Chemistry Program
Southeastern Oklahoma State University

Assessment Report
2008-2009

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Prepared by:
Mo Chehbouni
Steve McKim
Nancy Paiva
Tim Smith
Loide Wasmund
Jerry Polson, Chair
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A. Departmental Mission Statement

The Department of Chemistry, Computer, and Physical Sciences is dedicated to preparing its students to face the challenges and take advantage of the opportunities of the 21st century by providing excellence in teaching, outstanding academic programs, and relevant research opportunities.

B. Departmental Vision Statement

The Department of Chemistry, Computer, and Physical Sciences will continue to exemplify excellence in teaching, grantsmanship, research, and scholarship. It will be innovative and responsive to changing technologies and demographics and continue to pursue partnerships with regional constituencies.

C. Statement for Assessment and Student Learning

The Department of Chemistry, Computer, and Physical Sciences is dedicated to assessing its academic programs so that its students will be prepared to meet the challenges of the 21st century. Through continual assessment the department will be responsive to changing technologies and needs of the marketplace.

D. Program Goals

- Prepare students for career opportunities in academia, industry, and government;
- Provide students the pre-professional training required for entrance into schools of medicine, osteopath, dentistry, veterinary medicine, optometry, nursing, physical therapy, engineering, pharmacy, and allied public health fields;
- Prepare students to enter the teaching profession in science education;
- Prepare students for graduate study in chemistry.

E. Major Program Learning Outcomes

1. Demonstrate knowledge of chemical concepts, laws, theories, and the ability to use process skills in chemistry through observation, measurement, classification, inference, interpretation, and experimentation (including controlling variables, graphing, and communication).

2. Show competence in cognitive analysis of chemical information, recognition of organizing principles in information, and proficiency in library and computer skills in obtaining information and analyzing data.

3. Demonstrate skill in the synthesis of information by preparing and presenting reports,
proposing plans or sets of operations, and/or making derivations of abstract relations.

4. Exhibit intellectual honesty, open-mindedness, and objectivity in the accumulation and interpretation of information and form value judgments on ethical issues in the conduct of chemistry and the applications of chemistry in society.

5. Show interpersonal skills that promote the accomplishment of team goals in small groups.

6. Show the ability to anticipate, recognize, and respond appropriately to laboratory hazards or hazardous conditions, and take appropriate safety precautions.

F. Assessment of Each Program Outcome

Every student majoring in chemistry is required to take General Chemistry I and II (each with laboratory), Chemical Analysis (with laboratory), Organic Chemistry I (with laboratory), and Inorganic Chemistry. Other courses that are often taken include Organic Chemistry II (with laboratory), Instrumental Analysis (with laboratory), Biochemistry (with laboratory), Physical Chemistry I, Thermodynamics Laboratory, Physical Chemistry II, and Research.

Outcome 1: Demonstrate knowledge of chemical concepts, laws, theories, and the ability to use process skills in chemistry through observation, measurement, classification, inference, interpretation, and experimentation (including controlling variables, graphing, and communication).

This Outcome is assessed using the following instruments/methods.

a) American Chemical Society Standardized Exam in Analytical Chemistry

Every student majoring in chemistry is required to take Chemical Analysis. In the lecture portion of this course the student studies the concepts, laws, and theories governing analytical chemistry. The course also has an extensive experimental (laboratory) component which meets for four hours each week. During the laboratory period, the student must perform experiments in analytical chemistry in which they are charged with initiating and observing chemical reactions, measuring reaction products, classifying and recording data, analyzing and interpreting the data through graphical and statistical analysis, and communicating the results through a written laboratory report which must be maintained in the student's Laboratory Manual.

As a part of this course each student is required to take the American Chemical Society Standardized Exam in Analytical Chemistry. This exam tests the student's knowledge of both theoretical and experimental analytical chemistry. The scores are also compared with the national averages. This year ten students took the exam. The Southeastern chemistry majors had a mean score which was within the standard error of the national mean. This implies that there is no significant difference between the two. In the graph shown below there is evidence of consistency in the Southeastern mean score over the past five years.
b) American Chemical Society Standardized Exam in Organic Chemistry

Every student majoring in chemistry is required to take Organic Chemistry. In the lecture portion of this course, the student studies the concepts, laws, mechanisms, and theories governing organic chemistry. The course also has an extensive experimental (laboratory) component which meets for four hours each week. In the laboratory period the student must perform experiments in organic chemistry in which they are charged with initiating and observing chemical reactions, measuring reaction products, classifying and recording data, analyzing and interpreting the data through graphical and statistical analysis, identifying unknowns, and communicating the results through a written laboratory report which must be maintained in the student's Laboratory Manual.

As a part of this course each student is required to take the American Chemical Society Standardized Exam in Organic Chemistry. This exam tests the student's knowledge of both theoretical and experimental organic chemistry. The scores are also compared with the national averages. This year seventeen students took the exam. The Southeastern chemistry majors had a mean score which was within one standard deviation of the national mean. In the graph shown below there is evidence of consistency over the past five years.
c) American Chemical Society Standardized Exam in Instrumental Analysis

We offer a course in instrumental analysis which, although not required, is often taken by our chemistry majors. This course has both lecture and laboratory components involving basic electronics, computer control of chemical instrumentation, spectral, electrochemical and chromatographic methods of analysis, and laboratory automation. While the lecture portion deals with the theoretical concepts of instrumentation, the laboratory portion is very similar to analytical chemistry except more sophisticated instrumentation is used.

As a part of this course each student is required to take the American Chemical Society Standardized Exam in Instrumental Analysis. This exam tests the student's knowledge of both theoretical and experimental instrumental analysis. The scores obtained by the students have a direct impact on their final grade. The scores are also compared with the national averages.

This year three students took the exam. The Southeastern chemistry majors had a mean score of which was within two standard deviations of the national mean. In the graph shown below there is evidence that the last group of students performed badly on the standardized exam. The instructor commented that this was the worst instrumental class he had ever had. This year's score, when compared with previous years, would seem to bear that out.
d) Medical College Admissions Test (MCAT)

The MCAT is a test required for admission into all medical programs, medical doctorate and osteopathic doctorate, in the U.S. The MCAT is a standardized, multiple-choice examination designed to assess the examinee's problem solving, critical thinking, writing skills, and knowledge of science concepts and principles prerequisite to the study of medicine. Scores are reported in Verbal Reasoning, Physical Sciences, Writing Sample, and Biological Sciences. Chemistry represents between 35 and 40% of the MCAT by subject area. Students have taken a minimum of 20 hours of chemistry (General and Organic Chemistries) at the point of taking the MCAT and most have more than 30 hours at this point. The MCAT is administrated by the Association of Medical Colleges and student's performance on this critical test is made available to the pre-medical advisory committee at each undergraduate institution.
The data clearly indicates the student's performance has increased consistently over the past 5 years. This data set represents 42 students that took the MCAT over the most recent 5-year period. The minimum score to apply for Medical School varies among each program. However, both the University of Oklahoma Health Sciences Center and the Oklahoma State University Health Science Center require a minimum composite score of 21 to apply. The MCAT is a fairly good indicator of which students have a good chance of entering a Medical Program. The average MCAT for 7 students that took the MCAT was 20.6. Even though the average MCAT dropped compared to 07/08, an upward trend still exists for this data set. The graph shown below illustrates the success of SOSU students whom have applied to Medical Programs. Over the past 3 years the average of student acceptance-to-applicant ratio has increased over previous time periods. Five students were accepted in medical programs for the Fall 09 class, which ties 2005 for being one of the highest on record. The average percentage of the students that were accepted into medical programs increased from 19.4% in 2003-2005 to an outstanding 69.7% in 2006-2008. Because the number of students applying to Medical School varies significantly from year to year it is difficult to state that this is a absolute trend, but it is certainly a positive indicator of student learning.
Outcome 2: Show competence in cognitive analysis of chemical information, recognition of organizing principles in information, and proficiency in library and computer skills in obtaining information and analyzing data.

This outcome is measured in several courses and because of its nature it is difficult to quantitatively measure. The outcome can be seen in two aspects of the Department's instruction. The first is in the cognitive analysis of the students own information collected in the laboratory portion of core and elective courses. The instructional emphasis in the 5-semester hour courses is forty percent on these laboratory-based competencies. Specific requirements are discussed in the paragraphs below. The second aspect of this competency is exhibited in the cognitive analysis of literature information assigned in several of the courses. Several of the 3000 and 4000 level courses include a research paper that requires that the student perform a literature search, organize key scientific information, and prepare a report and/or oral presentation. While the grades can be tracked on an individual student basis for the assignment, the component of the assignment pertaining to Outcome 2 only is not separately recorded. All majors in chemistry are required to take the Senior Seminar course. This course includes a literature component in which students are taught to use current chemical information search engines and how to organize specific information in the resulting hits. The students are required to perform multiple searches on assigned literature as well as use these tools in their final report and presentation. The grade values are recorded and students over the past year have performed at a satisfactory level.
Due to the fact that most of the Biotechnology and Medical Sciences majors have taken senior seminar in Biology over the past three years, the limited data available has limited statistical significance.

General chemistry laboratory (CHEM 1315 and 1415) introduces the majors to computer assisted data acquisition, presentation and analysis. The courses have for the past sixteen years made the most extensive use of the twelve-station computer lab equipped with hardware and software for collecting and processing laboratory measurements. The system currently employed is LoggerPro® from Vernier Software & Technology. Options for data acquisition by electronic probes include temperature, light intensity, voltage, pH and a UV-Vis spectrometer. Data is displayed digitally, recorded to a spreadsheet and displayed on a graph all in real time. Students are required to learn to enter additional data and prepare calculations in the spreadsheet, refine graphic displays, and perform linear and curve fits of the data to determine results for the investigations.

Each week students in organic chemistry laboratory (CHEM 3062 and 3162) are required to perform pre-laboratory analysis of their experiment that involves data mining and organization of reagents to be utilized. Common data that the students are routinely required to find include: structure, boiling point, melting point, molecular weight, molecular formula, polarity, and solvent solubility. In addition, all Chemical and Instrumental Analysis (CHEM 3425 and 3525) students are required to perform data analysis in every laboratory experience using Excel. As a result, all students are required to be proficient in Excel at the completion of the CHEM 3425 course.

**Outcome 3:** *Demonstrate skill in the synthesis of information by preparing and presenting reports, proposing plans or sets of operations, and/or making derivations of abstract relations.*

These Outcomes are assessed in several of our advanced chemistry courses where students are required to write up extensive laboratory reports using both library and computer skills. However, every student taking Senior Seminar is required to do a research project which requires them to use library resources, organize and present their findings in both a poster presentation, a written report, and an oral presentation. It is important to note that while chemistry majors and chemistry major-minor students must take the chemistry Senior Seminar, some of the interdisciplinary double majors (chemistry-biology) opt to take the Biology Senior Seminar and, therefore, do not appear in the statistics. The chart below shows the number of students who have manifested the proficiencies of Outcomes 2 and 3 in Senior Seminar during the past five years. The chemistry faculty evaluates the poster presentations, the oral reports, and the written reports. The evaluations are used in assigning a grade for each individual student's performance. Generally, it can be said that the chemistry faculty believes that the students' performances on their presentations and reports met the requirements of Outcomes 2 and 3. Since students in the biology Senior Seminar have to meet similar requirements as those in chemistry it seems reasonable to assume that the interdisciplinary double majors also met the requirements of Outcomes 2 and 3.
Outcome 4: Exhibit intellectual honesty, open-mindedness, and objectivity in the accumulation and interpretation of information and form value judgments on ethical issues in the conduct of chemistry and the applications of chemistry in society.

The acceptance of papers for presentation and publication not only demonstrates the students’ skills in synthesis of information but also supports the first part of this competency as well. The papers are peer-reviewed before either presentation or publication. Without the qualities of intellectual honesty, open-mindedness and objectivity they would not be accepted. The same can be said for the students performance at state, regional and national meeting where they deliver poster and platform presentation.

The awareness of chemistry in society is perhaps the most difficult of all to quantify. Opportunities for discussion of relevant topics to form value judgments on ethical issues occur in all courses. It is however through the department’s support of out-of-class activities that the civic engagement of the students is best exemplified. The faculty has regularly been encouraged to sponsor a student group under the leadership of the Student Affiliate Chapter of the American Chemical Society. Since its charter at Southeastern in the late 60’s the SAACS has been a vehicle for the development of student leadership and civic responsibility. The student officers conduct regular meetings, plan involvement in university events, develop public school outreach programs, and prepare an annual report of chapter activities. Participating students attend local programs of invited speakers, perform demonstration for public and school groups, support university events, and travel as a group with the faculty to meet and hear nationally known speakers on a variety of topics at ACS local section meeting held across the state.
Outcome 5: Show interpersonal skills that promote the accomplishment of team goals in small groups.

The Department of Chemistry, Computer, and Physical Sciences has some very active research groups. These groups involve chemistry students and faculty who conduct original research, most of which is funded by external grants from places such as the National Institutes of Health (NIH), the Oklahoma Center for the Advancement of Science (OCAST), and National Aeronautics and Space Administration (NASA).

During the research process students typically work in teams under the direction of a faculty advisor. The students are intimately involved in accumulating, interpreting, and analyzing information acquired from the experiments they perform. They are also required to make value judgments on the validity of the information and experimental processes. In addition, they must be completely open and honest in the collecting and sharing of information with other team members in their respective research group.

Below is a chart which reflects the research production of approximately nineteen students who were involved in research projects in the 2007-2008 academic year. Historical data is also provided for the five previous years.

![Number of Presentations at State and National Meetings](chart.png)

A partial listing of students' presentations is given below:

**Poster presentations at Oklahoma Research Day, Broken Arrow, OK, November 14, 2008:**

- "Expression and Analyses of the c-Kit Tyrosine Kinase Its Mutant Kit-deltaS", Amanda Brock (SE Biotechnology major, NIH-INBRE summer intern), Shaofeng Wang (OUHSC), & Zhizhuang Joe Zhao (mentor), University Oklahoma Health Sciences Center-Pathology, Oklahoma City,
• "Optimization of a Bioassay for Carbohydrate Uptake by *Escherichia coli*", Joseph A. Sampson (SE Chemistry major) & Joel T. Smith (SE).

• "Monitoring metabolism changes in *E. coli* during amino acid starvation", G. Aaron Hightower (SE Chemistry/Biology major), Joel T. Smith (SE), Tyrrell Conway (OUHSC), & Matt Traxler (University Oklahoma-Microbiology, Norman).

• "Water Treatment using Molybdenum Oxide Capped Magnetic Nanoparticles. W. Apblett (Oklahoma State University-Chemistry, Stillwater), Mo. Chehbouni (SE), T. Trad (University Texas at Brownsville-Chemistry, Brownsville, TX.).


• "Comparison of oil feedstocks for biodiesel (B100) production", Nancy L. Paiva (SE), Joshua Brown, Justin Dodds, Ricardo Lemus, Micah Sampson, Jimmy Stephens (Durant Biodiesel), Ron Workman (Durant Biodiesel), & Miguel J. Dabdoub (University São Paulo-Department Chemistry, FFCLRP, Ribeirão Preto-Brazil).

**Additional Poster and Oral Presentations**

• Sampson NIH IDeA Central Region Conference, May 28-29, 2009, Oklahoma City, OK, two posters – one by Joe and one by JTS

• 54th Annual Pentasectional Meeting of the Oklahoma ACS, April 17-18, 2009, Tulsa, OK, 2 student posters and 1 oral presentation by JTS

• 64th Southwest Regional Meeting of the ACS, Oct. 1-4, Littlerock, AR, one student poster and oral presentation by JTS

Several of the upper level chemistry courses use group data. In Chemical Analysis (CHEM 3425), individual students contribute their replicate data to generate a statistical population of data which is shared by the class to perform statistical analysis. This class does one team-based inquiry-based experiment over chromatography. Each member of the team is assigned a particular solvent system and chromatographically analyzes a set of standards. Based on the performance with each solvent system, the team chooses an appropriate solvent system to identify components in an unknown mixture.

The Biochemistry laboratory (CHEM 4115) experience is almost completely focused around team/group inquiry-based learning in their experiments. Weekly, each group performs an experiment(s) under a different set of experiment conditions (example - enzymatic pH) and the
resulting data is used by the entire class to determine how to proceed with the next step of the experiment. This basic experimental format is repeated through the entire semester allowing for systematic variation of each parameter of a system under study.

**Outcome 6:** Show the ability to anticipate, recognize, and respond appropriately to laboratory hazards or hazardous conditions, and take appropriate safety precautions.

This is a very difficult Outcome to quantitatively assess. However, it is important to note that every chemistry student must view a laboratory safety video and receive basic instruction on laboratory safety before being allowed in a chemistry laboratory. The instruction includes how to handle various solvents, poisons, acids, and bases. It is also mandatory that all students wear protective eye goggles in the laboratory and demonstrate safe laboratory practices while engaged in laboratory work. If a laboratory accident occurs that requires emergency medical treatment, the Chemistry Stockroom Manager who is our chief safety officer in the department must file a written report regarding the particulars of the accident and subsequent treatment of the victim. The report is then forwarded to the Dean and other administrators as necessary. If deemed necessary, the Chemistry Safety Committee may be convened to review safety procedures.

Instruction on proper safety procedures is provided weekly to every student in every laboratory. The instructors always include relevant instruction at the beginning of every laboratory activity. Students who fail to adhere to the guidelines on any particular activity are immediately corrected in lab and may be dismissed for continuing to ignore those instructions. During the course of the work in the laboratory there are specific requirements for the disposal of excess reagents, waste or by-products of the chemical operations and the final product. Even “simple” actions such as smelling a chemical vapor, transferring a chemical reagent, weighing a chemical material, storing a chemical product, transporting a chemical material or reacting to a small chemical spill have prescribed protocols for responses which the students must learn and follow. The students learn to work in a state of safety-consciousness. Some measure of the success of this outcome is the lack of any report of any safety violation. A better measure is the overall safe environment of the majority of laboratory areas which would not be possible if left entirely to the faculty and staff.

**G. Faculty Level of Involvement in Assessment Process**

The chemistry faculty members in the Department of Chemistry, Computer, and Physical Sciences were involved in the collecting and analyzing of data and in the writing, proofreading, editing, and compiling of the assessment report. The following is a list of responsibilities for the 2007-2008 academic year:

<table>
<thead>
<tr>
<th>Faculty Member</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mo Chehbouni</td>
<td>Proofreading and editing</td>
</tr>
<tr>
<td>Steve McKim</td>
<td>Proofreading and editing</td>
</tr>
<tr>
<td>Nancy Paiva</td>
<td>Assist writing Sections F.4-5</td>
</tr>
<tr>
<td>Jerry Polson</td>
<td>Compiling report, organizing responsibilities, writing Sections H, J and L, assist writing F.4-5</td>
</tr>
</tbody>
</table>
H. Assessing IETV and/or Web-Based Instruction

The chemistry program does not have any IETV or web-based course offerings. The department does offer several courses online. However, they are not a part of the chemistry program. These courses are assessed in the department's General Education Assessment Reports and in the Computer Science and Computer Information Systems Assessment Reports.

I. Strengths and Weaknesses of the Program

The department of Chemistry, Computer and Physical Sciences has a broad range of interests and responsibilities. The chemistry program has been a center of strength for the Department’s mission and vision for many years. The source of the strength in these areas has been the faculty. All instruction is presented by faculty with terminal degrees in chemistry. The degrees for the six current faculty members represent the range of sub-disciplines in analytical, biochemical, inorganic, material science, organic, and physical chemistry. On the whole, the faculty continues to be professionally active and involved. Some strengths of the chemistry program are listed below.

• The program continues to offer undergraduates the opportunity to work in quality laboratories and to participate in significant research. This level of expertise is considerably above the norm for peer institutions in the region.

• The staff is very capable, always ready to assist and provides strong support for the conduct of the program.

• The program continues to invest in materials and equipment to enhance instruction in the classroom and the laboratory.

• Students have the opportunity to receive instruction and work with up-to-date facilities.

• The program provides goal-oriented advisement and assistance to the students throughout their time in the program.

Whether it is a goal of entry into professional school, to immediately enter the workforce, or to continue with graduate education in the chemical sciences, the chemistry program has a record of achievement and provides strong support to all students.

One weakness expressed in last year's report was in the area of recruiting students. The fall 2009 semester showed an increase in student enrollment in freshman chemistry of 13%. This increase can be attributed to many factors which include greater efforts by the faculty in recruiting activities, a bad
economy, and the overall increase in university enrollment (though it was not a 13% increase). Probably, the biggest weakness of the program (as well as across campus) is in the area of student retention.

J. Effectiveness of Previous Modifications

One of the problems that the department has encountered over the years is the variation in the skill levels of students entering freshman chemistry. It was decided in the 2006-2007 academic year to offer three levels of freshman chemistry to accommodate students majoring in pre-nursing, those majoring in safety (and other areas not needing a mathematically rigorous course), and chemistry or pre-professional majors. In the fall 2007 semester the department began offering CHEM 1004-Chemical Concepts (for pre-nursing), CHEM 1114-Basic Chemistry I (for safety majors), and CHEM 1315-General Chemistry I (for chemistry and pre-professional majors). The graph below shows a steady increase in enrollments in freshman chemistry. Feedback from other departments indicates that the two new courses added in fall 2007 (CHEM 1002 and CHEM 1114) are meeting the needs of students in the programs they service.

K. Modifications to be Made to the Program or the Assessment Plan

In order to better access various outcomes more quantitatively, we have started collecting more assessment data to address these outcomes. A grading rubric has been developed for the oral and poster presentation given by all senior seminar students. Evaluations of these projects are being collected from all faculty members and are being used to aid assessment of Outcome number 3. Organic Chemistry (CHEM 3053/3062 and 3153/3162) and Chemical Analysis (CHEM 3425) both give a laboratory practical final examination that includes various aspects of laboratory and chemical safety. We have begun tracking the performance on specific questions or skill sets that address Outcome number 6.
L. Relevant Constituents and Stakeholders

The chemistry program serves a variety of constituents and stakeholders. Those serviced by the program include students, potential employers, and graduate and professional schools. Data is shared with potential students by both the chemistry faculty and university recruiters (using literature produced by the department) at recruiting events, such as, the annual fall Sneak Preview, at career days at high schools, and at community colleges. Current students receive program data in Senior Seminar. Another entity that shares data with students is the Medical School Advisory Committee made up of faculty from chemistry and biology. The committee advises students on the minimum requirements of medical schools, the success rate of admission by southeastern graduates (in fall 2009, of the six students who met the minimum requirements, five were accepted to Oklahoma medical schools), and provides advice in career planning.

Faculty advisors attend an annual seminar at the Health Sciences Center in Oklahoma City where they network with professional schools regarding the chemistry program. The chemistry faculty is involved in both regional and national chemistry meetings and interacts with colleagues at universities that have graduate programs in chemistry. The Student Affiliate of the American Chemical Society hosts monthly meetings featuring an invited speaker from area comprehensive universities. One of the speaker's normal activities is to visit with prospective graduate students.

M. Signatures.

Department Chair  

Date 9-3-09

Dean of Arts and Sciences  

Date 09/03/09