM

<u>Community and graduate Success</u>

Standard H – Program Summary
Results of Previous Program Reviews

Problem Identified	Action Taken	Progress
Issue 1	Previous 5 Year Program Review:	**Curriculum –** Update the curriculum of the Chemistry Option 1 program to take full advantage of the 2008 ACS–CPT guidelines for Bachelor's Degree Programs. Develop the curriculum of the Chemistry Option 2 program into a Biochemistry (BS) program consistent with ACS–CPT guidelines.
	Year 1 Action Taken:	Department faculty held retreat to identify changes and plan time frame for implementation of changes in program.
	Year 2 Action Taken:	Began development of new courses and redevelopment of existing courses to align with ACS guidelines.
	Year 3 Action Taken:	Prepared curriculum program change proposal.
	Year 4 Action taken:	Shepherded program change proposal through department, college, university, and state approval process. Completed Summer 2016.
Issue 2	Previous 5 Year Program Review:	**Facilities -** Replace and update existing facilities and instrumentation with modern structures and instrumentation.
	Year 1 Action Taken:	Faculty participated in design of the new Tracy Hall Science Center, ensuring that new labs and classroom spaces will support active learning and high-impact teaching techniques.
	Year 2 Action Taken:	Continue efforts to support design and construction of new Tracy Hall Science Center.
	Year 3 Action Taken:	Continue efforts to support design and construction of new Tracy Hall Science Center.

	Year 4 Action taken:	Tracy Hall Science Center completed. Department able to occupy spaces during Summer 2016. Where necessary and with available funding, new and upgraded instrumentation were purchased and installed.
Issue 3	Previous 5 Year Program Review:	**Faculty -** Hire 2 new tenure-track faculty in the areas of analytical and biochemistry. Allow each faculty member to teach courses in the area of their expertise. Develop funding to support a decrease in teaching loads for faculty to develop and pursue their own research and research with students.
	Year 1 Action Taken:	Hired new faculty member with expertise in Biochemistry to replace retiring faculty member. More systematic tracking of undergraduate research course-load credit begun. Effort made to grant faculty course release credit during subsequent semester following mentoring of CHEM 4800 research. Faculty encouraged and supported in sabbatical requests.
	Year 2 Action Taken:	Continued effort to give faculty allowable credit for undergraduate research support and other demanding departmental service. All faculty given opportunity to teach courses in their area of specialization. Continued support for faculty sabbatical requests. Added new instructional faculty member on a one-year contract to teach support courses.
	Year 3 Action Taken:	Continued effort to give faculty allowable credit for undergraduate research support and other demanding departmental service. All faculty given opportunity to teach courses in their area of specialization. Continued support for faculty sabbatical requests. Instructional faculty member's contract continued.

	Year 4 Action taken:	Continued effort to give faculty allowable credit for undergraduate research support and other demanding departmental service. All faculty given opportunity to teach courses in their area of specialization. Continued support for faculty sabbatical requests. Instructional faculty's contract continued. Near the end of the review cycle and second instructor position was added to support instruction of support course taught in the department. No new tenure track faculty lines have been added during the review period.
Issue 4	Previous 5 Year Program Review:	**Pedagogy -** Create an environment that encourages the implementation of active, collaborative, student-centered teaching methods. Provide meaningful research experience for students. Diversify faculty workload responsibilities.
	Year 1 Action Taken:	Faculty encouraged to attend workshops related to pedagogical approaches to teaching chemistry. Resources and support provided as possible for undergraduate research. Research requirement supported in updated Chemistry (BS) program redesign. Effort made to ensure faculty assignments reflect faculty expertise.
	Year 2 Action Taken:	Continuing effort to encourage faculty to attend workshops and seek other opportunities related to developing new pedagogical approaches to teaching chemistry. Resources and support provided as possible for undergraduate research. Research requirement included in updated Chemistry (BS) program proposal. Continuing effort to ensure faculty assignments reflect faculty expertise.

	Year 3 Action Taken:	Continuing effort to encourage faculty to attend workshops and seek other opportunities related to developing new pedagogical approaches to teaching chemistry. Resources and support provided as possible for undergraduate research. Research requirement included in updated Chemistry (BS) program. Continuing effort to ensure faculty assignments reflect faculty expertise.
	Year 4 Action taken:	Continuing effort to encourage faculty to attend workshops and seek other opportunities related to developing new pedagogical approaches to teaching chemistry. Resources and support provided as possible for undergraduate research. Research requirement included in updated Chemistry (BS) program redesign. Continuing effort to ensure faculty assignments reflect faculty expertise.

Summary Information (as needed)

Action Plan for Ongoing Assessment Based on Current Self Study Findings

Action Plan for Evidence of Learning Related Findings

Problem Identified	Action to Be Taken
Issue 1	Current 5 Year Program Review:
	Year 1 Action to Be Taken:
	Year 2 Action to Be Taken:
	Year 3 Action to Be Taken:
	Year 4 Action to Be Taken:
Issue 2	Current 5 Year Program Review:
	Year 1 Action to Be Taken:
	Year 2 Action to Be Taken:
	Year 3 Action to Be Taken:
	Year 4 Action to Be Taken:

Summary Information (as needed)

Courses are assessed each semester they are taught with measures of student learning outcomes recorded and modifications to course content and pedagogy noted. Course and program learning outcome assessments are reviewed and submitted to the University Office of Institutional Effectiveness on a biennial basis. Feedback from the Office of Institutional Effectiveness is incorporated as necessary.

Action Plan for Staff, Administration, or Budgetary Findings

Problem Identified	Action to Be Taken
Issue 1	Current 5 Year Program Review:
	Year 1 Action to Be Taken:
	Year 2 Action to Be Taken:
	Year 3 Action to Be Taken:
	Year 4 Action to Be Taken:
Issue 2	Current 5 Year Program Review:
	Year 1 Action to Be Taken:
	Year 2 Action to Be Taken:
	Year 3 Action to Be Taken:
	Year 4 Action to Be Taken:

Summary Information (as needed)

The previous review did not directly address concerns about staff, administration, and budgetary issues. However, these are each related to Curriculum, Faculty, Facilities, and Pedagogy findings detailed earlier in this section.

APPENDICES

Appendix A: Student and Faculty Statistical Summary

(*Note*: Data provided by Institutional Effectiveness. This is an extract from the Program Review Dashboard and shows what will be sent to the Boards of Trustees and Regents)

	2014-15	2015-16	2016-17	2018-19	20xx-xx
Student Credit Hours Total	16,296	16,869	18,366	17,354	
Student FTE Total	543.20	562.30	612.20	578.5	
Student Majors					
Bachelor Degree	147	143	172	207	
Program Graduates					
Associate Degree	10	8	61	60	
Bachelor Degree	14	4	15	25	
Student Demographic Profile					
Female	65	62	64	84	
Male	82	81	108	123	
Faculty FTE Total	17.69	18.27	17.38	n/a	
Adjunct FTE	6.98	6.5	5.75	n/a	
Contract FTE	10.71	11.77	11.63	n/a	
Student/Faculty Ratio	30.71	30.78	35.22	n/a	

Appendix B:

Faculty (current academic year)

	Tenure and tenure-track	Contract	Adjunct
Number of faculty with Doctoral degrees	11	1	1
Number of faculty with Master's degrees		1	1
Number of faculty with Bachelor's degrees			1
Other Faculty			
Total	11	2	3

Contract/Adjunct Faculty Profile

Name	Rank	Tenure Status	Highest Degree	Years of Teaching	Areas of Expertise
H. Laine Berghout	Professor	Tenured	PHD	20	Physical
Brandon Burnett	Assistant	Tenure track	PHD	7	Inorganic
Carol Campbell	Instructor	Non-tenure track	PHD	8	Inorganic
Tracy Covey	Assistant	Tenure track	PHD	6	Biochemistry Medicinal
Charles Davidson	Professor	Tenured	PHD	22	Physical Geochemistry
Don Davies	Professor	Tenured	PHD	19	Organic
Timothy Herzog	Professor	Tenured	PHD	15	Inorganic Organometallic

Brooke Jenkins	Instructor	Non-tenure track	MS	2	Education
Todd Johnson	Professor	Tenured	PHD	26	Biochemistry Organic
Andreas Lippert	Professor	Tenured	PHD	21	Analytical
Barry Lloyd	Professor	Tenured	PHD	34	Organic
Michelle Paustenbaugh	Professor	Tenured	PHD	20	Physical Education
Edward Walker	Professor	Tenured	PHD	37	Analytical Biochemistry
Brian Albrecht	Adjunct	Non-tenure track	BS	8	Chemistry Industrial Chemical Hygiene
Wayne Aprill	Adjunct	Non-tenure track	MS	3	Chemistry
Michael Slabaugh	Adjunct	Non-tenure track	PHD	49	Organic

Summary Information (as needed)

Appendix C: Staff Profile

Name	Job Title	Years of Employment	Areas of Expertise
Colleen Boam	Administrative Specialist	8	Administrative
Vicki Britt	Lab Manager Science Store Manager	9	Science Store Lab Manager

Summary Information (as needed)

Appendix D: Financial Analysis Summary
(This information will be provided by the Office of Institutional Effectiveness)

Program Name					
Funding	**14-15**	**15-16**	**16-17**	**17-18**	**18-19**
Appropriated Fund	$1,279,143	$1,360,690	$1,931,306	$1,483,560	$1,588,719
Other:					
Special Legislative Appropriation					
Grants or Contracts					
Special Fees/Differential Tuition	$58,321	$51,786	$54,838	$41,720	$58,695
Total	$1,337,464	$1,412,476	$1,986,144	$1,525,280	$1,647,414

Summary Information (as needed)

Appendix E: External Community Involvement Names and Organizations

Name	Organization
Louis Cannizzo	Northrop Grumman
Yoon Mi Hamrick	Hill Air Force Base
Stephen Wise	NIH (ret.)
Allan Guymon	University of Iowa
Ben Prall	Roy High School, Weber County Schools
Debra Titmus	Northern Utah Academy of Math, Science and Engineering
Vince Hansen	Utah Hematology Oncology
Betty Yamashita	South Ogden IHC Pharmacy
Rick Williams	Capstone Nutrition
Jennifer Mickelsen	Brigham City Waste Treatment
Dustin Heslop	Nutraceutical Corporation
Jennifer McNair	Utah Bureau of Forensic Services
Shayne Morris	Systemic Formulas
Wayne Potter	OSHA Laboratory
Kyle Ashby	State of Utah Unified Labs
John Stoop	Big West Oil Refinery
Mont Johnson	Northrop Grumman (Orbital-ATK) Promontory
Mark Ward	Wasatch Labs
Dough Olmsted	Fresenius Medical Care
Shane Aardema	Sky Blue Industries
Richard Mickelsen	RJ Analytical Laboratories

Appendix F: Site Visit Team (both internal and external members)

Name	Position	Affiliation
Lou Cannizzo		Northrup Grumman

Angelica Stacy	Associate Vice Provost	University of California Berkeley
Matt Horn	Associate Professor of Chemistry	Utah Valley University
Matthew Nicholaou	Associate Professor and Chair, Medical Laboratory Sciences	Weber State University

Appendix G: Evidence of Learning Courses within the Major
(use as a supplement to your five-year summary, if needed. Be sure to delete the sample text before using)

Course: Principles of Chemistry I

Course CHEM 1210	Evidence of Learning: Courses within the Major				
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Knowledge & Comprehension of the core concepts of chemistry	Measure 1: Exam 1 covering measurements, components of matter, nomenclature, stoichiometry of formulas and equations	Measure 1: 80% of students will score above 69% on the exam.	Measure 1: 78% of students scored above 69%.	Measure 1: 78% of Students demonstrated competence in these topics.	A new textbook, homework delivery system, and adaptive learning system was chosen by the department for the use of this class. These new features will be implemented and evaluated. Additionally, the class will continue to have more group work and less lecture.
	Measure 2: Exam 2 covering, and three major classes of chemical reactions, gases and kinetic molecular theory, and thermochemistry.	Measure 2: 80% of students will score above 69% on the exam.	Measure 2: 54% of students scored above 69%.	Measure 2: 54% of Students demonstrated competence in these topics.	
	Measure 3: Exam 3 covering quantum theory, atomic structure, electron configurations, periodicity, and bonding models.	Measure 3: 80% of students will score above 69% on the exam.	Measure 3: 61% of students scored above 69%.	Measure 3: 61% of Students demonstrated competence in these topics.	
	Measure 4: Exam 4 covering covalent bonding, molecular, shape, and hybridization of orbitals.	Measure 4: 80% of students will score above 69%	Measure 4: 46% of students scored above 69%.	Measure 4: 46% of Students demonstrated competence in these topics.	

Course CHEM 1210		Evidence of Learning: Courses within the Major			
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
		on the exam.			
	Measure 5: ACS First semester Final exam covering intermolecular forces, colligative properties, and review of earlier material in course.	Measure 5: 60% of students will score above the 50th percentile on the ACS first semester general chemistry exam.	Measure 5: 80% of students will score above the 50th percentile on the ACS first semester general chemistry exam.	Measure 5: 80% of Students demonstrated competence in these topics and ranked higher than the 50th percentile nationwide.	
	Measure 1: Fall 2016 Unit Exam test performance.	Measure 1: Average score of 65% or better.	Measure 1: Student average on all exams was 80%	Measure 1: Exam average shows that course format concept coverage is working.	Measure 1: No need to make large changes to pedagogy, but small specific changes will be made.
	Measure 2: Fall 2016 Final standardized exam performance.	Measure 2: Average score above the national 50th percentile.	Measure 2: Student average on standardized exam was in the 64th percentile	Measure 2: Exam average of standardized test shows that the course works significantly better than the national average.	Measure 2: No need to make large changes to pedagogy, but small specific changes will be made.
	Measure 1: Fall 2016 Standardized American Chemical Society (ACS) Exam score	Average better than 50th percentile compared	Average score was the 70th percentile compared to national norms (up	Measure 1: This significantly exceeds our threshold. For an open	I use an active learning pedagogy in my classes called POGIL and have adapted my

Course CHEM 1210			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	in course is a good indicator of knowledge and comprehension of the core concepts of chemistry.	to national norms.	from 68th in 2015). Median score was the 76th percentile.	enrollment University in an introductory class, this is exceptional.	testing protocols to take advantage of evidence-based ideas. I continually optimize the content and pedagogy in my classes. Our scores on this measure increased. My biggest emphasis area for the future is collaborative testing environments to enhance student learning in assessment situations.
	Measure 2: Fall 2016 ACS exam	Measure 2: Greater than 80% of students exceed the 30th percentile on ACS exam compared to national norms.	Measure 2: 97% of students exceeded the 25th percentile compared to national norms (up from 87% in the previous year). And 86% of students exceeded the 50th percentile.	Measure 2: This is an excellent sign that there is broad success in meeting this outcome for a large majority of students in this class.	
Learning Outcome 2: Develop problems solving skills	Measure 1: Exam 1 covering measurements, components of matter, nomenclature, stoichiometry of formulas and equations	Measure 1: 80% of students will score above 69% on the exam.	Measure 1: 78% of students scored above 69%.	Measure 1: 78% of Students demonstrated competence in these topics.	A new textbook, homework delivery system, and adaptive learning system was chosen by the department for the use of this class. These new features will be implemented and evaluated.
	Measure 2: Exam 2 covering, and three major classes of chemical reactions, gases	Measure 2: 80% of students will score above 69%	Measure 2: 54% of students scored above 69%.	Measure 2: 54% of Students demonstrated competence in these topics.	

Course CHEM 1210		Evidence of Learning: Courses within the Major			
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	and kinetic molecular theory, and thermochemistry.	on the exam.			Additionally, the class will continue to have more group work and less lecture.
	Measure 3: Exam 3 covering quantum theory, atomic structure, electron configurations, periodicity, and bonding models.	Measure 3: 80% of students will score above 69% on the exam.	Measure 3: 61% of students scored above 69%.	Measure 3: 61% of Students demonstrated competence in these topics.	
	Measure 4: Exam 4 covering covalent bonding, molecular, shape, and hybridization of orbitals.	Measure 4: 80% of students will score above 69% on the exam.	Measure 4: 46% of students scored above 69%.	Measure 4: 46% of Students demonstrated competence in these topics.	
	Measure 5: ACS First semester Final exam covering intermolecular forces, colligative properties, and review of earlier material in course.	Measure 5: 60% of students will score above the 50th percentile on the ACS first semester general chemistry exam.	Measure 5: 80% of students will score above the 50th percentile on the ACS first semester general chemistry exam.	Measure 5: 80% of Students demonstrated competence in these topics and ranked higher than the 50th percentile nationwide.	
	Measure 1: Fall 2016 Class homework	Measure 1: Average score of 75% or better.	Measure 1: Student average on all homework was 90%	Measure 1: Average homework scores show that students are able to solve problems	Measure 1: No need to change homework to emphasize problem solving skills.

Course CHEM 1210			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
				at the level expected.	
	Measure 2: Fall 2016 In-class quizzes	Measure 2: Average score of 75% or better.	Measure 2: Student average on all in-class quizzes was 85%	Measure 2: Average quiz scores show that students are understanding problem solving skills in lecture.	Measure 2: Include more opportunities for in-class quiz success.
	Measure 1: Fall 2016 Successful completion of Aleks online homework requires consistent practice in problem solving.	Measure 1: Greater than 80% average score on Aleks.	Measure 1: Average Aleks score was 87%	Measure 1: Students are consistently successful in completing problems in Aleks.	We have instituted a MATH 1050 co-requisite for CHEM 1210 to give students even better scaffolding for success in problem solving in this course. We will assess in the future if this is improving outcomes.
	Measure 2: Fall 2016 ACS exam: Many of the questions on this exam require problem solving skills.	Measure 2: Average better than 50th percentile compared to national norms.	Measure 2: Average score was the 70th percentile compared to national norms.	Measure 2: This shows that students are developing effective problem solving skills as compared to national norms.	
Learning Outcome 3: Laboratory Skills	Measure 1: Lab reports that depend on understanding and execution of lab concepts and technique.	Measure 1: 90% of students will score above 60% on the lab reports.	Measure 1: 96% of students scored above 60%.	Measure 1: 96% of students are mastering lab concepts and techniques.	Measure 1: No plans to change.
	Measure 1:	Measure 1:	Measure 1:	Measure 1:	Measure 1:

Course CHEM 1210		Evidence of Learning: Courses within the Major			
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Fall 2016 Laboratory reports	Average score of 70% or better.	Student average on all laboratories was 84%	Students successfully demonstrated skills.	Continue to revise labs to make them more effective
	Measure 1: Fall 2016 Overall laboratory grade is a good indication of development of laboratory skill since our laboratory reports and prelab evaluate experimental competency as well as interpretation of data	Measure 1: >Average grade equal or better than 80% in lab.	Measure 1: The average lab grade was 84.9%	Measure 1: This indicates that, on average, students are mastering the important laboratory skills and practice. This is a slight improvement from 82.9% in 2015.	This is the first year in the roll out of a new laboratory program. These initial signs are promising and we will continue to work on improving these labs.
	Measure 2:	Measure 2: Greater than 80% of students get higher than 70% grade in laboratory	Measure 2: 98% of students in the class received greater than 70% in the lab.	Measure 2: This is a big improvement from Fall 2015 when only 81% of students received a grade better than 70%	
Learning Outcome 4: Presentation Skills	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable
	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable
Learning Outcome 5: Computer Skills	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable

Course CHEM 1210		Evidence of Learning: Courses within the Major			
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable
	Measure 1: Fall 2016 Successful completion of Aleks online homework requires competency in working with computers	Measure 1: Greater than 80% average score on Aleks.	Measure 1: Average Aleks score was 87%	Measure 1: This is a positive start, but we need to incorporate computer literacy into our courses more.	Our new CHEM 1210L inquiry based labs use computers in a variety of ways, but we haven't individually assessed these skills.

*Direct and indirect: at least one measure per objective must be a direct measure.

Course: Principle of Chemistry II

Course CHEM 1220		Evidence of Learning: Courses within the Major			
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Knowledge & Comprehension of the core concepts of chemistry	Measure 1: Exam 1 covering kinetics (rates and mechanisms of chemical reactions).	Measure 1: 80% of students will score above 69% on the exam.	Measure 1: 76% of students scored above 69%.	Measure 1: 76% of Students demonstrated competence in these topics.	To increase student understanding, the adaptive learning program ALEX will not be used, but LearnSmart will be used in the Fall 2018 CHEM 1220 class. LearnSmart has shown in itself in CHEM 1210 to not discourage students who
	Measure 2: Exam 2 covering equilibrium and simple acid-base equilibria and ionic equilibria in aqueous systems.	Measure 2: 80% of students will score above 69% on the exam.	Measure 2: 59% of students scored above 69%.	Measure 2: 59% of students demonstrated competence in these topics.	
	Measure 3: Exam 3 covering more complex acid-base equilibria, ionic	Measure 3: 80% of students will score above	Measure 3: 68% of students scored above 69%.	Measure 3: 68% of students demonstrated	

Course CHEM 1220			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	equilibria in aqueous systems. entropy, free energy, and the direction of chemical reaction.	69% on the exam.		competence in these topics.	fall behind as greatly as ALEX. To increase student learning, more small group problem solving will occur in class. The use of LearnSmart makes it possible to do significantly less introduction, i.e., lecturing, of the chemical concepts in this class.
	Measure 4: Exam 4 Electrochemistry	Measure 4: 80% of students will score above 69% on the exam.	Measure 4: 48% of students scored above 69%.	Measure 4: 48% of students demonstrated competence in these topics.	
	Measure 5: ACS Final exam	Measure 5: 50% of students will score above 60% on the exam.	Measure 5: 67% of students scored above 60% on the exam.	Measure 5: 67% of students scored score above 60% on the exam.	
	Measure 1: Spring 17 Unit exams	Measure 1: Average score of 70% or better	Measure 1: Student average on all unit exams was 76%	Measure 1: Exam average shows that course format concept coverage is working	Measure 1: No need to make large changes to pedagogy, but small specific changes will be made
	Measure 2: Spring 17 Final standardized exam	Measure 2: Average score better than the national 50th percentile	Measure 2: Student average on standardized exam was in the 59th percentile	Measure 2: Exam average of standardized test shows that the course works significantly better than the national average	Measure 2: No need to make large changes to pedagogy, but small specific changes will be made
	Measure 1:	Measure 1:	Measure 1:	Measure 1:	

Course CHEM 1220			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Spring 2017 Standardized American Chemical Society (ACS) Exam score in course is a good indicator of knowledge and comprehension of the core concepts of chemistry.	Average better than 50th percentile compared to national norms.	Average score was the 62nd percentile compared to national norms. This is a 10% drop from 2016.	This significantly exceeds our threshold. For an open enrollment University in an introductory class, this is exceptional.	While we still are exceeding the threshold, there is cause for concern about this result. With the addition of a math 1050 prerequisite for 1220 plus some evidence based pedagogy we are adding, we hope to improve this in the future.
	Measure 2: Spring 2017 ACS exam	Measure 2: Greater than 80% of students exceed the 30th percentile on ACS exam.	Measure 2: 91% of the class exceeded 30th percentile. This is a decrease of 4 percentile.	Measure 2: This significantly exceeds our threshold.	
	Measure 1: Spring 2017 Standardized American Chemical Society (ACS) Exam score in course is a good indicator of knowledge and comprehension of the core concepts of chemistry.	Measure 1: Average better than 50th percentile compared to national norms.	Measure 1: Average score was the 62nd percentile compared to national norms. This is a 10% drop from 2016.	Measure 1: This significantly exceeds our threshold. For an open enrollment University in an introductory class, this is exceptional.	While we still are exceeding the threshold, there is cause for concern about this result. With the addition of a math 1050 prerequisite for 1220 plus some evidence based pedagogy we are adding, we hope to improve this in the future.
	Measure 2: Spring 2017 ACS exam	Measure 2: Greater than 80% of students exceed the	Measure 2: 91% of the class exceeded 30th percentile.	Measure 2: This significantly exceeds our threshold.	

Course CHEM 1220			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
		30th percentile on ACS exam.	This is a decrease of 4 percentile.		
	Measure 1: Spring 2017 Students completed 11 weekly quiz assignments demonstrating mastery of the reading and video assignments.	Measure 1: Previous research shows that students who earned at least 50% of available credit on quiz and homework assignments passed CHEM 1220 (grade of C- or better) with 97% probability.	Measure 1: The class average score on weekly quizzes was 98%.	Measure 1: Class average scores were well above the threshold for predicted success in the course.	Quiz questions were based on assigned readings and video recordings. The high scores indicated that students mastered the readings successfully. This practice will be continued in subsequent course offerings.
Learning Outcome 2: Develop problems solving skills	Measure 1: Exam 1 covering kinetics (rates and mechanisms of chemical reactions).	Measure 1: 80% of students will score above 69% on the exam.	Measure 1: 76% of students scored above 69%.	Measure 1: 76% of Students demonstrated competence in these topics.	To increase student understanding, the adaptive learning program ALEX will not be used, but LearnSmart will be used in the Fall 2018 CHEM 1220 class. LearnSmart has shown in itself in CHEM 1210 to not discourage students who
	Measure 2: Exam 2 covering equilibrium and simple acid-base equilibria and ionic equilibria in aqueous systems.	Measure 2: 80% of students will score above 69% on the exam.	Measure 2: 59% of students scored above 69%.	Measure 2: 59% of students demonstrated competence in these topics.	
	Measure 3: Exam 3 covering more complex acid-base equilibria, ionic equilibria in	Measure 3: 80% of students will score above 69% on the exam.	Measure 3: 68% of students scored above 69%.	Measure 3: 68% of students demonstrated competence in these topics.	

Course CHEM 1220			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	aqueous systems. entropy, free energy, and the direction of chemical reaction.				fall behind as greatly as ALEX. To increase student learning, more small group problem solving will occur in class. The use of LearnSmart makes it possible to do significantly less introduction, i.e., lecturing, of the chemical concepts in this class
	Measure 4: Exam 4 Electrochemistry	Measure 4: 80% of students will score above 69% on the exam.	Measure 4: 48% of students scored above 69%.	Measure 4: 48% of students demonstrated competence in these topics.	
	Measure 5: ACS Final exam	Measure 5: 50% of students will score above 60% on the exam.	Measure 5: 67% of students scored above 60% on the exam.	Measure 5: 67% of students scored score above 60% on the exam.	
	Measure 1: Spring 17 In-class quizzes	Measure 1: Average score of 75% or better	Measure 1: Student average on all in-class quizzes was 89%	Measure 1: Average quiz scores show that students are understanding problem solving skills in lecture	Measure 1: Include more opportunities for in-class quiz success
	Measure 2: Spring17 Homework assignments	Measure 2: Average score of 75% or better	Measure 2: Student average on all homework assignments was 87%	Measure 2: Average homework scores show that students are able to solve problems at the level expected	Measure 2: No need to change homework to emphasize problem solving skills
	Measure 1: Spring 2017	Measure 1:	Measure 1:	Measure 1:	We have switched to

Course CHEM 1220			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Successful completion of Aleks online homework requires consistent practice in problem solving.	Greater than 80% average score on Aleks.	Average Aleks score was 83.3%.	Students are consistently successful in completing problems in Aleks.	Mastering Chemistry in our CHEM 1210 and 1220 classes so we don't yet know if that will result in improvement.
	Measure 2: Spring 2017 ACS exam: Many of the questions on this exam require problem solving skills.	Measure 2: Average better than 50th percentile compared to national norms.	Measure 2: Average score was the 62nd percentile compared to national norms.	Measure 2: This shows that students are developing effective problem solving skills as compared to national norms.	
	Measure 1: Spring 2017 Successful completion of Aleks online homework requires consistent practice in problem solving.	Measure 1: Greater than 80% average score on Aleks.	Measure 1: Average Aleks score was 83.3%.	Measure 1: Students are consistently successful in completing problems in Aleks.	We have switched to Mastering Chemistry in our CHEM 1210 and 1220 classes so we don't yet know if that will result in improvement
	Measure 2: Spring 2017 ACS exam: Many of the questions on this exam require problem solving skills.	Measure 2: Average better than 50th percentile compared to national norms.	Measure 2: Average score was the 62nd percentile compared to national norms.	Measure 2: This shows that students are developing effective problem solving skills as compared to national norms.	
	Measure 1: Spring 2017	Measure 1: Previous	Measure 1: The class	Measure 1: Class average	Homework assignments

Course CHEM 1220			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Students completed 11 weekly homework assignments requiring solving quantitative problems in each subject covered by the course.	research shows that students who earned at least 50% of available credit on quiz and homework assignments passed CHEM 1220 (grade of C- or better) with 97% probability.	average score on weekly homework assignments was 88%.	scores were well above the threshold for predicted success in the course.	were designed to encourage peer instruction and teamwork in solving the quantitative problems, although each student had a different set of assigned problems to solve. High scores on this assignment indicated mastery of both teamwork and problem-solving skills.
Learning Outcome 3: Laboratory Skills	Measure 1: Lab reports that depend on understanding and execution of lab concepts and technique.	Measure 1: 90% of students will score above 69% on the lab reports.	Measure 1: 97% of students scored above 69%.	Measure 1: Students are mastering lab concepts and techniques.	Measure 1: No plans to change.
	Measure 1: Spring 17 Laboratory reports	Measure 1: Average score of 70% or better	Measure 1: Student average on all lab reports was 90%	Measure 1: Students successfully demonstrated skills	Measure 1: Further refinement of laboratories and reports to enhance laboratory skills
	Measure 2: Spring 2017	Measure 2: Greater than 80% of students get higher than 70% grade in laboratory	Measure 2: 98% of students in the class received greater than 70% in the	Measure 2: Significant improvement over 2016	

Course CHEM 1220			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
			lab. In 2015, only 84% received greater than 70%)		
	Measure 1: Spring 2017 Laboratory final assesses practical and theoretical knowledge and skill.	Measure 1: >Average grade equal or better than 70% in lab.	Measure 1: The average grade on the lab final was 70.5%.	Measure 1: 3% improvement over last semester. We'd like to do better, but this is a challenging final.	This is a new lab final so we are not sure how to compare to last year. We are working to improve these inquiry-based labs every year.
	Measure 2: Spring 2017	Measure 2: Greater than 80% of students get higher than 70% grade in laboratory	Measure 2: 98% of students in the class received greater than 70% in the lab. In 2015, only 84% received greater than 70%)	Measure 2: Significant improvement over 2016	
	Measure 1: Spring 2017 Students were assigned 13 laboratory experiments including pre-lab assessments and post-lab reports.	Measure 1: Students were required to complete 60% of the available laboratory points in order to pass the overall course.	Measure 1: The class average score on the laboratory portion of the course was 93%.	Measure 1: Class average scores were well above the threshold for predicted success in the course.	Students in this section completed laboratory experiments under the direction of faculty teaching other sections of CHEM 1220.
Learning Outcome 4:	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable

Course CHEM 1220			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Presentation Skills	Measure 1: Spring 2017 Students were required to write a paper on a chemical process or technology and describe the impact of that technology on society. Each student made a brief oral presentation of the paper to the class.	Measure 1: Scores of 50% or more on this assignment demonstrated that students were able to articulate the connection between chemistry and risks/benefits to society in both written and oral presentations.	Measure 1: The class average score on this assignment was 90%.	Measure 1: Class average scores were well above the threshold for demonstrating mastery of understanding the roles of chemical technology in society.	Measure 1: This assignment helped students to appreciate the wider role of chemistry in society and will be continued in subsequent course offerings.
Learning Outcome 5: Computer Skills	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable
	Measure 1: Spring 2017 Successful completion of Aleks online homework requires competency in working with computers	Measure 1: Greater than 80% average score on Aleks.	Measure 1: Average Aleks score was 83.3 compared to 85 % in 2016%	Measure 1: This is a positive start, but we need to incorporate computer literacy into our courses more.	We are using computer skills in lab, but need to specifically assess them in the future.
	Measure 1: Spring 2017 Students were required to complete three midterm practice exams online, including qualitative and quantitative	Measure 1: Scores of 85% or better on these assignments demonstrate individual student mastery of knowledge,	Measure 1: Class average scores on this assignment were 94%. The lowest score on this assignment (average of 4	Measure 1: Class scores for every student in the course exceeded the threshold for coursework mastery.	Measure 1: This summative assessment demonstrated that every student successfully mastered the course material, and will be

Course CHEM 1220			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	question items, plus an ACS standard final exam.	concepts and problem-solving skills in the course.	exams) was 91%.		continued in subsequent course offerings.

Course: Organic Chemistry I

Course CHEM 2310			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Knowledge & Comprehension of the core concepts of chemistry	Measure 1: Fall 2016 Performance on comprehensive final exam.	Measure1: The average on the final exam will be at least 140 out of 200.	Measure 1: In the Fall 2016 semester, the class average was 136.	Measure 1: The class average performance was slightly below the standard.	Look at problems missed by 25% of the class and cover those topics in greater depth in the future. Make note of commonly missed problems. Hold review sessions.
	Measure 2: Fall 2016 Midterm exams	Measure 2: The average of the 3 midterm exams averages will be >70%.	Measure 2: The average of the 3 midterm exams was 68.	Measure 2: The average of the 3 exams was slightly below the standard.	
	Measure 1: Fall 2016 Final exam Chem 2310	Measure 1: 54.15% (40 students)	Measure 1: Lower than 60-80%	Measure 1: Many students are unprepared and overloaded.	Random homework card collection was effective, but impractical (time consuming). Class attendance noticeably improved. Have students present problems in class instead. Exam questions were analyzed, revisions and corrections made.
	Measure 2: Fall 2016 Midterm exams Chem 2310	Measure 2: 71.3, 64.0, 65.7, 54.8	Measure 2: All but exam 4 in 60-80% range.	Measure 2: Many students are unprepared and overloaded.	
	Measure 1: Spring 2017 Final exam Chem 2310	Measure 1: 64.7% (48 students)	Measure 1: In 60-80% range	Measure 1: Acceptable performance.	Random homework card collection was effective, but impractical

Course CHEM 2310			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Measure 2: Spring 2017 Midterm exams Chem 2310	Measure 2: 73.4, 67.5, 66.4, 75.6	Measure 2: All in 60-80% range	Measure 2: Acceptable performance.	(time consuming). Class attendance noticeably improved. Have students present problems in class instead. Exam questions were analyzed, revisions and corrections made.
Learning Outcome 2: Develop problems solving skills	Measure 1: Fall 2016 Performance on comprehensive final exam.	Measure 1: The average on the final exam will be at least 140 out of 200.	Measure 1: In the Fall 2016 semester, the class average was 136.	Measure 1: The class average performance was slightly below the standard.	Look at problems missed by 25% of the class and cover those topics in greater depth in the future. Make note of commonly missed problems. Hold review sessions.
	Measure 2: Fall 2016 Midterm exams	Measure 2: The average of the 3 midterm exams averages will be >70%.	Measure 2: The average of the 3 midterm exams was 68.	Measure 2: The average of the 3 exams was slightly below the standard.	
	Measure 1: Fall 2016 Final exam Chem 2310	Measure 1: 54.15% (40 students)	Measure 1: Lower than 60-80%	Measure 1: Trailer section had several repeating students who did poorly fall 2014.	Random homework card collection was effective, but impractical (time consuming). Class attendance noticeably improved. Have
	Measure 2: Fall 2016 Midterm exams Chem 2310	Measure 2: 71.3, 64.0, 65.7, 54.8	Measure 2: All but exam 4 in 60-80% range.	Measure 2: Trailer section had several repeating	

Course CHEM 2310			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
				students who did poorly fall 2014.	students present problems in class instead. Exam questions were analyzed, revisions and corrections made
	Measure 1: Spring 2017 Final exam Chem 2310	Measure 1: 64.7% (48 students)	Measure 1: In 60-80% range	Measure 1: Acceptable performance.	Random homework card collection was effective, but impractical (time consuming). Class attendance noticeably improved. Have students present problems in class instead. Exam questions were analyzed, revisions and corrections made.
	Measure 2: Spring 2017 Midterm exams Chem 2310	Measure 2: 73.4, 67.5, 66.4, 75.6	Measure 2: All in 60-80% range.	Measure 2: Acceptable performance.	
Learning Outcome 3: Laboratory Skills	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable
Learning Outcome 4: Presentation Skills	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable
Learning Outcome 5: Computer Skills	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable

Course: Organic Chemistry I Lab

Course CHEM 2315			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Knowledge & Comprehension of the core concepts of chemistry	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable
Learning Outcome 2: Develop problems solving skills	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable
Learning Outcome 3: Laboratory Skills	Measure 1: Spring 2017 Comparison of overall percentages.	Measure 1: Class average will be a B grade or higher.	Measure 1: The average percent for the class was 77%, which correlates to a B- grade.	Measure 1: Grades were slightly lower than expected.	Measure 1: Lower score due to removing participation points, but still improve clarity of expectations. Measure 2: No action needed.
	Measure 2: Spring 2017 Score on lab final where available.	Measure 2: Class score on final will be at least 60%.	Measure 2: The average on the lab final was 77%.	Measure 2: The standard was met.	
	Measure 1: Spring 2017 Laboratory Final Exam Chem 2315	Measure 1: 40 (80%) 19 students	Measure 1: In 60-80% range.	Measure 1: Acceptable performance	Some new exam questions were used. Exam questions were analyzed, revisions and corrections made.
	Measure 2: Spring 2017 Laboratory Scores Chem 2315	Measure 2: 225.3 (83.5%)	Measure 2: In 70-90% range.	Measure 2: Acceptable performance.	
Learning Outcome 4: Presentation Skills	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable
	Measure 1:	Measure 1:	Measure 1:	Measure 1:	Measure 1:

Course CHEM 2315			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 5: Computer Skills	Spring 2017 Comparison of overall percentages.	Class average will be a B grade or higher.	The average percent for the class was 77%, which correlates to a B- grade.	Grades were slightly lower than expected.	Lower score due to removing participation points, but still improve clarity of expectations.
	Measure 2: Spring 2017 Score on lab final where available.	Measure 2: Class score on final will be at least 60%.	Measure 2: The average on the lab final was 77%.	Measure 2: The standard was met.	Measure 2: No action needed.

Course: Organic Chemistry II

Course CHEM 2320			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Knowledge & Comprehension of the core concepts of chemistry	Measure 1: Spring 2017 Performance on the ACS standardized exam, which contains material from both semesters of Organic Chemistry.	Measure 1: The average on the ACS exam will be at least 65 out of 100 and at least 20% of the class will score +90%.	Measure 1: The average on the ACS exam was 77% and 28% of the class scored 90+ percent of the exam.	Measure 1: The class exceeded this standard.	Measure 1: No further action needed. Measure 2: No further action needed.
	Measure 2: Spring 2017 Midterm exams	Measure 2: The average of the 4 midterm exams averages will be >70%.	Measure 2: The class average of the 4 midterm exams was 75.7%.	Measure 2: The class exceeded the standard.	
	Measure 1: Fall 2016 ACS Final exam Chem 2320	Measure 1: 53.5 (76.4)% (12 students)	Measure 1: In 60-80% range	Measure 1: Acceptable performance.	Students presented homework problems in

Course CHEM 2320		Evidence of Learning: Courses within the Major			
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Measure 2: Fall 2016 Midterm exams Chem 2320	Measure 2: 74.4, 68.5, 73.8, 67.4	Measure 2: All in 60-80% range.	Measure 2: Acceptable performance.	class. Exam questions were analyzed, Revisions and corrections made
	Measure 1: Spring 2017 ACS Final exam Chem 2320	Measure 1: 45.0 (64.3)% (9 students)	Measure 1: In 60-80% range	Measure 1: Acceptable performance.	Students presented homework problems in class. Exam questions were analyzed, Revisions and corrections made.
	Measure 2: Spring 2017 Midterm exams Chem 2320	Measure 2: 71.7, 70.1, 58.3, 71.4	Measure 2: All but exam 3 in 60-80% range.	Measure 2: Acceptable performance.	
Learning Outcome 2: Develop problems solving skills	Measure 1: Spring 2017 Performance on the ACS standardized exam, which contains material from both semesters of Organic Chemistry.	Measure 1: The average on the ACS exam will be at least 65 out of 100 and at least 20% of the class will score +90%.	Measure 1: The average on the ACS exam was 77% and 28% of the class scored 90+ percent of the exam.	Measure 1: The class exceeded this standard.	Measure 1: No further action needed.
	Measure 2: Spring 2017 Midterm exams	Measure 2: The average of the 4 midterm exams averages will be >70%.	Measure 2: The class average of the 4 midterm exams was 75.7%.	Measure 2: The class exceeded the standard.	Measure 2: No further action needed.
	Measure 1: Spring 2017 ACS Final exam Chem 2320	Measure 1: 45.0 (64.3)% (9 students)	Measure 1: In 60-80% range.	Measure 1: Acceptable performance.	Students presented homework problems in class. Exam
	Measure 2:	Measure 2:	Measure 2:	Measure 2:	

Course CHEM 2320			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Spring 2017 Midterm exams Chem 2320	71.7, 70.1, 58.3, 71.4	All but exam 3 in 60-80% range.	Acceptable performance.	questions were analyzed, Revisions and corrections made.
	Measure 1: Spring 2017 ACS Final exam Chem 2320	Measure 1: 45.0 (64.3)% (9 students)	Measure 1: In 60-80% range.	Measure 1: Acceptable performance.	Students presented homework problems in class. Exam questions were analyzed, Revisions and corrections made.
	Measure 2: Spring 2017 Midterm exams Chem 2320	Measure 2: 71.7, 70.1, 58.3, 71.4	Measure 2: All but exam 3 in 60-80% range.	Measure 2: Acceptable performance.	
Learning Outcome 3: Laboratory Skills	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable
Learning Outcome 4: Presentation Skills	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable
Learning Outcome 5: Computer Skills	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable

Course: Organic Chemistry II Lab

Course CHEM 2325		Evidence of Learning: Courses within the Major			
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Knowledge & Comprehension of the core concepts of chemistry	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable
Learning Outcome 2: Develop problems solving skills	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable
Learning Outcome 3: Laboratory Skills	Measure 1: Spring 2017 Comparison of overall percentages.	Measure 1: Class average will be a B grade or higher.	Measure 1: One lab average was 80% and the other 84%, so both average a B grade	Measure 1: All labs met the standard.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 2: Spring 2017 Score on lab final where available.	Measure 2: Class score on final will be at least 60%.	Measure 2: One lab average was 56% and the other 76%.	Measure 2: One section met the standard and the other did not.	Measure 2: No curricular or pedagogical changes needed at this time
	Measure 1: Fall 2016 Laboratory final Chem 2325	Measure 1: 39 (78%)	Measure 1: In 60-80% range	Measure 1: Acceptable performance	Exam questions were analyzed, Revisions and corrections made.
	Measure 2: Fall 2016 Laboratory Scores Chem 2325	Measure 2: 250.5 (92.8%)	Measure 2: In 70-90% range	Measure 2: Better than goal.	
Learning Outcome 4: Presentation Skills	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable
	Measure 1:	Measure 1:	Measure 1:	Measure 1:	Measure 1:

Course CHEM 2325			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 5: Computer Skills	Spring 2017 Comparison of overall percentages.	Class average will be a B grade or higher.	One lab average was 80% and the other 84%, so both average a B grade	All labs met the standard.	No curricular or pedagogical changes needed at this time.
	Measure 2: Spring 2017 Score on lab final where available.	Measure 2: Class score on final will be at least 60%.	Measure 2: One lab average was 56% and the other 76%.	Measure 2: One section met the standard and the other did not.	Measure 2: . No curricular or pedagogical changes needed at this time
	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not Applicable

Course: Quantitative Analysis

Course CHEM 3000			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Knowledge & Comprehension of the core concepts of chemistry	Measure 1: Fall 2016 Exams All exams are essay-style to assess student mastery of problem solving skills.	Measure 1: Average overall exam score of 70% of all possible exam points	Measure 1: The average overall exam score was 78%, indicating that students successfully learned the concepts of analytical chemistry and how to solve related problems.	Measure 1: 73% of students had more than 70% of all possible exam points. The range was from 57% to 100%.	Continue the current format to teaching quantitative analysis in CHEM 3000. Even those students who did score below 70% were able to pass the course. The department is considering using an ACS analytical chemistry exam for assessment in Fall 2017.
Learning Outcome 2: Develop problems solving skills	Measure 1: Fall 2016 Graded homework assignments to help students learn effective problem solving strategies.	Measure 1: Target homework score of 75%.	Measure 1: 86% average, ranging from 70% to 100%. Only 20% of students scored less than 75% of points.	Measure 1: Students who complete the homework assignments regularly seem to acquire the problem solving skills.	No curricular or pedagogical changes needed at this time.
	Measure 2: Fall 2016 Students maintain a laboratory notebook where all data and analyses are recorded. Notebooks are	Measure 2: Target laboratory score of 75% represents good mastery of problem solving.	Measure 2: Student average laboratory score is 84%. The range is from 62% to 98%.	Measure 2: CHEM 3000 laboratory notebooks and reports are highly effective for teaching students problem solving skills	Measure 2: No curricular or pedagogical changes needed at this time.

Course CHEM 3000			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	regularly collected and reports are scored on completeness, accuracy, and precision of data analysis. This requires students to apply the problem solving skills learned in the lecture portion of the course.			related to analytical chemistry.	
Learning Outcome 3: Laboratory Skills	Measure 1: Fall 2016 Laboratory skills are assessed through review of laboratory notebooks and reports, and by observation of students as they work. Analytical laboratory skills are assessed by grading student reports on accuracy and precision of their data, including a statistical measure of the confidence level	Measure 1: Target laboratory score of 75% represents good mastery of analytical laboratory skills.	Measure 1: Student average laboratory score is 84%. The range is from 62% to 98%.	Measure 1: CHEM 3000 is a highly effective course for teaching students the quantitative laboratory skills that are essential for an analytical chemist.	Continue to assess and identify areas where student performance can be improved.

Course CHEM 3000			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	of their results based on uncertainty in their laboratory technique.				
Learning Outcome 4: Presentation Skills	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable
Learning Outcome 5: Computer Skills	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable

Course: Computer Applications

Course CHEM 3020			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Knowledge & Comprehension of the core concepts of chemistry	Measure 1: Fall 2016 Final Exam All exams questions are essay-style to assess student mastery of problem solving skills using a computer.	Measure 1: Average final score of 80% for 80% of class	Measure 1: The average final exam score was 90%. Scores ranged from 82% to 99%,	Measure 1: Students successfully learned the concepts of solving analytical chemistry problems with a computer.	No curricular or pedagogical changes needed at this time.
	Measure 1: Spring 2017 Students compute the acid content of unknown solutions by titration method analysis: they evaluate endpoints by three different numerical analysis methods and determine which method works the best Concepts: Acid-base equilibrium, pH changes near equivalence.	Measure 1: Students program Excel spreadsheets to calculate the resulting equivalence points from acid/base titration data; 80% of students successfully complete this assignment.	Measure 1: Student-generated spread-sheets are collected and analyzed. Example copies of student work are kept on file.	Measure 1: Each student's submitted spreadsheet is analyzed to determine if the objectives are being achieved. 80% of the students will achieve a minimum score of 70% on this assignment.	
	Measure 2: Spring 2017 Students calculate and	Measure 2: Students program Excel spreadsheets to	Measure 2: Student programs and resulting	Measure 2: Each student's submitted spreadsheet is	

Course CHEM 3020			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	discover the change in percent ionization and resulting pH of weak acids in aqueous solutions as a function of concentration.	calculate the ionization of weak acids at multiple different concentrations. 80% of students successfully complete this assignment.	reports are collected and analyzed. Example electronic copies of their work are retained.	analyzed to determine if the objectives are being achieved. 80% of the students will achieve a minimum score of 70% on this assignment.	
Learning Outcome 2: Develop problems solving skills	Measure 1: Fall 2016 Graded homework assignments to help students learn effective problem solving strategies using a computer.	Measure 1: Target homework score of 75%.	Measure 1: 80% average, ranging from 63% to 99%. Only 8% of students scored less than 75% of points.	Measure 1: Students who complete the homework assignments regularly seem to acquire the problem solving skills.	No curricular or pedagogical changes needed at this time.
	Measure 1: Spring 2017 Students analyze data in a series of 20 computer spreadsheet activities throughout the course.	Measure 1: 80% of students successfully complete 5 specific spreadsheet activities designed as measurement tools. Final exam extends upon basic concepts learned in class and on homework assignments.	Measure 1: Student-generated spread-sheets are collected and analyzed. Example copies of student work are kept on file.	Measure 1: Each student's 5 submitted spreadsheets are analyzed to determine if the objectives for the respective spreadsheets are being achieved. Each student will achieve a minimum score of 70% on each assignment.	No curricular or pedagogical changes needed at this time.

Course CHEM 3020			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Measure 2: Spring 2017 Students utilize "if…" statements in Excel programming to probe numerical values and determine if they meet certain criteria.	Measure 2: Students must identify at least 80% of the correct determinations of % moisture calculations in powdered matrices.	Measure 2: Student programs and resulting reports are collected and analyzed. Example electronic copies of their work are retained.	Measure 2: Each student will achieve at least 80% of the correct determinations for this activity.	
Learning Outcome 3: Laboratory Skills	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable
Learning Outcome 4: Presentation Skills	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable
Learning Outcome 5: Computer Skills	Measure 1: Fall 2016 Final Exam All exams questions are essay-style to assess student mastery of problem solving skills using a computer.	Measure 1: Average final score of 80% for 80% of class	Measure 1: The average final exam score was 90%. Scores ranged from 82% to 99%,	Measure 1: Students successfully learned the concepts of solving analytical chemistry problems with a computer.	
	Measure 2: Fall 2016 Graded homework assignments to help students learn effective	Measure 2: Target homework score of 75%.	Measure 2: 80% average, ranging from 63% to 99%. Only 8% of students scored less	Measure 2: Not applicable Students who complete the homework assignments regularly seem	

Course CHEM 3020			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	problem solving strategies using a computer.		than 75% of points.	to acquire the problem solving skills.	
	Measure 1: Spring 2017 Students analyze data in a series of 20 computer spreadsheet activities throughout the course.	Measure 1: 80% of students successfully complete 5 specific spreadsheet activities designed as measurement tools.	Measure 1: Student-generated spread-sheets are collected and analyzed. Example copies of student work are kept on file.	Measure 1: Each student's 5 submitted spreadsheets are analyzed to determine if the objectives for the respective spreadsheets are being achieved. Each student will achieve a minimum score of 70% on each assignment.	If less than 80% of the students in the course are not reaching a minimum of 70% on each of the 5 spreadsheets or molecular drawing, extra lecture time and more emphasis will be given to the topics covered in the one or more of the respective spreadsheet skills.
	Measure 2: Spring 2017 In addition to calculating numbers with computers, students are now expected to draw molecular structures and apply software tools to name compounds, determine mass	Measure 2: 80% of students will successfully complete at least one specific activity in drawing molecular structures for compounds assigned by the instructor.	Measure 2: Students create electronic images of their reports and submit (paperless) reports electronically. The instructor grades these; example copies are	Measure 2: Each student's molecular drawings are analyzed and each students is expected to achieve a minimum score of 70% on this assignment.	

Course CHEM 3020			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	spectral fragmentations, and estimate other physical constants.		maintained on file.		

Course: Instrumental Analysis

Course CHEM3050	Evidence of Learning: Courses within the Major				
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Knowledge & Comprehension of the core concepts of chemistry	Measure 1: Spring 2017 Exams All exams are essay-style to assess student mastery of problem solving skills.	Measure 1: 70% of students will score above 70% of all possible exam points	Measure 1: 1007% of students had more than 70% of all possible exam points. The range was from 71% to 90%.	Measure 1: The average overall exam score was 80%, indicating that the majority of students successfully learn the concepts of instrumental analysis and how to solve related problems.	Continue the current format of teaching instrumental analysis in CHEM 3050. All students passed the course.
Learning Outcome 2: Develop problems solving skills	Measure 1: Spring 2017 Graded homework assignments to help students learn effective problem solving strategies.	Measure 1: Target homework score of 75%.	Measure 1: 93% average, ranging from 80% to 100%.	Measure 1: Students who complete the homework assignments regularly seem to acquire the problem solving skills.	No curricular or pedagogical changes needed at this time.
	Measure 2: Spring 2017 Students maintain a laboratory notebook where all data and analyses are recorded. Notebooks are collected weekly. Reports are scored on completeness,	Measure 2: Target cumulative laboratory score of 75% represents good mastery of problem solving.	Measure 2: Student average cumulative laboratory scores are over 83%. The range is from 61% to 93%.	Measure 2: CHEM 3050 laboratory notebooks and reports are highly effective for teaching students problem solving skills related to instrumental analysis.	

Course CHEM3050			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	accuracy, and precision of data analysis. This requires students to apply the problem solving skills learned in the lecture portion of the course.				
Learning Outcome 3: Laboratory Skills	Measure 1: Spring 2017 Laboratory sills are assessed through weekly review of laboratory notebooks and reports, and by observation of students as they work. Analytical laboratory skills are assessed by grading student reports on accuracy and precision of their data, including a statistical measure of the confidence level of their results based on uncertainty in their laboratory technique.	Measure 1: Target cumulative laboratory score of 75% represents good mastery of analytical laboratory skills.	Measure 1: Student average cumulative laboratory scores are over 89%. The range is from 82% to 93%.	Measure 1: CHEM 3050 is a highly effective course for teaching students the instrumental analysis laboratory skills that are essential for an analytical chemist.	Continue to assess and identify areas where student performance can be improved. No curricular or pedagogical changes needed at this time.

Course CHEM3050			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Measure 2: Spring 2017 Effective laboratory notebook keeping skill is evaluated with a laboratory notebook final. Students are asked to answer questions about the experiments they performed during the semester. They have access to their own laboratory notebook for this exam practices for an analytical chemist working in a laboratory.	Measure 2: Target laboratory notebook final score of 70% represents good mastery of laboratory notebook keeping skills	Measure 2: Student average laboratory notebook final scores are 80%. The range is from 68% to 91%.	Measure 2: The scores exceeds the target threshold.	
Learning Outcome 4: Presentation Skills	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable
Learning Outcome 5: Computer Skills	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable

Course: Biochemistry I

Course CHEM 3070		Evidence of Learning: Courses within the Major			
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Knowledge & Comprehension of the core concepts of chemistry	Measure 1: Fall 2016 Students learn the zwitter ionic nature of amino acids and how this is governed by the core concept of acid/base equilibrium.	Measure 1: Students predict and draw the chemical structures of various amino acids at low, neutral, and high pH in aqueous solutions; 80% of students successfully complete this assignment.	Measure 1: Student assignments and exams are collected and analyzed. Example copies of student work are kept on file.	Measure 1: Each student's assignments and exams analyzed to determine if the objectives are being achieved. 80% of the students will achieve a minimum score of 70% on this assignment.	If less than 80% of the students in the course are not reaching a minimum of 70% on each of the 5 spreadsheets and 80% of Measure 2, extra lecture time and more emphasis will be given to the topics covered in the one or more of the respective spreadsheet skills.
	Measure 2: Fall 2016 Students learn that enzymes are sophisticated chemical catalysts.	Measure 2: Students perform rudimentary calculations of enzyme behavior as a function of substrate and enzyme concentrations. 80% of students successfully demonstrate their mastery on assignments and exams.	Measure 2: Student assignments and resulting reports are collected and analyzed. Example electronic copies of their work are retained.	Measure 2: Each student's submitted spreadsheet is analyzed to determine if the objectives are being achieved. 80% of the students will achieve a minimum score of 70% on this assignment and exam questions.	
	Measure 1: Spring 2017 American Chemical Society	Measure 1: The course average on the ACS standardized	Measure 1: The course average on the ACS standardized	Measure 1: Students scored below desired measurement	In an effort to have a standardized exam, I chose to give the ACS

Course CHEM 3070			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	standardized biochemistry exam focusing on core biochemistry concepts score will be used to measure proficiency.	exam is in the 50^{th} percentile (average) across the nation	exam was 35^{th} percentile across the nation	of demonstrating solid understanding of core biochemical concepts	exam for biochemistry. This is the first time it was given. Statistics of this exam tell me what areas we were strong in and what areas need more focus the next time. Additionally, more practice problems through the semester may help with this.
Learning Outcome 2: Develop problems solving skills	Measure 1: Fall 2016 Students apply the Michaelis–Menten equation to calculate the rate of enzyme-catalyzed reactions at various substrate concentrations.	Measure 1: 80% of students successfully complete homework activities and exam questions designed as measurement tools.	Measure 1: Student-generated reports are collected and analyzed. Example copies of student work are kept on file.	Measure 1: Each student's submitted assignments are analyzed to determine if they are being achieved. Each student will achieve a minimum score of 70% on each assignment.	If less than 80% of the students in the course are not reaching a minimum of 70% on each of the 5 spreadsheets and 80% of Measure 2, extra lecture time and more emphasis will be given to the topics covered in the one or more of the respective spreadsheet skills.
	Measure 2: Fall 2016 Students calculate the oxygen transport	Measure 2: 80% of students successfully complete homework activities and	Measure 2: Student-generated reports are collected and analyzed. Example	Measure 2: Each student's submitted assignments are analyzed to determine if they are being	

Course CHEM 3070			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	capacity of hemoglobin.	exam questions designed as measurement tools.	copies of student work are kept on file.	achieved. Each student will achieve a minimum score of 70% on each assignment.	
	Measure 1: Spring 2017 The third exam, which incorporates many aspects of biochemistry, is a good analysis of problem solving skills	Measure 1: Final Exam scores above 70%	Measure 1: The average for the 3rd exam was a 76%.	Measure 1: Students scored above the acceptable measure for this portion of the exam.	This exam is a combination of multiple choice, problem solving, and essay questions. The students performed best on this test as they had practiced throughout the semester.
Learning Outcome 3: Laboratory Skills	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	
Learning Outcome 4: Presentation Skills	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	
Learning Outcome 5: Computer Skills	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	

Course: Biochemistry Lab

Course CHEM 3075			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Knowledge & Comprehension of the core concepts of chemistry	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable
Learning Outcome 2: Develop problems solving skills	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable
Learning Outcome 3: Laboratory Skills	Measure 1: Spring 2017 Students use standard curves to find concentrations of unknown protein samples	Measure 1: Students will get 80% on lab report 8, "Quantitative analysis of soluble proteins"	Measure 1: Students received a 77.5% on lab report 8	Measure 1: Students are close to measured goal for this outcome	These labs represent essential laboratory skills in a biochemistry lab. A more refined assessment could be built to understand if students are understanding the lab skills. Perhaps a direct assessment (in lab) would be better for addressing lab skills.
	Measure 2: Students can interpret results of enzyme kinetics and determine kinetic rate constants from experimental set up	Measure 2: Students will get 80% on lab report 9, "Enzyme kinetics"	Measure 2: Students received a 73.1% on lab report 9	Measure 2: Students are a little below goal for this outcome	
Learning Outcome 4: Presentation Skills	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable
Learning Outcome 5: Computer Skills	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable

Course: Biochemistry II

Course CHEM 3080			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Knowledge & Comprehension of the core concepts of chemistry	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable
Learning Outcome 2: Develop problems solving skills	Measure 1: Spring 2017 Exams All exams are essay-style. Essay exams provide greater insight into a student's understanding of the core concepts that are being taught and detailed information regarding mastery of problem solving skills.	Measure 1: 80% of students will score above 70% of all possible exam points	Measure 1: 83% of students scored 70% or better for all possible exam points. The range was from 62% to 94%.	Measure 1: The average overall exam score was 82%, indicating that the majority of students successfully learned the concepts required for undergraduate level biochemistry and related problems.	Measure 1: Continue the current format for teaching the core concepts in Biochemistry II - CHEM 3080. All students finished with a D grade or higher in this course.
	Measure 2: Spring 2017 Graded homework assignments to help students learn effective problem solving strategies.	Measure 2: Target homework score of 80%.	Measure 2: 87% average score, ranging from 82% to 92%. No student scored less than 80% of the total points.	Measure 2: Students who complete the homework assignments regularly seem to acquire the problem solving skills.	Measure 2: No curricular or pedagogical changes needed at this time.
Learning Outcome 3:	Measure 1: Spring 2017	Measure 1: Target is to	Measure 1: Student	Measure 1: Including I	Measure 1: Continue to

Course CHEM 3080			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Laboratory Skills	There is no laboratory section associated with this class. However, the students are taught about specific biochemical techniques that are used in the lab.	include questions on the 1st exam that tests the student's knowledge of how these laboratory techniques actually work. Students should be able to score at least 70% on these particular questions.	average exam question scores. 83% of the students scored 70% or better on 5 questions directed toward laboratory techniques.	questions, on Exam 1, about laboratory techniques is an effective way of assessing the student's understanding regarding the theory behind biochemical laboratory procedures.	assess and identify areas where student performance can be improved.
Learning Outcome 4: Presentation Skills	Measure 1: Spring 2017 Students are required to synthesize a 5 page written formal report. The assignment requires the student to find 3 journal articles describing a current topic in biochemistry research and present the work as a review of the 3 articles.	Measure 1: Target score is 80% out of 25 points. Measures include Grammar and style of writing - 10 points; Topic - 5 points; Thoroughness of review - 5 points; and Presentation, which includes references and bibliography - 5 points.	Measure 1: The student average for the written assignment was 92%. All students scored above the 80% target.	Measure 1: Written assignments are highly effective in assessing the student's ability to read the literature and formulate a logical response to what is currently happening in biochemical research.	Measure 1: No curricular or pedagogical changes needed at this time.
Learning Outcome 5: Computer Skills	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable

Course: Biochemistry Techniques

Course CHEM 3090			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Knowledge & Comprehension of the core concepts of chemistry	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable
Learning Outcome 2: Develop problems solving skills	Measure 1: Spring 2017 **Exams** 1 final exam is given for this 1 hr. laboratory class.	Measure 1: 70% of students will score above 70% or above on the final exam.	Measure 1: 100% of students scored 70% or greater on the final exam. The range was from 84% to 91%	Measure 1: The average exam score was 88%. All students thoroughly understood the lab assignments and the necessary problem solving skills required to be successful in the lab.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 2: Spring 2017 Students maintain a laboratory notebook where all data and analyses are recorded. Notebooks are regularly collected and reports are scored on completeness, accuracy, and precision of	Measure 2: 80% of the students should have 90% or higher on all laboratory notebooks and laboratory reports.	Measure 2: 100% of the students had more than 90% of the total laboratory points.	Measure 2: Students who complete the lab notebooks and assignments regularly seem to acquire the problem solving skills necessary to do well with data collection and analysis.	Measure 2: No curricular or pedagogical changes needed at this time.

Course CHEM 3090			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	data analysis. Some of mathematical calculation models are given to the students because they are too complicated for derivation.				
	Measure 3: Spring 2017 Pre-laboratory assignments are given to help the students learn the proper problem solving skills needed for a given lab assignment. These assignments are completed at home with all information and example problem solving provided in the laboratory manual.	Measure 3: Target pre-laboratory score of 100% represents good mastery of problem solving necessary for a given laboratory exercise. Since these assignments are completed in advance of the laboratory exercise, it is expected that the students will complete these assignments with a score of 100%.	Measure 3: Student average pre-laboratory scores are over 95%. The range is from 90% to 100%.	Measure 3: Pre-laboratory assignments appear to be effective for teaching students problem solving skills related to the analytical skills that will be needed for a given laboratory exercise.	Measure 3: No curricular or pedagogical changes needed at this time.
Learning Outcome 3: Laboratory Skills	Measure 1: Spring 2017 Laboratory skills are	Measure 1: Target laboratory score of 75%	Measure 1: Student average laboratory	Measure 1: CHEM 3090 is a highly effective course for	Measure 1: Continue to assess and identify areas

Course CHEM 3090			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	assessed through review of laboratory notebooks and reports, and by observation of students as they work. Analytical laboratory skills are assessed by grading student reports on accuracy and precision of their data, including a statistical measure of the confidence level of their results based on uncertainty in their laboratory technique. The students are also required to present their data in a scientific report format with proper computer generated graphs.	represents good mastery of bioanalytical laboratory, presentation and computer skills.	scores are over 95%. The range is from 94% to 96%.	teaching students the quantitative laboratory skills that are essential for a bioanalytical chemist.	where student performance can be improved.
Learning Outcome 4: Presentation Skills	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable

Course CHEM 3090			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 5: Computer Skills	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable	Measure 1: Not Applicable

Course: Foundations in Physical Chemistry I

Course CHEM 3410		Evidence of Learning: Courses within the Major			
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Knowledge & Comprehension of the core concepts of chemistry	Measure 1: Fall 2016 Exam 1 covering thermodynamics (energy, enthalpy, first law of thermodynamics).	Measure 1: 80% of students will score above 69% on the exam.	Measure 1: 87% of students scored above 69%.	Measure 1: 87% of students demonstrated competence in these topics.	After teaching this course for the third time, it was decided that the next time this course was taught, less material will be covered, specifically ending quantum mechanics with particle-in-a-box (Exam 4 proved to contain material, quantum mechanics, that even taken more slowly than other topics, requires even more time for useful understanding). The use of POGIL will be continued to allow for better comprehension for the students and because they seem to enjoy it. Ongoing conversation with the instructor of the optional next course, In-Depth Physical Chemistry, will
	Measure 2: Fall 2016 Exam 2 covering thermodynamics (entropy, Gibbs energy, second and third law of thermodynamics).	Measure 2: 80% of students will score above 69% on the exam.	Measure 2: 100% of students scored above 69%. Two students dropped the class after the first exam due to overloaded schedules.	Measure 2: 100% of students demonstrated competence in these topics.	
	Measure 3: Fall 2016 Exam 3 covering physical and chemical equilibria, chemical potentials, colligative properties, partial molar quantities).	Measure 3: 80% of students will score above 69% on the exam.	Measure 3:73% of students scored above 69%.	Measure 3: 73% of students demonstrated competence in these topics.	
	Measure 4: Fall 2016 Exam 4 covering quantum mechanics (PIB, expectation	Measure 3: 80% of students will score above 69%	Measure 3:40% of students scored above 69%.	Measure 3: 40% of students demonstrated competence in these topics.	

Course CHEM 3410			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	values, wave functions, IR and UV spectroscopy)	on the exam.			continue to determine if the curriculum in this class is appropriate for the next class. N.B.: The ACS has changed its requirements for a chemistry degree and this particular class, Foundational Physical Chemistry, has much leeway in the topics covered (an impossibly long list of suggested topics). Both instructors of physical chemistry are constantly reviewing the curriculum of other ACS programs to stay in sync with this class.
Learning Outcome 2: Develop problems solving skills	Measure 1: Fall 2016 Exam 1 covering thermodynamics (energy, enthalpy, first law of thermodynamics).	Measure 1: 80% of students will score above 69% on the exam.	Measure 1: 87% of students scored above 69%.	Measure 1: 87% of students demonstrated competence in these topics.	After teaching this course for the third time, it was decided that the next time this course was taught, less

Course CHEM 3410		Evidence of Learning: Courses within the Major			
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Measure 2: Fall 2016 Exam 2 covering thermodynamics (entropy, Gibbs energy, second and third law of thermodynamics).	Measure 2: 80% of students will score above 69% on the exam.	Measure 2: 100% of students scored above 69%. Two students dropped the class after the first exam due to overloaded schedules.	Measure 2: 100% of students demonstrated competence in these topics.	material will be covered, specifically ending quantum mechanics with particle-in-a-box (Exam 4 proved to contain material, quantum mechanics, that even taken more slowly than other topics, requires even more time for useful understanding). The use of POGIL will be continued to allow for better comprehension for the students and because they seem to enjoy it. Ongoing conversation with the instructor of the optional next course, In-Depth Physical Chemistry, will continue to determine if the curriculum in this class is appropriate for the next class.
	Measure 3: Fall 2016 Exam 3 covering physical and chemical equilibria, chemical potentials, colligative properties, partial molar quantities).	Measure 3: 80% of students will score above 69% on the exam.	Measure 3:73% of students scored above 69%.	Measure 3: 73% of students demonstrated competence in these topics.	
	Measure 4: Fall 2016 Exam 4 covering quantum mechanics (PIB, expectation values, wave functions, IR and UV spectroscopy)	Measure 3: 80% of students will score above 69% on the exam.	Measure 3:40% of students scored above 69%.	Measure 3: 40% of students demonstrated competence in these topics.	

Course CHEM 3410			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
					N.B.: The ACS has changed its requirements for a chemistry degree and this particular class, Foundational Physical Chemistry, has much leeway in the topics covered (an impossibly long list of suggested topics). Both instructors of physical chemistry are constantly reviewing the curriculum of other ACS programs to stay in sync with this class.
Learning Outcome 3: Laboratory Skills	Measure 1: Fall 2016 Lab reports that depend on understanding and execution of lab concepts and technique.	Measure 1: 90% of students will score above 69% average on the lab reports.	Measure 1: 100% of students scored above 69%.	Measure 1: Students are mastering lab concepts and techniques.	No plans for change.
Learning Outcome 4: Presentation Skills	Measure 1: Fall 2016Lab reports that depend on understanding and execution	Measure 1: 90% of students will score above 69% average on	Measure 1: 100% of students scored above 69%.	Measure 1: Students are mastering lab concepts and techniques.	New lab report rubrics for both formal and informal lab reports will be created and used

Course CHEM 3410			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	(creation of a written report using a word processing program) of lab concepts and technique.	the lab reports.			in class. Though students are acceptably passing lab, their writing about chemical phenomena and their lab results and interpretation could improve.
Learning Outcome 5: Computer Skills	Measure 1: Fall 2016 Lab reports that depend on understanding and execution (creating graphs, use of spreadsheets and word processing programs) of lab concepts and technique.	Measure 1: 90% of students will score above 69% average on the lab reports.	Measure 1: 100% of students scored above 69%.	Measure 1: Students are mastering lab concepts and techniques.	No plans for change. Two new labs (Solid-Liquid Phase Diagram and Kinetics Measured with UV-VIS Spectrometry) were added this year that produced data in spreadsheet form.

Course: Physical Chemistry II

Course CHEM 3420			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Knowledge & Comprehension of the core concepts of chemistry	Measure 1: A written final exam is used as a summative assessment of student understanding of physical chemistry concepts.	Measure 1: 80% average on the exam.	Measure 1: Average was 89% with a high of 100%	Measure 1: Exceeds expectations	Measure 1: Knowledge and comprehension of key concepts of physical chemistry are excellent. Will review exam to ensure that it is sufficiently rigorous.
	Measure 2: Weekly quizzes – A written quiz is used to assess understanding of current material.	Measure 2: 75% average on quizzes.	Measure 2: Class average was 75% with high of 97%.	Measure 2: Class average just meets minimum expected outcome but improvement possible.	Measure 2: Will examine material related to those quizzes that students struggled with and use alternative approaches to teaching it.
	Measure 3: ACS Quantum Mechanics National Exam	Measure 3: Average score above 50th percentile nationally	Measure 3: Average Score was in the 79th percentile with range from 16th to 95th percentile	Measure 3: Overall very good performance on ACS final, well above the national norm, however some students are well below the national norm.	Measure 3: Identify and work directly with students that are struggling with understanding and retention.
Learning Outcome 2:	Measure 1: A written final exam is used	Measure 1: 80% average on the exam.	Measure 1: Spring 16, the average was	Measure 1: Exceeds expectations	Measure 1: Problem solving skills

Course CHEM 3420			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Develop problems solving skills	to assess student problem solving skills.		90% with a high of 98%.		are excellent. Will review exam to ensure that it is sufficiently rigorous.
	Measure 2: Weekly quizzes – A written quiz is used to assess student problem solving skills	Measure 2: 75% average on quizzes.	Measure 2: Class average was 75% with high of 97%.	Measure 2: Class average just meets minimum expected outcome but improvement possible.	Measure 2: Will examine material related to those quizzes that students struggled with and use alternative approaches to teaching it.
	Measure 3: ACS Quantum Mechanics National Exam	Measure 3: Average score above 50th percentile nationally	Measure 3: Average Score was in the 79th percentile with range from 16th to 95th percentile	Measure 3: Overall very good performance on ACS final, well above the national norm, however some students are well below the national norm.	Measure 3: Identify and work directly with students that are struggling with understanding and retention.
Learning Outcome 3: Laboratory Skills	Measure 1: Lab reports that depend on understanding of lab concepts and technique.	Measure 1: Average student scores for lab reports will be 70%.	Measure 1: Average student lab score was 90% with a high of 95%.	Measure 1: Students performed somewhat above the expectation. Efforts to emphasize historically	Measure: 1 Continue to emphasize important concepts.

Course CHEM 3420			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
				challenging concepts appear to have paid off.	
Learning Outcome 4: Presentation Skills	Measure 1: Formal written lab reports are required for four experiments. Reports consist of background, experimental, data, discussion, conclusion, and bibliography sections with an appendix containing calculations and error analysis.	Measure 1: Reports are scored on accuracy of data, completeness and correctness of calculations and error analysis, presentation of data, completeness and readability of the written report, and appropriate citation of literature sources. Composite scores of greater than 67% of possible points represent satisfactory completion of objectives.	Measure 1: Formal report scores averaged 87%.	Measure 1: Exceeds expectations but improvement possible.	Measure 1: Continue to emphasize quality lab report preparation. Propose that department consider implementing a technical writing and presentation requirement within major since these skills are expected but not taught in this course. Work with CHEM 3410 instructor to introduce formal lab report writing skills.
	Measure 2: Students design and carry out a lab experiment of their own design, write a formal report, and give an	Measure 2: Reports are scored as above for formal written lab reports on a 100-point scale. Presentation is graded on 50-point scale, (10	Measure 2: Spring 2016 report and presentation score averages were both 100%	Measure 2: Excellent performance Exceeds expectations.	Measure 2: Continue to emphasize quality lab report preparation. Propose that department consider

Course CHEM 3420			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	oral presentation.	points each) for thoroughness, neatness, clarity, understandability, and general effectiveness. Composite scores of greater than 67% of possible points represent satisfactory completion of objectives.			implementing a technical writing and presentation requirement within major since these skills are expected but not taught in this course. Work with CHEM 3410 instructor to introduce formal lab report writing skills
Learning Outcome 5: Computer Skills	Measure 1: Computational Chemistry is introduced in CHEM 3420 lab. A computational chemistry component is included in each of the other lab experiments.	Measure 1: Informal written lab report is graded on a 10-point scale. Composite scores of greater than 67% of possible points represent satisfactory completion of objectives.	Measure 1: Report average for computational chemistry labs was 80%.	Measure 1: Exceeds expectations but improvement possible.	Measure 1: Monitor student performance to discover trends and adjust as needed.

Course: Medicinal Chemistry

Course CHEM 4250		Evidence of Learning: Courses within the Major			
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Knowledge & Comprehension of the core concepts of chemistry	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	
Learning Outcome 2: Develop problems solving skills	Measure 1: Fall 2016 Students will demonstrate application of medicinal chemistry concepts	Measure 1: Students will achieve an 80% average on the second exam.	Measure 1: Students averaged a 86 % on this exam	Measure 1: Students are able to think about and apply medicinal chemistry concepts	This project was very successful and will be used on the future. A more refined assessment should be developed.
	Measure 2: Fall 2016 Students will develop a hypothesis and write a paper based on medicinal chemistry concepts	Measure 2: Students will achieve an 80% on their written paper.	Measure 2: Students averaged an 89% on their written project	Measure 2: Students were able to extend ideas talked about in class to an original hypothesis and support their hypothesis with online medicinal chemistry resources.	
Learning Outcome 3: Laboratory Skills	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	
Learning Outcome 4: Presentation Skills	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	
Learning Outcome 5: Computer Skills	Measure 1: Fall 2016 Use of software that allows	Measure 1: Students can use software to determine	Measure 1: Students averaged a	Measure 1: Students were able to use modeling	While students understand this how to use the modeling

Course CHEM 4250			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	modeling of protein-ligand binding sites, tested on third exam (take-home style)	key interactions, angstrom lengths, and bond angles in the protein binding site. An 80% is desired on this exam.	90% on this exam	program to demonstrate protein ligand binding sites	system and online medicinal chemistry resources, I will look for a more quantitative way to assess this knowledge.
	Measure 2: Fall 2016 Students demonstrate use of online medicinal chemistry resources	Measure 2: This is measured in the third exam. An 80% is desired on this exam.	Measure 2: Students averaged a 90% on this exam	Measure 2: Students were able to use 3 online medicinal chemistry resources to answer exam questions.	

Course: Spectrometric Separations

Course CHEM 4540		Evidence of Learning: Courses within the Major			
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Knowledge & Comprehension of the core concepts of chemistry	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable
Learning Outcome 2: Develop problems solving skills	Measure 1: Fall 2016 Exams All exams are essay-style to assess student mastery of problem solving skills.	Measure 1: 70% of students will score above 70% of all possible exam points	Measure 1: 67% of students had more than 70% of all possible exam points. The range was from 68% to 88%.	Measure 1: The average overall exam score was 80%, indicating that the majority of students successfully learn the concepts of advanced instrumental methods in analytical chemistry and how to solve related problems.	Continue the current format to teaching in CHEM 4540. Even those students who did score below 70% were able to pass the course. The department is considering using an ACS instrumental methods exam for assessment in Fall 2017. No curricular or pedagogical changes needed at this time.
	Measure 2: Fall 2016 Students maintain a laboratory notebook where all data and analyses are recorded. Notebooks are collected regularly. Students also prepare	Measure 2: Target cumulative laboratory score of 80% represents good mastery of problem solving.	Measure 2: Student average cumulative laboratory scores are over 88%. The range is from 77% to 94%.	Measure 2: CHEM 4540 laboratory notebooks and reports are highly effective for teaching students problem-solving skills related to advanced instrumental methods.	

Course CHEM 4540			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	extensive formal and informal laboratory reports that include estimates of uncertainty based on laboratory technique. Reports are scored on completeness, accuracy, and precision of data analysis.				
Learning Outcome 3: Laboratory Skills	Measure 1: Fall 2016 Laboratory sills are assessed through regular review of laboratory notebooks and a mixture of formal and informal reports. Analytical laboratory skills are assessed by grading student reports on accuracy and precision of their data, including a statistical measure of the	Measure 1: Target cumulative laboratory score of 80% represents good mastery of problem solving.	Measure 1: Student average cumulative laboratory scores are over 88%. The range is from 77% to 94%.	Measure 1: CHEM 4540 laboratory notebooks and reports are highly effective for teaching students problem-solving skills related to advanced instrumental methods.	Continue to assess and identify areas where student performance can be improved.

Course CHEM 4540			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	confidence level of their results based on uncertainty in their laboratory technique.				
Learning Outcome 4: Presentation Skills	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable
Learning Outcome 5: Computer Skills	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable

Course: Foundations Inorganic

Course CHEM 3610			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Knowledge & Comprehension of the core concepts of chemistry	Measure 1: Fall 2016 Solving problems on the final exam tests many of the core concepts of chemistry since they must apply these concepts to be able to complete the problems.	Measure 1: Greater than 60% raw score on ACS standardized final exam.	Measure 1: Average on final exam was 66%. Top score was 88%.	Measure 1: No national norms for this exam. The exam was very challenging so anything above 50% is good.	Work with ACS to help develop national norms. Continue to improve class.
	Measure 2: Fall 2016 Each of the semester exams tested core concepts of chemistry	Measure 2: Average score on semester exams of 75% or higher	Measure 2: Average score of all semester exams was 87%	Measure 2: Students consistently demonstrated core knowledge throughout course.	
Learning Outcome 2: Develop problems solving skills	Measure 1: Fall 2016 Every problem on the final exam involves complex problem solving. Overall final exam score is an excellent measure of problem solving skills.	Measure 1: Overall score of 75% or higher on final exam.	Measure 1: Average on final exam was 66%. Top score was 88%.	Measure 1: No national norms for this exam. The exam was very challenging so anything above 50% is good.	Continue to challenge students throughout course as they continue to develop advanced problem solving skills.
Learning Outcome 3: Laboratory Skills	Measure 1: Fall 2016 Laboratory skills are tested each week in lab with	Measure 1: Combined laboratory score of 75% higher is strong	Measure 1: Average score in laboratory was 84 %.	Measure 1: All students mastered complex laboratory skills as demonstrated	Continue to work to improve lab.

Course CHEM 3610			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	sophisticated experiments that challenge students with complex laboratory tasks. The overall lab grade is a good indicator of laboratory skill both in manipulation of equipment and interpretation of laboratory data.	evidence for mastery of laboratory skills.		by their overall performance in the lab.	
Learning Outcome 4: Presentation Skills	Measure 1: Fall 2016 Grade on Periodic Trends presentation.	Measure 1: Students score greater than 80% on this presentation based on rubric.	Measure 1: Average score was 97%	Measure 1: Students were proficient in their communication of complex theoretical and practical ideas.	
Learning Outcome 5: Computer Skills	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable

Course: Inorganic

Course CHEM 4600			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Knowledge & Comprehension of the core concepts of chemistry	Measure 1: Spring 2017 Solving problems on the final exam tests many of the core concepts of chemistry since they must apply these concepts to be able to complete the problems.	Measure 1: Greater than 60% raw score on ACS standardized final exam.	Measure 1: Average on final exam was 64%. Top score was 80%.	Measure 1: No national norms for this exam. This is the first time that we used it so we have no comparison available. My estimation is that a good student would be able to get 50% on this exam. Getting 80% is exceptional.	Work with ACS to help develop national norms. Continue to improve class.
	Measure 2: Spring 2017 Each of the semester exams tested core concepts of chemistry	Measure 2: Average score on semester exams of 75% or higher	Measure 2:Average score of all semester exams was 95%	Measure 2: Students consistently demonstrated core knowledge throughout course.	
Learning Outcome 2: Develop problems solving skills	Measure 1: Spring 2017 Every problem on the final exam involves complex problem solving. Overall final exam score is an excellent measure of problem solving skills.	Measure 1: Overall score of 75% or higher on final exam.	Measure 1: Average on final exam was 94.5% (up from 90% last year). Low score was 90.1% (up from 85 last year) so all students greatly exceeded the	Measure 1: All students in this course demonstrated high levels of problem solving skills.	Continue to challenge students throughout course as they continue to develop advanced problem solving skills.

Course CHEM 4600			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
			minimum threshold.		
Learning Outcome 3: Laboratory Skills	Measure 1: Spring 2017 Laboratory skills are tested each week in lab with sophisticated experiments that challenge students with complex laboratory tasks. The overall lab grade is a good indicator of laboratory skill both in manipulation of equipment and interpretation of laboratory data.	Measure 1: Combined laboratory score of 75% higher is strong evidence for mastery of laboratory skills.	Measure 1: Average score in laboratory was 95 %.	Measure 1: All students mastered complex laboratory skills as demonstrated by their overall performance in the lab.	This year we added a significant research component to the lab to make it more challenging and increase the impact. Need to develop more robust rubrics for grading in this environment.
Learning Outcome 4: Presentation Skills	Measure 1: Spring 2017 Grade on Weekly presentations.	Measure 1: Students score greater than 80% on average for weekly presentations.	Measure 1: Average score was 92%	Measure 1: Students were proficient in their communication of complex theoretical and practical ideas.	
Learning Outcome 5: Computer Skills	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable

Course: Special Topics

Course CHEM 4700			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Knowledge & Comprehension of the core concepts of chemistry	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable
Learning Outcome 2: Develop problems solving skills	Measure 1: Spring 2017 Students maintain a laboratory notebook where all data and analyses are recorded. Notebooks are regularly collected and reports are scored on completeness, accuracy, and precision of data analysis. Some of the mathematical calculation models are given to the students because they are too complicated for derivation.	Measure 1: 70% of students will score 80% or better on the notebook.	Measure 1: 100% of students scored more than 70% on the laboratory notebook. There was only one student who took the class this past semester and he scored 95%.	Measure 1: The score was 95% - with no range. All of the class members thoroughly understood the lab assignments and problem solving skills required to be successful in this lab class.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 2: Spring 2017 Students must develop a	Measure 2: Students should have a working	Measure 2: The separation method is judged by	Measure 2: Students who complete the lab notebooks	Measure 2: No curricular or pedagogical changes

Course CHEM 4700			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	working method for HPLC analysis of a complicated mixture. This year the students were given a mixture of different Vitamin B1, B2, B3 amide and B3 acid, B5, B7, and B9	knowledge of how to set up a method and run a sequence analysis on 20 different samples.	mathematical separations analysis and quantitative outcome.	and assignments regularly seem to acquire the problem solving skills necessary to do well with data collection and analysis.	needed at this time.
Learning Outcome 3: Laboratory Skills	Measure 1: Spring 2017 Laboratory skills are assessed through review of laboratory notebooks and reports, and by observation of students as they work. Analytical laboratory skills are assessed by grading student reports on accuracy and precision of their data, including a statistical measure of the confidence level of their	Measure 1: Target laboratory score of 75% represents good mastery of bioanalytical laboratory, presentation and computer skills.	Measure 1: Student average laboratory scores are over 95%.	Measure 1: CHEM 3090 is a highly effective course for teaching students the quantitative laboratory skills that are essential for a bioanalytical chemist.	Measure 1: Continue to assess and identify areas where student performance can be improved.

Course CHEM 4700			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	results based on				
Learning Outcome 4: Presentation Skills	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable
Learning Outcome 5: Computer Skills	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable

Course: Materials Chemistry

Course CHEM 4810	Evidence of Learning: Courses within the Major				
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Knowledge & Comprehension of the core concepts of chemistry	Measure 1: Spring 2017 Unit and final exams	Measure 1: Average score of 70% or better	Measure 1: Student average on unit and final exams was 86%	Measure 1: Exam average shows that course format concept coverage is working	Measure 1: No need to make large changes to pedagogy, but small specific changes will be made
	Measure 2: Spring 2017 Course reading	Measure 2: Average score of 80% or better	Measure 2: Student average on course reading was 94%	Measure 2: According to rubric, students read and understood readings	
Learning Outcome 2: Develop problems solving skills	Measure 1: Spring 2017 Homework assignments	Measure 1: Average score of 70% or better	Measure 1: Student average on homework assignments was 87%	Measure 1: Average homework scores show that students are able to solve problems at the level expected	Measure 1: No need to make large changes to homework to emphasize problem solving skills
	Measure 2: Spring 2017 Unit and final exams	Measure 2: Average score of 70% or better	Measure 2: Student average on laboratory notebook was 86%	Measure 2: Exam average shows that course format is working	Measure 2: Be more rigorous and specific with laboratory notebook etiquette
Learning Outcome 3: Laboratory Skills	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable
Learning Outcome 4: Presentation Skills	Measure 1: Spring 2017 Presentation Assignment	Measure 1: Average presentation grade of 70% or better	Measure 1: Student average on presentation was 81%	Measure 1: Students were successful in developing their	Measure 1: No need to make large changes to

Course CHEM 4810			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
				presentation skills	presentation assignment
	Measure 2: Spring2017 Journal Article Readings	Measure 2: Average grade of 70% or better	Measure 2: Student average on journal article readings was 77%	Measure 2: Students were successful in reading journal articles and learn how research science is presented	Measure 2: Be more rigorous and specific with journal article readings
Learning Outcome 5: Computer Skills	Measure 1: Spring 2017 Homework, specifically a computer modeling assignment	Measure 1: Average homework grade of 70% or better	Measure 1 Student average on homework was 87%. Average on the computer modeling assignment was 83%	Measure 1: Students were successful in learning computer skills.	Measure 1: Incorporate more opportunities to learn computer modeling in materials chemistry

Course: Senior Seminar

Course CHEM 4990			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Knowledge & Comprehension of the core concepts of chemistry	Measure 1: Fall 2016-Spring 2017 Students produced a written research paper based on their CHEM 4800 research that would be acceptable for submission to an undergraduate research journal.	Measure 1: 90% of students will write a research paper based on their CHEM 4800 research that would be acceptable for submission to an undergraduate research journal.	Measure 1: 100% of students wrote a research paper based on their CHEM 4800 research that would be acceptable for submission to an undergraduate research journal.	Measure 1: Students successfully interpreted their CHEM 4800 research and created a journal-quality research paper.	Measure 1: No change of plans.
Learning Outcome 2: Develop problems solving skills	Measure 1: Students produced a written research paper based on their CHEM 4800 research that would be acceptable for submission to an undergraduate research journal.	Measure 1: 90% of students will write a research paper based on their CHEM 4800 research that would be acceptable for submission to an undergraduate research journal.	Measure 1: 100% of students wrote a research paper based on their CHEM 4800 research that would be acceptable for submission to an undergraduate research journal.	Measure 1: Students successfully interpreted their CHEM 4800 research and created a journal-quality research paper.	Measure 1: No change of plans.
Learning Outcome 3: Laboratory Skills	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	
Learning Outcome 4:	Measure 1: Students produced a	Measure 1: 90% of students will	Measure 1: 100% of students wrote	Measure 1: Students successfully	Measure 1: No change of plans.

Course CHEM 4990			Evidence of Learning: Courses within the Major		
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Presentation Skills	written research paper based on each student's CHEM 4800 research that would be acceptable for submission to an undergraduate research journal.	write a research paper based on their CHEM 4800 research that would be acceptable for submission to an undergraduate research journal.	a research paper based on their CHEM 4800 research that would be acceptable for submission to an undergraduate research journal.	prepared and communicated their CHEM 4800 research in written form and created a journal-quality research paper.	
	Measure 2: Students produced a poster and gave an oral presentation based on their CHEM 4800 research that would be acceptable at an undergraduate research conference.	Measure 2: 90% of Students will produce a poster and give an oral presentation based on their CHEM 4800 research that would be acceptable at an undergraduate research conference.	Measure 2: 100% of Students produced a poster and gave an oral presentation based on their CHEM 4800 research that would be acceptable at an undergraduate research conference.	Measure 2: Students successfully produced and communicated their CHEM 4800 research in visual (poster) and oral form that would be acceptable at an undergraduate research conference.	Measure 2: No change of plans.
Learning Outcome 5: Computer Skills	Measure 1: Students produced a written research paper using a word-processing program based on each student's CHEM 4800 research that would be acceptable for	Measure 1: 90% of students will write a research paper using a word-processing program based on their CHEM 4800 research that would be acceptable for submission to	Measure 1: 100% of students wrote a research paper using a word-processing program based on their CHEM 4800 research that would be acceptable for submission to	Measure 1: Students successfully prepared using a word-processing program and communicated their CHEM 4800 research in written form and created a	Measure 1: No change of plans. .

Course CHEM 4990	Evidence of Learning: Courses within the Major				
Measurable Learning Outcome	Method of Measurement*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	submission to an undergraduate research journal.	an undergraduate research journal.	an undergraduate research journal.	journal-quality research paper.	
	Measure 2: Students produced a poster using a presentation program (PowerPoint) and gave an oral presentation based on their CHEM 4800 research that would be acceptable at an undergraduate research conference.	Measure 2: 90% of Students will produce a poster using a presentation program (PowerPoint) and give an oral presentation based on their CHEM 4800 research that would be acceptable at an undergraduate research conference.	Measure 2: 100% of Students produced a poster using a presentation program (PowerPoint) and gave an oral presentation based on their CHEM 4800 research that would be acceptable at an undergraduate research conference.	Measure 2: Students successfully produced using a presentation program (PowerPoint) and communicated their CHEM 4800 research in visual (poster) and oral form that would be acceptable at an undergraduate research conference.	Measure 2: No change of plans

<u>Evidence of Learning: General Education Courses</u>
(use as a supplement to your five-year summary, if needed)

Evidence of Learning: General Education Area CHEM 1010 Introductory Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Nature of science	Measure 1: Fall 2016 Elements of the scientific method: Exam 1, Quest. 3	Measure 1: Greater than 60% answer question correctly.	Measure 1: 96.2% of the students answered this question correctly.	Measure 1: Exceeded standard.	Measure 1: No further action necessary.

Evidence of Learning: General Education Area CHEM 1010 Introductory Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Measure 1: Spring 2017 Science knowledge continues to change as new discoveries occur. Exam 1, Quest 11	Measure 1: Greater than 60% answer question correctly.	Measure 1: 83.8% of the students answered this question correctly.	Measure 1: Exceeded standard.	Measure 1: No further action necessary.
	Measure 1: Homework	Measure 1: 60% of students will score 70% or better	Measure 1: Fall 2016: Average homework score 81% Spring 2017: Average homework score 81%	Measure 1: Goals are met.	Measure 1: Adopt LearnSmart reading and Connect homework assignments to encourage participation (new textbook). Online homework system has been effective in practicing concepts.
	Measure 2: Exam 1 (Particles of Matter; Elements of Chemistry; Subatomic Particles) with 60 multiple choice questions Exam 2 (How Atoms Bond, How Molecules Mix, How Chemicals React) with 60	Measure 2: 60% of students will score 70% or better	Measure 2: Fall 2016: Average exam scores 69% Students with Final Grade of C or above: 79% Spring 2017: Average exam score 73% Students with a Final	Measure 2: Goals are met.	Measure 2: Adopt LearnSmart reading and Connect homework assignments to encourage participation (new textbook). Online homework system has been effective in

Evidence of Learning: General Education Area CHEM 1010 Introductory Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	multiple choice questions Exam 3 (Acids and Bases, Organic Compounds, Nutrients of Life) with 60 multiple choice questions		grade of C or above: 72%		practicing concepts.
	Measure 1: Fall 2016 Exam I: Atoms vs Molecules question	Measure 1: Students will score at least 70% on this question	Measure 1: Students scored a 90% on this question	Measure 1: Students understand the concept of a atoms vs molecules	Measure 1: Sufficient time is given to this topic.
	Measure 2: Fall 2016 Exam I: Chemistry classifications	Measure 2: Students will score at least 70% on this question	Measure 2: Students scored a 73% on this question	Measure 2: Students demonstrate understanding of chemistry classifications	Measure 2: This is a good assessment question about chemistry 1010
	Measure 1: Spring 2017 Exam I: Atoms vs Molecules question	Measure 1: Students will score at least 70% on this question	Measure 1: Students scored a 70% on this question	Measure 1: Students understand the concept of a atoms vs molecules	Measure 1: Consider incorporating the assessment of an activity here
	Measure 2: Spring 2017 Exam I: Chemistry classifications	Measure 2: Students will score at least 70% on this question	Measure 2: Students scored a 75% on this question	Measure 2: Students demonstrate understanding of chemistry classifications	Measure 2: This is a good assessment question about chemistry 1010
	Measure 1: Fall 2016 Elements of the scientific method: Exam 1, Quest. 2	Measure 1: Greater than 60% answer question correctly.	Measure 1: Data not available – written exam	Measure 1: N/A	Measure 1: N/A
	Measure 2: Fall 2016	Measure 2:	Measure 2:	Measure 2:	Measure 2:

Evidence of Learning: General Education Area CHEM 1010 Introductory Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Science knowledge continues to change as new discoveries occur. Exam 1, Quest 1	Greater than 60% answer question correctly.	Data not available – written exam	N/A	N/A
	Measure 1: Spring 2017 Elements of the scientific method: Exam 1, Quest. 1	Measure 1: Greater than 60% answer question correctly.	Measure 1: 79% of the students answered this question correctly.	Measure 1: Exceeded standard.	Measure 1: No further action necessary
	Measure 2: Spring 2017 Science knowledge continues to change as new discoveries occur. Exam 1, Quest 5	Measure 2: Greater than 60% answer question correctly.	Measure 2: 79% of the students answered this question correctly.	Measure 2: Exceeded standard.	Measure 2: No further action necessary.
	Measure 1: 100 multiple choice questions from Exam #1	Measure 1: 97.5% of students responded correctly to the question.	Measure 1: 97% of students scored 70% or higher on these collective questions	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
Learning Outcome 2: Integration of science	Measure 1: Fall 2016 Elements of Greenhouse Effect. Exam 1, Quest 2.	Measure 1: Greater than 60% answer question correctly.	Measure 1: 74.1% of the students answered this question correctly.	Measure 1: Exceeded standard.	Measure 1: No further action necessary.
	Measure 1: Spring 2017 Atomic spectra of light, related to	Measure 1: Greater than 60% answer question correctly.	Measure 1: 74.1% of the students answered	Measure 1: Exceeded standard.	Measure 1: No further action necessary.

Evidence of Learning: General Education Area CHEM 1010 Introductory Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Stars ID. Exam 1, Quest 3.		this question correctly.		
	Measure 1: Homework	Measure 1: 60% of students will score 70% or better	Measure 1: Fall 2016: Average homework score 81% Spring 2017: Average homework score 81%	Measure 1: Goals are met.	Measure 1: Adopt LearnSmart reading and Connect homework assignments to encourage participation (new textbook). Online homework system has been effective in practicing concepts.
	Measure 2: Exam 4 (Medicinal Chemistry, Optimizing Food Production, Protecting Water and Air Resources) with 60 multiple choice questions	Measure 2: 60% of students will score 70% or better	Measure 2: Fall 2016: Average exam scores 69% Students with Final Grade of C or above: 79% Spring 2017: Average exam score 73% Students with a Final grade of C or above: 72%	Measure 2: Goals are met.	Measure 2: Adopt LearnSmart reading and Connect homework assignments to encourage participation (new textbook). Online homework system has been effective in practicing concepts.
	Measure 1: Fall 2016 Exam I: Ozone layer	Measure 1: Students will score at least	Measure 1: Students scored a	Measure 1: Students are at desired learning on this question	Measure 1: Ozone layer integrates air pollution

Evidence of Learning: General Education Area CHEM 1010 Introductory Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
		80% on this question	81% on this question		chemistry, reactions, and equilibrium.
	Measure 2: Fall 2016 Exam II: 1st Law Thermodynamics	Measure 2: Students will score at least 80% on this question	Measure 2: Students scored a 83% on this question	Measure 2: Students are at desired learning on this question	Measure 2: Continue talking about and assessing scientific laws
	Measure 1: Spring 2017 Exam I: Ozone layer	Measure 1: Students will score at least 80% on this question	Measure 1: Students scored a 82% on this question	Measure 1: Students are at desired learning on this question	Measure 1: Ozone layer integrates air pollution chemistry, reactions, and equilibrium.
	Measure 2: Spring 2017 Exam II: 1st Law Thermodynamics	Measure 2: Students will score at least 80% on this question	Measure 2: Students scored a 87% on this question	Measure 2: Students are at desired learning on this question	Measure 2: Continue talking about and assessing scientific laws
	Measure 1: Fall 2016 Acidity of lakes. Exam 3, Quest 14.	Measure 1: Greater than 60% answer question correctly.	Measure 1: 86% of the students answered this question correctly.	Measure 1: Exceeded standard.	Measure 1: No further action necessary.
	Measure 2: Fall 2016 Fertility of polar lakes. Exam 2, Quest 2.	Measure 2: Greater than 60% answer question correctly.	Measure 2: Data not available on Chi Tester	Measure 2:	Measure 2:
	Measure 1: Spring 2017 Which of the following is true of ozone? Exam 3, Quest 13.	Measure 1: Greater than 60% answer question correctly.	Measure 1: 75% of the students answered this question correctly.	Measure 1: Exceeded standard.	Measure 1: No further action necessary.
	Measure 2: Spring 2017	Measure 2:	Measure 2:	Measure 2:	Measure 2:

Evidence of Learning: General Education Area CHEM 1010 Introductory Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Solubility of gases. Exam 2, Quest 26.	Greater than 60% answer question correctly.	81% of the students answered this question correctly.	Exceeded standard.	No further action necessary.
	Measure 1: Exam question	Measure 1: 98.32% of students respond correctly to the question.	Measure 1: 98% of students scored 70% or higher on these collective questions	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
Learning Outcome 3: Science and society	Measure 1: Fall 2016 Elements of Greenhouse Effect. Exam 2, Quest 2.	Measure 1: Greater than 60% answer question correctly.	Measure 1: 82.1% of the students answered this question correctly.	Measure 1: Exceeded standard.	Measure 1: No further action necessary.
	Measure 1: Spring 2017 Atomic spectra of light, related to Stars ID. Exam 2, Quest 7.	Measure 1: Greater than 60% answer question correctly.	Measure 1: 76.7% of the students answered this question correctly.	Measure 1: Exceeded standard.	Measure 1: No further action necessary.
	Measure 1: Homework	Measure 1: 60% of students will score 70% or better	Measure 1: Fall 2016: Average homework score 81% Spring 2017: Average homework score 81%	Measure 1: Goals are met.	Measure 1: Adopt LearnSmart reading and Connect homework assignments to encourage participation (new textbook). Online homework system has been effective in

Evidence of Learning: General Education Area CHEM 1010 Introductory Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
					practicing concepts.
	Measure 2: Exam 4 (Medicinal Chemistry, Optimizing Food Production, Protecting Water and Air Resources) with 60 multiple choice questions	Measure 2: 60% of students will score 70% or better	Measure 2: Fall 2016: Average exam scores 69% Students with Final Grade of C or above: 79% Spring 2017: Average exam score 73% Students with a Final grade of C or above: 72%	Measure 2: Goals are met.	Measure 2: Adopt LearnSmart reading and Connect homework assignments to encourage participation (new textbook). Online homework system has been effective in practicing concepts.
	Measure 1: Fall 2016 Exam I: Human activity and air pollutants	Measure 1: Students will score at least 80% on this question	Measure 1: Students scored a 91% on this question	Measure 1: Students are at desired learning on this question	Measure 1: Human impact and chemistry is an important concept in
	Measure 2: Fall 2016 Exam II: Carbon fuels, types of coal	Measure 2: Students will score at least 75% on this question	Measure 2: Students scored a 50% on this question	Measure 2: Students are below learning on this question	Measure 2: Consider an additional activity looking at fuels with better assessment question
	Measure 1: Spring 2017 Exam I: Human activity and air pollutants	Measure 1: Students will score at least 80% on this question	Measure 1: Students scored a 82% on this question	Measure 1: Students are at desired learning on this question	Measure 1: Human impact and chemistry is an important concept in

Evidence of Learning: General Education Area CHEM 1010 Introductory Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Measure 2: Spring 2017 Exam II: Carbon fuels	Measure 2: Students will score at least 75% on this question	Measure 2: Students scored a 70% on this question	Measure 2: Students are at below learning on this question	Measure 2: Consider an additional activity looking at fuels with better assessment question
	Measure 1: Fall 2016 Global Warming effects. Exam 3, Quest 15.	Measure 1: Greater than 60% answer question correctly.	Measure 1: 39% of the students answered this question correctly.	Measure 1: Fell significantly below standard.	Measure 1: Personalize applications.
	Measure 2: Fall 2016 Battery redox chem. Exam 3, Quest 20.	Measure 2: Greater than 60% answer question correctly.	Measure 2: 61% of the students answered this question correctly.	Measure 2: Just did meet the standard.	Measure 2: No further action needed.
	Measure 1: Spring 2017 Applications of Fuel Cell. Exam 3, Quest 32.	Measure 1: Greater than 60% answer question correctly.	Measure 1: 85% of the students answered this question correctly.	Measure 1: Exceeded standard.	Measure 1: No further action necessary.
	Measure 2: Spring 2017 Difference between soap and detergent. Exam 2, Quest 28.	Measure 2: Greater than 60% answer question correctly.	Measure 2: 86% of the students answered this question correctly.	Measure 2: Exceeded standard.	Measure 2: No further action necessary.
	Measure 1: Exam question	Measure 1: 90.46% of students respond correctly to the question.	Measure 1: 79% of students scored 70% or higher on these	Measure 1: Students scored lower than desired	Measure 1: No curricular or pedagogical changes needed at this time.

Evidence of Learning: General Education Area CHEM 1010 Introductory Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
			collective questions		
Learning Outcome 4: Problem solving and data analysis	Measure 1: Spring 2017 Final Exam questions	Measure 1: 70% of students respond correctly to the questions.	Measure 1: 77.4% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Spring 2017 Final Exam questions	Measure 1: 70% of students respond correctly to the questions.	Measure 1: 77.4% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Homework	Measure 1: 60% of students will score 70% or better	Measure 1: Fall 2016: Average homework score 81% Spring 2017: Average homework score 81%	Measure 1: Goals are met.	Measure 1: Adopt LearnSmart reading and Connect homework assignments to encourage participation (new textbook). Online homework system has been effective in practicing concepts.
	Measure 2: Exam 1 (Particles of Matter; Elements of Chemistry; Subatomic	Measure 2: 60% of students will score 70% or better	Measure 2: Fall 2016: Average exam scores 69%	Measure 2: Goals are met.	Measure 2: Adopt LearnSmart reading and Connect homework

Evidence of Learning: General Education Area CHEM 1010 Introductory Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Particles) with 60 multiple choice questions Exam 2 (How Atoms Bond, How Molecules Mix, How Chemicals React) with 60 multiple choice questions Exam 3 (Acids and Bases, Organic Compounds, Nutrients of Life) with 60 multiple choice questions		Students with Final Grade of C or above: 79% Spring 2017: Average exam score 73% Students with a Final grade of C or above: 72%		assignments to encourage participation (new textbook). Online homework system has been effective in practicing concepts.
	Measure 1: Fall 2016 Exam I: Balancing Reactions	Measure 1: Students will score at least 70% on this question	Measure 1: Students scored 79% on this question	Measure 1: Students are above acceptable measure.	Measure 1: Question may have been too easy or sufficient time is given to topic
	Measure 2: Fall 2016 Exam III: Half-life nuclear species	Measure 2: Students will score at least 70% on this question	Measure 2: Students scored 76% on this question	Measure 2: Students are above acceptable measure.	Measure 2: Topic and question a good assessment for this.
	Measure 1: Spring 2017 Exam I: Balancing Reactions	Measure 1: Students will score at least 70% on this question	Measure 1: Students scored 57% on this question	Measure 1: Students are below acceptable measure.	Measure 1: Question may have been too hard or students need to practice this more.
	Measure 2: Spring 2017 Exam III: Half-life nuclear species	Measure 2: Students will score at least 70% on this question	Measure 2: Students scored 76% on this question	Measure 2: Students are above acceptable measure.	Measure 2: Topic and question a good assessment for this.

Evidence of Learning: General Education Area CHEM 1010 Introductory Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Measure 1: Fall 2016 Concentration calculation Exam 2, Quest. 4.	Measure 1: Greater than 60% answer question correctly.	Measure 1: Data not available on Chi Tester	Measure 1:	Measure 1: .
	Measure 2: Fall 2016 Calculate half reaction of redox equat. Exam 3, Quest. 17.	Measure 2: Greater than 60% answer question correctly.	Measure 2: 43% of the students answered this question correctly.	Measure 2: Fell short of standard.	Measure 2: Redox is challenging concept. More examples.
	Measure 1: Spring 2017 Conversion of meters to millimeters. Exam 1, Quest. 8.	Measure 1: Greater than 60% answer question correctly.	Measure 1: 58% of the students answered this question correctly.	Measure 1: Not quite up to standard.	Measure 1: Work additional problems.
	Measure 2: Spring 2017 Bond diss. energy calculation? Exam 3, Quest. 10.	Measure 2: Greater than 60% answer question correctly.	Measure 2: 25% of the students answered this question correctly.	Measure 2: Fell short of standard.	Measure 2: Work addition enthalpy reactions.
	Measure 1: Student Activity Which response is used graphical and data analysis.	Measure 1: 70% of students respond correctly to the question.	Measure 1: 70% of students scored 70% or higher on these collective questions	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
Learning Outcome 1: Organization of systems	Measure 1: Fall 2016 Final Exam questions	Measure 1: 70% of students respond correctly to the questions.	Measure 1: 71.9% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1:	Measure 1:	Measure 1:	Measure 1:	Measure 1:

Evidence of Learning: General Education Area CHEM 1010 Introductory Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Spring 2017 Final Exam questions	70% of students respond correctly to the questions.	77.4% of students respond correctly to the question.	Students successfully demonstrated competence.	No curricular or pedagogical changes needed at this time.
	Measure 1: Homework	Measure 1: 60% of students will score 70% or better	Measure 1: Fall 2016: Average homework score 81% Spring 2017: Average homework score 81%	Measure 1: Goals are met.	Measure 1: Adopt LearnSmart reading and Connect homework assignments to encourage participation (new textbook). Online homework system has been effective in practicing concepts.
	Measure 2: Exam 1 (Particles of Matter; Elements of Chemistry; Subatomic Particles) with 60 multiple choice questions Exam 2 (How Atoms Bond, How Molecules Mix, How Chemicals React) with 60 multiple choice questions	Measure 2: 60% of students will score 70% or better	Measure 2: Fall 2016: Average exam scores 69% Students with Final Grade of C or above: 79% Spring 2017: Average exam score 73% Students with a Final grade of C or above: 72%	Measure 2: Goals are met.	Measure 2: Adopt LearnSmart reading and Connect homework assignments to encourage participation (new textbook). Online homework system has been effective in practicing concepts.

Evidence of Learning: General Education Area CHEM 1010 Introductory Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Exam 3 (Acids and Bases, Organic Compounds, Nutrients of Life) with 60 multiple choice questions				
	Measure 1: Fall 2016 Exam II: Acid base ionization, base dissociation	Measure 1: Students will score at least 70% on this question	Measure 1: Students scored 64% on this question	Measure 1: Students are below acceptable measure.	Measure 1: More class time should be dedicated to this topic. This topic is complex. Perhaps an assessment activity would be better than exam question
	Measure 2: Fall 2016 Exam III: Structure and properties, drug characteristics	Measure 2: Students will score at least 70% on this question	Measure 2: Students scored 56% on this question	Measure 2: Students are below acceptable measure.	Measure 2: Students like this concept and is a good example of chemical organization, however it was rushed this semester.
	Measure 1: Fall 2016 Exam I: Atomic structure	Measure 1: Students will score at least 75% on this question	Measure 1: Students scored 80% on this question	Measure 1: Students demonstrate understanding of atomic structure	Measure 1: Sufficient class time and activities on this topic
	Measure 2: Fall 2016 Exam III: Molecular structure line angle drawings	Measure 2: Students will score at least 75% on this question	Measure 2: Students scored 73% on this question	Measure 2: Students demonstrate understanding of molecular structure, just	Measure 2: Sufficient class time and activities on this topic

Evidence of Learning: General Education Area CHEM 1010 Introductory Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
				slightly below measure	
	Measure 1: Spring 2017 Exam III: Acid base ionization	Measure 1: Students will score at least 70% on this question	Measure 1: Students scored 65% on this question	Measure 1: Students are below acceptable measure.	Measure 1: More class time should be dedicated to this topic. This topic is complex. Perhaps an assessment activity would be better than exam question
	Measure 2: Spring 2017 Exam IV: Structure and properties	Measure 2: Students will score at least 80% on this question	Measure 2: Students scored 87% on this question	Measure 2: Students are above acceptable measure.	Measure 2: Students like this concept and is a good example of chemical organization
	Measure 1: Fall 2016 What is transmutation? Exam 2, Quest 8.	Measure 1: Greater than 60% answer question correctly.	Measure 1: Data not available on Chi Tester	Measure 1:	Measure 1:
	Measure 2: Fall 2016 Electron dot struct for C. Exam 2, Quest 16.	Measure 2: Greater than 60% answer question correctly.	Measure 2: Data not available on Chi Tester	Measure 2:	Measure 2:
	Measure 1: Spring 2017 Which is in the same group as Si? Exam 1, Quest 22.	Measure 1: Greater than 60% answer question correctly.	Measure 1: 75% of the students answered this question correctly.	Measure 1: Exceeded standard.	Measure 1: No further action necessary.
	Measure 2: Spring 2017	Measure 2: Greater than 60% answer	Measure 2: 83% of the students	Measure 2: Exceeded standard.	Measure 2:

Evidence of Learning: General Education Area CHEM 1010 Introductory Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Description of a proton. Exam 1, Quest 29.	question correctly.	answered this question correctly.		No further action necessary.
	Measure 1: Exam question	Measure 1: 98.32% of students respond correctly to the question.	Measure 1: 98% of students scored 70% or higher on these collective questions.	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
Learning Outcome 2: Matter	Measure 1: Fall 2016 Final Exam questions	Measure 1: 70% of students respond correctly to the questions.	Measure 1: 71.9% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Spring 2017 Final Exam questions	Measure 1: 70% of students respond correctly to the questions.	Measure 1: 77.4% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Homework	Measure 1: 60% of students will score 70% or better	Measure 1: Fall 2016: Average homework score 81% Spring 2017: Average homework score 81%	Measure 1: Goals are met.	Measure 1: Adopt LearnSmart reading and Connect homework assignments to encourage participation (new textbook). Online homework system has been effective in

Evidence of Learning: General Education Area CHEM 1010 Introductory Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
					practicing concepts.
	Measure 2: Exam 1 (Particles of Matter; Elements of Chemistry; Subatomic Particles) with 60 multiple choice questions Exam 2 (How Atoms Bond, How Molecules Mix, How Chemicals React) with 60 multiple choice questions Exam 3 (Acids and Bases, Organic Compounds, Nutrients of Life) with 60 multiple choice questions	Measure 2: 60% of students will score 70% or better	Measure 2: Fall 2016: Average exam scores 69% Students with Final Grade of C or above: 79% Spring 2017: Average exam score 73% Students with a Final grade of C or above: 72%	Measure 2: Goals are met.	Measure 2: Adopt LearnSmart reading and Connect homework assignments to encourage participation (new textbook). Online homework system has been effective in practicing concepts.
	Measure 1: Fall 2016 Exam I: Atomic structure	Measure 1: Students will score at least 75% on this question	Measure 1: Students scored 80% on this question	Measure 1: Students demonstrate understanding of atomic structure	Measure 1: Sufficient class time and activities on this topic
	Measure 2: Fall 2016 Exam III: Molecular structure line angle drawings	Measure 2: Students will score at least 75% on this question	Measure 2: Students scored 73% on this question	Measure 2: Students demonstrate understanding of molecular structure, just slightly below measure	Measure 2: Sufficient class time and activities on this topic

Evidence of Learning: General Education Area CHEM 1010 Introductory Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Measure 1: Spring 2017 Exam I: Atomic structure	Measure 1: Students will score at least 75% on this question	Measure 1: Students scored 75% on this question	Measure 1: Students demonstrate understanding of atomic structure	Measure 1: Sufficient class time and activities on this topic
	Measure 2: Spring 2017 Exam IV: Molecular structure	Measure 2: Students will score at least 75% on this question	Measure 2: Students scored 73% on this question	Measure 2: Students demonstrate understanding of molecular structure, just slightly below measure	Measure 2: Sufficient class time and activities on this topic
	Measure 1: Fall 2016 Density of water. Exam 2, Quest. 33	Measure 1: Greater than 60% answer question correctly.	Measure 1: Data not available on Chi Tester.	Measure 1:	Measure 1:
	Measure 2: Fall 2016 Atomic mass of sucrose. Exam 2, Quest. 9	Measure 2: Greater than 60% answer question correctly.	Measure 2: Data not available on Chi Tester	Measure 2:	Measure 2:
	Measure 1: Spring 2017 Comparison between mass & weight. Exam 1, Quest. 9	Measure 1: Greater than 60% answer question correctly.	Measure 1: 71% of the students answered this question correctly.	Measure 1: Exceeded standard.	Measure 1: No further action necessary.
	Measure 2: Spring 2017 Define Chemistry? Exam 1, Quest. 6	Measure 2: Greater than 60% answer question correctly.	Measure 2: 96% of the students answered this question correctly.	Measure 2: Exceeded standard.	Measure 2: No further action necessary.
	Measure 1: Exam question	Measure 1: 97.54% of students	Measure 1: 97% of students	Measure 1: Students did not score as well in	Measure 1: I will include some additional

Evidence of Learning: General Education Area CHEM 1010 Introductory Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
		respond correctly to the question.	scored 70% or higher on these collective questions.	this area as expected	test questions to measure knowledge
Learning Outcome 3: Energy	Measure 1: Fall 2016 Final Exam questions	Measure 1: 70% of students respond correctly to the questions.	Measure 1: 71.9% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Spring 2017 Final Exam questions	Measure 1: 70% of students respond correctly to the questions.	Measure 1: 77.4% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Homework	Measure 1: 60% of students will score 70% or better	Measure 1: Fall 2016: Average homework score 81% Spring 2017: Average homework score 81%	Measure 1: Goals are met.	Measure 1: Adopt LearnSmart reading and Connect homework assignments to encourage participation (new textbook). Online homework system has been effective in practicing concepts.
	Measure 2: Exam 1 (Particles of Matter; Elements of	Measure 2: 60% of students will	Measure 2: Fall 2016: Average	Measure 2: Goals are met.	Measure 2: Adopt LearnSmart reading and

Evidence of Learning: General Education Area CHEM 1010 Introductory Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Chemistry; Subatomic Particles) with 60 multiple choice questions Exam 2 (How Atoms Bond, How Molecules Mix, How Chemicals React) with 60 multiple choice questions Exam 3 (Acids and Bases, Organic Compounds, Nutrients of Life) with 60 multiple choice questions	score 70% or better	exam scores 69% Students with Final Grade of C or above: 79% Spring 2017: Average exam score 73% Students with a Final grade of C or above: 72%		Connect homework assignments to encourage participation (new textbook). Online homework system has been effective in practicing concepts.
	Measure 1: Fall 2016 Exam II: Types of Energy	Measure 1: Students will score at least 80% on this question	Measure 1: Students scored 91% on this question	Measure 1: Students are above acceptable measure.	Measure 1: Question may have been too easy, or sufficient time was given to this topic
	Measure 1: Fall 2016 Exam II: Energy changes	Measure 1: Students will score at least 70% on this question	Measure 1: Students scored 45% on this question	Measure 1: Students do not demonstrate understanding energy changes	Measure 1: More class time and activities on this topic. PHET simulation on this topic
	Measure 1: Spring 2017 Exam II: Types of Energy	Measure 1: Students will score at least 80% on this question	Measure 1: Students scored 90% on this question	Measure 1: Students are above acceptable measure.	Measure 1: Question may have been too easy, or sufficient time was given to this topic
	Measure 1:	Measure 1:	Measure 1:	Measure 1:	Measure 1:

Evidence of Learning: General Education Area CHEM 1010 Introductory Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Spring 2017 Exam IV: Exothermic reaction	Students will score at least 80% on this question	Students scored 82% on this question	Students demonstrate understanding of exothermic reactions	Sufficient class time and activities on this topic
	Measure 1: Fall 2016 Which of the following elements is the most stab nucleus? Exam 2, Quest. 13.	Measure 1: Greater than 60% answer question correctly.	Measure 1: Data not available on Chi Tester	Measure 1:	Measure 1: .
	Measure 2: Fall 2016 Which E profile diagram rep exothermic rxn? Exam 3, Quest. 3	Measure 2: Greater than 60% answer question correctly.	Measure 2: 54% of the students answered this question correctly.	Measure 2: Fell short of standard	Measure 2: Provide additional examples.
	Measure 1: Spring 2017 Which is an example of Potential energy? Exam 1, Quest. 13.	Measure 1: Greater than 60% answer question correctly.	Measure 1: 100% of the students answered this question correctly.	Measure 1: Exceeded standard.	Measure 1: No further action necessary.
	Measure 2: Spring 2017 Einstein's equation. Exam 2, Quest. 2	Measure 2: Greater than 60% answer question correctly.	Measure 2: 19% of the students answered this question correctly.	Measure 2: Fell short of standard	Measure 2: Greater emphasis of correlation of mass & energy.
	Measure 1: Exam question	Measure 1: 58.15% of students respond correctly to the question.	Measure 1: 43% of students scored 70% or higher on these collective questions	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.

Evidence of Learning: General Education Area CHEM 1010 Introductory Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 4: Forces	Measure 1: Fall 2016 Final Exam questions	Measure 1: 70% of students respond correctly to the questions.	Measure 1: 71.9% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Spring 2017 Final Exam questions	Measure 1: 70% of students respond correctly to the questions.	Measure 1: 77.4% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Homework	Measure 1: 60% of students will score 70% or better	Measure 1: Fall 2016: Average homework score 81% Spring 2017: Average homework score 81%	Measure 1: Goals are met.	Measure 1: Adopt LearnSmart reading and Connect homework assignments to encourage participation (new textbook). Online homework system has been effective in practicing concepts.
	Measure 2: Exam 1 (Particles of Matter; Elements of Chemistry; Subatomic Particles) with 60 multiple choice questions	Measure 2: 60% of students will score 70% or better	Measure 2: Fall 2016: Average exam scores 69% Students with Final Grade of C or above: 79%	Measure 2: Goals are met.	Measure 2: Adopt LearnSmart reading and Connect homework assignments to encourage participation

Evidence of Learning: General Education Area CHEM 1010 Introductory Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Exam 2 (How Atoms Bond, How Molecules Mix, How Chemicals React) with 60 multiple choice questions Exam 3 (Acids and Bases, Organic Compounds, Nutrients of Life) with 60 multiple choice questions		Spring 2017: Average exam score 73% Students with a Final grade of C or above: 72%		(new textbook). Online homework system has been effective in practicing concepts.
	Measure 1: Fall 2016 Exam III: Predicting radiation	Measure 1: Students will score at least 70% on this question	Measure 1: Students scored 77% on this question	Measure 1: Students demonstrate understanding of radiation	Measure 1: Sufficient class time and activities on this topic
	Measure 1: Fall 2016 Exam III: Fission energy	Measure 2: Students will score at least 80% on this question	Measure 2: Students scored 87% on this question	Measure 2: Students are above acceptable level	Measure 2: Sufficient time is dedicated to this topic
	Measure 1: Spring 2017 Exam IV: Exothermic reaction	Measure 1: Students will score at least 80% on this question	Measure 1: Students scored 82% on this question	Measure 1: Students demonstrate understanding of exothermic reactions	Measure 1: Sufficient class time and activities on this topic
	l Measure 1: Spring 2017 Exam III: Fission	Measure 2: Students will score at least 70% on this question	Measure 2: Students scored 67% on this question	Measure 2: Students are slightly under acceptable level	Measure 2: More time should be dedicated to this topic
	Measure 1: Fall 2016 Intermolecular forces Exam 2, Quest. 22.	Measure 1: Greater than 60% answer question correctly.	Measure 1: Data not available on Chi Tester	Measure 1:	Measure 1:

Evidence of Learning: General Education Area CHEM 1010 Introductory Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Measure 2: Fall 2016 Which sample shows the greatest adhesive force of attraction? Exam 2, Quest. 36.	Measure 2: Greater than 60% answer question correctly.	Measure 2: Data not available on Chi Tester	Measure 2:	Measure 2:
	Measure 1: Spring 2017 What intermolecular forces are in the following substance? Exam 2, Quest. 22.	Measure 1: Greater than 60% answer question correctly.	Measure 1: 29% of the students answered this question correctly.	Measure 1: Fell short of standard.	Measure 1: Greater emphasis on types of intermolecular attraction.
	Measure 2: Spring 2017 Which sample shows the greatest cohesive force of attraction? Exam 2, Quest. 34.	Measure 2: Greater than 60% answer question correctly.	Measure 2: 95% of the students answered this question correctly.	Measure 2: Exceeded standard.	Measure 2: No further action necessary.
	Measure 1: Exam question	Measure 1: 87.77% of students respond correctly to the question.	Measure 1: 83% of students scored 70% or higher on these collective questions	Measure 1: Students successfully demonstrated understanding.	Measure 1: Will add additional test questions to measure student understanding

*At least one measure per objective must be a direct measure; indirect measures may be used to supplement direct measure(s).

Evidence of Learning: General Education Area CHEM 1050 Intro. General, Organic, & Biochemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Nature of science	Measure 1: Summer 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 81% of students respond correctly to the question.	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Fall 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 81% of students respond correctly to the question.	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Spring 2017 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 79% of students respond correctly to the question.	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Fall 2016, Spring 2017 Students learn chemical concepts related to medical care: %(w/v), Molarity, Normality (equivalents/L), osmolality.	Measure 1: Students prepare solutions of various concen-trations and analyze them by titration and other methods in lab. They also perform calculations involving %, M, N in homework and exams. 80% of students successfully complete these activities.	Measure 1: Student lab reports and lecture exams are evaluated. Example copies of student work are kept on file.	Measure 1: Each student's submitted assignments and exams are analyzed to determine if the objectives are being achieved. 80% of the students will achieve a minimum score of 70% on this assignment.	Measure 1: If less than 80% of the students in the course are not reaching a minimum of 70% on each of the %, M, N and 80% of Measure 2, extra lecture time and more emphasis will be given to the topics covered in the one or more of the respective skills.

Evidence of Learning: General Education Area CHEM 1050 Intro. General, Organic, & Biochemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Measure 2: Fall 2016, Spring 2017 Students learn how to name chemical compounds.	Measure 2: Students name inorganic acids, bases, and salts as well as organic compounds. 80% of students successfully complete these tests and assignments.	Measure 2: Student programs and resulting reports are collected and analyzed. Example electronic copies of their work are retained.	Measure 2: Each student's submitted assignments and exams are analyzed to determine if the objectives are being achieved. 80% of the students will achieve a minimum score of 70% on this assignment.	Measure 2: If less than 80% of the students in the course are not reaching a minimum of 70% on each of the inorganic and organic naming exams and 80% of Measure 2, extra lecture time and emphasis are given.
Learning Outcome 2: Integration of science	Measure 1: Summer 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 77% of students respond correctly to the question.	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Fall 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 77% of students respond correctly to the question.	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Spring 2017 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 76% of students respond correctly to the question.	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1:	Measure 1:	Measure 1:	Measure 1:	Measure 1:

Evidence of Learning: General Education Area CHEM 1050 Intro. General, Organic, & Biochemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Fall 2016, Spring 2017 Students learn about barometric pressure and partial pressure of oxygen affects respiration in humans.	80% of students successfully learn how Dalton's law of partial pressures functions to determine available oxygen for clinical settings. Homework assignments and exams measure student mastery.	Student-homework and exams are collected and analyzed. Example copies of student work are kept on file.	Each student's assignments covering partial pressure are analyzed to determine if the objectives are being achieved. Each student will achieve a minimum score of 70% on each assignment.	If less than 80% of the students in the course are not reaching a minimum of 70% for their related assignments, extra lecture time and more emphasis will be given to the topics.
	Measure 2: Spring 2016 Students apply acid-base chemistry to understand how to enhance the solubility of alkaloid drugs.	Measure 2: 80% of students successfully learn that protonation of organic amines dramatically increases solubility of drugs. Homework assignments and exams measure student mastery.	Measure 2: Student-homework and exams are collected and analyzed. Example copies of student work are kept on file.	Measure 2: Each student's assignments regarding protonation of organic amines are analyzed to determine if the objectives are being achieved. Each student will achieve a minimum score of 70% on each assignment.	Measure 2: If less than 80% of the students in the course are not reaching a minimum of 70% for their related assignments, extra lecture time and more emphasis will be given to the topics.
Learning Outcome 3: Science and society	Measure 1: Summer 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 74% of students respond correctly to the question.	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.

Evidence of Learning: General Education Area CHEM 1050 Intro. General, Organic, & Biochemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Measure 1: Fall 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 73% of students respond correctly to the question.	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Spring 2017 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 75% of students respond correctly to the question.	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable
Learning Outcome 4: Problem solving and data analysis	Measure 1: Summer 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 73% of students respond correctly to the question.	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Fall 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 74% of students respond correctly to the question.	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Spring 2017 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 72% of students respond correctly to the question.	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable	Measure 1: Not applicable
Learning Outcome 1: Organization of systems	Measure 1: Summer 2016 Exam question	Measure 1: 70% of students respond	Measure 1: 84% of students respond	Measure 1: Students successfully	Measure 1: No curricular or pedagogical changes

Evidence of Learning: General Education Area CHEM 1050 Intro. General, Organic, & Biochemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
		correctly to the question.	correctly to the question.	demonstrated understanding.	needed at this time.
	Measure 1: Fall 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 81% of students respond correctly to the question.	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Spring 2017 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 83% of students respond correctly to the question.	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Fall 2016, Spring 2017 Students learn electronic organization and communication skills by preparing and submitting electronic reports in a completely paperless environment.	Measure 1: 100% of students will successfully submit at least 90% of all assignment and lab reports electronically.	Measure 1: Students create electronic images of their reports and submit (paperless) reports electronically. The instructor grades these; example copies are maintained on file.	Measure 1: Each student's electronic submission is analyzed and each student is expected to achieve a minimum score of 90% on this activity.	Measure 1: Any student who does not submit reports electronically is tutored personally to help them accomplish this goal.
	Measure 2: Fall 2016, Spring 2017 Students learn the highly-organized nature of chemical bonds and how this	Measure 2: 80% of students successfully apply the octet rule to describe how atoms combine to form molecules.	Measure 2: Student-homework and exams are collected and analyzed. Example copies of	Measure 2: Each student's assignments regarding chemical bonding are analyzed to determine if the	Measure 2: If less than 80% of the students in the course are not reaching a minimum of 70% for their

Evidence of Learning: General Education Area CHEM 1050 Intro. General, Organic, & Biochemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	applies to all molecular substances in nature.	Homework and exams measure student mastery.	student work are kept on file.	objectives are being achieved. Each student will achieve a minimum score of 70% on each assignment.	related assignments, extra lecture time and more emphasis will be given to the topics.
Learning Outcome 2: Matter	Measure 1: Summer 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 74% of students respond correctly to the question.	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Fall 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 73% of students respond correctly to the question.	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Spring 2017 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 71% of students respond correctly to the question.	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Fall 2016, Spring 2017 Students learn the three primary states of matter: gases, liquids, and solids.	Measure 1: 80% of students successfully describe these states and interconversion between them. Homework and exams measure student mastery.	Measure 1: Student-homework and exams are collected and analyzed. Example copies of student work are kept on file.	Measure 1: Each student's assignments regarding states of matter and are analyzed to determine if the objectives are being achieved. Each student will achieve a minimum score	Measure 1: If less than 80% of the students in the course are not reaching a minimum of 70% for their related assignments, extra lecture time and more emphasis will

Evidence of Learning: General Education Area CHEM 1050 Intro. General, Organic, & Biochemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
				of 70% on each assignment.	be given to the topics.
	Measure 2: Fall 2016, Spring 2017 Students learn the periodic table and how it can be used to understand the behavior of elements.	Measure 2: 80% of students successfully predict metals and non-metals and their periodic repetitive behavior. Homework and exams measure student mastery.	Measure 2: Student-homework and exams are collected and analyzed. Example copies of student work are kept on file.	Measure 2: Each student's assignments regarding the periodic table are analyzed to determine if the objectives are being achieved. Each student will achieve a minimum score of 70% on each assignment.	Measure 2: If less than 80% of the students in the course are not reaching a minimum of 70% for their related assignments, extra lecture time and more emphasis will be given to the topics.
Learning Outcome 3: Energy	Measure 1: Summer 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 81% of students answered the questions correctly.	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Fall 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 77% of students answered the questions correctly.	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Spring 2017 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 79% of students answered the questions correctly.	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1:	Measure 1:	Measure 1:	Measure 1:	Measure 1:

Evidence of Learning: General Education Area CHEM 1050 Intro. General, Organic, & Biochemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Fall 2016, Spring 2017 Students learn about exothermic and endothermic reactions.	80% of students successfully describe exothermic and endothermic reactions. Homework and exams measure student mastery.	Student-homework and exams are collected and analyzed. Example copies of student work are kept on file.	Each student's assignments regarding exothermic and endothermic reactions and are analyzed to determine if the objectives are being achieved. Each student will achieve a minimum score of 70% on each assignment.	If less than 80% of the students in the course are not reaching a minimum of 70% for their related assignments, extra lecture time and more emphasis will be given to the topics.
	Measure 2: Fall 2016, Spring 2017 Students learn about the kinetic nature of matter.	Measure 2: 80% of students successfully understand kinetic nature of matter. Homework and exams measure student mastery.	Measure 2: Student-homework and exams are collected and analyzed. Example copies of student work are kept on file.	Measure 2: Each student's assignments regarding the kinetic nature of matter and are analyzed to determine if the objectives are being achieved. Each student will achieve a minimum score of 70% on each assignment.	Measure 2: If less than 80% of the students in the course are not reaching a minimum of 70% for their related assignments, extra lecture time and more emphasis will be given to the topics.
Learning Outcome 4: Forces	Measure 1: Summer 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 74% of students respond correctly to the question.	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.

Evidence of Learning: General Education Area CHEM 1050 Intro. General, Organic, & Biochemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Measure 1: Fall 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 74% of students respond correctly to the question.	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Spring 2017 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 75% of students respond correctly to the question.	Measure 1: Students successfully demonstrated understanding.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Fall 2016, Spring 2017Students learn about intermolecular forces with special emphasis on hydrogen bonding.	Measure 1: 80% of students successfully describe intermolecular forces. Homework and exams measure student mastery.	Measure 1: Student-homework and exams are collected and analyzed. Example copies of student work are kept on file.	Measure 1: Each student's assignments regarding inter-molecular forces and are analyzed to determine if the objectives are being achieved. Each student will achieve a minimum score of 70% on each assignment.	Measure 1: If less than 80% of the students in the course are not reaching a minimum of 70% for their related assignments, extra lecture time and more emphasis will be given to the topics.
	Measure 2: Fall 2016, Spring 2017 Students learn the highly-organized nature of chemical bonds and how this applies to all molecular	Measure 2: 80% of students successfully apply the octet rule to describe how atoms combine to form molecules. Homework and exams measure student mastery.	Measure 2: Student-homework and exams are collected and analyzed. Example copies of student work are kept on file.	Measure 2: Each student's assignments regarding chemical bonding are analyzed to determine if the objectives are being achieved. Each student	Measure 2: If less than 80% of the students in the course are not reaching a minimum of 70% for their related assignments, extra lecture

Evidence of Learning: General Education Area CHEM 1050 Intro. General, Organic, & Biochemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	substances in nature.			will achieve a minimum score of 70% on each assignment.	time and more emphasis will be given to the topics.

Evidence of Learning: General Education Area CHEM 1110 Elementary Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Nature of science	Measure 1: Laboratory Experience: Prelab and Lab Reports (12 labs)	Measure 1: 70% of students earn an average of 70% or greater.	Measure 1: Fall 2016: Average 83% Spring 2017: Average 85%	Measure 1: Labs are a successful and positive hands-on learning experience.	Measure 1: No change.
	Measure 2: Chapter Exams (13 exams), supported by on-line homework (unlimited attempts as a study tool)	Measure 2: 70% of students earn an average of 70% or greater.	Measure 2: Fall 2016: Average 71% Spring 2017: Average 73%	Measure 2: Overall class averages are on target.	Measure 2: Class contains a broad cross-section of students with differing career goals and different levels of preparation. Restructured this year to have pre-exam review days. Next year adopting new textbook with LearnSmart reading assignments, and Connect on-line homework.
	Measure 1: Summer 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 85% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Fall 2016 Exam question	Measure 1: 70% of students respond	Measure 1: 85% of students respond	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.

Evidence of Learning: General Education Area CHEM 1110 Elementary Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
		correctly to the question.	correctly to the question.		
	Measure 1: Spring 2017 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 84% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
Learning Outcome 2: Integration of science	Measure 1: Laboratory Experience: Prelab and Lab Reports (12 labs)	Measure 1: 70% of students earn an average of 70% or greater.	Measure 1: <u>Fall 2016</u>: Average 83% <u>Spring 2017</u>: Average 85%	Measure 1: Labs are a successful and positive hands-on learning experience.	Measure 1: No change.
	Measure 2: Chapter Exams (13 exams), supported by on-line homework (unlimited attempts as a study tool)	Measure 2: 70% of students earn an average of 70% or greater.	Measure 2: <u>Fall 2016</u>: Average 71% <u>Spring 2017</u>: Average 73%	Measure 2: Overall class averages are on target.	Measure 2: Class contains a broad cross-section of students with differing career goals and different levels of preparation. Restructured this year to have pre-exam review days. Next year adopting new textbook with LearnSmart reading assignments, and Connect on-line homework.
	Measure 1: Summer 2016 Exam question	Measure 1: 70% of students	Measure 1: 76% of students	Measure 1: Students successfully	Measure 1: No curricular or pedagogical

Evidence of Learning: General Education Area CHEM 1110 Elementary Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
		respond correctly to the question.	respond correctly to the question.	demonstrated competence.	changes needed at this time.
	Measure 1: Fall 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 73% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Spring 2017 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 74% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
Learning Outcome 3: Science and society	Measure 1: Laboratory Experience: Prelab and Lab Reports (12 labs)	Measure 1 70% of students earn an average of 70% or greater.	Measure 1: Fall 2016: Average 83% Spring 2017: Average 85%	Measure 1: Labs are a successful and positive hands-on learning experience.	Measure 1: No change.
	Measure 2: Chapter Exams (13 exams), supported by on-line homework (unlimited attempts as a study tool)	Measure 2: 70% of students earn an average of 70% or greater.	Measure 2: Fall 2016: Average 71% Spring 2017: Average 73%	Measure 2: Overall class averages are on target.	Measure 2: Class contains a broad cross-section of students with differing career goals and different levels of preparation. Restructured this year to have pre-exam review days. Next year adopting new textbook with LearnSmart reading

Evidence of Learning: General Education Area CHEM 1110 Elementary Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
					assignments, and Connect on-line homework.
	Measure 1: Summer 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 79% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Fall 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 84% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Spring 2017 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 81% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
Learning Outcome 4: Problem solving and data analysis	Measure 1: Laboratory Experience: Prelab and Lab Reports (12 labs)	Measure 1: 70% of students earn an average of 70% or greater.	Measure 1: Fall 2016: Average 83% Spring 2017: Average 85%	Measure 1: Labs are a successful and positive hands-on learning experience.	Measure 1: No change.
	Measure 2: Chapter Exams (13 exams), supported by on-line homework (unlimited attempts as a study tool)	Measure 2: 70% of students earn an average of 70% or greater.	Measure 2: Fall 2016: Average 71% Spring 2017: Average 73%	Measure 2: Overall class averages are on target.	Measure 2: Class contains a broad cross-section of students with differing career goals and different levels of preparation. Restructured this year to

Evidence of Learning: General Education Area CHEM 1110 Elementary Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
					have pre-exam review days. Next year adopting new textbook with LearnSmart reading assignments, and Connect on-line homework.
	Measure 1: Summer 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 76% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Fall 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 76% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Spring 2017 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 77% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
Learning Outcome 1: Organization of systems	Measure 1: Laboratory Experience: Prelab and Lab Reports (12 labs)	Measure 1: 70% of students earn an average of 70% or greater.	Measure 1: Fall 2016: Average 83% Spring 2017: Average 85%	Measure 1: Labs are a successful and positive hands-on learning experience.	Measure 1: No change.
	Measure 2: Chapter Exams (13 exams), supported by	Measure 2: 70% of students earn an average of	Measure 2: Fall 2016: Average 71%	Measure 2: Overall class averages are on target.	Measure 2: Class contains a broad cross-section of

Evidence of Learning: General Education Area CHEM 1110 Elementary Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	on-line homework (unlimited attempts as a study tool)	70% or greater.	Spring 2017: Average 73%		students with differing career goals and different levels of preparation. Restructured this year to have pre-exam review days. Next year adopting new textbook with LearnSmart reading assignments, and Connect on-line homework.
	Measure 1: Summer 2017 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 84% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Fall 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 89% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Spring 2017 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 87% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
Learning Outcome 2: Matter	Measure 1: Laboratory Experience:	Measure 1: 70% of students earn	Measure 1: Fall 2016: Average 83%	Measure 1: Labs are a successful and	Measure 1: No change.

Evidence of Learning: General Education Area CHEM 1110 Elementary Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Prelab and Lab Reports (12 labs)	an average of 70% or greater.	Spring 2017: Average 85%	positive hands-on learning experience.	
	Measure 2: Chapter Exams (13 exams), supported by on-line homework (unlimited attempts as a study tool)	Measure 2: 70% of students earn an average of 70% or greater.	Measure 2: Fall 2016: Average 71% Spring 2017: Average 73%	Measure 2: Overall class averages are on target.	Measure 2: Class contains a broad cross-section of students with differing career goals and different levels of preparation. Restructured this year to have pre-exam review days. Next year adopting new textbook with LearnSmart reading assignments, and Connect on-line homework.
	Measure 1: Summer 2016 Exam question	Measure 1: 70% of the students respond correctly to the question.	Measure 1: 76% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Fall 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 74% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.

Evidence of Learning: General Education Area CHEM 1110 Elementary Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Measure 1: Spring 2017 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 73% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
Learning Outcome 3: Energy	Measure 1: Laboratory Experience: Prelab and Lab Reports (12 labs)	Measure 1: 70% of students earn an average of 70% or greater.	Measure 1: <u>Fall 2016</u>: Average 83% <u>Spring 2017</u>: Average 85%	Measure 1: Labs are a successful and positive hands-on learning experience.	Measure 1: No change.
	Measure 2: Chapter Exams (13 exams), supported by on-line homework (unlimited attempts as a study tool)	Measure 2: 70% of students earn an average of 70% or greater.	Measure 2: <u>Fall 2016</u>: Average 71% <u>Spring 2017</u>: Average 73%	Measure 2: Overall class averages are on target.	Measure 2: Class contains a broad cross-section of students with differing career goals and different levels of preparation. Restructured this year to have pre-exam review days. Next year adopting new textbook with LearnSmart reading assignments, and Connect on-line homework.
	Measure 1: Summer 2016 Exam question	Measure 1: 70% of students respond	Measure 1: 74% of students respond	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.

Evidence of Learning: General Education Area CHEM 1110 Elementary Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
		correctly to the question.	correctly to the question.		
	Measure 1: Fall 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 75% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular of pedagogical changes needed at this time.
	Measure 1: Spring 2017 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 77% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
Learning Outcome 4: Forces	Measure 1: Laboratory Experience: Prelab and Lab Reports (12 labs)	Measure 1: 70% of students earn an average of 70% or greater.	Measure 1: <u>Fall 2016</u>: Average 83% <u>Spring 2017</u>: Average 85%	Measure 1: Labs are a successful and positive hands-on learning experience.	Measure 1: No change.
	Measure 2: Chapter Exams (13 exams), supported by on-line homework (unlimited attempts as a study tool) Chapter Exams (13 exams), supported by on-line homework (unlimited attempts as a study tool)	Measure 2: 70% of students earn an average of 70% or greater.	Measure 2: <u>Fall 2016</u>: Average 71% <u>Spring 2017</u>: Average 73%	Measure 2: Overall class averages are on target.	Measure 2: Class contains a broad cross-section of students with differing career goals and different levels of preparation. Restructured this year to have pre-exam review days. Next year adopting new textbook with LearnSmart reading assignments,

Evidence of Learning: General Education Area CHEM 1110 Elementary Chemistry					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
					and Connect on-line homework.
	Measure 1: Summer 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 84% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Fall 2016 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 85% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.
	Measure 1: Spring 2017 Exam question	Measure 1: 70% of students respond correctly to the question.	Measure 1: 83% of students respond correctly to the question.	Measure 1: Students successfully demonstrated competence.	Measure 1: No curricular or pedagogical changes needed at this time.

Evidence of Learning: General Education Area CHEM 1210 Principles of Chemistry I					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 1: Nature of science	Measure 1: Exam 1 question.	Measure 1: 80% of students will answer the question correctly.	Measure 1: 100% of students answered the question correctly.	Measure 1: 100% of students have mastered this concept.	Measure 1: A new textbook and learning platform (homework and adaptive learning system) will be implemented in Spring 2018 as

Evidence of Learning: General Education Area CHEM 1210 Principles of Chemistry I					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
					directed by the department.
	Measure 1: Fall 2016 Exam 1 and final exam	Measure 1: Average score of 70% or better	Measure 1: Student average was 82%	Measure 1: Students successfully demonstrated skills	Measure 1: No curricular or pedagogical changes needed at this time
Learning Outcome 2: Integration of science	Measure 1: Exam 3 question relating to the use of quantum mechanics developed by physicists and used by chemists to understand atomic orbitals.	Measure 1: 80% of students will answer the question correctly.	Measure 1: 90% of students answered the question correctly.	Measure 1: 90% of students have mastered this concept.	Measure 1: A new textbook and learning platform (homework and adaptive learning system) will be implemented in Spring 2018 as directed by the department.
	Measure 1: Fall 2016 Unit exams and final exam	Measure 1: Average score of 70% or better	Measure 1: Student average was 81%	Measure 1: Students successfully demonstrated skills	Measure 1: No curricular or pedagogical changes needed at this time
Learning Outcome 3: Science and society	Measure 1: Explanation on lab reports to questions about lab topics.	Measure 1: 80% of students will answer lab report question correctly for 70% of the questions.	Measure 1: 89% of students answered lab report the question correctly for 70% of the questions.	Measure 1: 89% of students are in agreement with learning outcome 3.	Measure 1: A new textbook and learning platform (homework and adaptive learning system) will be implemented in Spring 2018 as directed by the department.

Evidence of Learning: General Education Area CHEM 1210 Principles of Chemistry I					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Measure 1: Fall 2016 Pre-lab 8, lab report 12, and exam 3	Measure 1: Average score of 70% or better	Measure 1: Student average was 76%	Measure 1: Students successfully demonstrated skills	Measure 1: No curricular or pedagogical changes needed at this time
Learning Outcome 4: Problem solving and data analysis	Measure 1: Final course grade of C- or higher (includes UWs).	Measure 1: 80% of students will have a final course grade of C- or higher (includes UWs).	Measure 1: 88% of students have a final course grade of C- or higher (includes UWs).	Measure 1: 88% of students demonstrated competence in these problem solving and data analysis topics.	Measure 1: A new textbook and learning platform (homework and adaptive learning system) will be implemented in Spring 2018 as directed by the department.
	Measure 1: Fall 2016 Lab report 2,3,10,&11 and final exam	Measure 1: Average score of 70% or better	Measure 1: Student average was 79%	Measure 1: Students successfully demonstrated skills	Measure 1: No curricular or pedagogical changes needed at this time
Learning Outcome 1: Organization of systems	Measure 1: Exam 3 covering electron configurations of atoms and ions.	Measure 1: 80% of students will score above 69% on the exam.	Measure 1: 95% of students scored above 69%.	Measure 1: 95% of students demonstrated competence in these topics.	Measure 1: A new textbook and learning platform (homework and adaptive learning system) will be implemented in Spring 2018 as directed by the department.
	Measure 1: Fall 2016 Exams 1&2 and final exam	Measure 1: Average of 70% or better	Measure 1: Student average was 78%	Measure 1: Students successfully demonstrated skills	Measure 1: No curricular or pedagogical changes needed at this time

Evidence of Learning: General Education Area CHEM 1210 Principles of Chemistry I					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Learning Outcome 2: Matter	Measure 1: Exam 1 questions concerning matter both quantitatively and qualitatively.	Measure 1: 80% of students will score above 69% on the exam.	Measure 1: 90% of students scored above 69% on exam 1.	Measure 1: 90% of students have mastered the concepts on Exam 1 concerning matter.	Measure 1: A new textbook and learning platform (homework and adaptive learning system) will be implemented in Spring 2018 as directed by the department.
	Measure 1: Fall 2016 Unit exams and final exam	Measure 1: Average score of 70% or better	Measure 1: Student average was 81%	Measure 1: Students successfully demonstrated skills	Measure 1: No curricular or pedagogical changes needed at this time
Learning Outcome 3: Energy	Measure 1: Exams 2 and 3 questions concerning both quantitative and qualitative changes in energy accompanying chemical and physical reactions.	Measure 1: 80% of students will score above 69% on the exam 3.	Measure 1: 90% of students scored above 69% on exam 3.	Measure 1: 90% of students can correctly answer the quantitative and qualitative changes in energy accompanying chemical and physical reactions.	Measure 1: A new textbook and learning platform (homework and adaptive learning system) will be implemented in Spring 2018 as directed by the department.
	Measure 1: Fall 2016 Exam 2 &3 and final exam	Measure 1: Average score of 70% or better	Measure 1: Student average was 76%	Measure 1: Students successfully demonstrated skills	Measure 1: No curricular or pedagogical changes needed at this time
Learning Outcome 4: Forces	Measure 1: Exam 4 questions covering chemical	Measure 1: 80% of students will score above	Measure 1: 74% of students scored above 69%.	Measure 1: 74% of Students demonstrated competence in these topics.	Measure 1: A new textbook and learning platform (homework and

Evidence of Learning: General Education Area CHEM 1210 Principles of Chemistry I					
Measurable Learning Outcome Students will…	Method of Measurement	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	bonding, shapes of molecules, and polarity of molecules.	69% on the exam.			adaptive learning system) will be implemented in Spring 2018 as directed by the department.
	Measure 1: Fall 2016 Report 11, exams 2&3, and final exam	Measure 1: Average score of 70% or better	Measure 1: Student average was 77%	Measure 1: Students successfully demonstrated skills	Measure 1: No curricular or pedagogical changes needed at this time

*At least one measure per objective must be a direct measure. Indirect measures may be used to supplement evidence provided via the direct measures.
Appendix H: sample Signature Assignments

Additional Summary Information (as needed)