Weber State University
Five-Year Program Review
Self-Study
Chemistry Program Review

Department of Chemistry
College of Science

Semester Submitted: Fall 2012

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A. Brief Introductory Statement

The Department of Chemistry is housed within the College of Science. It is approved and certified by the American Chemical Society (ACS). Two options are offered that lead to the Bachelor of Science degree in Chemistry. Option 1 specifically meets all the requirements of the ACS and the graduates' names are submitted to the ACS and certified by the department. Option 2 provides a solid foundation in chemistry that is suitable for Pre-Medical, Pre-Dental, Pre-Pharmacy, and other Pre-Medical Professional students. The Chemistry Teaching Major leads to a Bachelor of Science Degree with secondary education licensure. The Chemistry minor, Chemistry Teaching Minor, and a Bachelor of Integrated Studies, BIS, emphasis in Chemistry are also available. The two-year Chemical Technician Program, leading to an Associate of Applied Science Degree or a Certificate of Skill Proficiency, is designed to emphasize skills required for employment as a technician in chemical laboratories. The chemistry faculty's range of expertise includes Analytical Chemistry, Biochemistry, Inorganic Chemistry, Organic Chemistry, and Physical Chemistry.

B. Program Mission and Vision

The mission of the Chemistry Department is to provide chemistry majors with the skills and knowledge of chemistry they need to successfully pursue their chosen professional careers and other activities following graduation from Weber State University. Included with this goal is the more global application to provide a solid theoretical and experimental chemistry foundation for other majors across campus, including but not limited to: Physics, Microbiology, Botany, Zoology, Geosciences, Criminalistics, Allied Health, Pre-Engineering, Pre-Profession students, and a general liberal education in chemistry for non-science majors (general education). The Department also provides services that require chemical expertise at the University and in our community. Faculty members are involved in community science and research projects which promote science education at all levels. Along with the faculty members, chemistry students render significant service each year at events such as the Utah State Science and Engineering Fair and Science Olympiad. The five main chemical expertise areas are: physical, analytical, organic, inorganic and biochemistry. The Department seeks to foster and promote learning and proficiency in each of these areas.

Our vision for the Weber State University Chemistry department is to be recognized as Utah's leader in undergraduate chemistry education by providing a highly versatile four-year American Chemistry Society certified program with outstanding faculty and specific strengths in analytical and medicinal chemistry, offering a strong two-year chemical technician degree, and fostering meaningful relationships with industry and government agencies.

C. Program Overview

1. Chemistry Major (BS)

    a. Option 1, ACS Certified – 75 credit hours required within major (57 credit hours of chemistry coursework and 18 credits hours of support coursework provided by other departments)
    b. Option 2 – 71 credit hours required within major (53 credit hours of chemistry coursework and 18 credit hours support coursework provided by other departments)
2. Chemistry Teaching Major (BS) – 43 credit hours required within major (40 credit hours of chemistry coursework and 3 credit hours of coursework provided by other departments)
3. Chemistry Minor – 20 credit hours required within minor
4. Chemistry Teaching Minor – 26 credits required within minor
5. Chemistry BIS Emphasis – 18 credit hours required within emphasis
6. Chemical Technician (AAS) – 35 credit hours required within program
7. Chemical Technician (Institutional Certificate) – 41 credit hours required

Complete program descriptions and requirements are listed in the WSU Catalog along with course descriptions. The following summarizes current chemistry major requirements.

1a. Major Course Requirements for BS Degree

Core Requirements

CHEM 1210 PS - Principles of Chemistry I (5)
CHEM 1220 - Principles of Chemistry II (5)
CHEM 2310 - Organic Chemistry I (4)
CHEM 2315 - Organic Chemistry I Lab (1)
CHEM 2320 - Organic Chemistry II (4)
CHEM 2325 - Organic Chemistry II Lab (1)
CHEM 3000 - Quantitative Analysis (4)
CHEM 3020 - Computer Applications in Chemistry (1)

Option 1 (ACS Certified) Required Courses Beyond the Core

CHEM 3050 - Instrumental Analysis (4)
CHEM 3070 - Biochemistry I (4)
CHEM 3400 - Molecular Symmetry and Applied Math for Physical Chemistry (3)
CHEM 3410 - Physical Chemistry I (4) and
CHEM 3420 - Physical Chemistry II (4)
CHEM 4540 - Spectrometric and Separation Methods (4)
CHEM 4600 - Inorganic Chemistry (4) *
CHEM 4700 - Special Topics in Chemistry (1-3) (2 credit hours required)
CHEM 4800 - Research and Independent Study in Chemistry (1-3) (2 credit hours required) *
CHEM 4990 - Senior Seminar (1)

Required Support Courses

MATH 1210 - Calculus I (4) and

MATH 1220 - Calculus II (4)
PHYS 2210 PS - Physics for Scientists and Engineers I (5) and
PHYS 2220 - Physics for Scientists and Engineers II (5)

1b. Option 2 Required Courses Beyond the Core
CHEM 3050 - Instrumental Analysis (4)
CHEM 3400 - Molecular Symmetry and Applied Math for Physical Chemistry (3)
CHEM 3410 - Physical Chemistry I (4)
CHEM 3420 - Physical Chemistry II (4)
CHEM 4700 - Special Topics in Chemistry (1-3) (2 credit hours required) *
CHEM 4800 - Research and Independent Study in Chemistry (1-3) (2 credit hours required) *
CHEM 4990 - Senior Seminar (1)

Chemistry Electives (8 credit hours required from the following)
CHEM 3070 - Biochemistry I (4)
CHEM 3080 - Biochemistry II (3)
CHEM 3090 - Biochemical Techniques (1)
CHEM 4540 - Spectrometric and Separation Methods (4)
CHEM 4600 - Inorganic Chemistry (4)

Required Support Courses (18 credit hours)
MATH 1210 - Calculus I (4) and
MATH 1220 - Calculus II (4)
PHYS 2210 PS - Physics for Scientists and Engineers I (5) and
PHYS 2220 - Physics for Scientists and Engineers II (5)
Major Course Requirements for BS Degree
Chemistry Core Courses Required (25 credit hours)

CHEM 1210 PS - Principles of Chemistry I (5) and
CHEM 1220 - Principles of Chemistry II (5)
CHEM 2310 - Organic Chemistry I (4) and
CHEM 2315 - Organic Chemistry I Lab (1)
CHEM 2320 - Organic Chemistry II (4) and
CHEM 2325 - Organic Chemistry II Lab (1)
CHEM 3000 - Quantitative Analysis (4)
CHEM 3020 - Computer Applications in Chemistry (1)

2. Teaching Major Required Courses Beyond the Core
CHEM 2600 - Laboratory Safety (1)
CHEM 3570 - Foundations of Science Education (3)
CHEM 4570 - Secondary School Science Teaching Methods (3)
CHEM 4800 - Research and Independent Study in Chemistry (1-3) (1 credit hour required)

Electives (7 credit hours required from the following)
- CHEM 3050 - Instrumental Analysis (4)
- CHEM 3070 - Biochemistry I (4)
- CHEM 3080 - Biochemistry II (3)
- CHEM 3410 - Physical Chemistry I (4)
- CHEM 3420 - Physical Chemistry II (4)

Required Support Course
- HIST 3350 - History and Philosophy of Science (3)

3. Course Requirements for Minor
- CHEM 1210 PS - Principles of Chemistry I (5)
- CHEM 1220 - Principles of Chemistry II (5)

Chemistry Electives (10 credit hours of chemistry coursework numbered 2000 and above)

4. Course Requirements for Teaching Minor
- CHEM 1210 PS - Principles of Chemistry I (5)
- CHEM 1220 - Principles of Chemistry II (5)
- CHEM 2310 - Organic Chemistry I (4) and
- CHEM 2315 - Organic Chemistry I Lab (1)
- CHEM 2320 - Organic Chemistry II (4) and
- CHEM 2325 - Organic Chemistry II Lab (1)

Elective (3 credit hours of approved chemistry elective, 3000 or above)

Required Support Course
- HIST 3350 - History and Philosophy of Science (3)

For students not obtaining Teaching Majors in Sciences, the following courses are also required:
- CHEM 2600 - Laboratory Safety (1)
- CHEM 3570 - Foundations of Science Education (3)
- CHEM 4570 - Secondary School Science Teaching Methods (3)

5. Course Requirements for BIS Emphasis
- CHEM 1210 PS - Principles of Chemistry I (5)
- CHEM 1220 - Principles of Chemistry II (5)

Chemistry Electives (Select additional chemistry coursework including at least 8 credit hours of upper division courses numbered 3000 and above.)

6. Major Course Requirements for AAS Degree
- CHEM 1210 PS - Principles of Chemistry I (5)

CHEM 1220 - Principles of Chemistry II (5)
CHEM 2600 - Laboratory Safety (1)
CHEM 2990 - Chemical Technician Seminar (1)
CHEM 3000 - Quantitative Analysis (4)
CHEM 3020 - Computer Applications in Chemistry (1)
CHEM 3050 - Instrumental Analysis (4)

Required Support Course
minimum MATH 1010 - Intermediate Algebra (4) or equivalent

Elective Courses (10 credit hours from the following with at least 4 credit hours must be 2000-level or higher)
CHEM 2310 - Organic Chemistry I (4) and
CHEM 2315 - Organic Chemistry I Lab (1)
CHEM 2320 - Organic Chemistry II (4) and
CHEM 2325 - Organic Chemistry II Lab (1)
CHEM 2890 - Cooperative Work Experience (1-6)
CHEM 3070 - Biochemistry I (4)
CHEM 3080 - Biochemistry II (3)
CHEM 3090 - Biochemical Techniques (1)
CHEM 4540 - Spectrometric and Separation Methods (4)
CHEM 4890 - Cooperative Work Experience (1-6)
MICR 2054 LS - Principles of Microbiology (4)
MICR 3053 - Microbiological Procedures (3)
MICR 3254 - Immunology (4)
MICR 4154 - Microbial Genetics (4)
MICR 4252 - Cell Culture (2)
BTNY 1403 LS - Environment Appreciation (3-4)
BTNY 2104 - Plant Form and Function (4)
BTNY 3153 - Biology of the Plant Cell (3)
GEO 1110 PS - Dynamic Earth: Physical Geology (3)
GEO 1115 - Physical Geology Lab (1)
GEO 2050 - Earth Materials (4)
PHYS 1010 PS - Elementary Physics (3)
PHYS 2010 PS - College Physics I (5) or
PHYS 2210 PS - Physics for Scientists and Engineers I (5)
PHYS 2020 - College Physics II (5) or
PHYS 2220 - Physics for Scientists and Engineers II (5)
ZOOL 2200 - Human Physiology (4)
ZOOL 3200 - Cell Biology (4)
ZOOL 3300 - Genetics (4)
ZOOL 4300 - Molecular Genetics (4)
CJ 1350 - Introduction to Forensic Science (3)
CJ 4110 - Physical Methods in Forensic Science (4)
CJ 4115 - Friction Ridge Analysis (4)
CJ 4120 - Advanced Methods in Forensic Science (4)

7. Course Requirements for Institutional Certificate

CHEM 1210 PS - Principles of Chemistry I (5) and
CHEM 1220 - Principles of Chemistry II (5)
CHEM 2600 - Laboratory Safety (1)
CHEM 2990 - Chemical Technician Seminar (1)
CHEM 3000 - Quantitative Analysis (4)
CHEM 3020 - Computer Applications in Chemistry (1)
CHEM 3050 - Instrumental Analysis (4)

Required Support Courses
ENGL 1010 EN - Introductory College Writing (3)
One additional course in oral or written communications (3)
Minimum MATH 1010 - Intermediate Algebra (4) or equivalent

Elective Courses (10 credit hours from the following with at least 4 credit hours must be 2000-level or higher)
CHEM 2310 - Organic Chemistry I (4) and
CHEM 2315 - Organic Chemistry I Lab (1)
CHEM 2320 - Organic Chemistry II (4) and
CHEM 2325 - Organic Chemistry II Lab (1)
CHEM 2890 - Cooperative Work Experience (1-6)
CHEM 3070 - Biochemistry I (4)
CHEM 3080 - Biochemistry II (3)
CHEM 3090 - Biochemical Techniques (1)
CHEM 4540 - Spectrometric and Separation Methods (4)
CHEM 4890 - Cooperative Work Experience (1-6)
MICR 2054 LS - Principles of Microbiology (4)
MICR 3053 - Microbiological Procedures (3)
MICR 3254 - Immunology (4)
MICR 4154 - Microbial Genetics (4)
MICR 4252 - Cell Culture (2)
BTNY 1403 LS - Environment Appreciation (3-4)
BTNY 2104 - Plant Form and Function (4)
BTNY 3153 - Biology of the Plant Cell (3)
GEO 1110 PS - Dynamic Earth: Physical Geology (3)
GEO 1115 - Physical Geology Lab (1)
GEO 2050 - Earth Materials (4)
PHYS 1010 PS - Elementary Physics (3)
PHYS 2010 PS - College Physics I (5) or
PHYS 2210 PS - Physics for Scientists and Engineers I (5)
PHYS 2020 - College Physics II (5) or
PHYS 2220 - Physics for Scientists and Engineers II (5)
ZOOL 2200 - Human Physiology (4)
ZOOL 3200 - Cell Biology (4)
ZOOL 3300 - Genetics (4)

ZOOL 4300 - Molecular Genetics (4)
CJ 1350 - Introduction to Forensic Science (3)
CJ 4110 - Physical Methods in Forensic Science (4)
CJ 4115 - Friction Ridge Analysis (4)
CJ 4120 - Advanced Methods in Forensic Science (4)

The program and curriculum changes that have taken place during the past five years are described in the next section.

Chemistry is a versatile program. The Option 1 Chemistry Major is certified by the American Chemical Society's Committee on Professional Training, ACS-CPT. All chemistry majors are required to gain a basic knowledge of chemistry principles and instrumentation with an emphasis on problem solving, critical thinking, and analytical skills. By the time a chemistry major is ready for graduation, he or she will have experience and, in some cases, expertise with many of the instruments we have in the department. The learning experience presented to our majors is unique because chemistry is one of the few academic disciplines included in a traditional liberal education that provides technical skills and training suitable for direct employment after graduation.

As part of the training process, the Chemistry Department in conjunction with the Center for Chemical Technology has provided cooperative work experiences for many of our majors. Indeed, some chemistry students have the opportunity to work with industrial and governmental laboratories before they graduate. On occasion, faculty members consult with these companies and continue to maintain active partnerships. These partnerships stimulate faculty vitality and scholarly research activity. Moreover, they provide an outside source of funding to help maintain equipment here at WSU. When faculty actively pursue research interests, students become involved and the process benefits both the student and the community. Some of our students have been promoted beyond the internship and are presently employed with the same company. These companies frequently ask us to provide them with additional students as interns and full-time employees.

The Chemistry Department demonstrates impressive scholarship and collegiality. Of the eleven full-time (tenured or tenure track) faculty members, nine are authors and/or coauthors of commercially published chemistry textbooks and laboratory CD's. Four are authors of widely used materials. If in-house laboratory manuals are included, ten out of eleven of the faculty has authored essential material for chemical education. Nine faculty members have mentored undergraduate research students in the past five years, and some have made presentations outside the university and published papers in peer-reviewed journals. Thus, a majority of the faculty are actively engaged in development and delivery of course material and/or research.

Nationally, higher education is becoming increasingly dependent on adjunct and part time faculty. Our students have the benefit of being taught by the faculty members who are internationally recognized authors of the books used by the students in the course. Moreover, full-time faculty members who have either authored the laboratory manuals and/or teach the lecture series teach many of the laboratory sections offered at WSU. We do not offer any laboratory courses taught by instructor specialists. We currently cover some laboratory sections with a teaching assistant (TA). However, the TA is usually an upper classman who works directly with a faculty member who is simultaneously teaching another section of the same laboratory course in a neighboring lab room. All laboratory students have access to the faculty member for any questions or concerns they may have during the laboratory exercise. Our laboratory classes are an integral part of the courses here, which allows for better correlation of laboratory exercises with lecture material.

Much of what we do in the Chemistry Department is considered service to other disciplines across campus. In general, the Chemistry Department has averaged 10.4 B.S. graduates per year for the last five years (see Appendix A) but our service courses are filled with 60-120 students per section with over 17,354 student credit hours, SCHs, taught last year (see Appendix A). The Chemistry Department provides a knowledge base for many other disciplines on campus ranging from pre-engineering to nursing. We offer upper-division service courses in biochemistry for life science majors and pre-professional students.

The service provided by the Chemistry Department is often directed towards the community and rendered beyond the boundaries of WSU. Many faculty members are actively involved in community science projects that promote science education at all levels. Numerous teachers from local school districts, some of which are former students, regularly request prepared materials for scientific experiments. Others request information on safe handling procedures and disposal of materials. Occasionally, faculty members travel to local elementary schools and give chemistry demonstrations. Over the years, faculty members of the chemistry department along with other members of the College of Science have organized and directed the Utah State Science and Engineering Fair for junior and senior high school students. The Chemistry Department is actively engaged in community affairs because the faculty members generally strive to be involved with education at all levels.

Part of the community awareness and the cohesiveness of the chemistry department can be attributed to the connection that our faculty members have with the community. The six adjunct professors currently teaching chemistry at WSU are seasoned professionals. The adjunct faculty complements the strengths of the department and has proven to be valuable assets. We have only had three faculty members leave the institution for reasons other than retirement in the past 20 years. Low employee turnover can be interpreted to indicate satisfaction with work and the workplace environment. The Chemistry Department remains a positive influence in the university and general public served by the university.

The Chemistry Department offers an extensive summer program every year. The number of students in the summer program remains strong. Our department continues to offer accelerated chemistry courses during the summer that serve students throughout the state and neighboring states. The structure of the summer semester allows students the opportunity to complete a full academic year of course material in principles of chemistry or organic chemistry in one semester. The principles and organic courses are taught in two seven-week blocks, each covering the same material that is covered in a normal semester. Students attend lecture for 2.5 hours a day, four days a week. They complete two three-hour laboratory assignments each week. Accelerated courses are not recommended for all students due to pace and intensity, but they continue to provide a valuable opportunity for many students who are seeking to move ahead in their schooling during the summer semester.

Online courses provide an important service to out-of-area students and local students who have difficult schedules. Chemistry's online CHEM 1050, CHEM 1110, and CHEM 1120 courses serve students in health professions and technology that require a full year of chemistry. We offer multiple online sections of CHEM 1010, which specifically satisfies the university General Education requirement. All of these courses are in high demand by both local students as well as out-of-area students. Our online CHEM 1050, CHEM 1110, and CHEM 1120 courses are recognized and recommended by health professions programs across the nation and around the world.

D. Curriculum Overview and Student Learning Outcomes and Assessment

Course Descriptions

The following courses are regularly offered by the Chemistry Department at Weber State University

CHEM PS1010. Introductory Chemistry (3)
A lecture-demonstration course for students with no previous chemistry background who are not majoring in areas requiring further chemistry. Three hours of lecture-demonstration a week.

CHEM PS1050. Introduction to General, Organic & Biochemistry (5)
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. Four hours of lecture and one 3-hour lab a week. The associated lab, CHEM 1055, is offered for transfer students that have already completed an equivalent lecture course elsewhere.

CHEM PS1110. Elementary Chemistry (5)
Fundamentals of inorganic chemistry and introduction to organic chemistry. The first course in a two-semester sequence designed primarily for students of nursing, engineering technology and some other fields of science and health professions who will take no more than one year of chemistry. Four hours of lecture and one 3-hour lab a week. The associated lab, CHEM 1115, is offered for transfer students that have already completed an equivalent lecture course elsewhere.

CHEM 1120. Elementary Organic Bio-Chemistry (5)
Elementary study of the compounds of carbon and chemical compounds and reactions of biological systems. Four hours of lecture and one 3-hour lab a week. Prerequisite: CHEM PS1110 or equivalent. The associated lab, CHEM 1125, is offered for transfer students that have already completed an equivalent lecture course elsewhere.

CHEM 1200. Preparation for College Chemistry (3)
A course designed to provide the minimal prerequisite skills needed for entry into CHEM PS1210. Three hours of lecture per week.

CHEM PS1210. Principles of Chemistry I (5)
The first course in a series designed primarily for science majors and others who will take more than one year of chemistry such as pre-medical students, clinical/medical laboratory scientists and some engineering students. The fundamental principles of chemistry are covered, including measurement, matter, stoichiometry, chemical reactions, thermochemistry, atomic structure, chemical periodicity, chemical bonding, intermolecular forces, gases, liquids, solids, and solutions. Laboratory emphasis is on qualitative and quantitative methods of analysis. Four hours of lecture and one 3-hour lab a week. Prerequisite: MATH 1010 or equivalent and a chemistry course equivalent to high school chemistry or CHEM 1200. The associated lab, CHEM 1215, is offered for transfer students that have already completed an equivalent lecture course elsewhere.

CHEM 1220. Principles of Chemistry II (5)
Second semester of principles of chemistry. Topics include chemical kinetics, equilibrium, thermodynamics, electrochemistry, properties of the elements, nuclear chemistry, and an introduction to organic chemistry. Four hours of lecture and one 3-hour lab a week. Prerequisite: CHEM 1210. The associated lab, CHEM 1225, is offered for transfer students that have already completed an equivalent lecture course elsewhere.

CHEM PS1360. Principles of Physical Science (3)
A lecture/laboratory course designed to provide an introduction to the scientific method and its application to the study of selected topics in physics and chemistry. Two hours of lecture and one 3-hour lab per week. Recommended for Elementary Education majors.

CHEM 2310. Organic Chemistry I (4)
Principles of organic chemistry, including structure and reactivity of carbon based molecules. Detailed study of mechanisms, synthesis, and reactions. Alkane, alkyl halide, alkyne, alcohol, and ether families are covered. Four hours of lecture a week. Prerequisite: CHEM 1220. Corequisite: CHEM 2315.

CHEM 2315. Organic Chemistry I Lab (1)

Lab course designed to be taken with CHEM 2310. Includes organic laboratory techniques, synthesis, product isolation, spectroscopy and analysis. Prerequisite: CHEM 1220. Co-requisite: must have completed or currently be enrolled in CHEM 2310 lecture.

CHEM 2320. Organic Chemistry II (4)
Principles of organic chemistry, second semester. A continuation of structure and reactivity analysis, along with structure elucidation techniques, spectroscopy and synthetic reactions. Coverage includes aromatics, carbonyls, carboxylic acid derivatives, and sugars. Four hours of lecture a week. Prerequisites: CHEM 2310 and 2315.

CHEM 2325. Organic Chemistry II Lab (1)
Lab course designed to be taken with CHEM 2320. Includes organic laboratory techniques, synthesis, product isolation, spectroscopy and analysis. Prerequisites: CHEM 2310 and 2315. Co-requisite: must have completed or currently be enrolled in CHEM 2320 lecture.

CHEM 2600. Laboratory Safety (1)
An interdisciplinary, team-taught course that will be an overview of the major chemical, biological and physical safety issues related to science laboratories and field work. Class will meet once per week and will be taught in a lecture/demonstration format.

CHEM 2890. Cooperative Work Experience (1-6)
Open to all students in the Chemistry Department who meet the minimum Cooperative Work Experience requirements of the department. Provides academic credit for on-the-job experience. Grade and amount of credit will be determined by the department.

CHEM 2990. Chemical Technician Seminar (1)
A course designed to provide the skills necessary to enter the job market as a Chemical Technician. Prerequisite: CHEM 1220. One hour of lecture/discussion a week.

CHEM 3000. Quantitative Analysis (4)
Theory and methods of gravimetric and volumetric analysis and simple instrumentation. Includes statistical evaluation of results. Three hours of lecture and one 3-hour lab per week. Prerequisite: CHEM 1220. Prerequisite or co-requisite: CHEM 3020. The associated lab, CHEM 3005, is offered for transfer students that have already completed an equivalent lecture course elsewhere.

CHEM 3020. Computer Applications in Chemistry (1)
A course designed to provide students computer skills for applications including computation and electronic data bases searches. It is required that this course be

taken before or with CHEM 3000. One hour of lecture/discussion a week. Prerequisite: CHEM 1210.

CHEM 3050. Instrumental Analysis (4)
Theory and methods of modern instrumental analysis. Includes practical applications in electrochemical, spectrometric, and chromatographic techniques. Three hours of lecture and one three hour laboratory per week. Prerequisite: CHEM 3000.

CHEM 3070. Biochemistry I (4)
Structure and function of biomolecules including proteins, nucleic acids, fats and carbohydrates. A focus on proteins as energy transforming and catalytic devices; their role in metabolism, defense and other biochemical processes. Three lectures and one three hour lab a week. Prerequisite: CHEM 2310. The associated lab, CHEM 3075, is offered for transfer students that have already completed an equivalent lecture course elsewhere.

CHEM 3080. Biochemistry II (3)
A detailed study of the molecular basis of life: nucleic acids, biosynthetic pathways, molecular aspects of disease and pharmacology. Three lectures a week. Prerequisite: CHEM 2320 , CHEM 3070.

CHEM 3090. Biochemical Techniques (1)
Advanced techniques including instrumentation for biochemistry. One 3-hour lab per week. Prerequisites CHEM 2320 and Chem3070. To be taken concurrently with CHEM 3080.

CHEM 3400. Molecular Symmetry and Applied Math for Physical Chemistry (3)
An introduction to molecular symmetry, experimental error analysis, and physical chemistry applications of algebra, linear algebra, and differential equations. Prerequisite: MATH 1220. Co-requisite: CHEM 3410.

CHEM 3410. Physical Chemistry I (4)
The first semester course of Physical Chemistry covering chemical thermodynamics and kinetics. Three hours of lecture and one 3-hour lab a week. Prerequisites: CHEM 3000 and PHYS 2220. Co-requisite: CHEM 3400.

CHEM 3420. Physical Chemistry II (4)
The second semester course of Physical Chemistry covering quantum mechanics, statistical mechanics, and chemical reaction dynamics. Three hours of lecture and one 3-hour lab a week. Prerequisite: CHEM 3410

CHEM 3570. Foundations of Science Education (3)
A thorough investigation of research in science learning and curricular standards at the state and national levels. Foundations of the philosophy of science and scientific inquiry as applicable to science teaching at the secondary

level. This course serves as a foundation to a preservice science teacher's education coursework.

CHEM 4540. Spectrometric and Separation Methods (4)
Theory and practice of spectrometric and separation methods in the study of chemical systems. Three hours of lecture and one 3-hour lab per week. Prerequisite: CHEM 3420 or permission of instructor.

CHEM 4550. Geochemistry (3)
The chemistry of the earth and geochemical processes operating in the lithosphere, hydrosphere, and atmosphere with a synthesis of these ideas to account for the chemical evolution of the earth. Applications to mineral stability and chemical reactions, geochemical cycles, and isotope geochemistry. Three hours of lecture a week. Prerequisites: CHEM 1220 and GEO 2050 or consent of instructor.

CHEM 4570. Secondary School Science Teaching Methods (3)
Acquaintance and practice with various teaching and assessment methods. Development of science curricula including lesson and unit plans. It is recommended that this course be completed immediately before student teaching. Prerequisite: Admission to the Teacher Education Program.

CHEM 4600. Inorganic Chemistry (4)
A study of the elements and their compounds based on the periodic table, current theories and laboratory work. Prerequisites: CHEM 3420 or permission of instructor. Three hours of lecture and one 3-hour lab a week.

CHEM 4700. Special Topics in Chemistry (1-3) variable title
This course may be repeated for credit. Prerequisite: CHEM 3420 or permission of instructor.

CHEM 4710. Chemical Preparations (1-3)
Synthesis and determination of the properties of selected chemical compounds. Three to nine hours of lab a week. Prerequisite: Permission of the instructor.

CHEM 4800. Research and Independent Study in Chemistry (1-3)
Open to qualified students for one or more semesters. May be repeated for credit with instructor approval.

CHEM 4890. Cooperative Work Experience (1-6)
A continuation of CHEM 2890. Open to all students.

CHEM 4990. Senior Seminar (1)
A seminar course where students will share their research results with fellow students and faculty in written and oral formats. Prerequisite: CHEM 4800 or permission of instructor.

CHEM 5030. Chemistry for Teachers (3-5)
Science content course for teachers in the M. Ed Science Emphasis Program. To register, select another departmental course and develop a contract detailing additional work required for graduate credit. Course may be repeated. Contract must be approved by instructor, department chair, and Director of the Master of Education Program.

Measureable Learning Outcomes – Chemistry Majors

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.

The following table lists required and elective courses in the chemistry major and the extent to which each is intended to address each of the chemistry learning outcomes.

	Department/Program Learning Outcomes				
Core and Elective Courses in Department/Program	Knowledge & Comprehension of the core	Problem Solving Skills	Laboratory skills	Presentation skills	Computer skills
Chemistry 1210 Principles of Chemistry I (5)	3	2	2	1	1

Core and Elective Courses in Department/Program	Department/Program Learning Outcomes				
	Knowledge & Comprehension of the core	Problem Solving Skills	Laboratory skills	Presentation skills	Computer skills
Chemistry 1220 Principles of Chemistry II (5)	3	2	2	1	1
Chemistry 2310/2315 Organic Chemistry I (4/1)	3	2	2	1	1
Chemistry 2320/2325 Organic Chemistry II (4/1)	3	2	2	1	1
Chemistry 3000 Quantitative Analysis (4)	3	3	3	2	2
Chemistry 3020 Computer Application in Chemistry (1)	3	3	1	1	3
Chemistry 3050 Instrumental Analysis (4)	3	3	3	2	2
Chemistry 3070 Biochemistry I (4)	3	3	3	1	1
Chemistry 3080 Biochemistry II (3)	3	3	1	1	1
Chemistry 3090 Biochemistry Techniques (1)	3	3	3	2	2
Chemistry 3400 Symmetry and Applied Math (3)	3	2	1	1	2
Chemistry 3410 Physical Chemistry I (4)	3	3	3	2	2
Chemistry 3420 Physical Chemistry II (4)	3	3	3	2	2
Chemistry 4540 Spectrometric and Separation Methods (4)	3	3	3	2	2
Chemistry 4600 Inorganic Chemistry (4)	3	3	2	1	1
Chemistry 4700 Special Topics in Chemistry (1)	3	1	1	1	1
Chemistry 4800 Research and Independent Study in Chemistry (1)	3	3	2	1	1
Chemistry 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.

Assessment of learning outcomes has been ongoing in the Chemistry Department and in academia for some time. 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	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. a. 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
2. b. 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
2. c. Presentation 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
2. d. 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 National Exam is administered for organic chemistry courses, Chemistry 2310 and Chemistry 2320, and results are compared to national percentiles. The most recent year's results place the Weber

State University average score at the 77th percentile, with our high scoring students scoring in the 96th percentile. These score are not unusual. During the past ten years, averages scores have ranged from 48% to 87% of the national average. The table below summarizes the performance of each Chem 2320 Organic II Chemistry class on the ACS national standardized organic chemistry exam during the period of this selfstudy. The exam is administered as the final for this class each semester. Since the ACS exam covers material from both Organic I & II Chemistry courses, it provides a good assessment of what students have learned and retained throughout the semester.

ACS Organic Chemistry Subject Exam Results, 2007-12

	Number of students in class	Test version	High Score and percentile (70 points possible)	Average score and percentile	Number of students scoring in or above the 90th percentile
Summer 2007	18	1998	65(99%)	51(87%)	7 (39%)
Fall 2007	25	2002	64(97%)	50 (67%)	6(24%)
Spring 2008	28	2004	68 (100%)	53 (85%)	13 (46%)
Fall 2008	29	1998	68 (100%)	49 (83%)	12 (41%)
Spring 2009	36		69 (100%)	53 (76%)	16 (44%)
Fall 2009	23		67 (100%)	75%	9 (39%)
Spring 2010	17		65 (99%)	70%	3 (18%)
Summer 2010	19	2002	(98%)	77%	4 (21%)
Fall 2010	18	2002	69 (100%)	77%	4 (22%)
Spring 2011	29	2004	67 (100%)	77%	8 (28%)
Summer 2011	13	2002	(97%)	72%	2 (15%)
Fall 2011	30	1998	67 (100%)	76%	10 (30%)
Spring 2012	24	2008	62 (97%)	77%	6 (25%)

The department is currently considering implementing the ACS Subject exams in other courses, which could provide a comprehensive picture of how well students are prepared in chemistry at Weber State University relative to programs across the nation.

The existing assessment policies have resulted in changes both within existing courses and in the overall curriculum of the program. The changes within courses are largely due to the observations of the individual faculty instructing those courses and are not cataloged in this report.

Examples of assessment materials and student work for CHEM 2310/2320, CHEM 3050, CHEM 3420, CHEM 4540, and CHEM 4990 are available for review in the chemistry department office.

Recent changes prompted by ongoing program assessment are:

a. Two hours of CHEM 4800 (Research and Independent Study in Chemistry) are now required for both Option I and Option II Chemistry Majors. This change addresses student requests for a research experience and better aligns the program with current ACS-CPT guidelines. This requirement places a substantial burden on the faculty to mentor students in undergraduate research projects and the added load represented by these efforts goes largely uncompensated within the current faculty load model. Also, because of the match between student and faculty interests, CHEM 4800 SCHs are not equally distributed among faculty.

b. One hour of CHEM 4990 (Senior Seminar) is now required for both Options I and II. This change is related to the CHEM 4800 requirement. It was noted in the previous program review that standards were needed for the evaluation of student CHEM 4800 projects. CHEM 4990 addresses that need. It was the responsibility of the faculty member who was advising a student's CHEM 4800 project to insure that the student learning outcomes are being met and that each student generates a research report. Generating the research report along with a research presentation is now the focus of CHEM 4990. This also provides a constructive venue for evaluation of the student's CHEM 4800 project.

c. The CHEM 4700 (Special Topics in Chemistry) requirement was increased from one hour to two hours for all chemistry majors. Continuing changes prompted by student feedback and program assessment will create more courses, some of them interdisciplinary that can be used to fulfill this requirement.

d. Students must now complete 40 upper division credit hours for both options I and II. This brings these programs into line with university requirements, and with other state universities, but is not required by the ACS-CPT. Further review of similar requirements at other schools has revealed in some cases, upper-division credit is awarded for Calculus I and II, the calculus based physics series, and the organic chemistry series. Changes to this requirement are being discussed since all of these courses are required for chemistry majors and for others across campus.

e. The CHEM 3060, Applied Analysis, was merged with CHEM 3050, Instrumental Analysis, and is no longer offered as a separate course.

f. The Organic Chemistry series, CHEM 2310/2320 has recently changed labs from being integrated with the lecture portion of the course to being separate, but co-requisite with lecture. This change addresses the assessment observation that some students are retaking the organic chemistry series to improve their earned grade but have already done well in the laboratory portion of the course during the first attempt. Until now, students have been required to retake both lecture and laboratory, but such a requirement is both an necessary burden on the student and a poor use of already limited laboratory space and supplies. The change to separate lecture and laboratory courses for organic chemistry brings the department into conformity with the other Utah System of Higher Education programs. Similar changes have been examined for the Principles of Chemistry courses but no change has been made because of the intentionally close link between lecture and laboratory for those courses.

g. The credit-hour requirement for the Chemistry Minor was increased from 18 to 20 credit hours. The elective requirement was increased from 8 to 10 credit hours in chemistry coursework numbered 2000. This change was in part prompted by the previous program review, which recommended increasing the required credit hours to more closely align with other comparable chemistry programs. This change has just been implemented and the department will evaluate its impact in the future.

h. The elective requirements for the Chemistry Bachelor of Integrated Studies (BIS) emphasis were modified to require 8 hours of upper-division (courses numbered 3000 and above) chemistry coursework. This was prompted by feedback from the faculty that frequently work with BIS students, who found that students in that program were not able with only lower division coursework to pursue meaningful chemistry projects related to their BIS Degree. The BIS program also noted that its students struggle to achieve the required 40 credit hours of upper-division credit required for the degree. This change has just been implemented and the department will evaluate its impact in the future.

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 2008. The 2008 revision represents a significant change in the guidelines. In particular, the revised guidelines are intended to:

- Promote the development of modern and innovative curricula by chemistry departments.
- Encourage innovations in pedagogy that promote student learning and success.
- Define faculty and infrastructure attributes of excellent undergraduate programs, and
- Simplify the guidelines document and streamline the program approval and review procedures.

The guidelines recommend a shift from a traditional chemistry curriculum that introduces the subdisciplines of chemistry in a sequential fashion over the course of a four-year bachelors program to one where the subdisciplines are all introduced in sophomore-year foundation-level courses that require the first year of chemistry equivalent to our Principles of Chemistry series as a prerequisite. The current chemistry-program curriculum can largely be adapted directly to this new model. However, there are two areas that require particular attention. Weber State University currently has no inorganic chemistry course that is suitable to be taught at the sophomore level. The existing course is strictly a senior level course. The department is currently working to develop an inorganic chemistry course that is suitable for students at the sophomore level. Appropriate texts exist around which such a course could be designed and there are courses currently taught at other institutions that can act as models for a course at Weber State University. The biggest obstacle currently is availability of faculty time to develop such a course. As noted else where in this report, the faculty are currently stretched very thin in their teaching loads and it has not been possible to provide sufficient reassigned time for a faculty member to develop the needed course. The second area that the department is struggling with in fully adopting the current ACS guidelines is physical chemistry. This remains a challenge for most chemistry programs as noted in a recent ACS-CPT report. The prevailing response is to make no real changes to the physical chemistry courses – an option that is explicitly allowed in the ACS guidelines. The year of physical chemistry is traditionally broken into two very different halves. One focuses on thermodynamics and the other on quantum chemistry. Both of these courses require one year of calculus as a prerequisite. A majority of chemistry majors are still completing their year of calculus when they are sophomores and are not yet prepared to take a traditional, calculus-based physical chemistry course as sophomores. A single-semester foundation-level course would presumably focus on both physical chemistry facets and perhaps have calculus as a co-requisite. Such a course might serve students with an interest in biochemistry or synthetic organic chemistry well, allowing them more time to focus in the upper division on coursework more closely aligned with their interests. However, this faculty know of no such course that can be used as a model and the available textbooks are inadequate. In spite of the challenges, the faculty are enthusiastic about the possibility of designing an ACS certified degree track that emphasizes organic and biochemistry and would fit alongside the current ACS certified degree track with its analytical chemistry emphasis.

Moving forward, Weber State University is initiating a more structured program and course assessment model that includes annual reports and completion of tables outlining the full assessment process for each course in the curriculum. The following table is completed as an example. Future department assessment efforts will make use of similar tables to compile program and course assessment information. In addition to the normal day-to-day assessment activity that instructors do in their teaching as a matter of course, each course will undergo formal assessment at least once each program review cycle.

Evidence of Learning: Courses within the Major

Evidence of Learning: Courses within the Major					
Measurable Learning Outcome Students will have developed:	Method of Measurement Direct and Indirect Measures*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Knowledge & comprehension of the core concepts of chemistry	Measure 1: Exams – All courses use written and/or multiple-choice exams to assess student understanding of chemistry concepts. Couse specific example: The ACS Organic Chemistry Standardized Exam is given at the end of the CHEM 2320 as a summative assessment of learning and understanding of chemistry concepts.	Measure 1: Course specific example: CHEM 2320: Student average ACS Organic Chemistry Standardized Exam Scores above the 50th percentile of the national average.	Measure 1: Course specific example: CHEM 2320 average ACS Organic Chemistry Standardized Exam Scores during the past five years averaged in the 77th percentile with a range from the 67th to 87th percentile with no apparent trend.	Measure 1: Course specific example: CHEM 2320 average ACS Organic Chemistry Standardized Exam Scores during the past five years is well above the national average and indicates that the CHEM 2310/2320 series is highly effective in teaching organic chemistry concepts that the students retain at the end of the course.	Measure 1: Course specific example: Continue current approach to teaching organic chemistry content in CHEM 2310/2320. Examine performance of those whose scores fall significantly below the average to identify what actions might be taken to help their scores improve. The department is also considering extending the use of ACS Standardized Exams for assessment of other courses in program.
	Measure 2: Quizzes and graded assignments – Most courses use a combination of weekly quizzes and graded assignment to provide formative	Measure 2: Course specific example: CHEM 3420 average weekly quiz scores above 75%	Measure 2: Course specific example: CHEM 3420 average weekly quiz scores vary significantly with the group of	Measure 2: Course specific example: CHEM 3420 weekly quiz scores indicate that most students are learning the concepts but the variance of scores	Measure 2: Course specific example: CHEM 3420 weekly quiz scores provide the instructor with valuable formative

Evidence of Learning: Courses within the Major					
Measurable Learning Outcome Students will have developed:	Method of Measurement Direct and Indirect Measures*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	assessment of student learning throughout the semester.		students and with the topic. Average scores are near 80%, but vary between 50% and 95%.	relative to topic shows that the presentation of some topics needs to be examined, especially where the quiz results are consistently low from year to year.	assessment information that allows immediate intervention. However, the extent of material that is covered in the course limits the time that can be invested in review. Overall outline of the course should be reviewed to make sure that sufficient time is given on each topic, especially focusing on historically difficult topics.
	Measure 3: Exit Questionnaire and Interview – All chemistry majors fill out a questionnaire upon applying for graduation then review the questionnaire with the chemistry department chair. The questionnaire includes questions regarding the student's	Measure 3: All responses are collected and summarized, then shared with the faculty. Any response that indicates a concern is examined and methods for addressing the concern are developed by the	Measure 3: Almost all students recognized their understanding of core chemistry concepts and can cite specific examples and courses that they feel have been most beneficial.	Measure 3: This measure is highly subjective but also very informative and important. Graduates need to understand core chemistry concepts and they should also recognize that they understand them. We also hope that students graduate with confidence in themselves.	Measure 3: The exit questionnaire will continue to be used and the questions will be evaluated to determine if we can obtain more useful information in the process. The department is also interested in using a similar questionnaire

Evidence of Learning: Courses within the Major					
Measurable Learning Outcome Students will have developed:	Method of Measurement Direct and Indirect Measures*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	perception of their understanding of core chemistry concepts that they have developed as a result of completing the program.	faculty and implemented.			with graduates at one year and five years post graduation. Our current information is limited to informal feed back..
Problem solving skills	Measure 1: Exams – All courses use written and/or multiple-choice exams to assess student mastery of problem solving. Couse specific example: The ACS Organic Chemistry Standardized Exam is given at the end of the CHEM 2320 as a summative assessment of learning and problem solving skills.	Measure 1: Course specific example: CHEM 2320: Average ACS Organic Chemistry Standardized Exam Scores above the 50th percentile of the national average.	Measure 1: Course specific example: CHEM 2320 average ACS Organic Chemistry Standardized Exam Scores during the past ten years averaged in the 77th percentile with a range from the 67th to 87th percentile with no apparent trend.	Measure 1: Course specific example: CHEM 2320 average ACS Organic Chemistry Standardized Exam Scores during the past ten years is well above the national average and indicates that the CHEM 2310/2320 series is effective in teaching organic chemistry problem solving skills that the students retain at the end of the course.	Measure 1: Course specific example: Continue current approach to teaching organic chemistry content in CHEM 2310/2320. Examine performance of those whose scores fall significantly below the average to identify what actions might be taken to help their scores improve. Also, consider extending the use of ACS Standardized Exams for assessment of other courses in program.
	Measure 2: All courses that include a	Measure 2: Course specific example:	Measure 2: Course specific example:	Measure 2: Course specific example: CHEM 3000 is	Measure 2: Course specific example:

Evidence of Learning: Courses within the Major					
Measurable Learning Outcome Students will have developed:	Method of Measurement Direct and Indirect Measures*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	laboratory component that assesses problem-solving skills by review of student laboratory notebooks and reports. Course specific example: CHEM 3000: Students maintain a laboratory notebook where all data and analyses are recorded. Notebooks are collected each week and scored on completeness and accuracy of data analysis.	CHEM 3000: Student laboratory notebooks are collected each week and scored on completeness and accuracy of data analysis. Target scores of 75% on calculations and data analysis represent good mastery of problem solving related to this course.	CHEM 3000: Student average laboratory notebook scores are over 85%.	highly effective for teaching students problem solving skills related to analytical chemistry.	CHEM 3000 was increased from three credit hours to a four credit hours to increase depth of topic coverage and improve laboratory technique.
	Measure 3: Weekly quizzes and graded assignments – Most courses use a combination of weekly quizzes and graded assignments to provide formative assessment of student problem-solving skills.	Measure 3: Course specific example: CHEM 3400 average weekly quiz scores above 75%	Measure 3: Course specific example: CHEM 3400 average weekly quiz scores vary significantly with the group of students and with the topic. Average scores are near 80%, but vary between 60% and 95%.	Measure 3: Course specific example: CHEM 3400 weekly quiz scores indicate that most students are good at problem solving but there are difficult topics, indicated by scores that are consistently low from year to year. Students consistently struggle with differential calculus, which is central to chemistry problem solving at the upper division level.	Measure 3: Course specific example: CHEM 3400 weekly quiz scores provide the instructor with valuable formative assessment information that allows immediate intervention. Focus on improving student performance with differential calculus.
	Measure 4: Exit	Measure 4: All	Measure 4: Almost	Measure 4: This measure is	Measure 4: The exit

Evidence of Learning: Courses within the Major					
Measurable Learning Outcome Students will have developed:	Method of Measurement Direct and Indirect Measures*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Questionnaire and Interview – All chemistry majors fill out a questionnaire upon applying for graduation then review the questionnaire with the chemistry department chair. The questionnaire includes questions regarding the student's perception of the problem solving skills that they have developed as a result of completing the program.	responses are collected and summarized, then shared with the faculty. Any response that indicates a concern is examined and methods for addressing the concern are developed by the faculty and implemented.	all students recognized their development of problem solving skills and can cite specific examples and courses that they feel have been most beneficial.	highly subjective but also very informative and important. Graduates need to develop skills but they should also be aware enough to recognize that they are developing them. We also hope that students graduate with confidence in themselves.	questionnaire will continue to be used and the questions will be evaluated to determine if we can obtain more useful information in the process. The department is also interested in using a similar questionnaire with graduates at one year and five years post graduation. Our current information is limited to informal feed back.
Laboratory skills	Measure 1: Laboratory skills are assessed in all courses that include a laboratory component where laboratory skills are developed. Laboratory skills are assessed through review of student laboratory notebooks and reports, and by observation of students as they work.	Measure 1: Course specific example: CHEM 3000: Student laboratory notebooks are collected each week and scored on completeness, neatness, and accuracy of data. Target scores of 75% on collected data represent good	Measure 1: Course specific example: CHEM 3000: Student average laboratory notebook scores are typically over 85%	Measure 1: Course specific example: CHEM 3000 is a highly effective course for teaching students the quantitative laboratory skills that are essential for an analytical chemist.	Measure 1: Course specific example: CHEM 3000: Continue to assess and identify areas where student performance can be improved.

Evidence of Learning: Courses within the Major					
Measurable Learning Outcome Students will have developed:	Method of Measurement Direct and Indirect Measures*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Course specific example: CHEM 3000, Quantitative Analysis: Students maintain a laboratory notebook where all data and analyses are recorded. Notebooks are collected each week and scored on completeness and accuracy of data.	mastery of laboratory technique related to this course.			
	Measure 2: Laboratory skills are assessed in all courses that include a laboratory component where laboratory skills are developed. Laboratory skills are assessed through review of student laboratory notebooks and reports, and by observation of students as they work. Course specific example: CHEM 3410/3420, Physical Chemistry: Students maintain a laboratory notebook where all data and analyses are recorded. They also prepare	Measure 2: Course specific example: CHEM 3410/3420: Student laboratory reports scored on completeness and accuracy of data and analysis including error analysis. Target scores of 80% on collected data represent good mastery of laboratory technique and analysis related to this course.	Measure 2: Course specific example: CHEM 3410/3420: Student average laboratory report grades are 85%	Measure 2: Course specific example: CHEM 3410 is a highly effective course for teaching students careful collection and analysis of data, including analysis and reporting of uncertainties in collected data.	Measure 2: Course specific example: CHEM 3410/3420: Physical chemistry lab is universally challenging. Based on previous assessment data, the chemistry department developed a course (CHEM 3400) to help students master data and error analysis. Students have shown marked improvement as a result of this course addition.

Evidence of Learning: Courses within the Major					
Measurable Learning Outcome Students will have developed:	Method of Measurement Direct and Indirect Measures*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	extensive formal and informal lab reports Formal lab reports include differential error analysis, which includes estimates of uncertainties based on laboratory technique. Reports grades are based on completeness and accuracy of data and analysis, including error analysis.				
	Measure 3: Exit Questionnaire and Interview – All chemistry majors fill out a questionnaire upon applying for graduation then review the questionnaire with the chemistry department chair. The questionnaire includes questions regarding the student's perception of the laboratory skills that they have developed as a result of completing the program.	Measure 3: All responses are collected and summarized, then shared with the faculty. Any response that indicates a concern is examined and methods for addressing the concern are developed by the faculty and implemented.	Measure 3: Almost all students recognized their development of problem solving skills and can cite specific examples and courses that they feel have been most beneficial.	Measure 3: This measure is highly subjective but also very informative and important. Graduates need to develop skills but they should also be aware enough to recognize that they are developing them. We also hope that students graduate with confidence in themselves.	Measure 3: The exit questionnaire will continue to be used and the questions will be evaluated to determine if we can obtain more useful information in the process. The department is also interested in using a similar questionnaire with graduates at one year and five years post graduation. Our current information is limited to informal

Evidence of Learning: Courses within the Major					
Measurable Learning Outcome Students will have developed:	Method of Measurement Direct and Indirect Measures*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
					feed back.
Presentation skills	Measure 1: Several courses in the curriculum require students to prepare a paper and/or give a presentation based on library or laboratory research. Assessment of presentation skills is based on these papers and presentations. Course specific example: CHEM 3420, Physical Chemistry II: Students carry out a physical chemistry related research project, prepare a formal laboratory report and present their finding to the class. The presentation is rated on thoroughness, neatness, clarity, understandability, and general effectiveness. The student's scores on the written and oral portions of this assignment reflect student success in achieving this leaning outcome.	Measure 1: Course specific example: CHEM 3420, Physical Chemistry II, The research presentation and research report scores directly reflect the mastery of this learning outcome. A "B" grade or better indicates that a student has developed good presentations skills.	Measure 1: Couse specific example: CHEM 3420, Physical Chemistry II average research report and presentation grades are "B+".	Measure 1: Course specific example: CHEM 3420, Physical Chemistry II average research report and presentation grades of "B+" indicate that most of our students are achieving this learning outcome at a level that is appropriate for a junior level chemistry student. Chemistry students continue to struggle with report writing and organization. Anecdotal evidence indicates that this is a problem across the College of Science.	Measure 1: Course specific example: CHEM 3420, Physical Chemistry II research and presentations have been required for many years and the results generally show that students are developing presentations skills that are appropriate for junior level chemistry students. The Technical Writing course that is currently offered by the English Department has not been effective for majors in other COS departments. Department Chairs in the College of Science have begun discussing the design of a course in scientific writing that would benefit all science majors.

Evidence of Learning: Courses within the Major					
Measurable Learning Outcome Students will have developed:	Method of Measurement Direct and Indirect Measures*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Measure 2: CHEM 4990, Senior Seminar is specifically designed as a capstone course in the major, which is taken during the student's last semester. Chemistry majors are required to complete two semester-hours of CHEM 4800, Research and Independent Study in Chemistry. In CHEM 4990, Students prepare a research paper based on their CHEM 4800 research, which is reviewed by the class. They also present their research in oral or poster form to the faculty and students. The paper and presentation provide a measure of student learning related to presentation skills.	Measure 2: Course specific example: CHEM 4990, Senior Seminar, course is specifically designed as a capstone course in the major. The student's grade directly reflects the mastery of this learning outcome. A "B" grade or better is the departments accepted threshold indicating that a student has developed good presentation skills.	Measure 2: Course specific example: CHEM 4990, Senior Seminar average grades are B+.	Measure 2: Course specific example: CHEM 4990, Senior Seminar average grades of B+ indicate that most of our students are achieving this learning outcome by the time they graduate.	Measure 2: Course specific example: CHEM 4990, Senior Seminar. Since this course is a relatively new requirement in the major, we have few examples of student work so far. This course's impact will be evaluated again when we have a larger sampling of student work.
	Measure 3: Exit Questionnaire and	Measure 3: All responses are	Measure 3: Almost all students	Measure 3: This measure is highly subjective but also	Measure 3: The exit questionnaire will

Evidence of Learning: Courses within the Major					
Measurable Learning Outcome Students will have developed:	Method of Measurement Direct and Indirect Measures*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Interview – All chemistry majors fill out a questionnaire upon applying for graduation then review the questionnaire with the chemistry department chair. The questionnaire includes questions regarding the student's perception of the problem solving skills that they have developed as a result of completing the program.	collected and summarized, then shared with the faculty. Any response that indicates a concern is examined and methods for addressing the concern are developed by the faculty and implemented.	recognized their development of problem solving skills and can cite specific examples and courses that they feel have been most beneficial.	very informative and important. Graduates need to develop skills but they should also be aware enough to recognize that they are developing them. We also hope that students graduate with confidence in themselves.	continue to be used and the questions will be evaluated to determine if we can obtain more useful information in the process. The department is also interested in using a similar questionnaire with graduates at one year and five years post graduation. Our current information is limited to informal feed back.
Computing Skills	Measure 1: CHEM 3020, Computer Applications in Chemistry is specifically designed to expand chemistry student's computer skills for collecting and analyzing data. Because the course is focused on achieving this outcome, student grades provide a measure of the development of computing skills.	Measure 1: Course specific example: CHEM 3020, Computer Applications in Chemistry. A "B" grade or better in this course indicates that a student has developed good computer skills.	Measure 1: Course specific example: CHEM 3020, Computer Applications in Chemistry average grades are A-.	Measure 1: Course specific example: CHEM 3020, Computer Applications in Chemistry average grades of A- indicate that most of our students are achieving this learning outcome at a level that is appropriate for a sophomore/junior student.	Measure 1: Course specific example: CHEM 3020, Computer Applications in Chemistry. This course has been required of chemistry students for many years and is a good preparation for using computers as tools in data collection and analysis.

Evidence of Learning: Courses within the Major					
Measurable Learning Outcome Students will have developed:	Method of Measurement Direct and Indirect Measures*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	Measure 2: Computer skills are assessed in the laboratory portion of several upper division chemistry laboratory courses. Computer skills are assessed through review of student laboratory reports. Course specific example: CHEM 3410/3420, Physical Chemistry: Students maintain use computers extensively in data analysis, data plots and graphs, and laboratory report preparation including equation editing. Laboratory report grades reflect in part the mastery of these computer skills.	Measure 2: Course specific example: CHEM 3410/3420, Physical Chemistry: Student laboratory reports are graded in part on accuracy of data and analysis and clarity of presentation, all highly dependent on a students computer skills. Target grades of 80% in these categories represent good mastery of computer skills.	Measure 2: Course specific example: CHEM 3410/3420, Physical Chemistry: Student average laboratory report grades are 80%	Measure 2: Couse specific example: CHEM 3410/3420, Physical Chemistry: Student computer skills evidenced in Physical Chemistry Laboratory indicate a need for improvement in helping students effectively use computers at the junior/senior level. In particular, plot and graph formatting to best express the data needs to be improved.	Measure 2: Course specific example: CHEM 3410/3420 Physical Chemistry: Based on the recognized need for improving student use of computers in preparing data plots and reports, a new laboratory lecture has been developed in physical chemistry lab that introduces students to data graphing and effective report formatting. The results will be monitored during the coming years to determine how effective the changes have been.

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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 of the Natural Sciences and Physical Sciences Learning Outcomes:

Foundations of the Natural Sciences Learning Outcomes

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

1. Nature of science. 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. Integration of science. All natural phenomena are interrelated and shared basic organizational principles. Scientific explanations obtained from different disciplines should be cohesive and integrated.
3. Science and society. 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. Problem solving and data analysis. Science relies on empirical data, and such data must be analyzed, interpreted, and generalized in a rigorous manner.

The Physical Sciences Learning Outcomes

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

1. Organization of systems**:** 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.

While chemistry faculty have been using various methods to assess student learning relative to the Natural Science Student Learning Outcomes, no uniform reporting and evaluation system is currently in use at the department level. The chemistry department is developing a uniform assessment process for all of its general education courses. The first step is currently in progress and involves the development of a general-education exam database. Each faculty member that teaches a general education course has been requested to provide questions for the database that can be used to assess each of the learning outcomes. The chemistry faculty will review the collected questions for inclusion in the database. Each accepted question will be tagged with the corresponding learning outcome. When the database is sufficiently complete, faculty will be able to choose questions from it to include on the final exam in each of the general education courses. The university maintained computerized testing system call ChiTester will be used to administer a final exam for each GenEd course. Questions in ChiTester exams can be connected to each of the learning outcome and a report will be generated that summarizes each class' performance on the questions related to the GenEd outcomes. We expect to have this assessment system fully functional by the 2013/2014 school year.

The university is implementing a more structured program and course assessment model that includes an annual report with tables outlining the full assessment process for each course in the curriculum. The following table is completed as an example. Future department assessment efforts will make use of similar tables to compile program assessment information. In addition to the normal day-to-day assessment activity that instructors do in their teaching as a matter of course, each course will undergo formal assessment at least once each program review cycle.

Evidence of Learning: General Education Courses

Evidence of Learning: General Education Courses					
Natural Science Measurable Learning Outcome Students will demonstrate their understanding of:	Method of Measurement Direct and Indirect Measures*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
1) the nature of science	Measure 1: Each instructor will select a multiple-choice question addressing the learning outcome from a departmental assessment database and include it on the final examination.	Measure 1: 70% of students respond correctly to the question.	Measure 1: Not available, question database is currently being developed.	Measure 1: Not available, question database is currently being developed.	Measure 1: Develop database from questions submitted by faculty that are currently teaching the course. Once database is completed, more uniform assessment will be carried out.
2) the integration of science	Measure 1: Each instructor will select a multiple-choice question addressing the learning outcome from a departmental assessment database and include it on the final examination.	Measure 1: 70% of students respond correctly to the question.	Measure 1: Not available, question database is currently being developed.	Measure 1: Not available, question database is currently being developed.	Measure 1: Develop database from questions submitted by faculty that are currently teaching the course. Once database is completed, more uniform assessment can be carried out.
3) science and society	Measure 1: Each instructor will select a multiple-choice question addressing the learning outcome from a departmental assessment database and include it on the	Measure 1: 70% of students respond correctly to the question.	Measure 1: Not available, question database is currently being developed.	Measure 1: Not available, question database is currently being developed.	Measure 1: Develop database from questions submitted by faculty that are currently teaching the course. Once database is completed, more uniform assessment

Evidence of Learning: General Education Courses					
Natural Science Measurable Learning Outcome Students will demonstrate their understanding of:	Method of Measurement Direct and Indirect Measures*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
	final examination.				can be carried out.
4) problem solving and data analysis	Measure 1: Each instructor will select a multiple-choice question addressing the learning outcome from a departmental assessment database and include it on the final examination.	Measure 1: 70% of students respond correctly to the question.	Measure 1: Not available, question database is currently being developed.	Measure 1: Not available, question database is currently being developed.	Measure 1: Develop database from questions submitted by faculty that are currently teaching the course. Once database is completed, more uniform assessment can be carried out.

Evidence of Learning: General Education Courses					
Physical Science Measurable Learning Outcome Students will demonstrate their understanding of:	Method of Measurement Direct and Indirect Measures*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
1) organization of systems	Measure 1: Each instructor will select a multiple-choice question addressing the learning outcome from a departmental assessment database and include it on the final examination.	Measure 1: 70% of students respond correctly to the question.	Measure 1: Not available, question database is currently being developed.	Measure 1: Not available, question database is currently being developed.	Measure 1: Develop database from questions submitted by faculty that are currently teaching the course. Once database is completed, more uniform assessment can be carried out.

Evidence of Learning: General Education Courses					
Physical Science Measurable Learning Outcome Students will demonstrate their understanding of:	Method of Measurement Direct and Indirect Measures*	Threshold for Evidence of Student Learning	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
2) Matter	Measure 1: Each instructor will select a multiple-choice question addressing the learning outcome from a departmental assessment database and include it on the final examination.	Measure 1: 70% of students respond correctly to the question.	Measure 1: Not available, question database is currently being developed.	Measure 1: Not available, question database is currently being developed.	Measure 1: Develop database from questions submitted by faculty that are currently teaching the course. Once database is completed, more uniform assessment can be carried out.
3) Energy	Measure 1: Each instructor will select a multiple-choice question addressing the learning outcome from a departmental assessment database and include it on the final examination.	Measure 1: 70% of students respond correctly to the question.	Measure 1: Not available, question database is currently being developed.	Measure 1: Not available, question database is currently being developed.	Measure 1: Develop database from questions submitted by faculty that are currently teaching the course. Once database is completed, more uniform assessment can be carried out.
4) Forces	Measure 1: Each instructor will select a multiple-choice question addressing the learning outcome from a departmental assessment database and include it on the final examination.	Measure 1: 70% of students respond correctly to the question.	Measure 1: Not available, question database is currently being developed.	Measure 1: Not available, question database is currently being developed.	Measure 1: Develop database from questions submitted by faculty that are currently teaching the course. Once database is completed, more uniform assessment can be carried out.

Measureable Learning Outcomes – High Impact or Service Learning

Most of the courses that the Chemistry Department offers fall naturally into the category of "high impact" or "service learning" courses. Almost all chemistry courses include a "high-impact" hands-on laboratory component. Additionally, high-impact teaching techniques that encourage class participation and active learning have long been employed in all chemistry courses. Many courses include in-class demonstrations that require direct student participation and engagement. Some faculty use specific high-impact teaching techniques such as Process Oriented Guided Inquiry, POGIL, in their teaching. The latest high-impact teaching craze, the "Flipped Classroom" closely resembles the approach used in the hybrid CHEM 1210 course, which has now been taught for seven years – well before the term "Flipped Classroom" was coined. These courses are assessed as discussed in the Courses within the Major section above. The following courses are explicitly high-impact or service learning courses:

CHEM 2890 & CHEM 4890 – Cooperative Work Experience
CHEM 4800 – Research and Independent Study in Chemistry

These courses have the same set of intended learning outcomes as other major courses but because of their less structured nature, the degree to which they address each outcome varies with the instructor and the semester. They are assessed largely through student reports and presentations in CHEM 4990, Senior Seminar. All chemistry majors take at least two credits of CHEM 4800, Research and independent Study in Chemistry, with one credit of CHEM 4990, Senior Seminar. Based on their CHEM 4800 and other research experience, CHEM 4990 students prepare a paper of publishable quality and format, and they give an oral presentation of their work.

Evidence of Learning: High Impact or Service Learning

No table is provided for this section because it would be essentially the same as the table for Evidence of Learning for courses within the major above.

Evidence of Learning Summary

Perhaps the most important and telling measure of the effectiveness of chemistry courses and the chemistry program as a whole at achieving the learning outcomes is the fact that almost all of our students immediately find jobs in industry or are admitted to top rated graduate programs in chemistry or to medical professional schools, where they continue to find success. We frequently invite recent graduates who are attending graduate school to give a lecture for our majors. These returning students are happy to share with the faculty and students the things that have made them successful and things that they would improve. We take their suggestions very seriously and strive to implement positive changes related to their recommendations.

E. Academic Advising

Advising Strategy and Process

a. Chemistry major and minor advising is primarily the responsibility of the department chair. This phase of advising focuses on questions of which courses to take and the best sequence in which to take them so that students can make efficient progress toward their education goals. In addition to program specific advising, individual faculty members are frequently called upon to provide informal advising related to specific student interests. For example, students interested in graduate school or industry frequently seek advice from faculty members that have had experience in both academia and industry and who are able to share their experiences with those students. Students that are interested in medicine, veterinary medicine, dentistry, or pharmacy are directed to the appropriate College of Science pre-professional advisor for formal advising about preparation and requirements to enter those programs. Small majors' class sizes allow students and faculty to interact closely with each other and facility informal advising.

b. Majors and non-majors alike with questions concerning the availability of classes and scheduling consult with the department chair and the department secretary. Chemistry majors are encouraged to meet annually with the department chair to evaluate their progress toward a degree and to help plan their schedules. Chemistry is moving forward with distributing advising for majors across faculty members.

c. The College of Science has a dedicated academic advising office with a full time academic advisor, Jane Stout. The College of Science advisor serves students who are interested in science programs but who have not yet chosen a major. The advisor also provides advising regarding physical and life science General Education requirements. The science academic advisor is a member of the College of Science Chair's Council and works closely with department chairs to insure that students receive appropriate advising regarding the available science majors.

d. Campus online resources provide a further level of advising. The university catalog is available on the university web site and serves as the authoritative description of the programs of study available at Weber State University. The online degree evaluation system, " 'cat tracks", provides students and advisors with up-to-date information about a students academic progress and remaining requirements. The Chemistry Department web page is available online and provides detailed information about what courses are appropriate based on program of study.

e. The university Student Success Center at Weber State University provides support for students seeking an Associates degree in General Studies. Academic advisors in the Student Success Center assist General Studies majors with academic planning, graduation sign-offs and referrals to other campus support services.

Effectiveness of Advising

We have incorporated a survey section in the student exit interview, which attempts to assess the effectiveness of the academic advising throughout the student's academic career here at WSU. This assessment process is providing information regarding strengths or weaknesses in the mechanisms of academic advising. Because of the close interaction between majors and faculty members, majors generally receive excellent formal and informal advising once they enter their junior and senior year coursework.

One persistent challenge is that many students do not declare chemistry as their major until after their freshman or sophomore year. By that time they may have taken courses that are related to the chemistry major but do not fulfill the specific program requirements, such as trigonometry based Physics 2010 and Physics 2020 instead of the required calculus based Physics 2210 and Physics 2220. This is especially common among pre-medical students since the Pre-med Program does not require calculus-based physics. We advise all students of this problem as soon as they sign up as majors.

A related challenge arises with students who are advised to take most of their general education coursework while they explore their options for a bachelor's degree. These students often reach the end of their sophomore year before they start taking the math and science coursework that they need to begin the chemistry program and they become discouraged when they find that they still have three to four years of study ahead before they can complete a chemistry major. It can also have implications for their eligibility for financial aid. This frequently leads to students choosing a less structured major that they can complete within a shorter timeframe.

Advising students on broader university degree requirements also presents a challenge. The College of Science advising office does an excellent job of advising students about general education requirements but students that are later in their degree programs frequently overlook the 40 credit hours of upper-division coursework that is needed to fulfill the university requirement for a bachelor's degree. This is a recent problem that has arisen as a result of state-wide course articulation requirements. Previously, sufficient upper-division coursework existed within the major to satisfy the university requirement. Under the state-wide articulation agreement, Organic Chemistry is now numbered at the 2000 level and no longer provides upper-division credit. Students graduating with a chemistry degree now require a further three to seven credit hours of upper-division coursework, compared with the requirement that existed five years ago. This is an advising problem because students often do not recognize that the upper-division requirement exists until they apply for graduation during what they intend to be their last semester. Students are reminded of this upper-division requirement throughout the advising process but we continue to encounter the problem.

Past Changes and Future Recommendations

In an effort to improve ongoing advising and student-faculty interaction, the chemistry department is in the process of assigning faculty mentors to chemistry majors at the time that students declare the major. Students will be encouraged to meet at least annually with their faculty mentors to review their progress and plan their future schedules. Faculty advisors will also be able to provide timely guidance based on a student's developing interests.

The Chemistry Department has asked academic advising to especially encourage students that are broadly interested in the sciences to start early to take the math and chemistry course-work that will support them in a broad range of science related majors, including chemistry.

F. Faculty

The Chemistry Department's real strength lies in the expertise, experience, and dedication of the eleven fulltime and six adjunct faculty. (see Appendix B). This represents a decrease of one fulltime faculty line since the previous program review. Presently, all tenured or tenure-track faculty members within the Chemistry Department have Ph.D. degrees with unique training and technical expertise that allows the department to offer courses in each of the main sub-disciplines of chemistry required for ACS certification. The Chemistry Department has always placed priority on hiring and maintaining qualified and experienced faculty who complement the design, goals, mission, and vision of the program. Due to the eclectic and technical nature of chemistry, the program requires faculty members who are qualified to teach one or more of the sub-discipline chemistry areas including, but not limited to: general, inorganic, organic, physical and biochemistry, instrumentation, and quantitative and qualitative analysis.

As noted above, the Chemistry Department lost one faculty line in 2010 during a period of extensive budget cuts. The remaining eleven faculty members are required to teach larger classes with more overload in order to meet the accommodate the growing numbers of students. (see Appendix B). Since most area chemists with advanced degrees have regular day-time employment, it is almost impossible to find qualified adjunct faculty members that can teach daytime courses when most students are on campus. Even if we had a pool of daytime adjunct faculty, there is no funding to support an adjunct faculty for daytime teaching. Finally, adjunct faculty will always have to balance their teaching responsibilities with those of their normal employment and will never be able to dedicate themselves to serving students as completely as full-time faculty are expected to. Adjunct faculty tend not to be available for day-time office hours and are not sufficiently knowledgeable regarding the program to advise students.

One method that the department uses to provide the service courses required by programs across campus is to teach some of those courses in an online or hybrid format, funded as faculty overload by WSU Continuing Education. The added load is not considered part of the 12 semester hours contract faculty normally carry and amounts to overtime work. Nevertheless, department faculty willingly take on this extra load to provide a needed service for out students.

The following table with data from WSU Institutional Research shows the decreasing cost per student FTE for the chemistry department.

Cost of Instruction

	2007-08	2008-09	2009-10	2010-11	2011-12
Direct Instructional Expenditures	$1,369,489	$1,493,902	$1,362,604	$1,328,688	$1,330,525
Student FTE	465.67	488.37	567.73	542.23	578.47
Cost Per Student FTE	2,941	3,059	2,400	2,450	2,300

Cost per Student FTE has decreased approximately 25% in the last four years as budgets have been cut and student enrollments have increased approximately 25%. While the number of graduating chemistry majors has experienced normal cyclical fluctuation during this period of time, the numbers of students in our service courses have grown significantly. Chemistry has always served large numbers of students in General Education, Chemistry Principles, and Organic Chemistry courses. While these course enrollments have continued to grow in recent years, so have enrollments in courses such as biochemistry that used to serve primarily majors but now serve students in many areas of science. Faculty load calculations do not acknowledge the number of students in a course. Nevertheless, the work associated with a normal faculty-teaching load has increased substantially. With faculty workload associated with service courses increasing, faculty have less time to dedicate to teaching and interacting with our majors. Undergraduate research also suffers as faculty have little time to spare beyond what is required simply to teach, yet expectations for undergraduate research continue to increase and scholarship is one of the metrics for analysis of a faculty members performance related to tenure and post tenure review. There exists a significant danger that faculty will burnout if the current situation does not improve. In order for the chemistry program to remain functional, effective, and provide majors with the breadth and depth of understanding across the various sub disciplines, we must maintain the core expertise present in the department.

Finally, budgetary restrictions and the loss of the faculty line have resulted in the loss of course sections. Quantitative Analysis, CHEM 3000, was offered both spring and fall semesters for decades but we have been able to offer it only during fall semester the past two years. Quantitative Analysis is a required course in the major and in the AAS and is a common elective course in the minor and BIS Chemistry option. Quantitative Analysis has become a bottleneck for students seeking a chemistry degree. Because it is only offered only during Fall Semester and it is a prerequisite for Physical Chemistry, CHEM 3410, students that are otherwise prepared to take Physical Chemistry are faced with the choice of delaying a year or pursuing another major. Quantitative Analysis is the basis for analytical chemistry and is a key component related to the department's vision to provide a strong analytical chemistry emphasis for our students.

Faculty Demographic Information

See appendix A and included faculty curriculum vitae.

Programmatic/Departmental Teaching Standards

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 2008. ACS-CPT accreditation standards 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 this accreditation. 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. Some faculty deliver traditional lectures, some 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.

Faculty Qualifications

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, ceramic 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.

Evidence of Effective Instruction

The 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.

The 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. In Organic Chemistry, 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. Regular Faculty

All courses taught by tenure track faculty members and at least two courses taught by tenured faculty are evaluated by students each year.

These student evaluations are included as part of faculty annual reviews and 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. A similar process will likely result from the current efforts for post tenure review.

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 similar to the annual review required in the College of Science.

<u>Mentoring Activities</u>

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.

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.

<u>Diversity of Faculty</u>

Individuals of divers backgrounds are specifically encouraged to apply for positions when they come open. 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. Despite departmental and university-wide efforts to bring the department's profile closer to that of the local community, the department remains fairly homogeneous on the basis of race and gender with all faculty members being white and ten of eleven being male. This 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 years, two female and six 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. No change in the diversity of chemistry faculty can be made until new faculty can be hired.

Ongoing Review and Professional Development

The full time faculty provides an update of activities beyond teaching loads that include areas of service and professional growth or scholarship. 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 internal and external 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 members 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 new post-tenure review policy during the past year that requires that all faculty undergo a post-tenure review every five years.

The College of Science is currently designing a post-tenure review process that is consistent with the policy adopted by the Faculty Senate, and which will be implemented during the coming year.

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 is that this will be monitored much more actively for all faculty, not just those who are seeking tenure or promotion. This will be very challenging for faculty with very large teaching loads. 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.

f. Support Staff, Administration, Facilities, Equipment, and Library Adequacy of Staff

The number of support staff has decreased during the past five years. We currently have one full-time secretary, one lab manager. The science store manager has been cut from full time to half time but supplemented with a student assistant (see Appendix A). The secretary handles much of the department business. The lab manager directs the setup and logistics of all teaching laboratories including the laboratory at the Davis campus. The lab manager usually hires a few students per semester to help prepare chemicals and deal with the ongoing needs of all laboratory sections. The Science Stores manager maintains the chemical inventory for Chemistry as well as other departments in the College of Science.

i. Ongoing Staff Development

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.

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 facilities in the College of Science are nearly 45 years old. There is not enough space within the building to provide research rooms for all faculty members. 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 basically 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 a competitive granting process. Even if one is awarded an RS&PG grant, the amount of money provided will only allow for very small research projects and 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 because of inadequate facilities. We have been fortunate to obtain funding from a private donor for a 90 MHz NMR instrument in the last five years but funding for major instrumentation remains a challenge. Faculty members requiring routine NMR analysis of compound related to their research must contract with Hill Air Force Base or 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. Some faculty members in the Chemistry Department have continued to fight 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. Other instruments in the department are heavily used by students and are in constant need of repair. A small budget is maintained for instruments related to laboratory courses by requiring a lab fee for those courses. Most of the Department's instruments have no maintenance contracts and sometimes become unusable for months or even 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 a number of instruments donated to it, but these donated items are usually in disrepair or no longer supported and it is very difficult to find parts to remedy the situation. Some equipment is passed on to surplus for disposal. We have written several requests for outside funding to assist in updating outdated instrumentation. Only very limited awards have been granted which do not allow for a broad, quality undergraduate research program in chemistry. A state-of-the-art program in chemistry will require an order of magnitude greater funding to begin acquiring, implementing, and maintaining modern instruments and equipment. Moreover, new space will be needed.

Presently we have some serviceable equipment and instruments available for teaching basic courses. Because the freshman courses utilize relatively simple, inexpensive equipment, such as flasks, beakers, and balances, they are better able to function than higher-level courses. Our organic chemistry laboratory has never been adequately equipped to utilize all 48 student stations at the same time. For several years we have had to stagger the schedule so that half of the students could use the equipment one week, while the other half uses it the following week. This creates unnecessary confusion among the students and difficulty for the instructors and staff people who must prepare and run two different lab experiments at the same time.

Adequacy of Library Resources

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. The faculty has desktop access to the ACS Chemical Abstracts online through the Science and Technology Network (STN) International, but we do not have access to certain indices such as Science Citation Index. We anticipate a growing need for these resources as the department, university, and the ACS increasingly emphasize undergraduate research.

g. Relationships with External Communities

Description of Role in External Communities

The chemistry department plays is a valuable resource for education and business in northern Utah. Faculty in the Chemistry Department provide extensive support for the Richey State Science Fair. In addition to providing judges and other services that are necessary for the function of the science fair, out faculty also support students in science fair project development. Chemistry faculty provide presentations to school children in the local school districts. Dr. Seager is invited and provides several presentations to elementary school classes each year.

The Utah Center of Excellence for Chemical Technology is housed in the Department of Chemistry. The mission of the Center is to enhance the learning environment at Weber State University. The Center involves students and faculty in applied research activities that also provide extra-curricular learning opportunities, service to the community, and generate resources and good will for the University.

The Chemical Technology Center…

1. involves students in meaningful extra-curricular learning and research activities.
2. provides support for students to assist them in their education.
3. obtains resources to support faculty development and enrichment.
4. provides service by working with community entities.
5. generates opportunities and good will for the University.

The Chemical Technology Center is designed to assist Utah businesses in developing new products thus enabling them to be more competitive in their respective markets. The Center conducts innovative, applied research in a variety of chemically-related areas, usually focused on challenges unique to each company. Due to the cooperative, multi-disciplinary nature of the Center, a large variety of technological opportunities exist here. Ranging from natural product chemistries to new separation technologies, the diversified areas of expertise among our faculty (e.g., chemistry, microbiology, botany, and geology) makes the Center a perfect place for entrepreneurs to receive aid in high technology research and development.

The Center cultivates an interaction between the Chemistry Department at Weber State and the commercial sector. This interaction creates benefits for the Chemistry Department by stimulating innovative applied research, providing new equipment or paying for maintenance of existing items, and offering advanced training and experience for the chemistry students. Many of the graduates are recruited and become employees of companies involved.

In response to industrial demand, the Chemical Technology Center also provides research and technological assistance to industry to help them comply with environmental regulations and Good Manufacturing/Lab Practice (GxP). Information concerning chemical and hazardous materials management as well as technological assistance for OSHA and FDA compliance continues to be an important and growing mission of the center.

The Director of the Center, Dr. Edward B Walker, also works with a much larger community, participating on various boards and councils for economic development and international communities. This year, he is a member of the committee to approve new analytical methods for the Association of Official Analytical Chemists (AOAC), an international organization responsible for establishing validated methods of analysis for the world community that are recognized as legally defensible in courts of law and regulatory agencies around the world. He is also the chairman of the technical program committee for the analysis of juices and beverages for this organization.

Industrial Partners and Project Descriptions

Great Salt Lake Minerals: Explore the potential of harvesting beta-carotene from the Great Salt Lake.

Nutraceutical, Inc.: Develop new and innovative methods of analysis for dietary supplements, validate them and practice them. Supporter of efforts to formulate new phytopharmaceutical products.

Harmony Concepts: Aid in the development of better methods of synthesizing and analyzing many organometallic products for the dietary supplement market.

RJ Analytical: Provide assistance in developing new analytical methods for the dietary supplement and water treatment industries.

Artistic Precision Ent.: spray colors for foods. Helped to solve a manufacturing problem with "creative Color"

High-Country Thoroughbreds: Sourcing of chemical compounds for use in the horse-breeding and racing industry.

Photokinetic Coatings & Adhesives: Assist with test methods requiring FTIR spectroscopy and finding networking opportunities.

JLB, Inc.: Supporting technology transfer of patented technologies.

Support of Public Education in Northern Utah

The Department of Chemistry has expanded its support of concurrent enrollment in Davis County and Weber County schools. A new concurrent enrollment CHEM 1110 course came on line during the 2011-2012 school year at Fremont High School that focuses on serving students that are preparing to enter the registered nursing program at the Ogden/Weber Applied Technology College. Wayne April teaches the course and works closely with Spence Seager to design assignments, exams, and laboratory experiments. Chemistry lab experiments that require specialized laboratory facilities are conducted on the main Weber State University campus. The department continues to support the Viewmont High School CHEM 1110 and 1120 concurrent enrollment courses taught by Nancee Ott. A further concurrent enrolment course was added for the 2012-2013 school year taught by Nancy Treasure at Layton High School.

Summary of External Advisory Committee Minutes

The Chemistry Department does not currently have an external review committee as such. The department is currently discussing creating such an organization. However, the ACS functions in this capacity with regard to expected curriculum and resources. The College of Science Advisory Board also makes recommendations related to developing and leveraging specific strengths within the College of Science.

h. Results of Previous Program Reviews

Problem Identified	Action Taken	Progress
Issue 1 – Lack of modern and functional laboratory equipment required for teaching and undergraduate research	Pursue external funding through NSF, other organizations and campus connections to alumni.	Failed to obtain funding through NSF but successful in obtaining funding through connections to alumni and other campus sources resulting in the purchase of a 90 MHz NMR instrument. An FTIR instrument was purchased using student fee money for use in the organic chemistry laboratory.
Issue 2 – Mentoring of junior faculty. Department chair needs to be more proactive in the tenure/mentoring process to ensure requirements for tenure are transparent.	Policy required formal tenure review with the department chair is supplemented with frequent informal mentoring between the tenure track faculty member and the department chair.	We lost one tenure-track faculty member at the end of the 2009-10 school year for failure to progress toward tenure. The department chair and faculty put forth significant effort to help the tenure track member succeed and we continue to examine how we can be more supportive of the success of our faculty. This loss has had a large and lasting impact on the department and has resulted in the loss of a faculty line and the corresponding loss in our ability to offer courses. We currently have one tenure track faculty member that is making excellent progress toward tenure.
Issue 3 – Address the inherent conflict between research and full-load teaching (12 hr).	• When possible, a slight load reduction of one hour is given to those faculty that are heavily	• Departmental teaching requirements severely limit the load reduction that can be given.

	involved with undergraduate research, CHEM 4800. • The College of Science drafted a new workload model that would allow for reduction of teaching load under certain circumstances of research involvement.	• There is no funding to support the new College of Science workload model.
Issue 4 – Achieve a department and college consensus as to research and scholarship expectations to tenure and promotion.	The college has recently formed an *ad hoc* committee to review the college tenure document related to this and other issues.	The committee has not yet met to begin work.
Issue 5 – Review Minor requirements to insure that they are consistent with programs at peer institutions.	Requirements for the Chemistry Minor across USHE institutions were reviewed.	The department increased the minimum number of credits required in the minor to 20 but with no specific upper-division requirement, similar to the requirement at USU.
Issue 6 – Student Learning Outcomes Assessment	Assessment of learning outcomes is developing.	CHEM 4990, Senior Seminar, provides a means to assess student research. ACS Subject exams are being considered for all areas of chemistry. They are currently used only in the organic chemistry series. Further information is contained in Section D of this study.

i. 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 – General Education Assessment	Current 5 Year Program Review: With Natural and Physical Science General Education Learning Outcome defined, the department is presently compiling a database of questions that are linked to each of the learning outcomes for use on final exams administered in courses General Education courses.
	Year 1 Action to Be Taken: Instructors teaching GE courses will use questions from the exam database on final exams. Assessment database questions will be reevaluated. The department will begin gathering statistics on student performance with respect to the GE NS and PS learning outcomes.
	Year 2 Action to Be Taken: The department will continue gathering statistics on student performance with respect to the GE NS and PS learning outcomes.
	Year 3 Action to Be Taken: The department will continue gathering statistics on student performance with respect to the GE NS/PS learning outcomes. Review student performance relative to the GE NS/PS leaning outcomes of each course that provides GE NS/PS credit and plan methods to address any weaknesses that are revealed.
	Year 4 Action to Be Taken: The department will continue gathering statistics on student performance with respect to the GE NS/PS learning outcomes. Develop plans to identify strengths and address weaknesses in GE NS/PS courses and implement as required.
Issue 2 – Assessment of Courses in the Major	Current 5 Year Program Review: Courses within the major have been identified for assessment regarding program learning outcomes. Instructors are collecting artifacts related to the learning outcomes for

	many of those courses but a more formal archiving method is required to facilitate the periodic review of courses relative to program learning outcomes.
	Year 1 Action to Be Taken: Develop a formal archiving method that can be used broadly across the chemistry curriculum and facilitate periodic review of courses relative to program learning outcomes. Discuss use of ACS standardize exams where they are available.
	Year 2 Action to Be Taken: Begin archiving collected artifacts at the department level related to program learning outcomes. Obtain and begin to use of ACS standardize exams where the faculty deems them appropriate.
	Year 3 Action to Be Taken: Continue collecting artifacts at the department level related to program learning outcomes.
	Year 4 Action to Be Taken: Review student performance relative to the program leaning outcomes and plan methods to address any weaknesses that are revealed.

Action Plan for Staff, Administration, or Budgetary Findings

Problem Identified	Action to Be Taken
Issue 1 – Additional faculty line in area of Analytical and Biochemistry	Current 5 Year Program Review: Adopt departmental vision statement that provides clear goals for continued development of the department and its programs. Clearly communicate to administration the need and purpose for the faculty line.
	Year 1 Action to Be Taken: Work with administration to obtain a faculty line. Clearly communicate the need and purpose for the faculty line.
	Year 2 Action to Be Taken: Review progress. As necessary, continue to pursue additional faculty line with administration.
	Year 3 Action to Be Taken: Review progress. As necessary, continue to pursue additional faculty line with administration.
	Year 4 Action to Be Taken: Review progress. As necessary, continue to pursue additional faculty line with administration.
Issue 2 – Funding for maintenance and upkeep of chemistry instrumentation and equipment.	Current 5 Year Program Review: Adopt departmental vision statement that provides clear goals for continued development of the department and its programs. Develop a timetable for replacement of existing equipment that becomes obsolete or unusable. Clearly communicate the need and purpose for instrumentation and equipment along with associated maintenance. Identify possible alternative funding options such as external grants that can assist in obtaining needed resources.
	Year 1 Action to Be Taken: Work with administration to obtain needed instrumentation and equipment. Clearly communicate the need and purpose for the instrumentation and equipment. Pursue alternative funding options such as external grants that can assist in obtaining needed resources.
	Year 2 Action to Be Taken: Review progress. As necessary, continue to pursue additional funding for instrumentation and resources from internal and external sources.

	Year 3 Action to Be Taken: Review progress. As necessary, continue to pursue additional funding for instrumentation and resources from internal and external sources.
	Year 4 Action to Be Taken: Review progress. As necessary, continue to pursue additional funding for instrumentation and resources from internal and external sources.

j. Summary of Artifact Collection Procedure

Artifact	Learning Outcome Measured	When/How Collected?	Where Stored?
(i.e. Final Project Rubric)		(i.e. end of semester)	(i.e. electronic copies)
(i.e. Chi Tester Outcome Report)		(i.e. 2-3 times per semester)	(i.e. electronic format, chi tester warehouse)

Individual instructors collect artifacts related to their own courses. Examples of current collected artifacts and collection procedures are outlined in Section D above.

APPENDICES

Appendix A: **Student and Faculty Statistical Summary**

	2007-08	2008-09	2009-10	2010-11	2011-12
Student Credit Hours Total	13,970	14,651	17,032	16,267	17,354
Student FTE Total	465.67	488.37	567.73	542.23	578.47
Student Majors	162	167	186	170	171
Program Graduates, BS	14	13	9	8	6
AAS	12	5	7	4	13
Student Demographic Profile,	162	167	186	170	171
Female	50	44	59	67	67
Male	112	123	127	103	104
Faculty FTE Total	22.08	22.59	22.26	21.44	NA
Adjunct FTE	10.59	11.03	10.4	10.58	NA
Contract FTE	11.49	11.56	11.86	10.86	NA
Student/Faculty Ratio	21.09	21.62	25.50	25.29	NA

Note: Data provided by WSU Institutional Research

Appendix B: **Contract/Adjunct Faculty Profile**

Name	Gende	Ethnicity	Rank	Tenure Status	Highest Degree	Years of Teaching	Areas of Expertise
Berghout, H. Laine	M	white	Prof	2009	Ph.D.	13	Physical/Structure
Davidson, Charles F.	M	white	Prof	2004	Ph.D.	16	Inorganic/Physical
Davies, Don	M	white	Assoc	2009	Ph.D.	12	Organic/Synthesis
Herzog, Timothy	M	white	Asst	2008	Ph.D.	9	Organometallic
Johnson, Todd M.	M	white	Prof	2001	Ph.D.	18	Bio-organic
Lippert, J. Andreas	M	white	Prof	2008	Ph.D.	14	Analytical/Instrumental
Lloyd, Barry A.	M	white	Prof	1992	Ph.D.	27	Physical Organic
Paustenbaugh, Michelle B.	F	white	Prof	2009	Ph.D.	13	Physical Inorganic
Seager, Spencer L.	M	white	Prof	1966	Ph.D.	51	General/Physical
Stoker, H. Stephen	M	white	Prof	1975	Ph.D.	44	Inorganic
Walker, Edward B.	M	white	Prof	1988	Ph.D.	31	Bio-analytical
Davidson, Robert	M	white	Adjun		MS	12	Analytical/ Environmental
Francis, MaryAnn	F	white	Adjun		BS	10	
Hartman, Laird	M	white	Adjun		Ph.D.	9	Continuing Education
Litvinov, Dmitry N.	M	white	Adjun		Ph.D.	2	Bio-organic
Russell, Geoffrey	M	white	Adjun		Ph.D.	9	Material Sciences
Slabaugh, Michael R.	M	white	Adjun	1978	Ph.D.	41	Bio-organic

Faculty Vitae

Appendix C: **Staff Profile**

Name	Gender	Ethnicity	Job Title	Years of Employment	Areas of Expertise
Miller, Karen J.	F	white	Chemistry Store Manager	37	Stock/Supplies
Britt, Vicki	F	white	Lab Manager	1	Lab Manager
Boam, Colleen	F	white	Chemistry Secretary	4	Dept. Secretary
Kinikin, JaNae	F	white	Science Librarian	10	Library

Appendix D: **Financial Analysis Summary**

Department	2007-08	2008-09	2009-10	2010-11	2011-12
Undergraduate					
Instructional Costs	$1,369,489	$1,493,902	$1,362,604	$1,328,688	$1,330,525
Support Costs					
Other Costs					
Total Expense	$1,369,489	$1,493,902	$1,362,604	$1,328,688	$1,330,525
Graduate					
Instructional Costs					
Support Costs					
Other Costs					
Total Expense					

Note: Data provided by Provost's Office

Appendix E: **External Community Involvement Names and Organizations**

Name	Organization

Appendix F: External Community Involvement Financial Contributions

Organization	Amount	Type
		Grant
		Contract
		Donation

Financial contribution to the chemistry program

The Chemical Technology Center provides financial assistance to the Chemistry Department through the maintenance, repair and acquisition of chemical instruments. The Center acquires state-of-the-art instruments and fosters industrial partnerships who allow WSU students to obtain experience and/or on-the-job training with expensive, specialized instrumentation that the Chemistry Department cannot afford. For example, the Nutraceutical Corporation occupies space in the Center Laboratories, where they keep and maintain instruments such as ICP, ICP-MS, GC, GC-MS, HPLC, HPLC-MS, HPLC-LSD, FTIR, dissolution, stability chambers, etc, that cost in excess of $1-million dollars and require more than $75,000 per year to maintain. Chemistry majors in our advanced instrumentation courses and our 2-year Chemistry Technician Program have the opportunity to use their equipment and conduct experiments for free as part of their laboratory course curricula. The Center also works closely with the 2-year Chem Tech Program, to arrange tours and COOP work experience with local industries. Most of the instruments above are owned by Neutraceutical Corporation and are used daily by their employees (some of whom are former students). Access to Weber State chemistry students and faculty has always been limited by instrument availability and by the appropriate training.

The Center generally brings in $100,000 - $200,000 annually through grants, contracts, and donations, to support itself and helps the Chemistry program at WSU. In addition, to helping with educational efforts, the Center provides support for research that leads to publications and presentations at scientific meetings for students interested in Bio-analytical chemistry.