Assessment Update Spring 2011

**Learning Goal 1 – Content Knowledge:  Key Concepts of Chemistry 121.**

*The student will understand key concepts of Reaction Stoichiometry, Equilibrium, Atomic and Molecular Structure and Acid – Base chemistry.*

We are also planning on having our students take a standardized General Chemistry final exam so that we 1) can have a more complete quantitative assessment of our student competency, and 2) can compare ourselves to students outside of Albion.  Our learning goal will NOT change based on the collected results. If any deficiencies in student learning are discovered, such that we do not achieve our learning goals, we hope to try new approaches to teaching these core areas that will increase our students learning of them.

The results of the American Chemical Society’s General Chemistry exam, which was given to students this spring semester indicate that we are slightly below the national average for this exam. The difference is not statistically significant given our small numbers (N = 95) relative to the national data (N = 3,262), but it reflects well on our curriculum that we are meeting the needs of entry – level chemistry students.



**Learning Goal 2 – Content Knowledge: Key Concepts of Chemistry 211/212.**

*The student will have mastered the key concepts of Chemical Bonding, organic nomenclature, stereochemistry, structure determination using NMR and IR Spectroscopy, specific organic chemical reactions and mechanisms, upon completion of chemistry 211 and 212.*

We have given the ACS Organic Chemistry final every Spring. This year, with help from the registrar’s office, we purchased the 2008 version (the most current) of the ACS Standardized Organic exam. Our student performance on this exam has improved every year over the past decade. We have been at or above the national average of this exam. We are very happy with where we are with respect to organic chemistry content understanding.

The 2008 Organic chemistry exam was given this year and once again Albion students scored well above the national average. There was a drop in performance over last year, which is of some concern, but we remain well above the national norm for this exam.



**Learning Goal 4 – Content Knowledge: Core Chemistry**

*Our graduates will have obtained knowledge of the basic core of chemistry and the professional skill set needed to be successful in postgraduate chemical endeavors.  This would include graduate school in chemistry, professional employment as chemists, medical school, or other graduate programs with significant chemistry content.*

Our graduates are well-satisfied, according to their self assessment at zero, two, and five years post graduation. They continue to place into outstanding graduate and professional programs; this year’s list includes Oregon, Purdue, and Cal-Irvine, For the second year we gave an external assessment device to better evaluate our students core knowledge of chemistry. The results of the American Chemical Society’s Diagnostic of Undergraduate Chemistry Knowledge (DUCK, from 2008), which was given to our graduating majors in the spring 2010 and 2011 semester, indicate that our students are performing on par with the national average performance for this exam. While the absolute values indicate that our students are performing slightly above the national average, this difference is not statistically significant and most likely results from our small sample population relative to the national data. Nonetheless, this result reflects well on our curriculum with respect to meeting the needs of entry-level (BA) chemists.



**Step 6: How will the data collected be used for decision-making, strategic planning, etc.**

The Chemistry department has continued to use its assessment results to evaluate and make changes to its pedagogy with respect to our learning goals.  With the implementation of American Chemical Society Standardized Exams in place, the department will use them to critically evaluate what and how we bring the curriculum to our students.

Chemistry 121 is a unique course in the Chemistry department. Recognized as the entryway to all higher level chemistry courses in our department, *all* members of the chemistry faculty have equal rights with respect to input on the structure, content and direction of the course. Additionally, *all* faculty members have taken active teaching roles in the lecture and laboratory sections of this course. As a result of this shared departmental ownership, any desired change to the course, lecture or lab, is proposed to all faculty members in the Chemistry department, discussed and decided on collectively. We find from our assessment plan that we are doing a good job of meeting the academic and experiential needs of our students. From the graduate survey data, and from our standardized exam data from this year, we feel we need not make any significant changes to our curriculum at this time. At the end of the spring semester, we held a meeting of a majority of our faculty to discuss our Chemistry 121 and 123 laboratory courses with an eye to perhaps making some changes to these labs to bring them more in line with the lecture content. While we made no decisions at these meetings, we have decided to hold a retreat in January of 2012, when all of our faculty will be on campus, to work on this aspect of our curriculum. We are in the second year of a Chemistry 121 textbook this year, and look to continue with our ACS-supplied standardized exams in the future to gain better insight to our meeting the curricular expectations of our students. Because we have an external society that guides and assesses our curriculum, through these exams, and program reviews, we are encouraged that we are on the right track.

 **Chemistry Minor Assessment**

In Fall 2010, The chemistry Department implemented its Minor Assessment. The plan is below as well as the outcome of our first year of data gathering.

**Department of Chemistry**

**Minor Assessment Plan (submitted Fall 2010)**

**Part 1: Department Mission**
The mission of the chemistry department is to provide an outstanding undergraduate education in the chemical sciences and an active intellectual community within the liberal arts tradition. Our goal is to equip students with the critical skills and understanding that will enable them to pursue careers in the chemical and medical sciences, as well as to create an informed citizenry that will serve as leaders in the societal discussion of science and technology. We believe that chemistry serves as a key partner in the increasingly interdisciplinary nature of science. To achieve these goals, we utilize an active pedagogical approach, which emphasizes the process of scientific discovery, the ever-changing body of scientific knowledge, and student-faculty interactions. We believe it is essential that students experience the process of scientific investigation, in the laboratory, the classroom, and through the unique mentoring relationship that develops through collaborative student-faculty research. We emphasize the integral nature of chemistry in our society, both as an endeavor that betters our lives and as a way of understanding and exploring our world.

**Part 2: Minor Definition, Learning Goals, and Expected Outcomes**

The minor in Chemistry is comprised of five units in chemistry: 121, 123, 206, 211, and either 301 or 337. Two units in cognate areas; one semester of calculus (Mathematics 141 or equivalent), one semester of physics (Physics 115 or 167), are also required. Two semesters of physics are recommended. The curriculum in the Chemistry minor is vertical, where one course prepares a student for the next course in the sequence. This is particularly true of Chemistry 121, a course designed to lay the foundation for Chemistry 123, Chemistry 206, and Chemistry 211.

All courses for the minor, including cognates, must be taken for a numerical grade.

A minor in chemistry is a credential that indicates an understanding of chemical knowledge and processes that surpasses experiences and expectations gained by students completing a random collection of five units in chemistry. At minimum it is the department's expectation that a student completing the minor should be able to function in a position equivalent to a technician in a chemical laboratory. As such, the department of chemistry has specific expectations for our minors to ensure that the earned credential carries the implied abilities.

* *Learning Goal 1 – Content Knowledge: Key Concepts of Chemistry 121*

The student will have mastered key concepts of stoichiometry, equilibrium, atomic and molecular structure and acid – base chemistry prior to their entry into Chemistry 206 or Chemistry 211.

* *Learning Goal 2 – Content Knowledge: Key Concepts of Chemistry 211.*

The student will have mastered the key concepts of chemical bonding, organic nomenclature, stereochemistry, structure determination using NMR and IR Spectroscopy, specific organic chemical reactions and mechanisms, upon completion of Chemistry 211.

* *Learning Goal 3 – Laboratory Processes*

The student will demonstrate a basic understanding of how laboratory processes, both “wet” chemistry techniques and instrumental techniques, work to achieve desired outcomes, whether they be synthesis or measurements of a product. The student will be able to follow routine operating procedures to achieve a desired outcome. This includes the ability carry out experiments, to collect and properly analyze data, and to make conclusions from the results.

* *Learning Goal 4—* *Communication Skills*

The student will have demonstrated communications skills that include the ability to keep professional laboratory notebooks, to prepare technical reports, and the ability to prepare poster presentations of laboratory results.

* *Learning Goal 5—Breadth of Knowledge at an Advanced Level*

The student will add breadth to their content knowledge through in-depth study of chemistry at an advanced level by completing either Chemistry 301 or 337.

**Part 3: Identification of program components**

The following are the required courses for the minor, their catalog description, and the learning goals that they help achieve.

* *121 Structure and Equilibrium (1) Fall, Spring (Learning Goal: 1, 3, 4)*Basic principles of stoichiometry, atomic and molecular structure, and chemical equilibria, including the study of weak acids and bases in aqueous solution. Proficiency in algebra is expected. Lecture and laboratory. *Staff.*
* *123 Inorganic Chemistry: Introduction (1) Spring (Learning Goal: 3, 4)*Prerequisite: Chemistry 121 or permission of instructor. A systematic introduction to the chemistry of the elements; concepts include electrochemistry, solubility and complex ion equilibria. Lecture and laboratory. *Staff.*
* *206 Chemical Analysis (1) Fall, Spring (Learning Goal: 3, 4)*

 Prerequisite: Chemistry 121. Chemistry 123 is recommended. Laboratory course emphasizing the collection, analysis and interpretation of quantitative data, using both traditional and instrumental techniques. *Metz, Bieler, Lewis.*

* *211 Organic Chemistry: Structure and Mechanism (1) Fall (Learning Goal: 2, 3, 4)*
Prerequisite: Chemistry 121.
An integrated two-semester introduction to the chemistry of carbon-based molecules--the molecules of life. The structure and stability of carbon compounds, including: nomenclature, physical properties, spectroscopic properties, stereoisomerism and acid-base properties. The physical and mechanistic understanding of organic chemical reactions, focusing on: substitution, addition, elimination and rearrangement reactions. Laboratory involves techniques of synthesis and purification. *French, Harris, McCaffrey.*
* *301 Chemical Energetics and Kinetics (1) Fall**(Learning Goal: 5)*
Prerequisites: Chemistry 123 or 211 and Math 141 or equivalent.
An exploration of the basic thermodynamic and kinetic principles that govern the outcome of all chemical reactions and physical processes. Primary emphasis is placed upon macroscopic chemical thermodynamics with applications to solutions, colligative properties and phase equilibria. Additional topics include kinetic molecular theory; the experimental basis for determining reaction rates, rate laws and rate constants; the relationship of rate laws to reaction mechanisms; and the effect of temperature change on the rate constant. *Bieler, Lewis.*

**--OR—**

*337 Biochemistry (1) Spring (Learning Goal: 5)*
Prerequisite: Chemistry 211 or permission of instructor.
An in-depth study of biochemical structure, catalysis, metabolism and cellular regulation. Understanding living systems through molecular and chemical models. Areas of emphasis include macromolecular structure, enzyme mechanisms and kinetics, metabolic mechanisms and regulation, genomics, and proteomics. Same as Biology 337. *Rohlman.*

**Part 4: Minor Assessment Methods, Data Sources and Instruments**

Assessing the Chemistry Minor is a particularly difficult task for two reasons. First, many of minors do not declare their intentions until they are in their 3rd year of study. This represents a time typically following completion of Chemistry 121, 123, and 211, which are required for the minor. Second, the structure of the minor allows for selection of either Chemistry 301 or 337 for the advanced level coursework. Thus, assessment at the beginning of the minor is difficult because we do not know which students plan on pursuing the minor, and assessment near the end of the minor is difficult because our minors split into two groups.

Chemistry 206, however, provides a rare opportunity for assessment. Recent data trends show that approximately 99% of students enrolled in the course are chemistry majors or minors. This is often the last course students take to complete the chemistry minor. As such, students entering the class have already declared their intentions to complete the minor and have completed the introductory coursework that encompass Learning Goals 1 and 2. Furthermore, the expectations from Learning Goals 1 and 2 are the foundation material for Chemistry 206. Additionally, since Chemistry 206 is a laboratory-based course, Learning Goals 3 and 4 are practiced and improved. **Thus, Chemistry 206 will serve as the assessment point for Learning Goals 1-4 in our departmental minor.** This portion of our assessment plan includes 4 points of assessment: the final exam, select laboratory experiences, select laboratory notebook pages and technical reports, and the course final posters.

*Learning Goals 1 & 2—Content knowledge from Chemistry 121 & 211* will be assessed through a multiple choice final exam. We can achieve this in Chemistry 206 given that Chemistry 121 and 211 provide the foundation materials for this course, and the majority of students have completed these courses prior to starting Chemistry 206. The final exam has been selected to ensure that students who are concurrently enrolled in both Chemistry 211 and Chemistry 206 are not penalized. This multiple-choice exam will include questions that cover learning goals from 121 and 211, *selected by and agreed upon by the department as a whole*. The scores from this exam will be collected, analyzed, and tracked for assessment of the minor students. Much akin to our departmental major assessment, mastery of key concepts will be defined as students achieving a score of 85% or higher. Our goal is to have 75% or more of all minors achieve mastery in *all* key areas.

*Learning Goal 3—Chemical Processes* will be assessed throughout the semester through laboratory experiences and projects. Students will be graded on their ability to follow standard operating procedures, their ability to collect and analyze data, and their ability to make conclusions based on the results of their measurements. Scores from key experiments performed every semester will be collected and tracked for comparison. As above, mastery in these areas will be defined as students achieving a score of 85% or higher, and our goal is for all minors to achieve this score on these experiments.

*Learning Goal 4—Communication Skills* will also be assessed throughout the semester. Laboratory notebooks are graded for every laboratory experience in the class. Additionally, several of the laboratory experiences require the preparation of technical reports. In addition to notebook keeping and technical report authorship, Chemistry 206 concludes in a class poster session that provides the students with an opportunity to prepare and present their results.

As proposed for the assessment of *Learning Goal 3*, grades for notebook and technical reports from key experiments will be collected and tracked from semester to semester for assessment purposes. Given that notebook keeping and technical writing skills are taught in every laboratory class, our definition of mastery will be achieving a score 90% or higher. As with *Learning Goal 3*, our goal is for *all* minors to achieve mastery in this learning goal.

The poster session will also provide an opportunity for assessment of communication skills. Historically, the posters have been presented to the entire chemistry department, during an event open to the entire college community. It has been the norm that multiple chemistry professors, and occasionally professors from other disciplines, have reviewed these posters. Under this model, we as a department are provided the opportunity to critique the communication abilities of our minors. Poster scores and reviews will be collected and tracked as a final assessment tool.

**Learning Goal 5, as well as the overall structure of our minor, will be assessed through alumni assessment.** We will survey our alumni at graduation, at two years and five years after their graduation from Albion. We will question them about their success in graduate school, professional schools, or on the job as professional chemists or scientists. We ask them if they think their minor course work gave the necessary knowledge base for their post graduate study or jobs. If they have been doing research, we will ask them if they learned to write acceptable reports, keep adequate laboratory notebooks, and to present their research results during their minor course work. From their responses we will be able to evaluate the breadth requirement as well as the overall structure of our minor, and we will be able to make changes as appropriate to best serve our students.

**Results from Learning Goals 1 and 2**

Collectively, the minors passed 62% of the exam questions with 50% proficiency or better, while the majors passed 75% of the exam questions at the same pass rate.

The overall results looks like this;

|  |  |
| --- | --- |
| **Exam Overall Results** | **Spring 2011** |
|  | Minors | Majors |
| n | 5 | 12 |
| mean | 56 | 69 |
| st dev | 10 | 9 |

These results and those assembled in the fall semester will be part of our retreat agenda in January, 2012.