Detailed Assessment Report
As of: 7/17/2014 07:52 AM CENTRAL

Analysis Questions and Analysis Answers

For Academic Programs

Informed by your assessment activities related to student learning, what changes have you made in your degree program in the last three to five years? Describe the changes (e.g., curriculum revision, new courses, faculty development), the general results that prompted the changes (e.g., student performance on an assessment measure), and any impact on student learning that you might attribute to these changes.

Analysis of assessment results from aligned final exam questions in our 2009 and 2010 multi-section 100-level courses revealed a significant disparity in student performance across the course sections. Discussions with course instructors revealed that the disparity was not necessarily caused by varied topic emphasis or effectiveness of instruction but more significantly by a difference in student familiarity with the type or the overall difficulty of questions asked. This finding prompted the Department to require all CH 101, CH 102, and CH 117 instructors to devise mutually agreeable targeted final exam questions at the start of each semester. Impending use of these questions on the final exam in all sections compelled instructors to offer comparable emphasis toward the associated topics during the semester and provided a more uniform final exam testing experience for students in different course sections. Assessment findings in subsequent years indicated a reduced standard deviation in the percentage of students who mastered the concepts associated with student learning outcomes across all course sections. A byproduct of the change in this 100-level assessment mechanism was more meaningful assessment data for comparative purposes between academic years. A similar testing approach was implemented in our three CH 232 Organic Chemistry II course sections during Spring 2014. Our most recent findings indicate modestly reduced disparity in performance results across all CH 232 sections when compared to previous years.

Mission / Purpose

The Department of Chemistry is committed to the intellectual, technological, cultural, and economic advancement of the state, region, and nation through the discovery and development of new scientific knowledge. Research programs in the Department are both fundamental (create new knowledge) and applied (solve technical problems). Many of these research endeavors are anchored in interdisciplinary efforts drawing on and adding to the research base within The University. A strong and active research effort allows the faculty to enable and keep abreast of the latest scientific advances and to impart new ideas and concepts into the curricula. Research activities play a vital role in the education of the next generation of academic, industrial, and government laboratory scientists who will be called upon to solve new problems. By maintaining these research programs, the Department helps to increase the recognition and reputation for quality of The University of Alabama locally, regionally, nationally, and internationally. Critical research areas include the synthesis and characterization of chemicals and materials and biochemistry. There is a strong emphasis in materials for advanced energy technologies including applications of ‘green chemistry’ and for information storage.

The Department is dedicated to the instruction, training, and intellectual growth of undergraduate students. This mission is accomplished through the use of several mechanisms including 1) classic and innovative classroom and laboratory instruction, 2) student advising, and 3) undergraduate research. The Department reaches out not only to chemistry, science, and engineering majors but also to other non-science majors in its mission. Undergraduate research is strongly encouraged and supported in the Department. There are two basic degree tracks in the Department: a Bachelor of Science in Chemistry including a Biochemistry track and a Pre-health Professional track leading to a Bachelor’s of Science degree in Chemistry.

The Department offers opportunities for graduate study in a variety of exciting interdisciplinary programs as well as the traditional fields of analytical, inorganic, organic, physical, and biochemistry leading to the Master of Science and the Doctor of Philosophy degrees in chemistry. The Chemistry faculty offer the highest quality graduate education.

Service is an important function of the Department. Faculty and staff are bound by mutual respect and dedication to the field of chemistry and provide their expertise in science to serve the people of Alabama, the region, and the nation. The Department has strong outreach activities and has strong efforts in technology transfer.

Overall, the Department is truly the capstone of chemistry within the state of Alabama and beyond.

Student Learning Outcomes, with Any Associations and Related Measures, Targets, Findings, and Action Plans

SLO 1: Apply Fundamental Chemistry Knowledge
Students will apply fundamental chemistry knowledge in solving problems related to kinetic and thermodynamic principles, chemical reactivity and synthesis, reaction stoichiometry, molecular structure and bonding, and chemical analysis

Connected Documents
BS Chemistry Curriculum Maps
BS Chemistry Program Outcome Addendum
Curriculum Maps Chemistry B S. 2013-2014
Relevant Associations:
Student Learning Outcome #1 Improvement Action(s) to be advanced (copied from 2010-11 report);

We must ensure that instructors work together to establish and agree upon aligned final exam questions across multiple course sections so that students in one section do not obtain perceived advantages in answering the aligned questions.

Standard Associations
SACS 3.3.1
3.3.1.1 Educational programs, to include student learning outcomes

General Education/Core Curriculum Associations
8 Mathematics - SLO is related to the essential characteristics and basic processes of inquiry and analysis in the discipline, encourages the development of critical thinking and requires students to analyze, synthesize and evaluate knowledge

Strategic Plan Associations
University of Alabama
1.1 Promote and enhance areas of academic, scholarship, and research excellence.

Related Measures
M 1: CH 101 Final Exam Questions
In CH 101 General Chemistry I, students will answer a set of common targeted questions related to stoichiometry and thermodynamic principles on the final exam in all course sections.

Source of Evidence: Academic direct measure of learning - other

Target:
No Target Established

Finding (2013-2014) - Target: Not Reported This Cycle
Assessment was conducted in CH 102 in 2013-14, so no data is reported this cycle.

Related Action Plans (by Established cycle, then alpha):
For full information, see the Details of Action Plans section of this report.

Assessment of Fundamental Knowledge Learning Outcomes in CH 102 and CH 118
Established in Cycle: 2012-2013
The Department has conducted assessment of fundamental chemistry knowledge student learning outcomes in CH 101 and CH 117 sectio...

M 2: CH 117 Final Exam Questions
In CH 117 Honors General Chemistry I, students will answer a set of common targeted questions related to stoichiometry and thermodynamic principles on the final exam in both course sections.

Source of Evidence: Academic direct measure of learning - other

Target:
No Target Established

Finding (2013-2014) - Target: Not Reported This Cycle
Assessment was conducted in CH 118 in 2013-14, so no data is reported this cycle.

Related Action Plans (by Established cycle, then alpha):
For full information, see the Details of Action Plans section of this report.

Assessment of Fundamental Knowledge Learning Outcomes in CH 102 and CH 118
Established in Cycle: 2012-2013
The Department has conducted assessment of fundamental chemistry knowledge student learning outcomes in CH 101 and CH 117 sectio...

M 3: CH 102 Final Exam Questions
In CH 102 General Chemistry II, students will answer a set of common targeted questions related to fundamental knowledge in chemistry (topics to be determined by instructors) on the final exam in all course sections.

Source of Evidence: Writing exam to assure certain proficiency level

Target:
No target established

Finding (2013-2014) - Target: Met
The four CH 102 instructors gave aligned multiple choice final exam questions in the four Spring 2014 CH 102 sections. Questions were related to Kinetics: 78% of students (n = 666) answered question correctly (avgs. ranged from 68%-84% across the 4 sections; standard deviation = 6.0%) and Thermodynamics: 84% of students answered question correctly (avgs. ranged from 84%-95% across the 4 sections; standard deviation = 4.0%) Considering that most students enrolled in CH 102 are not Chemistry majors, and many are not science majors, students performed extremely well across all four course sections with respect to demonstrating fundamental chemistry knowledge.

M 4: CH 118 Final Exam Questions
In CH 118 Honors General Chemistry II, students will answer a set of common targeted questions related to fundamental topics in chemistry (topics will be selected by the course instructor or multiple section instructors) on the final exam in the sole course section or in both course sections, as applicable.

Source of Evidence: Writing exam to assure certain proficiency level
Target:
No target established.

Finding (2013-2014) - Target: Met
The CH 118 instructor gave multiple choice final exam questions from a publisher’s text book related to kinetics and thermodynamics principles to assess student mastery of fundamental chemistry knowledge. 100% of students (n = 68) answered the two targeted questions related to kinetics correctly. 99%, 78%, and 78% of students answered the three questions related to thermodynamics correctly. This was an outstanding performance by the students in the Honors General Chemistry II course with respect to knowledge of fundamental kinetics and thermodynamics principles. The students are performing at or above expected levels in those subject areas.

M 5: Quantitative Analysis Questions from ACS Exam
In CH 223 Quantitative Analysis, 40 questions from the American Chemical Society (ACS) Chemical Education Analytical Chemistry Examination will be used to assess students’ application of fundamental chemistry knowledge as it relates to kinetic and thermodynamic principles and chemical analysis. This standardized test is used by universities across the country to assess fundamental chemistry knowledge from students in undergraduate courses and for placement of students in graduate-level coursework.

Source of Evidence: Standardized test of subject matter knowledge

Target:
scores >66th percentile

Finding (2013-2014) - Target: Met
Students (n = 37) averaged 35.1/50 correct on the ACS Chemical Education Analytical Chemistry Examination, placing the class in the 75th percentile nationally as determined by comparison with composite norms compiled from scores submitted to the ACS by national universities. The averaged class score fell within the top 1/4 of all U.S. students whose exam scores were reported to the ACS. In addition, this was a slight improvement over the results from 2011-12 and 2012-13 student performances in CH 223.

M 6: Organic Chemistry Questions from ACS Exam - First Semester
In CH 231 Organic Chemistry I, 30-40 questions (number depends upon the final exam length and amount of material covered during the semester) from the American Chemical Society (ACS) Chemical Education First Term Organic Chemistry Examination will be used to assess students’ application of fundamental chemistry knowledge as it relates to kinetic and thermodynamic principles, chemical reactivity and synthesis, molecular structure and bonding, and chemical analysis. This standardized test is used by universities across the country to assess fundamental chemistry knowledge from students in undergraduate courses and for placement of students in graduate-level coursework. Composite norms are available based upon the performance of 1560 students at 25 national universities on the standardized test.

Source of Evidence: Standardized test of subject matter knowledge

Target:
scores >66th percentile

Finding (2013-2014) - Target: Met
Students (n = 497) averaged 56.0/70, 53.0/70, and 52.5/70 correct on the ACS Chemical Education Organic Chemistry First Term Examination, placing the classes in the 96th, 93rd, and 92nd percentiles nationally as determined by comparison with composite norms compiled from scores submitted to the ACS by 25 universities. UA students who completed the UA Organic Chemistry I course performed among the best in the nation on the ACS Organic Chemistry Exam again in Fall 2013.

M 7: Organic Chemistry Questions from ACS Exam - Second Semester
In CH 232 Organic Chemistry II, 30-40 questions (number depends upon the final exam length and amount of material covered during the semester) from the American Chemical Society (ACS) Chemical Education Organic Chemistry Examination will be used to assess students’ application of fundamental chemistry knowledge as it relates to kinetic and thermodynamic principles, chemical reactivity and synthesis, molecular structure and bonding, and chemical analysis. This standardized test is used by universities across the country to assess fundamental chemistry knowledge from students in undergraduate courses and for placement of students in graduate-level coursework. [Target: scores >66th percentile]

Source of Evidence: Standardized test of subject matter knowledge

Target:
scores >66th percentile

Finding (2013-2014) - Target: Met
Students (n = 340) averaged 30.7/42, 21.5/25, and 22.6/35 correct on the ACS Chemical Education Organic Chemistry Examination in the three sections, placing the classes in the 88th, 97th, and 75th percentiles nationally as determined by comparison with composite norms compiled from scores submitted to the ACS by 25 universities. UA students who completed the UA Organic Chemistry II course performed among the top 3-25% in the nation on the ACS Organic Chemistry Exam.

SLO 2: Apply Higher Order Thinking Skills
Students will apply chemistry-related critical thinking skills (higher order learning) including multistep problem-solving abilities, proper selection and implementation of mathematical equations, and visualization of molecules in three-dimensional space

Connected Documents
BS Chemistry Curriculum Maps
BS Chemistry Program Outcome Addendum
Curriculum Maps Chemistry B.S. 2013-2014

Relevant Associations:
Student Learning Outcome #2 Improvement Action(s) to be advanced (copied from 2010-11 report):
We must ensure that instructors work together to establish and agree upon aligned final exam questions across multiple course sections so that students in one section do not obtain perceived advantages in answering the aligned questions (e.g., measure 2.2). Data from 2011-2012 courses may also more accurately reveal strengths and deficiencies of students, applied assessment methods, or the curriculum.

**Standard Associations**

**SACS 3.3.1**

3.3.1.1 Educational programs, to include student learning outcomes

**General Education/Core Curriculum Associations**

8 Mathematics - SLO is related to the essential characteristics and basic processes of inquiry and analysis in the discipline, encourages the development of critical thinking and requires students to analyze, synthesize and evaluate knowledge

**Strategic Plan Associations**

University of Alabama

1.1 Promote and enhance areas of academic, scholarship, and research excellence.

**Related Measures**

**M 8: CH 101 Final Exam Questions -- Higher Order Thinking**

In CH 101 General Chemistry I, students will answer a set of common targeted questions related to solving multistep mathematical problems and visualizing molecules in three dimensions on the final exam in all course sections.

Source of Evidence: Academic direct measure of learning - other

**Target:**

- No Target Established

  **Finding (2013-2014) - Target: Not Reported This Cycle**

  Assessment was conducted in CH 102 in 2013-14, so no data is reported this cycle.

  **Related Action Plans (by Established cycle, then alpha):**

  For full information, see the Details of Action Plans section of this report.

  **Assessment of Higher Order Thinking Learning Outcomes in CH 102 and CH 118**

  Established in Cycle: 2012-2013

  The department has conducted assessment of higher order thinking student learning outcomes in CH 101 and CH 117 sections for sev...

**M 9: CH 117 Final Exam Questions -- Higher Order Thinking**

In CH 117 Honors General Chemistry I, students will answer a set of common targeted questions related to solving multistep mathematical problems and visualizing molecules in three dimensions on the final exam in both course sections.

Source of Evidence: Academic direct measure of learning - other

**Target:**

- No Target Established

  **Finding (2013-2014) - Target: Not Reported This Cycle**

  Assessment was conducted in CH 118 in 2013-14, so no data is reported this cycle.

  **Related Action Plans (by Established cycle, then alpha):**

  For full information, see the Details of Action Plans section of this report.

  **Assessment of Higher Order Thinking Learning Outcomes in CH 102 and CH 118**

  Established in Cycle: 2012-2013

  The department has conducted assessment of higher order thinking student learning outcomes in CH 101 and CH 117 sections for sev...

**M 10: CH 102 Final Exam Questions -- Higher Order Thinking**

In CH 102 General Chemistry II, students will answer a set of common targeted questions related to solving multistep mathematical problems and visualizing molecules in three dimensions on the final exam in all course sections.

Source of Evidence: Writing exam to assure certain proficiency level

**Target:**

- No target established

  **Finding (2013-2014) - Target: Met**

  The four CH 102 instructors gave an aligned multiple choice final exam question requiring students to apply multiple chemistry concepts and associated math skills to solve the complex problem in the four CH 102 sections. This was arguably among the most challenging problems asked in the CH 101/102 sequence of General Chemistry courses. 53% of students (n = 866) answered the multistep problem correctly (avg. ranged from 33%-67% correct across the four sections; standard deviation = 12.0%). Considering that most students enrolled in CH 102 are not Chemistry majors, and many are not science majors, students performed about as expected across all four course sections with respect to applying higher order thinking skills. Those students who continue through a physical science curriculum will further develop these skills in their 200-, 300-, and 400-level science courses.

**M 11: CH 118 Final Exam Questions -- Higher Order Thinking**

In CH 118 Honors General Chemistry II, students will answer a set of common targeted questions related to solving multistep mathematical problems and visualizing molecules in three dimensions on the final exam in the single course section or in both course sections, if a second section is offered.

Source of Evidence: Writing exam to assure certain proficiency level

**Target:**
Finding (2013-2014) - Target: Met
Students were asked to solve a multiple choice multistep applied mathematics problem taken from a publisher's chemistry test bank. 66% of students (n = 68) answered the question correctly. Considering the complexity of the problem, the correct response percentage was commensurate with the instructor's expectations of the first year students' problem-solving abilities.

M 12: CH 232 Final Exam Questions – Higher Order Thinking
In CH 232 Organic Chemistry II, two targeted final exam questions related to solving a complex multistep chemical synthesis problem and proposing a viable multistep electron-pushing reaction mechanism will be used in both course sections. Correctly solving each of these problems will require application of chemistry principles from two semesters of organic chemistry, synthesis of concepts from multiple textbook chapters, and advanced problem-solving skills.

Source of Evidence: Academic direct measure of learning - other

Target: No Target Established

Finding (2013-2014) - Target: Met
Students in all three Spring sections of CH 232 were asked two common embedded assessment questions targeting critical thinking on the respective final exams. Questions involved proposing a viable reaction mechanism of an organic reaction, with 78%, 84%, and 90% of students (standard deviation = 4.9%) mastering this skill across the three course sections, and proposing a viable multistep synthesis of an organic molecule, with 76%, 47%, and 66% of students (standard deviation = 12.0%) mastering this skill across the sections. These types of questions, particularly proposing viable synthetic routes, are among the most difficult in the Chemistry curriculum for many students, and this level of achievement is expected on the basis of the wide variation in problem solving skills amongst students in 200-level organic chemistry "service" courses. Even so, it is difficult to account for the standard deviation across the sections regarding mastery of multistep synthesis, since only a slight variation of the problem was asked on the final exams in the three sections. Other variables including relative final exam length, final exam day and time, awarding partial credit by graduate student and faculty final exam graders, amount of time between concept coverage in class and the final exam, and degree of emphasis with respect to the concept may all contribute to the variability in performance across the sections. Now that instructors are agreeing to use similar embedded assessment questions in all Spring CH 232 course sections, we will consider the data obtained from the Spring 2015 CH 232 course sections and then establish a target for this measure.

M 13: CH 341 Final Exam Questions – Higher Order Thinking
In CH 341 Physical Chemistry I, students will demonstrate critical thinking skills by solving at least one targeted complex problem related to proper selection and implementation of physical chemistry-based mathematical equations on the final exam.

Source of Evidence: Academic direct measure of learning - other

Target: >67% of the class will supply a satisfactory answer

Finding (2013-2014) - Target: Met
Higher order learning skills were assessed through student average performance on four complex exam questions. Students had to combine mathematics with an understanding of quantum mechanics and other chemistry principles to solve the problems. The 15 students in the course averaged scores of 15.3/16, 13.4/16, and 14.1/15 on the three questions related to selection and application of mathematical equations to solve quantum mechanics problems. The students earned an average score of 8/10 on a question regarding application of group theory to construct molecular orbitals and to describe energy states. The class exceeded expectations with regard to solving these complex problems, although the course instructor plans to cover group theory and symmetry earlier in the semester in 2014 so that more emphasis can be placed on the topic.

M 14: CH 461 Biochemistry Pre/Post-Tests
In CH 461 Biochemistry I, specific quiz and test questions will be used to probe the ability of students to think about proteins in three dimensions. A pretest will be given during the first class period asking students to sketch their idea of a protein. A similar question will be asked on one semester test and on the final exam to measure growth and application of knowledge as it relates to three-dimensional protein structures.

Source of Evidence: Faculty pre-test / post-test of knowledge mastery

Target: No Target Established

Finding (2013-2014) - Target: Met
During a first day of class pretest, 4 of 75 (5%) students were able to sketch a reasonable representation of a protein and provide a brief description. During the final exam, 64 of 77 (85%) students were able to sketch a representation of a protein and describe common structural elements. This dramatic increase in the students' knowledge of protein structure over the course of the semester reflects the effectiveness of the course and the instructor's pedagogical approach to enhancing student knowledge of protein structure and application of covered principles.

SLO 3: Select and Express Chemical Terminology Appropriately
Students will select and express chemical terminology appropriately and write using accepted technical formats with adequate and appropriate referencing (e.g., American Chemical Society (ACS) standards).

Connected Documents
- BS Chemistry Curriculum Maps
- BS Chemistry Program Outcome Addendum
- Curriculum Maps Chemistry B.S. 2013-2014

Relevant Associations:
- Student Learning Outcome #3 Improvement Action(s) to be advanced (copied from 2010-11 report):
No changes necessary for 2011-2012.

**Standard Associations**

**SACS 3.3.1**
3.3.1.1 Educational programs, to include student learning outcomes

**General Education/Core Curriculum Associations**

8 Mathematics - SLO is related to the essential characteristics and basic processes of inquiry and analysis in the discipline, encourages the development of critical thinking and requires students to analyze, synthesize and evaluate knowledge
11 Writing - SLO is related to building on students’ competency in academic writing skills and aims to extend those skills

**Strategic Plan Associations**

University of Alabama
1.1 Promote and enhance areas of academic, scholarship, and research excellence.

**Related Measures**

**M 15: CH 338 Organic Lab Report**

In CH 338 Organic Lab II, students will report experimental results from two lab sessions using an Organic Letters manuscript template and ChemBioDraw 12.0 for creation of the illustrations. Thus, the reports will require the students to employ conventions and formatting that is consistent with publication in an ACS journal.

Source of Evidence: Academic direct measure of learning - other

Target: No Target Established

**Finding (2013-2014) - Target: Met**

Students reported experimental results from two lab sessions using an ACS publication template and common formatting conventions. 35 of 39 (90%) students demonstrated satisfactory or exemplary ability to use the template, describe their results, and format the document properly. This is excellent attainment of communication outcomes in the course.

**M 16: CH 463 Biochemistry Lab Reports**

In CH 463 Biochemistry Lab, students will conduct a semester-long research project related to the study of the protein frataxin. The students will write two reports during the semester related to their research findings. The reports will follow conventions and formatting consistent with the ACS journal Biochemistry. Report grading will be conducted using a detailed rubric.

Source of Evidence: Written assignment(s), usually scored by a rubric

Target: No Target Established

**Finding (2013-2014) - Target: Met**

With respect to the first report of the semester, in which students described the expression and purification of a protein, 7 of 20 (35%) students wrote an exemplary report, 12 of 20 (60%) of students wrote a satisfactory report, and 1 of 20 (5%) students wrote an unsatisfactory report. With respect to the second report of the semester, in which students described the characterization of the protein using protein analytical techniques (e.g., assays and mass spectrometry), 15 of 19 (79%) students wrote an exemplary report, 4 of 19 (21%) of students wrote a satisfactory report, and 0 of 20 (0%) students wrote an unsatisfactory report. The marked improvement in the overall quality of the second report relative to the first suggests a general increase in the students’ technical writing abilities. This includes improved organization of a technical manuscript, application of accepted conventions in the formatting of text, tables, and figures, and appropriate citation of referenced media.

**SLO 4: Demonstrate Laboratory Skills and Knowledge**

Students will employ fundamental laboratory skills and knowledge related to laboratory safety, chemical synthesis techniques, precise and accurate measurement, chemical analysis and characterization, and proper use of instrumentation

**Connected Documents**

BS Chemistry Curriculum Maps
BS Chemistry Program Outcome Addendum
Curriculum Maps Chemistry B S. 2013-2014

**Relevant Associations:**

Student Learning Outcome #4 Improvement Action(s) to be advanced (copied from 2010-11 report):

No changes are necessary for 2011-2012.

**Standard Associations**

**SACS 3.3.1**
3.3.1.1 Educational programs, to include student learning outcomes

**General Education/Core Curriculum Associations**

9 Natural Science - SLO is related to a hands-on laboratory or field experience that emphasizes the scientific method and analysis of data

**Strategic Plan Associations**

University of Alabama
1.1 Promote and enhance areas of academic, scholarship, and research excellence.
Related Measures

M 17: CH 223 Laboratory Safety Quiz
In CH 223 Quantitative Analysis, students will demonstrate their knowledge of laboratory safety rules and procedures by answering targeted questions on a laboratory safety quiz given within the first month of the Fall and Spring semesters.

Source of Evidence: Academic direct measure of learning - other

Target:
>80% of students will earn 90% or more credit

Finding (2013-2014) - Target: Met
During Fall 2013, 36 of 37 (97%) students earned a perfect score on the 10 question laboratory safety quiz. These results reflect UA students’ knowledge of general laboratory safety and the effectiveness of its emphasis in the curriculum.

M 18: CH 223 Laboratory Skills Activities
In CH 223 Quantitative Analysis, students’ reported results from two laboratory experiments, “Gravimetric Analysis of Chloride” and “Determination of Copper by Atomic Absorption” will be used to assess student mastery of accurate and precise measurement and proper use of instrumentation, respectively.

Source of Evidence: Project, either individual or group

Target:
No more than a class average of 10% relative error in the quantitative experiments.

Finding (2013-2014) - Target: Met
During fall 2012, the class of 37 students mastered the 2.5 week “Gravimetric Analysis of Chloride” experiment, producing on average only 9% relative error in the quantitation of chloride concentration relative to the results obtained by Thorn Smith Laboratories who provided the analytical samples. The students also mastered the “Determination of Copper by Atomic Absorption” experiment, producing on average only 7% relative error in the quantitation of copper content in unknowns relative to the results obtained by Thorn Smith Laboratories who provided the analytical samples. These results show that students in CH 223 are meeting or exceeding departmental expectations with regard to demonstrating analytical laboratory skills and knowledge.

M 19: CH 338 Laboratory Safety Quiz
In CH 338 Organic Lab II, students will demonstrate their knowledge of laboratory safety rules and procedures by answering targeted questions on a laboratory safety quiz given within the first week of the course.

Source of Evidence: Academic direct measure of learning - other

Target:
>90% of students will earn 75% or higher credit

Finding (2013-2014) - Target: Met
36 of 39 (92%) students earned 75% or greater credit on a laboratory safety quiz given the first week of the course. This quiz is more challenging than that offered in CH 223, primarily because of the increased number and potential severity of dangers in the organic laboratory. Even so, all but three enrollees met or surpassed expectations on the safety quiz.

M 20: CH 338 Laboratory Skills Activities
In CH 338 Organic Lab II, results from a multi-lab session synthesis of lidocaine, and nuclear magnetic resonance spectroscopic characterization of the synthesized product, will be used to assess student mastery of chemical synthesis techniques and chemical analysis and characterization skills.

Source of Evidence: Academic direct measure of learning - other

Target:
>75% of students will obtain a high chemical yield of the target molecule and be able to characterize their product using NMR spectroscopy

Finding (2013-2014) - Target: Met
34 of 39 (87%) students obtained a chemical yield of >75% in the multiweek synthesis of lidocaine and were also able to successfully characterize the product by NMR spectroscopy. This is a particularly challenging project for fledgling researchers, and the high percentage of CH 338 students who completed the multiweek project successfully is a testament to the laboratory skills learned and applied by the UA students.

Other Outcomes, with Any Associations and Related Measures, Targets, Findings, and Action Plans

OthOtcn 5: Sustain High Level of Recognized Quality
The program will improve and sustain a high level of recognized quality.

Relevant Associations:
Program Outcome #1 Improvement Action(s) to be advanced (copied from 2010-11 report):

1. Be more attentive and responsive to undergraduate concerns.
2. (With contributions from The University administration.) Provide one-time funds for a major upgrade of instructional laboratory equipment and permanently increase the budget to allow for annual maintenance and upgrade of equipment.

Related Measures
M 21: % of Courses Taught by Tenure-Track Faculty
The percentage of undergraduate courses taught by tenure-track faculty may be viewed as a measure of quality of instruction, since such faculty typically have extensive experience in research laboratories and can more readily identify real world applications and convey the significance of topics covered in their courses.

Source of Evidence: Climate / Environment
Target: No target established

M 22: ACS Subject Test Scores in 200-Level Courses
The effectiveness of instruction in CH 231 Organic Chemistry I, CH 232 Organic Chemistry II, and CH 223 Analytical Chemistry can be determined by the average student performance on the ACS Subject Exams offered at the end of those classes. The results will be compared to national norms to determine the quality and effectiveness of instruction relative to national averages.

Source of Evidence: Standardized test of subject matter knowledge
Target: Average Score > 65th percentile nationally in all three courses
Finding (2013-2014) - Target: Met
In CH 231 Organic Chemistry I, students (n = 497) averaged 56.0/70, 53.0/70, and 52.5/70 correct on the ACS Chemical Education Organic Chemistry First Term Examination, placing the classes in the 96th, 93rd, and 92nd percentiles nationally as determined by comparison with composite norms compiled from scores submitted to the ACS by 25 universities. In the CH 232 Organic Chemistry II courses, students (n = 340) averaged 30.7/42, 21.5/25, and 22.6/35 correct on the ACS Chemical Education Organic Chemistry Examination, placing the classes in the 88th, 97th, and 75th percentiles nationally as determined by comparison with composite norms compiled from scores submitted to the ACS by 25 universities. In CH 223 Analytical Chemistry, students (n = 37) averaged 35.1/50 correct on the ACS Chemical Education Analytical Chemistry Examination, placing the class in the 75th percentile nationally as determined by comparison with composite norms compiled from scores submitted to the ACS by national universities In all, UA students performed among the top third in the nation on the ACS Subject Examinations in all three courses where students were tested. This is a testament to the quality of instruction and the rigor with which the subjects are taught.

M 23: % of Senior Chemistry Majors with Undergraduate Research Experience
Data will be obtained related to the number of senior (> 90 credit hours) Chemistry majors who have earned a minimum of 1 credit hour of course credit for supervised research activities in Chemistry, Biology, Chemical and Biological Engineering, Physics, or Computer Based Honors.

Source of Evidence: Activity volume

OthOtm 6: Sustain Optimal Level of Enrollment
The program will build and sustain an optimal level of annual program enrollments and degree completions.

Relevant Associations:
Program Outcome #2 Improvement Action(s) to be advanced (copied from 2010-11 report):

The Department's optimal enrollment of undergraduate majors is 175 with a goal of growing to 200 majors over the next 5 years. Current enrollments and degree production are strong, but growth in the number of majors and BS graduates is required to reach optimal program size and production. The action plan for 2011-12 focuses on increasing the recruitment and retention of undergraduate majors.

Related Measures

M 24: Undergraduate Credit Hour Production
Undergraduate credit hour production for the last three semesters

Source of Evidence: Existing data
Target: No target established.

M 25: Number of Students in Undergraduate Major
Number of students in the undergraduate major during the academic year

Source of Evidence: Existing data
Target: No target established.

M 26: Number of Degrees Awarded in Undergraduate Major
Number of degrees awarded in the undergraduate major during last three semesters (August, December, and May) [Target: >25 degrees]

Source of Evidence: Existing data
Target: No target established.

M 27: Relate Number of Degrees Awarded to ACHE Standards
Relation of number of degrees awarded to ACHE viability standards [average of 7.5 degrees per year over five years required to meet ACHE viability standards.]

Source of Evidence: Administrative measure - other
Target: average of 7.5 degrees per year over five years required to meet ACHE viability standards.

OthOtm 7: Program Will Be Highly Valued
The program will be highly valued by its program graduates and other key constituencies it serves.

Relevant Associations:
Program Outcome #3 Improvement Action(s) to be advanced (copied from 2010-11 report):

Acquire more satisfaction survey data from undergraduate majors at the department and university levels

Related Measures:

M 28: Chemistry Major Satisfaction Survey
An anonymous electronic satisfaction survey will be distributed to all Chemistry majors. A Lickert scale will be used to obtain numerical averages for each question asked.

Source of Evidence: Student satisfaction survey at end of the program
Target: No target established.

M 29: Placement Survey
Students who graduated with a Chemistry degree within the past year will be asked to complete an anonymous survey. Results will indicate the percentage of respondents who are employed in a science-related field, who are studying in a science or chemical engineering graduate program, or who are studying in a post-baccalaureate health/medical program (e.g., Medicine, Dentistry, Pharmacy, Veterinary Medicine, Nursing, etc.).

Source of Evidence: Job placement data, esp. for career/tech areas
Target: A minimum of 87% of our graduates are gainfully employed or enrolled in other academic programs.

M 30: NSSE DATA
NSSE (National Survey of Student Engagement) data collected from graduating senior Chemistry majors by Office of Institutional Effectiveness.

Source of Evidence: Academic indirect indicator of learning - other
Target: No target established.

Finding (2013-2014) - Target: Not Reported This Cycle
NSSE Data was not reported this cycle.

Details of Action Plans for This Cycle (by Established cycle, then alpha)

Assessment of Fundamental Knowledge Learning Outcomes in CH 102 and CH 118
The Department has conducted assessment of fundamental chemistry knowledge student learning outcomes in CH 101 and CH 117 sections for several years. We wish to assess attainment of these outcomes in the second semester General Chemistry courses to determine if students are performing as well or better with respect to this SLO after having successfully completed CH 101 or CH 117. Data for 2013-2014 will be derived from targeted final exam questions related to fundamental chemistry knowledge in all spring 2014 CH 102 and CH 118 course sections. This will provide our first assessment data from students enrolled in our second semester chemistry classes.

Established in Cycle: 2012-2013
Implementation Status: Planned
Priority: High

Relationships (Measure | Outcome/Objective):
- Measure: CH 101 Final Exam Questions | Outcome/Objective: Apply Fundamental Chemistry Knowledge
- Measure: CH 117 Final Exam Questions | Outcome/Objective: Apply Fundamental Chemistry Knowledge

Implementation Description: Instructors of all spring 2014 CH 102 and CH 118 course sections will devise and implement common final exam questions related to fundamental chemistry concepts and then collect data corresponding to student performances on those targeted questions.

Responsible Person/Group: All CH 102 and CH 118 instructors

Assessment of Higher Order Thinking Learning Outcomes in CH 102 and CH 118
The Department has conducted assessment of higher order thinking student learning outcomes in CH 101 and CH 117 sections for several years. We wish to assess attainment of these outcomes in the second semester General Chemistry courses to determine if students are performing as well or better with respect to this SLO after having successfully completed CH 101 or CH 117. Data for 2013-2014 will be derived from targeted final exam questions related to higher order thinking skills (i.e., associated with solving multistep chemistry problems or visualizing structures in three dimensional space) in all spring 2014 CH 102 and CH 118 course sections. This will provide our first assessment data from students enrolled in our second semester chemistry classes.

Established in Cycle: 2012-2013
Implementation Status: Planned
Priority: High

Relationships (Measure | Outcome/Objective):
- Measure: CH 101 Final Exam Questions -- Higher Order Thinking | Outcome/Objective: Apply Higher Order Thinking Skills
- Measure: CH 117 Final Exam Questions -- Higher Order Thinking | Outcome/Objective: Apply Higher Order Thinking Skills

Implementation Description: Instructors of all spring 2014 CH 102 and CH 118 course sections will devise and
implement common final exam questions that address higher order thinking skills as applied to concepts in chemistry. The instructors will then collect data corresponding to student performances on those targeted questions.

**Responsible Person/Group:** All CH 102 and CH 118 instructors
Mission / Purpose

The Department of Chemistry is committed to the intellectual, technological, cultural, and economic advancement of the state, region, and nation through the discovery and development of new scientific knowledge. Research programs in the Department are both fundamental (create new knowledge) and applied (solve technical problems). Many of these research endeavors are anchored in interdisciplinary efforts drawing on and adding to the research base within The University. A strong and active research effort allows faculty to enable and keep abreast of the latest scientific advances and to impart new ideas and concepts into the curricula. Research activities play a vital role in the education of the next generation of academic, industrial, and government laboratory scientists who will be called upon to solve new problems. By maintaining these research programs, the Department helps to increase the recognition and reputation for quality of The University of Alabama locally, regionally, nationally, and internationally. Critical research areas include the synthesis and characteristic of chemicals and materials and biochemistry. There is a strong emphasis in materials for advanced energy technologies including applications of ‘green chemistry’ and for information storage.

The Department is dedicated to the instruction, training, and intellectual growth of undergraduate students. This mission is accomplished through the use of several mechanisms including 1) classic and innovative classroom and laboratory instruction, 2) student advising, and 3) undergraduate research. The Department reaches out not only to chemistry, science, and engineering majors but also to other non-science majors in its mission. Undergraduate research is strongly encouraged and supported in the Department. There are two basic degree tracks in the Department: a bachelor of science in Chemistry including a Biochemistry track and a Pre-health Professional track leading to a Bachelor’s of Science degree in Chemistry.

The Department offers opportunities for graduate study in a variety of exciting interdisciplinary programs as well as the traditional fields of analytical, inorganic, organic, physical, and biochemistry leading to the Master of Science and the Doctor of Philosophy degrees in chemistry. The Chemistry faculty offer the highest quality graduate education.

Service is an important function of the Department. Faculty and staff are bound by mutual respect and dedication to the field of chemistry and provide their expertise in science to serve the people of Alabama, the region, and the nation. The Department has strong outreach activities and has strong efforts in technology transfer.

Overall, the Department is truly the capstone of chemistry within the state of Alabama and beyond.

Student Learning Outcomes, with Any Associations and Related Measures, Targets, Findings, and Action Plans

SLO 1: Apply Fundamental Chemistry Knowledge
Students will apply fundamental chemistry knowledge in solving problems related to kinetic and thermodynamic principles, chemical reactivity and synthesis, reaction stoichiometry, molecular structure and bonding, and chemical analysis

Connected Documents
BS Chemistry Curriculum Maps
BS Chemistry Program Outcome Addendum

Relevant Associations:
Student Learning Outcome #1 Improvement Action(s) to be advanced (copied from 2010-11 report);

We must ensure that instructors work together to establish and agree upon aligned final exam questions across multiple course sections so that students in one section do not obtain perceived advantages in answering the aligned questions.

Standard Associations
SACS 3.3.1
3.3.1.1 Educational programs, to include student learning outcomes

General Education/Core Curriculum Associations
8 Mathematics - SLO is related to the essential characteristics and basic processes of inquiry and analysis in the discipline, encourages the development of critical thinking and requires students to analyze, synthesize and evaluate knowledge

Strategic Plan Associations
University of Alabama
1.1 Promote and enhance areas of academic, scholarship, and research excellence.

Related Measures
M 1: CH 101 Final Exam Questions
In CH 101 General Chemistry I, students will answer a set of common targeted questions related to stoichiometry and thermodynamic principles on the final exam in all course sections.
Finding (2012-2013) - Target: Met
The seven CH 101 instructors gave aligned multiple choice final exam questions in the seven CH 101 sections. Questions were related to the following concepts/skills: Nomenclature: 82% of students (n = 1167) answered question correctly (avgs. ranged from 77%-87% across the 7 sections; standard deviation = 3.4%). Stoichiometry: 85% of students answered question correctly (avgs. ranged from 73%-96% across the 7 sections; standard deviation = 7.1%) Thermochemistry: 82% of students answered question correctly (avgs. ranged from 61%-92% across the 7 sections; standard deviation = 9.9%) Considering that most students enrolled in CH 101 are not Chemistry majors, and many are not science majors, students performed extremely well across all seven course sections with respect to demonstrating fundamental chemistry knowledge.

Related Action Plans (by Established cycle, then alpha):
For full information, see the Details of Action Plans section of this report.

Assessment of Fundamental Knowledge Learning Outcomes in CH 102 and CH 118
Established In Cycle: 2012-2013
The Department has conducted assessment of fundamental chemistry knowledge student learning outcomes in CH 101 and CH 117 sectio...

M 2: CH 117 Final Exam Questions
In CH 117 Honors General Chemistry I, students will answer a set of common targeted questions related to stoichiometry and thermodynamic principles on the final exam in both course sections.

Finding (2012-2013) - Target: Partially Met
The two CH 117 instructors gave aligned multiple choice final exam questions in the two CH 117 sections. It should be noted that this is an honors course, and the questions posed were more challenging than those offered in the CH 101 courses. Questions were related to the following concepts/skills: Structural Properties and Problem Solving: 57% and 92% of students (n = 153) answered the targeted questions correctly in the two sections (standard deviation = 17.5%). Thermodynamics: 44% and 82% of students answered the targeted questions correctly in the two sections (standard deviation = 19%). No questions related to stoichiometry were asked on the Final Exam in either section, because both instructors noted that their students mastered the corresponding concepts, as reflected in student performances on associated semester test and quiz questions. The disparity in the performances of the students on the targeted Final Exam questions likely relates to the instructor's emphasis of each topic in the respective sections. One section was taught by a first time CH 117 instructor who offered less emphasis on principles of thermodynamics than the other instructor who is a veteran in the course. With less emphasis on select topics, and less exposure to related problems and test questions during the semester, one group of students did not perform quite as well as the other.

Related Action Plans (by Established cycle, then alpha):
For full information, see the Details of Action Plans section of this report.

Assessment of Fundamental Knowledge Learning Outcomes in CH 102 and CH 118
Established In Cycle: 2012-2013
The Department has conducted assessment of fundamental chemistry knowledge student learning outcomes in CH 101 and CH 117 sectio...

M 3: Quantitative Analysis Questions from ACS Exam
In CH 223 Quantitative Analysis, 40 questions from the American Chemical Society (ACS) Chemical Education Analytical Chemistry Examination will be used to assess students' application of fundamental chemistry knowledge as it relates to kinetic and thermodynamic principles and chemical analysis. This standardized test is used by universities across the country to assess fundamental chemistry knowledge from students in undergraduate courses and for placement of students in graduate-level coursework.

Finding (2012-2013) - Target: Met
Students (n = 38) averaged 33.6/50 correct on the ACS Chemical Education Analytical Chemistry Examination, placing the class in the 68th percentile nationally as determined by comparison with composite norms compiled from scores submitted to the ACS by national universities. The averaged class score fell within the top 1/3 of all U.S. students whose exam scores were reported to the ACS.

M 4: Organic Chemistry Questions from ACS Exam - First Semester
In CH 231 Organic Chemistry I, 30-40 questions (number depends upon the final exam length and amount of material covered during the semester) from the American Chemical Society (ACS) Chemical Education First Term Organic Chemistry Examination will be used to assess students' application of fundamental chemistry knowledge as it relates to kinetic and thermodynamic principles, chemical reactivity and synthesis, molecular structure and bonding, and chemical analysis. This standardized test is used by universities across the country to assess fundamental chemistry knowledge from students in undergraduate courses and for placement of students in graduate-level coursework. Composite norms are available based upon the performance of 1560 students at 25 national universities on the standardized test.

Finding (2012-2013) - Target: Met
Students (n = 38) averaged 33.6/50 correct on the ACS Chemical Education Analytical Chemistry Examination, placing the class in the 68th percentile nationally as determined by comparison with composite norms compiled from scores submitted to the ACS by national universities. The averaged class score fell within the top 1/3 of all U.S. students whose exam scores were reported to the ACS.
scores >66th percentile

**Finding (2012-2013) - Target: Met**
Students (n = 482) averaged 51.1/70, 50.4/70, and 49.4/70 correct on the ACS Chemical Education Organic Chemistry First Term Examination, placing the classes in the 90th, 88th, and 84th percentiles nationally as determined by comparison with composite norms compiled from scores submitted to the ACS by 25 universities. UA students who completed the UA Organic Chemistry I course performed among the best in the nation on the ACS Organic Chemistry Exam.

**M 5: Organic Chemistry Questions from ACS Exam - Second Semester**
In CH 232 Organic Chemistry II, 30-40 questions (number depends upon the final exam length and amount of material covered during the semester) from the American Chemical Society (ACS) Chemical Education Organic Chemistry Examination will be used to assess students' application of fundamental chemistry knowledge as it relates to kinetic and thermodynamic principles, chemical reactivity and synthesis, molecular structure and bonding, and chemical analysis. This standardized test is used by universities across the country to assess fundamental chemistry knowledge from students in undergraduate courses and for placement of students in graduate-level coursework.  
[Target: scores >66th percentile]

Source of Evidence: Standardized test of subject matter knowledge

**Target:**

**Finding (2012-2013) - Target: Met**
Students (n = 278) averaged 19.5/30 and 20.4/25 correct on the ACS Chemical Education Organic Chemistry Examination, placing the classes in the 75th and 93rd percentiles nationally as determined by comparison with composite norms compiled from scores submitted to the ACS by 25 universities. UA students who completed the UA Organic Chemistry II course performed among the top 10-25% in the nation on the ACS Organic Chemistry Exam.

**SLO 2: Apply Higher Order Thinking Skills**
Students will apply chemistry-related critical thinking skills (higher order learning) including multistep problem-solving abilities, proper selection and implementation of mathematical equations, and visualization of molecules in three-dimensional space.

**Connected Documents**
- BS Chemistry Curriculum Maps
- BS Chemistry Program Outcome Addendum

**Relevant Associations:**
Student Learning Outcome #2 Improvement Action(s) to be advanced (copied from 2010-11 report):

We must ensure that instructors work together to establish and agree upon aligned final exam questions across multiple course sections so that students in one section do not obtain perceived advantages in answering the aligned questions (e.g., measure 2.2). Data from 2011-2012 courses may also more accurately reveal strengths and deficiencies of students, applied assessment methods, or the curriculum.

**Standard Associations**
- **SACS 3.3.1**
  3.3.1.1 Educational programs, to include student learning outcomes

**General Education/Core Curriculum Associations**
- **8 Mathematics - SLO is related to the essential characteristics and basic processes of inquiry and analysis in the discipline, encourages the development of critical thinking and requires students to analyze, synthesize and evaluate knowledge**

**Strategic Plan Associations**
- University of Alabama
  1.1 Promote and enhance areas of academic, scholarship, and research excellence.

**Related Measures**

**M 6: CH 101 Final Exam Questions -- Higher Order Thinking**
In CH 101 General Chemistry I, students will answer a set of common targeted questions related to solving multistep mathematical problems and visualizing molecules in three dimensions on the final exam in all course sections.

Source of Evidence: Academic direct measure of learning - other

**Target:**
No Target Established

**Finding (2012-2013) - Target: Met**
The seven CH 101 instructors gave aligned multiple choice final exam questions in the seven CH 101 sections. Questions were related to the following concepts/skills: Math/Problem Solving: 79% of students (n = 1167) answered question correctly (avgs. ranged from 73%-87% across the 7 sections; standard deviation = 4.1%) 3D Visualization: 75% of students answered question correctly (avgs. ranged from 59%-87% across the 7 sections; standard deviation = 9.7%). Considering that most students enrolled in CH 101 are not Chemistry majors, and many are not science majors, students performed reasonably well across all five course sections with respect to demonstrating fundamental chemistry knowledge.

**Related Action Plans (by Established cycle, then alpha):**
For full information, see the Details of Action Plans section of this report.
Assessment of Higher Order Thinking Learning Outcomes in CH 102 and CH 118
Established in Cycle: 2012-2013
The Department has conducted assessment of higher order thinking student learning outcomes in CH 101 and CH 117 sections for sev...

M 7: CH 117 Final Exam Questions -- Higher Order Thinking
In CH 117 Honors General Chemistry I, students will answer a set of common targeted questions related to solving multistep mathematical problems and visualizing molecules in three dimensions on the final exam in both course sections.

Source of Evidence: Academic direct measure of learning - other

Target:
No Target Established

**Finding (2012-2013) - Target: Met**
The two CH 117 instructors gave aligned multiple choice final exam questions in the two CH 117 sections. It should be noted that this is an honors course, and the questions posed were more challenging than those offered in the CH 101 courses. Questions were related to the following concepts/skills: Math/Multistep Problem Solving: 64% and 70% of students (n = 153) answered correctly in the two sections (standard deviation = 3%).

3D Visualization: 78% of students answered correctly in the one section where an associated question was asked on the Final Exam. A first time instructor of CH 117 did not ask an aligned question related to 3D visualization on the Final Exam, although the concept was covered and student knowledge was assessed during a semester test. The CH 117 students in both sections performed above expectations on the challenging math/multistep problem-solving question on the Final Exams, suggesting that students in first semester honors chemistry courses are mastering these higher order learning skills and applying them to solve chemistry-related problems.

**Related Action Plans (by Established cycle, then alpha):**
For full information, see the Details of Action Plans section of this report.

**Assessment of Higher Order Thinking Learning Outcomes in CH 102 and CH 118**
Established in Cycle: 2012-2013
The Department has conducted assessment of higher order thinking student learning outcomes in CH 101 and CH 117 sections for sev...

M 8: CH 232 Final Exam Questions -- Higher Order Thinking
In CH 232 Organic Chemistry II, two targeted final exam questions related to solving a complex multistep chemical synthesis problem and proposing a viable multistep electron-pushing reaction mechanism will be used in both course sections. Correctly solving each of these problems will require application of chemistry principles from two semesters of organic chemistry, synthesis of concepts from multiple textbook chapters, and advanced problem-solving skills.

Source of Evidence: Academic direct measure of learning - other

**Target:**
No Target Established

**Finding (2012-2013) - Target: Met**
Students in both sections of CH 232 were asked embedded assessment questions targeting critical thinking on the respective final exams. In one section, 73 of 187 (39%) were able to propose a viable multistep synthesis of an organic molecule, and 78 of 187 (42%) students were able to propose a viable reaction mechanism of an organic reaction. In the other section, 66 of 91 (73%) demonstrated the ability to propose a viable multistep synthesis of an organic molecule, and 68 of 91 (75%) students were able to propose a viable reaction mechanism of an organic reaction. It should be noted that different exam questions were given in each section, so the results between sections are not directly comparable. These types of questions are among the most difficult in the Chemistry curriculum for many students, and this level of achievement is expected on the basis of the wide variation in problem-solving skills amongst students in 200-level organic chemistry "service" courses. The total enrollment in each section (one section had twice as many students as the other) also might have affected student learning.

M 9: CH 341 Final Exam Questions -- Higher Order Thinking
In CH 341 Physical Chemistry I, students will demonstrate critical thinking skills by solving at least one targeted complex problem related to proper selection and implementation of physical chemistry-based mathematical equations on the final exam.

Source of Evidence: Academic direct measure of learning - other

**Target:**
>67% of the class will supply a satisfactory answer

**Finding (2012-2013) - Target: Met**
Students were required to select the appropriate mathematical equations and solve two complex problems using the appropriate equations. 4 of 13 (31%) students demonstrated exemplary problem solving skills, while 6 others (46%) provided satisfactory responses with respect to the first problem. 2 of 13 (15%) students demonstrated exemplary problem solving skills, while 8 others (62%) provided satisfactory responses with respect to the second problem. The class exceeded expectations with 77% of the class supplying a satisfactory or exemplary response to each of two complex, multi-step problems in physical chemistry.

M 10: CH 461 Biochemistry Pre/Post-Tests
In CH 461 Biochemistry I, specific quiz and test questions will be used to probe the ability of students to think about proteins in three dimensions. A pretest will be given during the first class period asking students to sketch their idea of a protein. A similar question will be asked on one semester test and on the final exam to measure growth and application of knowledge as it relates to three-dimensional protein structures.

Source of Evidence: Faculty pre-test / post-test of knowledge mastery

**Target:**
No Target Established

**Finding (2012-2013) - Target: Met**
During a first day of class pretest, 5 of 44 (11%) students were able to sketch a reasonable representation of a
protein and provide a brief description. During the final exam, 44 of 47 (94%) students were able to sketch a representation of a protein and describe common structural elements. This dramatic increase in the students’ knowledge of protein structure over the course of the semester reflects the effectiveness of the course and the instructor's pedagogical approach to enhancing student knowledge of protein structure and application of covered principles.

**SLO 3: Select and Express Chemical Terminology Appropriately**

Students will select and express chemical terminology appropriately and write using accepted technical formats with adequate and appropriate referencing (e.g., American Chemical Society (ACS) standards).

**Connected Documents**
- BS Chemistry Curriculum Maps
- BS Chemistry Program Outcome Addendum

**Relevant Associations:**
Student Learning Outcome #3 Improvement Action(s) to be advanced (copied from 2010-11 report):

No changes necessary for 2011-2012.

**Standard Associations**
- SACS 3.3.1
  - 3.3.1.1 Educational programs, to include student learning outcomes

**General Education/Core Curriculum Associations**
8. Mathematics - SLO is related to the essential characteristics and basic processes of inquiry and analysis in the discipline, encourages the development of critical thinking and requires students to analyze, synthesize and evaluate knowledge
11. Writing - SLO is related to building on students' competency in academic writing skills and aims to extend those skills

**Strategic Plan Associations**
- University of Alabama
  - 1.1 Promote and enhance areas of academic, scholarship, and research excellence.

**Related Measures**

**M 11: CH 338 Organic Lab Report**
In CH 338 Organic Lab II, students will report experimental results from two lab sessions using an Organic Letters manuscript template and ChemBioDraw 12.0 for creation of the illustrations. Thus, the reports will require the students to employ conventions and formatting that is consistent with publication in an ACS journal.

Source of Evidence: Academic direct measure of learning - other

**Target:**
No Target Established

**Finding (2012-2013) - Target: Met**
Students reported experimental results from two lab sessions using an ACS publication template and common formatting conventions. 19 of 23 (83%) students demonstrated satisfactory or exemplary ability to use the template, describe their results, and format the document properly. This is excellent attainment of communication outcomes in the course.

**M 12: CH 463 Biochemistry Lab Reports**
In CH 463 Biochemistry Lab, students will conduct a semester-long research project related to the study of the protein frataxin. The students will write two reports during the semester related to their research findings. The reports will follow conventions and formatting consistent with the ACS journal Biochemistry. Report grading will be conducted using a detailed rubric.

Source of Evidence: Written assignment(s), usually scored by a rubric

**Target:**
No Target Established

**Finding (2012-2013) - Target: Met**
With respect to the first report of the semester, in which students described a mutation, expression, and purification of a protein, 1 of 16 (6%) students wrote an exemplary report, 14 of 16 (88%) of students wrote a satisfactory report, and 1 of 16 (6%) students wrote an unsatisfactory report. With respect to the second report of the semester, in which students described the analysis of an unknown protein, 9 of 16 (56%) students wrote an exemplary report, 7 of 16 (44%) of students wrote a satisfactory report, and 0 of 16 (0%) students wrote an unsatisfactory report. The marked improvement in the overall quality of the second report relative to the first suggests a general increase in the students’ technical writing abilities. This includes improved organization of a technical manuscript, application of accepted conventions in the formatting of text, tables, and figures, and appropriate citation of referenced media.

**SLO 4: Demonstrate Laboratory Skills and Knowledge**
Students will employ fundamental laboratory skills and knowledge related to laboratory safety, chemical synthesis techniques, precise and accurate measurement, chemical analysis and characterization, and proper use of instrumentation

**Connected Documents**
- BS Chemistry Curriculum Maps
- BS Chemistry Program Outcome Addendum

**Relevant Associations:**
Student Learning Outcome #4 Improvement Action(s) to be advanced (copied from 2010-11 report):

No changes are necessary for 2011-2012.

**Standard Associations**

**SACS 3.3.1**
3.3.1.1 Educational programs, to include student learning outcomes

**General Education/Core Curriculum Associations**

9 Natural Science - SLO is related to a hands-on laboratory or field experience that emphasizes the scientific method and analysis of data

**Strategic Plan Associations**

University of Alabama
1.1 Promote and enhance areas of academic, scholarship, and research excellence.

**Related Measures**

**M 13: CH 223 Laboratory Safety Quiz**
In CH 223 Quantitative Analysis, students will demonstrate their knowledge of laboratory safety rules and procedures by answering targeted questions on a laboratory safety quiz given within the first month of the Fall and Spring semesters.

Source of Evidence: Academic direct measure of learning - other

**Target:**
>80% of students will earn 90% or more credit

**Finding (2012-2013) - Target: Met**
During fall 2012, 33 of 38 (87%) students earned a perfect score on the 10 question laboratory safety quiz, while five (13%) students earned 90% credit. These results reflect UA students' knowledge of general laboratory safety and the effectiveness of its emphasis in the curriculum.

**M 14: CH 223 Laboratory Skills Activities**
In CH 223 Quantitative Analysis, students' reported results from two laboratory experiments, "Gravimetric Analysis of Chloride" and "Determination of Copper by Atomic Absorption" will be used to assess student mastery of accurate and precise measurement and proper use of instrumentation, respectively.

Source of Evidence: Project, either individual or group

**Target:**
No more than a class average of 10% relative error in the quantitative experiments.

**Finding (2012-2013) - Target: Met**
During fall 2012, the class of 38 students mastered the 2.5 week "Gravimetric Analysis of Chloride" experiment, producing on average only 6% error in the quantitation of chloride concentration relative to the results obtained by Thorn Smith Laboratories who provided the analytical samples. The students also mastered the "Determination of Copper by Atomic Absorption" experiment, producing on average only 10% error in the quantitation of copper content in unknowns relative to the results obtained by Thorn Smith Laboratories who provided the analytical samples. These results show that students in CH 223 are meeting or exceeding departmental expectations with regard to demonstrating analytical laboratory skills and knowledge.

**M 15: CH 338 Laboratory Safety Quiz**
In CH 338 Organic Lab II, students will demonstrate their knowledge of laboratory safety rules and procedures by answering targeted questions on a laboratory safety quiz given within the first week of the course.

Source of Evidence: Academic direct measure of learning - other

**Target:**
>90% of students will earn 75% or higher credit

**Finding (2012-2013) - Target: Met**
22 of 23 (96%) students earned 75% or greater credit on a laboratory safety quiz given the first week of the course. This quiz is more challenging than that offered in CH 223, primarily because of the increased number and potential severity of dangers in the organic laboratory. Even so, all but one enrollee met or surpassed expectations on the safety quiz.

**M 16: CH 338 Laboratory Skills Activities**
In CH 338 Organic Lab II, results from a multi-lab session synthesis of lidocaine, and nuclear magnetic resonance spectroscopic characterization of the synthesized product, will be used to assess student mastery of chemical synthesis techniques and chemical analysis and characterization skills.

Source of Evidence: Academic direct measure of learning - other

**Target:**
No Target Established

**Finding (2012-2013) - Target: Met**
19 of 23 (83%) students obtained a chemical yield of >75% in the multiweek synthesis of lidocaine and were also able to successfully characterize the product by NMR spectroscopy. This is a particularly challenging project for fledgling researchers, and the high percentage of CH 338 students who completed the multiweek project successfully is a testament to the laboratory skills learned and applied by the UA students.

**Other Outcomes, with Any Associations and Related Measures, Targets, Findings, and Action Plans**
OthOtm 5: Sustain High Level of Recognized Quality
The program will improve and sustain a high level of recognized quality.

Relevant Associations:
Program Outcome #1 Improvement Action(s) to be advanced (copied from 2010-11 report):

1. Be more attentive and responsive to undergraduate concerns.
2. (With contributions from The University administration.) Provide one-time funds for a major upgrade of instructional laboratory equipment and permanently increase the budget to allow for annual maintenance and upgrade of equipment.

Related Measures
M 17: % of Courses Taught by Tenure-Track Faculty
The percentage of undergraduate courses taught by tenure-track faculty may be viewed as a measure of quality of instruction, since such faculty typically have extensive experience in research laboratories and can more readily identify real world applications and convey the significance of topics covered in their courses.
Source of Evidence: Climate / Environment
Target:
No target established
Finding (2012-2013) - Target: Met
During Summer 2012, 7 of 9 courses (78%) were taught by tenure-track faculty. During Fall 2012, 19 of 26 courses/course sections (73%) were taught by tenure-track faculty. During Spring 2013, 21 of 23 courses/course sections (91%) were taught by tenure-track faculty. These percentages are impressive considering the rapid enrollment increases in Chemistry courses over the past several years. We have added multiple new course sections each year to accommodate the explosive enrollment growth, yet still make it priority to staff those courses with as many tenure-track faculty as possible.

M 18: ACS Subject Test Scores in 200-Level Courses
The effectiveness of instruction in CH 231 Organic Chemistry I, CH 232 Organic Chemistry II, and CH 223 Analytical Chemistry can be determined by the average student performance on the ACS Subject Exams offered at the end of those classes. The results will be compared to national norms to determine the quality and effectiveness of instruction relative to national averages.
Source of Evidence: Standardized test of subject matter knowledge
Target:
Average Score > 65th percentile nationally in all three courses
Finding (2012-2013) - Target: Met
In CH 231 Organic Chemistry I, students (n = 482) averaged 51.1/70, 50.4/70, and 49.4/70 correct on the ACS Chemical Education Organic Chemistry First Term Examination, placing the classes in the 90th, 88th, and 84th percentiles nationally as determined by comparison with composite norms compiled from scores submitted to the ACS by 25 universities. In the CH 232 Organic Chemistry II courses, students (n = 278) averaged 19.5/30 and 20.4/25 correct on the ACS Chemical Education Organic Chemistry Examination, placing the classes in the 75th and 93rd percentiles nationally as determined by comparison with composite norms compiled from scores submitted to the ACS by 25 universities. In CH 223 Analytical Chemistry, students (n = 38) averaged 33.6/50 correct on the ACS Chemical Education Analytical Chemistry Examination, placing the class in the 88th percentile nationally as determined by comparison with composite norms compiled from scores submitted to the ACS by national universities. In all, UA students performed among the top third in the nation on the ACS Subject Exams in all three courses where students were tested. This is a testament to the quality of instruction and the rigor with which the subjects are taught.

OthOtm 6: Sustain Optimal Level of Enrollment
The program will build and sustain an optimal level of annual program enrollments and degree completions.

Relevant Associations:
Program Outcome #2 Improvement Action(s) to be advanced (copied from 2010-11 report):

The Department’s optimal enrollment of undergraduate majors is 175 with a goal of growing to 200 majors over the next 5 years. Current enrollments and degree production are strong, but growth in the number of majors and BS graduates is required to reach optimal program size and production. The action plan for 2011-12 focuses on increasing the recruitment and retention of undergraduate majors.

Related Measures
M 19: Undergraduate Credit Hour Production
Undergraduate credit hour production for the last three semesters

Source of Evidence: Existing data
Target:
No target established.
Finding (2012-2013) - Target: Met
Credit hour production for Summer 2012 = 1,501, for Fall 2012 = 12,090, and for Spring 2013 = 10,117. We will have to consider trends in credit hour production in the coming years to correlate how changes in enrollment and credit hours effect the quantity and quality of undergraduate teaching and research offerings.

M 20: Number of Students in Undergraduate Major
Number of students in the undergraduate major during the academic year
Source of Evidence: Existing data
Target: No target established.
Finding (2012-2013) - Target: Met
AS of Fall 2012, the Department had 170 Chemistry majors. We continually work to add students to our program, and we hope to see the number of majors increase annually.

M 21: Number of Degrees Awarded in Undergraduate Major
Number of degrees awarded in the undergraduate major during last three semesters (August, December, and May) [Target: >25 degrees]

Source of Evidence: Existing data
Target: No target established.
Finding (2012-2013) - Target: Met
18 undergraduate B.S. degrees in Chemistry were awarded in 2012-2013. This number is lower than anticipated; however, with our increased number of Chemistry majors in 2012-2013, we expect the number of B.S. degrees earned to climb significantly in the coming years.

M 22: Relate Number of Degrees Awarded to ACEH Standards
Relation of number of degrees awarded to ACEH viability standards [average of 7.5 degrees per year over five years required to meet ACEH viability standards.]

Source of Evidence: Administrative measure - other
Target: average of 7.5 degrees per year over five years required to meet ACEH viability standards.
Finding (2012-2013) - Target: Met
The average number of BS degrees awarded in Chemistry over the past five years = 22.6 degrees. This value far exceeds the ACEH viability standards.

OthOtcm 7: Program Will Be Highly Valued
The program will be highly valued by its program graduates and other key constituencies it serves.

Relevant Associations:
Program Outcome #3 Improvement Action(s) to be advanced (copied from 2010-11 report):
Acquire more satisfaction survey data from undergraduate majors at the department and university levels

Related Measures

M 23: Chemistry Major Satisfaction Survey
An anonymous electronic satisfaction survey will be distributed to all Chemistry majors. A Lickert scale will be used to obtain numerical averages for each question asked.

Source of Evidence: Student satisfaction survey at end of the program
Target: No target established.
Finding (2012-2013) - Target: Met
Fifty one (51) 2012-2013 undergraduate Chemistry/Biochemistry majors responded to the survey. Two different Lickert scales were used depending upon the question asked. One scale had five possible responses ranging in value from 0 to 4 points (the values correspond to worded responses ranging from 'not effective or satisfied' (worth 0 points) to 'extremely effective or satisfied' (worth 4 points) along with scored responses in between) while the other scale had seven possible responses ranging in value from 0 to 6 points (the values correspond to worded responses ranging from 'extremely dissatisfied' (worth 0 points) to 'extremely satisfied' (worth 6 points) along with scored responses in between).

The average score for "How effective was instruction in your undergraduate Chemistry courses?" = 2.82 out of 4.00, with a value of 2.00 equaling 'effective' and 3.00 equaling 'very effective'.
The average score for "How effective was instruction in your undergraduate courses outside of Chemistry?" = 2.63 out of 4.00, with a value of 2.00 equaling 'effective' and 3.00 equaling 'very effective'.
The average score for "How satisfied were you with course content?" = 4.98 out of 6.00, with a value of 4.00 equaling 'slightly satisfied' and 5.00 equaling 'satisfied'.
The average score for "How satisfied were you with the classrooms and other facilities in Shelby Hall?" = 3.47 out of 4.00, with a value of 3.00 equaling 'very satisfied' and 4.00 equaling 'extremely satisfied'.
The average score for "How helpful was your Chemistry academic advisor?" = 2.79 out of 4.00, with a value of 2.00 equaling 'helpful' and 3.00 equaling 'very helpful'.
The average score for "How effective are the Chemistry and Biochemistry laboratory courses in furthering knowledge in...?" = 2.60 out of 4.00, with a value of 2.00 equaling 'effective' and 3.00 equaling 'very effective'.
The average score for "How effective were the teaching assistants in your Chemistry laboratory courses in providing guidance and enhancing your learning?" = 2.49 out of 4.00, with a value of 2.00 equaling 'effective' and 3.00 equaling 'very effective'.
The average score for "If applicable, how satisfied are/were you with your undergraduate research experiences in Chemistry?" = 5.22 out of 6.00, with a value of 5.00 equaling 'satisfied' and 6.00 equaling 'extremely satisfied'.
The average score for "How satisfied are/were you with Chemistry undergraduate program overall?" = 4.98 out of 6.00, with a value of 4.00 equaling 'slightly satisfied' and 5.00 equaling 'satisfied'.
Results from other questions asked, but not scored, included: 31 of 36 respondents claimed there are adequate opportunities to conduct undergraduate research in Chemistry, if desired, and 35 of 51 respondents claimed there are adequate opportunities to meet and interact with other Chemistry/Biochemistry majors outside of the classroom.

Overall, the responses were quite positive and reflect the strengths of the undergraduate graduate program in terms of its instruction, facilities, undergraduate research experiences, and overall environment. Less than 5% of responses to any one scored question were negative and a much greater percentage, in all cases, was strongly positive.

M 24: NSSE DATA
NSSE (National Survey of Student Engagement) data collected from graduating senior Chemistry majors by Office of Institutional Effectiveness.
Source of Evidence: Academic indirect indicator of learning - other
Target:
No target established.
Finding (2012-2013) - Target: Not Reported This Cycle
Not reported this cycle.

M 25: Placement Survey
Students who graduated with a Chemistry degree within the past year will be asked to complete an anonymous survey. Results will indicate the percentage of respondents who are employed in a science-related field, who are studying in a science or chemical engineering graduate program, or who are studying in a post-baccalaureate health/medical program (e.g., Medicine, Dentistry, Pharmacy, Veterinary Medicine, Nursing, etc.).
Source of Evidence: Job placement data, esp. for career/tech areas
Target:
A minimum of 67% of our graduates are gainfully employed or enrolled in other academic programs.
Finding (2012-2013) - Target: Met
100% of survey respondents (8 of 8) are enrolled in other academic programs. Four are in medical school, two are in graduate school specializing in a physical science, one is in dental school, and one is in pharmacy school. In addition, 63% of respondents (5 of 8) indicated they are 'extremely satisfied' with the preparation they received in The Department of Chemistry, while the remaining 38% claimed they are 'satisfied' with their preparation. These are outstanding results for The UA Department of Chemistry, and reflect the perceived value, quality, and effectiveness of our undergraduate program.

Details of Action Plans for This Cycle (by Established cycle, then alpha)

Assessment of Fundamental Knowledge Learning Outcomes in CH 102 and CH 118
The Department has conducted assessment of fundamental chemistry knowledge student learning outcomes in CH 101 and CH 117 sections for several years. We wish to assess attainment of these outcomes in the second semester General Chemistry courses to determine if students are performing as well or better with respect to this SLO after having successfully completed CH 101 or CH 117. Data for 2013-2014 will be derived from targeted final exam questions related to fundamental chemistry knowledge in all spring 2014 CH 102 and CH 118 course sections. This will provide our first assessment data from students enrolled in our second semester chemistry classes.
Established in Cycle: 2012-2013
Implementation Status: Planned
Priority: Hgh
Relationships (Measure | Outcome/Objective):
Measure: CH 101 Final Exam Questions | Outcome/Objective: Apply Fundamental Chemistry Knowledge
Measure: CH 117 Final Exam Questions | Outcome/Objective: Apply Fundamental Chemistry Knowledge
Implementation Description: Instructors of all spring 2014 CH 102 and CH 118 course sections will devise and implement common final exam questions related to fundamental chemistry concepts and then collect data corresponding to student performances on those targeted questions.
Responsible Person/Group: All CH 102 and CH 118 instructors

Assessment of Higher Order Thinking Learning Outcomes in CH 102 and CH 118
The Department has conducted assessment of higher order thinking student learning outcomes in CH 101 and CH 117 sections for several years. We wish to assess attainment of these outcomes in the second semester General Chemistry courses to determine if students are performing as well or better with respect to this SLO after having successfully completed CH 101 or CH 117. Data for 2013-2014 will be derived from targeted final exam questions related to higher order thinking skills (i.e., associated with solving multistep chemistry problems or visualizing structures in three dimensional space) in all spring 2014 CH 102 and CH 118 course sections. This will provide our first assessment data from students enrolled in our second semester chemistry classes.
Established in Cycle: 2012-2013
Implementation Status: Planned
Priority: Hgh
Relationships (Measure | Outcome/Objective):
Measure: CH 101 Final Exam Questions -- Higher Order Thinking | Outcome/Objective: Apply Higher Order Thinking Skills
Measure: CH 117 Final Exam Questions -- Higher Order Thinking | Outcome/Objective: Apply Higher Order Thinking Skills
Implementation Description: Instructors of all spring 2014 CH 102 and CH 118 course sections will devise and implement common final exam questions that address higher order thinking skills as applied to concepts in chemistry. The instructors will then collect data corresponding to student performances on those targeted questions.
Responsible Person/Group: All CH 102 and CH 118 instructors
Mission / Purpose

The Department of Chemistry is committed to the intellectual, technological, cultural, and economic advancement of the state, region, and nation through the discovery and development of new scientific knowledge. Research programs in the Department are both fundamental (create new knowledge) and applied (solve technical problems). Many of these research endeavors are anchored in interdisciplinary efforts drawing on and adding to the research base within The University. A strong and active research effort allows faculty to enable and keep abreast of the latest scientific advances and to impart new ideas and concepts into the curricula. Research activities play a vital role in the education of the next generation of academic, industrial, and government laboratory scientists who will be called upon to solve new problems. By maintaining these research programs, the Department helps to increase the recognition and reputation for quality of The University of Alabama locally, regionally, nationally, and internationally. Critical research areas include the synthesis and characterization of chemicals and materials and biochemistry. There is a strong emphasis in materials for advanced energy technologies including applications of ‘green chemistry’ and for information storage.

The Department is dedicated to the instruction, training, and intellectual growth of undergraduate students. This mission is accomplished through the use of several mechanisms including 1) classic and innovative classroom and laboratory instruction, 2) student advising, and 3) undergraduate research. The Department reaches out not only to chemistry, science, and engineering majors but also to other non-science majors in its mission. Undergraduate research is strongly encouraged and supported in the Department. There are two basic degree tracks in the Department: a bachelor of science in Chemistry including a Biochemistry track and a Pre-health Professional track leading to a Bachelor’s of Science degree in Chemistry.

The Department offers opportunities for graduate study in a variety of exciting interdisciplinary programs as well as the traditional fields of analytical, inorganic, organic, physical, and biochemistry leading to the Master of Science and the Doctor of Philosophy degrees in chemistry. The Chemistry faculty offer the highest quality graduate education.

Service is an important function of the Department. Faculty and staff are bound by mutual respect and dedication to the field of chemistry and provide their expertise in science to serve the people of Alabama, the region, and the nation. The Department has strong outreach activities and has strong efforts in technology transfer.

Overall, the Department is truly the capstone of chemistry within the state of Alabama and beyond.

Student Learning Outcomes, with Any Associations and Related Measures, Targets, Findings, and Action Plans

SLO 1: Demonstration and Application of Chemistry Knowledge
Students will demonstrate and apply fundamental chemistry knowledge in solving problems related to kinetic and thermodynamic principles, chemical reactivity and synthesis, reaction stoichiometry, molecular structure and bonding, and chemical analysis

Connected Documents
BS Chemistry Curriculum Maps
BS Chemistry Program Outcome Addendum

Relevant Associations:
Student Learning Outcome #1 Improvement Action(s) to be advanced (copied from 2010-11 report);

We must ensure that instructors work together to establish and agree upon aligned final exam questions across multiple course sections so that students in one section do not obtain perceived advantages in answering the aligned questions.

Standard Associations
SACS 3.3.1
3.3.1.1 Educational programs, to include student learning outcomes

General Education/Core Curriculum Associations
8 Mathematics - SLO is related to the essential characteristics and basic processes of inquiry and analysis in the discipline, encourages the development of critical thinking and requires students to analyze, synthesize and evaluate knowledge

Strategic Plan Associations
University of Alabama
1.1 Promote and enhance areas of academic, scholarship, and research excellence.

Related Measures
M 1: CH 101 Final Exam Questions
In CH 101 General Chemistry I, students will answer a set of common targeted questions related to stoichiometry and
thermodynamic principles on the final exam in all course sections.

Source of Evidence: Academic direct measure of learning - other

**Target:**
No Target Established

**Finding (2011-2012) - Target: Met**
The four CH 101 instructors gave aligned multiple choice final exam questions in the five CH 101 sections. Questions were related to the following concepts/skills:

**Nomenclature:** 65.4% of students (n = 851) answered question correctly (avgs. ranged from 53.6%-73.0% across the 5 sections; standard deviation = 7.1%)

**Stoichiometry:** 78.5% of students answered question correctly (avgs. ranged from 68.2%-89.3% across the 5 sections; standard deviation = 6.5%)

**Thermochemistry:** 76.6% of students answered question correctly (avgs. ranged from 59%-85.8% across the 5 sections; standard deviation = 10.3%)

Considering that most students enrolled in CH 101 are not Chemistry majors, and many are not science majors, students performed reasonably well across all five course sections with respect to demonstrating fundamental chemistry knowledge.

**M 2: CH 117 Final Exam Questions**
In CH 117 Honors General Chemistry I, students will answer a set of common targeted questions related to stoichiometry and thermodynamic principles on the final exam in both course sections.

Source of Evidence: Academic direct measure of learning - other

**Target:**
No Target Established

**Finding (2011-2012) - Target: Met**
The two CH 117 instructors gave aligned multiple choice final exam questions in the two CH 117 sections. It should be noted that this is an honors course, and the questions posed were more challenging than those offered in the CH 101 courses. Questions were related to the following concepts/skills:

**Structural Properties and Problem Solving:** 68% and 49% of students (n = 140) answered the targeted questions correctly in the two sections (standard deviation = 9.5%).

**Thermodynamics:** 71% and 89% of students answered the targeted questions correctly in the two sections (standard deviation = 9%).

**Stoichiometry:** 80% and 79% of students answered the targeted questions correctly in the two sections (standard deviation = 0.5%).

With the exception of the students who had difficulty with targeted questions related to "Structural Properties and Problem Solving" in the one section, CH 117 students performed very well on these challenging chemistry knowledge questions.

**M 3: Quantitative Analysis Questions from ACS Exam**
In CH 223 Quantitative Analysis, 50 questions from the American Chemical Society (ACS) Chemical Education Analytical Chemistry Examination will be used to assess students’ application of fundamental chemistry knowledge as it relates to kinetic and thermodynamic principles and chemical analysis. This standardized test is used by universities across the country to assess fundamental chemistry knowledge from students in undergraduate courses and for placement of students in graduate-level coursework.

Source of Evidence: Standardized test of subject matter knowledge

**Target:**
Scores >66th percentile

**Finding (2011-2012) - Target: Met**
Students (n = 31) averaged 33.5/50 correct on the ACS Chemical Education Analytical Chemistry Examination, placing the class in the 68th percentile nationally as determined by comparison with composite norms compiled from scores submitted to the ACS by national universities.

The averaged class score fell within the top 1/3 of all U.S. students whose exam scores were reported to the ACS.

**M 4: Organic Chemistry Questions from ACS Exam - First Semester**
In CH 231 Organic Chemistry I, 30-40 questions (number depends upon the final exam length and amount of material
covered during the semester) from the American Chemical Society (ACS) Chemical Education First Term Organic Chemistry Examination will be used to assess students' application of fundamental chemistry knowledge as it relates to kinetic and thermodynamic principles, chemical reactivity and synthesis, molecular structure and bonding, and chemical analysis. This standardized test is used by universities across the country to assess fundamental chemistry knowledge from students in undergraduate courses and for placement of students in graduate-level coursework. Composite norms are available based upon the performance of 1560 students at 25 national universities on the standardized test.

Source of Evidence: Standardized test of subject matter knowledge

**Target:**

**Finding (2011-2012) - Target: Met**
Students (n = 298) averaged 30.4/40 and 26.7/34 correct on the ACS Chemical Education Organic Chemistry First Term Examination, placing the classes in the 90th and 95th percentiles nationally as determined by comparison with composite norms compiled from scores submitted to the ACS by 25 universities.

UA students who completed the UA Organic Chemistry I course performed among the best in the nation on the ACS Organic Chemistry Exam.

**M 5: Organic Chemistry Questions from ACS Exam - Second Semester**
In CH 232 Organic Chemistry II, 30-40 questions (number depends upon the final exam length and amount of material covered during the semester) from the American Chemical Society (ACS) Chemical Education Organic Chemistry Examination will be used to assess students' application of fundamental chemistry knowledge as it relates to kinetic and thermodynamic principles, chemical reactivity and synthesis, molecular structure and bonding, and chemical analysis. This standardized test is used by universities across the country to assess fundamental chemistry knowledge from students in undergraduate courses and for placement of students in graduate-level coursework. [Target: scores >66th percentile]

Source of Evidence: Standardized test of subject matter knowledge

**Target:**

**Finding (2011-2012) - Target: Met**
Students (n = 255) averaged 25/35 and 24/35 (standard deviation = 0.5) correct on the ACS Chemical Education Organic Chemistry Examination, placing the classes in the 85th and 80th percentiles nationally as determined by comparison with composite norms compiled from scores submitted to the ACS by 25 universities.

UA students who completed the UA Organic Chemistry II course performed among the top 15-20% in the nation on the ACS Organic Chemistry Exam.

**M 6: Variation in Annual Performance Results**
Statistical measures will be used to compare variation in the performance results between sections of multi-section courses in 2010-2011 with variation in the performance results between sections of multi-section courses in 2011-2012 to determine whether the 2011-2012 results are more consistent across all course sections

Source of Evidence: Academic direct measure of learning - other

**Target:**

No Target Established

**Finding (2011-2012) - Target: Met**
Comparison of standard deviations is possible between 2010-2011 CH 101 and CH 117 multi-section courses and 2011-2012 CH 101 and CH 117 multi-section courses. Due to the truncation of the spring 2011 semester, no data is available from 2010-2011 multi-section CH 232 courses to compare with the 2011-2012 CH 232 multi-section courses. CH 231 was a single section course in 2010-2011; hence, there was no standard deviation across multiple sections in 2010-2011.

CH 101 standard deviations across multiple course sections: Nomenclature Questions -- 6.9% (2010-2011), 7.1% (2011-2012); Stoichiometry Questions -- 2.8% (2010-2011), 6.5% (2011-2012); Thermochemistry -- 21.1% (2010-2011), 10.3% (2011-2012);

The variation in student performance across multiple course sections in CH 101 was comparable in 2010-2011 and in 2011-2012, with one important exception. There was far less variation in student performance this past year on questions related to student understanding of thermochemistry.

CH 117 standard deviations across multiple course sections: Structural Properties Questions -- 22.5% (2010-2011), 9.5% (2011-2012); Stoichiometry Questions -- 4.0% (2010-2011), 0.5% (2011-2012); Thermochemistry -- 11.5% (2010-2011), 9.0% (2011-2012);

The variation in student performance across multiple course sections in CH 117 improved markedly in 2011-2012 relative to 2010-2011, particularly with respect to understanding of structural properties. This is a welcome change. The improved variance results from CH 101 and CH 117 courses in 2011-2012 imply that instructors in all sections worked together to devise and agree upon targeted exam questions and/or emphasized similar concepts in their respective course sections.

**SLO 2: Demonstrate Higher Order Thinking Skills**
Students will demonstrate chemistry-related critical thinking skills (higher order learning) including multistep problem-solving abilities, proper selection and implementation of mathematical equations, and visualization of molecules in three-dimensional space.
Connected Documents
BS Chemistry Curriculum Maps
BS Chemistry Program Outcome Addendum

Relevant Associations:
Student Learning Outcome #2 Improvement Action(s) to be advanced (copied from 2010-11 report):

We must ensure that instructors work together to establish and agree upon aligned final exam questions across multiple course sections so that students in one section do not obtain perceived advantages in answering the aligned questions (e.g., measure 2.2). Data from 2011-2012 courses may also more accurately reveal strengths and deficiencies of students, applied assessment methods, or the curriculum.

Standard Associations
SACS 3.3.1
3.3.1.1 Educational programs, to include student learning outcomes

General Education/Core Curriculum Associations
8 Mathematics - SLO is related to the essential characteristics and basic processes of inquiry and analysis in the discipline, encourages the development of critical thinking and requires students to analyze, synthesize and evaluate knowledge

Strategic Plan Associations
University of Alabama
1.1 Promote and enhance areas of academic, scholarship, and research excellence.

Related Measures

M 7: CH 101 Final Exam Questions -- Higher Order Thinking
In CH 101 General Chemistry I, students will answer a set of common targeted questions related to solving multistep mathematical problems and visualizing molecules in three dimensions on the final exam in all course sections.

Source of Evidence: Academic direct measure of learning - other
Target:
No Target Established
Finding (2011-2012) - Target: Met
The four CH 101 instructors gave aligned multiple choice final exam questions in the five CH 101 sections. Questions were related to the following concepts/skills:

Math/Problem Solving: \(86.5\%\) of students (n = 851) answered question correctly (avgs. ranged from 72.5%-92.9% across the 5 sections; standard deviation = 8.5%)

3D Visualization: \(51.9\%\) of students answered question correctly (avgs. ranged from 36.5%-67.6% across the 5 sections; standard deviation = 11.4%).

Considering that most students enrolled in CH 101 are not Chemistry majors, and many are not science majors, students performed reasonably well across all five course sections with respect to demonstrating fundamental chemistry knowledge.

M 8: CH 117 Final Exam Questions -- Higher Order Thinking
In CH 117 Honors General Chemistry I, students will answer a set of common targeted questions related to solving multistep mathematical problems and visualizing molecules in three dimensions on the final exam in both course sections.

Source of Evidence: Academic direct measure of learning - other
Target:
No Target Established
Finding (2011-2012) - Target: Met
The two CH 117 instructors gave aligned multiple choice final exam questions in the two CH 117 sections. It should be noted that this is an honors course, and the questions posed were more challenging than those offered in the CH 101 courses. Questions were related to the following concepts/skills:

Math/Multistep Problem Solving: \(80\%\) and \(82\%\) of students (n = 140) answered correctly in the two sections (standard deviation = 1\%).

3D Visualization: \(78\%\) and \(65\%\) of students answered correctly in the two sections (standard deviation = 6.5\%).

With the exception of the students who had difficulty with targeted questions related to “3D Visualization” in the one section, CH 117 students performed very well on these challenging higher order learning chemistry questions.
M 9: CH 232 Final Exam Questions -- Higher Order Thinking
In CH 232 Organic Chemistry II, two targeted final exam questions related to solving a complex multistep chemical synthesis problem and proposing a viable multistep electron-pushing reaction mechanism will be used in both course sections. Correctly solving each of these problems will require application of chemistry principles from two semesters of organic chemistry, synthesis of concepts from multiple textbook chapters, and advanced problem-solving skills.

Source of Evidence: Academic direct measure of learning - other

Target:
No Target Established

Finding (2011-2012) - Target: Met
Students in both sections of CH 232 were asked embedded assessment questions targeting critical thinking on the respective final exams. In one section, 65 of 151 (43%) students demonstrated the ability to predict an appropriate reaction outcome, 55 of 151 (36%) were able to propose a viable multistep synthesis of an organic molecule, and 107 of 151 (71%) were able to determine the structure of a molecule based upon the interpretation of a $^1$H NMR spectrum. In the other section, 45 of 104 (43%) students were able to propose a viable reaction mechanism of an organic reaction, and 68 of 104 (65%) demonstrated the ability to propose a viable multistep synthesis of an organic molecule. It should be noted that different questions were given in each section, so the results between sections are not directly comparable. These types of questions are among the most difficult in the Chemistry curriculum for many students, and this level of achievement is expected on the basis of the wide variation in problem solving skills amongst students in 200-level organic chemistry "service" courses.

M 10: CH 341 Final Exam Questions -- Higher Order Thinking
In CH 341 Physical Chemistry I, students will demonstrate critical thinking skills by solving at least one targeted complex problem related to proper selection and implementation of physical chemistry-based mathematical equations on the final exam.

Source of Evidence: Academic direct measure of learning - other

Target:
>67% of the class will supply a satisfactory answer

Finding (2011-2012) - Target: Met
Students were required to select the appropriate mathematical equation and solve a complex problem using that equation. 3 of 13 (23%) students demonstrated exemplary problem solving skills, while 7 others (54%) provided satisfactory responses. The class exceeded expectations with 77% of the class supplying a satisfactory or exemplary response to a complex, multi-step problem in physical chemistry.

M 11: CH 461 Biochemistry Pre/Post-Tests
In CH 461 Biochemistry I, specific quiz and test questions will be used to probe the ability of students to think about proteins in three dimensions. A pretest will be given during the first class period asking students to sketch their idea of a protein. A similar question will be asked on one semester test and on the final exam to measure growth and application of knowledge as it relates to three-dimensional protein structures.

Source of Evidence: Faculty pre-test / post-test of knowledge mastery

Target:
No Target Established

Finding (2011-2012) - Target: Met
During a first day of class pretest, 3 of 27 (11%) students were able to sketch a reasonable representation of a protein and provide a brief description. During the final exam, 22 of 24 (92%) students were able to sketch a representation of a protein and describe common structural elements. This dramatic increase in the students' knowledge of protein structure over the course of the semester reflects the effectiveness of the course and the instructor's pedagogical approach to enhancing student knowledge of protein structure and application of covered principles.

M 12: Variation in Annual Performance Results
Statistical measures will be used to compare variation in the performance results between sections of multi-section courses in 2010-2011 with variation in the performance results between sections of multi-section courses in 2011-2012 to determine whether the 2011-2012 results are more consistent across all course sections

Source of Evidence: Academic indirect indicator of learning - other

Target:
No Target Established

Finding (2011-2012) - Target: Met
Comparison of standard deviations is possible between 2010-2011 CH 101 and CH 117 multi-section courses and 2011-2012 CH 101 and CH 117 multi-section courses. Due to the truncation of the spring 2011 semester, no data is available from 2010-2011 multi-section CH 232 course to compare with the 2011-2012 CH 232 multi-section courses. CH 231 was a single section course in 2010-2011; hence, there was no standard deviation across multiple sections in 2010-2011.

CH 101 standard deviations across multiple course sections: Math/Problem Solving Questions -- 7.9% (2010-2011), 8.5% (2011-2012); 3D Visualization Questions -- 29.4% (2010-2011), 11.4% (2011-2012)

The variation in student performance across multiple course sections in CH 101 was comparable in 2010-2011 and in 2011-2012 with respect to math/problem solving skills; however, gratifyingly, there was far less variation in student performance this past year on questions related to 3D visualization of molecules.

CH 117 standard deviations across multiple course sections: Math/Problem Solving Questions -- 18.0% (2010-2011), 1.0% (2011-2012); 3D Visualization Questions -- 24.0% (2010-2011), 6.5% (2011-2012)

The variation in student performance with respect to student demonstration of critical thinking skills across multiple course sections in CH 117 improved markedly in 2011-2012 relative to 2010-2011. This is a welcome change. The improved variance results from CH 101 and CH 117 courses in 2011-2012 imply that instructors in all sections worked together to devise and agree upon targeted exam questions and/or emphasized similar
concepts in their respective course sections.

**SLO 3: Appropriate Use of Chemical Terminology**
Students will select and express chemical terminology appropriately and write using accepted technical formats with adequate and appropriate referencing (e.g., American Chemical Society (ACS) standards).

**Connected Documents**
- BS Chemistry Curriculum Maps
- BS Chemistry Program Outcome Addendum

**Relevant Associations:**
Student Learning Outcome #3 Improvement Action(s) to be advanced (copied from 2010-11 report):

No changes necessary for 2011-2012.

**Standard Associations**
- SACS 3.3.1
  - 3.3.1.1 Educational programs, to include student learning outcomes

**General Education/Core Curriculum Associations**
- 8 Mathematics - SLO is related to the essential characteristics and basic processes of inquiry and analysis in the discipline, encourages the development of critical thinking and requires students to analyze, synthesize and evaluate knowledge
- 11 Writing - SLO is related to building on students' competency in academic writing skills and aims to extend those skills

**Strategic Plan Associations**
- University of Alabama
  - 1.1 Promote and enhance areas of academic, scholarship, and research excellence.

**Related Measures**

**M 13: Organic Lab Report**
In CH 338 Organic Lab II, students will report experimental results from two lab sessions using an Organic Letters manuscript template and ChemBioDraw 12.0 for creation of the illustrations. Thus, the reports will require the students to employ conventions and formatting that is consistent with publication in an ACS journal.

Source of Evidence: Academic direct measure of learning - other

**Target:**
No Target Established

**Finding (2011-2012) - Target: Met**
Students reported experimental results from two lab sessions using an ACS publication template and common formatting conventions. 17 of 19 (89%) students demonstrated satisfactory or exemplary ability to use the template, describe their results, and format the document properly. This is excellent attainment of communication outcomes in the course.

**M 14: Service Learning Project Report**
In CH 424 Instrumental Analysis, students will report findings from a service learning project related to community environmental analysis. The extensive report will require students to employ conventions and formatting that is consistent with ACS style guidelines.

Source of Evidence: Project, either individual or group

**Target:**
No Target Established

**Finding (2011-2012) - Target: Met**
Enrollment in CH 424 was too small (one student) to allow for program-level assessment. However, in CH 462, 19 undergraduate students were asked to write separate sections of group reports related to the biosynthetic pathways of nucleotides using ACS formatting guidelines. 19 of 19 (100%) of students earned a score of 90% or higher on their report.

This is outstanding achievement by undergraduates in preparing a technical document with stringent formatting requirements.

**Related Action Plans (by Established cycle, then alpha):**
For full information, see the Details of Action Plans section of this report.

**Assessment of Chemical Terminology Learning Outcomes in CH 343, CH 413, or CH 463**

*Established in Cycle: 2011-2012*
Because of the low enrollment in CH 424, we will assess attainment of oral and/or written technical communication student learn...

**SLO 4: Demonstrate Laboratory Skills and Knowledge**
Students will demonstrate fundamental laboratory skills and knowledge related to laboratory safety, chemical synthesis techniques, precise and accurate measurement, chemical analysis and characterization, and proper use of instrumentation.

**Connected Documents**
- BS Chemistry Curriculum Maps
Relevant Associations:
Student Learning Outcome #4 Improvement Action(s) to be advanced (copied from 2010-11 report):
No changes are necessary for 2011-2012.

Standard Associations
SACS 3.3.1
3.3.1.1 Educational programs, to include student learning outcomes

General Education/Core Curriculum Associations
9 Natural Science - SLO is related to a hands-on laboratory or field experience that emphasizes the scientific method and analysis of data

Strategic Plan Associations
University of Alabama
1.1 Promote and enhance areas of academic, scholarship, and research excellence.

Related Measures
M 15: CH 223 Laboratory Safety Quiz
In CH223 Quantitative Analysis, students will demonstrate their knowledge of laboratory safety rules and procedures by answering targeted questions on a laboratory safety quiz given within the first month of the Fall and Spring semesters.

Source of Evidence: Academic direct measure of learning - other
Target:
>80% of students will earn 90% or more credit

Finding (2011-2012) - Target: Met
During fall 2011, 30 of 33 (91%) students earned a perfect score on the 10 question laboratory safety quiz, while three (9%) students earned 90% credit. These results reflect UA students' knowledge of general laboratory safety and the effectiveness of its emphasis in the curriculum.

M 16: CH 223 Laboratory Skills Activities
In CH 223 Quantitative Analysis, students' reported results from two laboratory experiments, "Gravimetric Analysis of Chloride" and "Determination of Copper by Atomic Absorption" will be used to assess student mastery of accurate and precise measurement and proper use of instrumentation, respectively.

Source of Evidence: Project, either individual or group
Target:
No Target Established

Finding (2011-2012) - Target: Met
During fall 2011, 30 of 33 (91%) students mastered the 2.5 week "Gravimetric Analysis of Chloride" experiment, and 21 of 31 (68%) students mastered the "Analysis of Chloride and Iodide by Potentiometric Titration" instrumentation experiment. The experiment, "Determination of Copper by Atomic Absorption" originally targeted for assessment was replaced due to some reporting errors by an inexperienced teaching assistant. Over 2/3 of CH 223 students were capable of mastering two complex laboratory experiments, which suggests appreciable attainment of laboratory skills by students in the course.

M 17: CH 338 Laboratory Safety Quiz
In CH 338 Organic Lab II, students will demonstrate their knowledge of laboratory safety rules and procedures by answering targeted questions on a laboratory safety quiz given within the first week of the course.

Source of Evidence: Academic direct measure of learning - other
Target:
>90% of students will earn 75% or higher credit

Finding (2011-2012) - Target: Met
18 of 19 (95%) students earned 75% or greater credit on a laboratory safety quiz given the first week of the course. This quiz is more challenging than that offered in CH 223, primarily because of the increased number and potential severity of dangers in the organic laboratory. Even so, all but one enrollee met or surpassed expectations on the safety quiz.

M 18: CH 338 Laboratory Skills Activities
In CH 338 Organic Lab II, results from a multi-lab session synthesis of lidocaine, and nuclear magnetic resonance spectroscopic characterization of the synthesized product, will be used to assess student mastery of chemical synthesis techniques and chemical analysis and characterization skills.

Source of Evidence: Academic direct measure of learning - other
Target:
No Target Established

Finding (2011-2012) - Target: Met
16 of 19 (84%) students obtained a chemical yield of >75% in the multweek synthesis of lidocaine and were also able to successfully characterize the product by NMR spectroscopy. This is a particularly challenging project for fledgling researchers, and the high percentage of CH 338 students who completed the multweek project successfully is a testament to the laboratory skills learned and applied by the UA students.
Other Outcomes, with Any Associations and Related Measures, Targets, Findings, and Action Plans

OthOtcm 5: Sustain High Level of Recognized Quality
The program will improve and sustain a high level of recognized quality.

Relevant Associations:
Program Outcome #1 Improvement Action(s) to be advanced (copied from 2010-11 report):

1. Be more attentive and responsive to undergraduate concerns.
2. (With contributions from The University administration.) Provide one-time funds for a major upgrade of instructional laboratory equipment and permanently increase the budget to allow for annual maintenance and upgrade of equipment.

Related Measures

M 19: Strengths from Program Review
(8-year program review strengths)

1. Rapidly increasing number of chemistry majors.
2. High quality students.
3. Increased attention to introductory chemistry courses – use of technology

Source of Evidence: Academic indirect indicator of learning - other

M 20: Opportunities for Improvement from Program Review
(8-year program review opportunities for improvement)

1. Improve the quality of the equipment in the undergraduate teaching laboratories.

Source of Evidence: Administrative measure - other

M 21: Changes Made as Result of Program Review
List of changes made as a result of the review:

In response to Improvement Action 1, the department enacted the following:

1. Reenergize undergraduate student organization (SAACS). Progress: The department historically has had two student organizations primarily for undergraduates: the Student Affiliates of the American Chemical Society (SAACS) and the national honorary Gamma Sigma Epsilon (GSE). In spring 2007, GSE was reactivated with Dr. Kevin Shaughnessy as faculty advisor. This group has become active and inducted classes of 15-30 students each year since. Dr. Shaughnessy also attempted to revive the SAACS group with less success. Drs. Busenlehner and Frantom worked to reestablish this group as a joint graduate/undergraduate chapter of the ACS in 2010-2011. This item is not fully complete, but substantial progress has been made.

2. More career advising (maybe through SAACS). Progress: The department has made progress in this area through the posting of career opportunities and job advertisements in the undergraduate section of the department web site. The SAACS and GSE groups have also hosted a few talks by local chemists about career opportunities in areas such as forensic science and medicine. This item is not complete. Additional efforts to communicate career opportunities to our majors are needed. In particular, a better job of communicating this information to chemistry majors and potential majors in our lower level courses is needed. Constant and continuing effort must be applied here. GSE and the reactivated SAACS group began this effort in 2010-11.

3. Designate a room (with PCs) for undergraduates to gather. Progress: This is still an area of interest for department majors and the faculty. As noted for the graduate student lounge, a suitable space for a student lounge has not been identified in Shelby, nor have funds been designated to retrofit a suitable area. The addition of wireless internet access throughout the building has reduced the need for a computer lounge. Students routinely use their personal laptop computers in the break rooms throughout Shelby to study and work on group projects. We recognize that a communal space for students to interact is still an important component to building community amongst our students. This item is not complete. Continued discussion with the VP for Research and the Dean’s office to determine if a feasible space can be found and outfitted will be needed.

In response to Improvement Action 2, the department enacted the following:

Provide one-time funds for a major upgrade of instructional laboratory equipment and permanently increase the budget to allow for annual maintenance and upgrade of equipment. Progress: With the new freshman labs in the SEC coming on line in fall 2009, the Provost, Dean and Department committed approximately $600,000 in 2008 and 2009 to updating lab equipment in the freshman labs as well as upper level labs. With the first allotment of $300,000 in 2008 from the administration, new balances, spectrophotometers, pH meters, and drawer equipment were purchased for the freshman chemistry labs in Lloyd. A second allotment of approximately $300,000 was provided in 2009. These funds were used to outfit the additional drawers in the new General Chemistry labs in the SEC; upgrade equipment in the Analytical, Organic, Biochemistry, and Physical teaching labs. With these infusions of funds, the Department has been able to address the significant deficiencies in its lab programs. Two other developments will allow the department to maintain a top-level lab experience for its students. First, the newly instituted course fees that are returned to the Department provide a source of funds for the education mission, including upgrading lab equipment. Second, the Dean’s Office agreement to fund the salary line for the General Chemistry Lab Coordinator has freed up additional funds for purchase of lab equipment. With careful management, it is expected that the department will be able to commit significant funds to replace obsolete equipment and purchase new equipment and instruments for use in the lab curriculum. This item is complete, although continued effort to keep the labs updated will be required. The Instrumentation Committee has been charged by the Chair to develop a priority list of equipment purchases and upgrades for both teaching and research support. Funds remaining in lab fee and course fee accounts at the end of the year (ca. $30-50 K) will be used to purchase necessary upgraded or new equipment for teaching labs. Larger scale equipment needs will be pursued through external funding mechanisms, such as the NSF-CCLI program.

Source of Evidence: Administrative measure - other
**OthOtcm 6: Sustain Optimal Level of Enrollment**

The program will build and sustain an optimal level of annual program enrollments and degree completions.

**Relevant Associations:**

Program Outcome #2 Improvement Action(s) to be advanced (copied from 2010-11 report):

The Department's optimal enrollment of undergraduate majors is 175 with a goal of growing to 200 majors over the next 5 years. Current enrollments and degree production are strong, but growth in the number of majors and BS graduates is required to reach optimal program size and production. The action plan for 2011-12 focuses on increasing the recruitment and retention of undergraduate majors.

**Related Measures**

**M 22: Undergraduate Credit Hour Production**

Undergraduate semester credit hour production for the last three fall semesters

Source of Evidence: Existing data

**M 23: Number of Undergraduate Courses and Sections**

Number of undergraduate courses and sections offered for the last three fall semesters

Source of Evidence: Existing data

**M 24: Number of Students in Undergraduate Major**

Number of students in the undergraduate major for the last three fall semesters [Target: >145 students]

Source of Evidence: Existing data

**M 25: Number of Degrees Awarded in Undergraduate Major**

Number of degrees awarded in the undergraduate major for last three years (August, December, and May) [Target: >25 degrees]

Source of Evidence: Existing data

**M 26: Relate Number of Degrees Awarded to ACHE Standards**

Relation of number of degrees awarded to ACHE viability standards [average of 7.5 degrees per year over five years required to meet ACHE viability standards.]

Source of Evidence: Administrative measure - other

**M 27: Changes Made in Response to Previous Year Observations**

List of changes made as a result of last year's information:

Retention efforts are focused on developing a sense of community, particularly among lower division majors through the rejuvenation of chemistry student organization and increased interaction between entering students and current majors (see measure 1.3 for details). Improved recruiting will be done through outreach to non-major students taking lower level chemistry service courses. Dr. Snowden instructed a new course, AS 101 Chemistry in Everyday Life during spring 2011 to a mix of 14 freshman and sophomore majors and non-majors specifically for this purpose. During courses and advising sessions, freshman and sophomores are also routinely encouraged to become involved in undergraduate research opportunities with a chemistry faculty member in order to enhance student interest in chemistry or an associated field.

Source of Evidence: Academic indirect indicator of learning - other

**OthOtcm 7: Program Will Be Highly Valued**

The program will be highly valued by its program graduates and other key constituencies it serves.

**Relevant Associations:**

Program Outcome #3 Improvement Action(s) to be advanced (copied from 2010-11 report):

Acquire more satisfaction survey data from undergraduate majors at the department and university levels

**Related Measures**

**M 28: Graduating Senior Survey Results**

Results from University-wide Graduating Senior Survey for senior department majors

Source of Evidence: Student satisfaction survey at end of the program

**M 29: NSSE DATA**

NSSE (National Survey of Student Engagement) data collected from graduating senior Chemistry majors by Office of Institutional Effectiveness.

Source of Evidence: Academic indirect indicator of learning - other

**M 30: Exit Survey Results**

Results from exit survey for graduating majors and minors

Source of Evidence: Student satisfaction survey at end of the program
M 31: Informal Faculty Advising and Discussion
Results from informal faculty advising or discussion with students regarding future plans
Source of Evidence: Discussions / Coffee Talk

M 32: Changes Made in Response to Previous Year Information
List of changes made as a result of last year’s information:

New satisfaction surveys were devised and distributed to undergraduate majors during advising sessions in spring 2011. Beginning in 2011-2012, we also intend to work with the UA Office of Institutional Research and Assessment to devise and implement an online satisfaction survey for senior Chemistry majors. Students will be encouraged to complete the survey through email notices. Students may also be asked to complete the survey during the advising period prior to the student's final semester as an undergraduate major.
Source of Evidence: Student satisfaction survey at end of the program

Details of Action Plans for This Cycle (by Established cycle, then alpha)

Assessment of Chemical Terminology Learning Outcomes in CH 343, CH 413, or CH 463
Because of the low enrollment in CH 424, we will assess attainment of oral and/or written technical communication student learning outcomes in alternative upper level Chemistry courses. Data for 2012-2013 will be derived from student presentations and/or reports in CH 343 Elementary Physical Chemistry Laboratory, CH 413 Intermediate Inorganic Chemistry, or CH 463 Biochemistry Laboratory. This change to assessment in a course with larger enrollment should cover a more representative cross section of our Chemistry majors, thereby generating more meaningful program level assessment data.
Established in Cycle: 2011-2012
Implementation Status: Planned
Priority: High

Relationships (Measure | Outcome/Objective):
Measure: Service Learning Project Report | Outcome/Objective: Appropriate Use of Chemical Terminology

Implementation Description: Selection will be based upon each course instructor’s (to be determined) planned student learning outcomes, major assignments, and the projected student enrollments of each course.
**Curriculum Maps #1 (In which courses are Student Learning Outcomes Addressed)**

Use “Introduce” when outcome is first address; “Reinforce” when outcome is reinforced; and “Master” when outcome is expected to be mastered.

<table>
<thead>
<tr>
<th></th>
<th>Fundamental chemistry knowledge</th>
<th>Chemistry-related critical thinking skills</th>
<th>Written communication skills</th>
<th>Fundamental laboratory skills and safety knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH 101</td>
<td>Introduce</td>
<td>Introduce</td>
<td></td>
<td>Introduce</td>
</tr>
<tr>
<td>CH 117</td>
<td>Introduce</td>
<td>Introduce</td>
<td></td>
<td>Introduce</td>
</tr>
<tr>
<td>CH 102</td>
<td>Introduce</td>
<td>Introduce</td>
<td></td>
<td>Reinforce</td>
</tr>
<tr>
<td>CH 118</td>
<td>Introduce</td>
<td>Introduce</td>
<td></td>
<td>Reinforce</td>
</tr>
<tr>
<td>CH 223</td>
<td>Reinforce</td>
<td>Introduce</td>
<td></td>
<td>Introduce</td>
</tr>
<tr>
<td>CH 231</td>
<td>Introduce</td>
<td>Introduce</td>
<td></td>
<td>Introduce</td>
</tr>
<tr>
<td>CH 232</td>
<td>Introduce</td>
<td>Reinforce</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 237</td>
<td>Introduce</td>
<td></td>
<td></td>
<td>Introduce</td>
</tr>
<tr>
<td>CH 338</td>
<td>Reinforce</td>
<td>Introduce</td>
<td>Reinforce</td>
<td></td>
</tr>
<tr>
<td>CH 340</td>
<td>Reinforce</td>
<td>Introduce</td>
<td></td>
<td>Reinforce</td>
</tr>
<tr>
<td>CH 341</td>
<td>Reinforce</td>
<td>Introduce</td>
<td></td>
<td>Introduce</td>
</tr>
<tr>
<td>CH 342</td>
<td>Reinforce</td>
<td>Introduce</td>
<td></td>
<td>Reinforce</td>
</tr>
<tr>
<td>CH 343</td>
<td>Introduce</td>
<td></td>
<td></td>
<td>Introduce</td>
</tr>
<tr>
<td>CH 348</td>
<td>Introduce</td>
<td></td>
<td></td>
<td>Introduce</td>
</tr>
<tr>
<td>CH 413</td>
<td>Reinforce</td>
<td>Reinforce</td>
<td>Reinforce</td>
<td>Introduce</td>
</tr>
<tr>
<td>CH 424</td>
<td>Introduce</td>
<td>Reinforce</td>
<td>Reinforce</td>
<td>Introduce</td>
</tr>
<tr>
<td>CH 461</td>
<td>Introduce</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 462</td>
<td>Introduce</td>
<td>Reinforce</td>
<td></td>
<td>Reinforce</td>
</tr>
<tr>
<td>CH 463</td>
<td>Introduce</td>
<td></td>
<td></td>
<td>Introduce</td>
</tr>
</tbody>
</table>

**Curriculum Maps #2 (What assessment measures will be employed in which courses for each SLO)**

Indicate which measure is being obtained in which course by typing “Measure n.n” in the appropriate cell. If you’d rather use a description of the measure, that is fine. Also, indicate the year/semester in which the measure will be obtained (e.g., Fall 2011). Student learning outcomes must be assessed at least once within a 2-year period. Note that a measure does not need to be obtained from every course in which an outcome is covered (see Map #1).

<table>
<thead>
<tr>
<th></th>
<th>Fundamental chemistry knowledge</th>
<th>Chemistry-related critical thinking skills</th>
<th>Written communication skills</th>
<th>Fundamental laboratory skills and safety knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH 101</td>
<td>embedded final exam questions in all course sections. (Fall 2011)</td>
<td>embedded final exam questions in all course sections. (Fall 2011)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 117</td>
<td>embedded final exam questions in all course sections. (Fall 2011)</td>
<td>embedded final exam questions in all course sections. (Fall 2011)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 102</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Exam or Report Details</td>
<td>Additional Details</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>CH 223</td>
<td>ACS Analytical Chemistry Standardized Exam (Fall 2011)</td>
<td>lab safety quiz</td>
<td>reported results from targeted lab experiments</td>
<td></td>
</tr>
<tr>
<td>CH 231</td>
<td>ACS First Term Organic Chemistry Standardized Exam (Fall 2011)</td>
<td>embedded final exam questions in all course sections (Spring 2012)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 232</td>
<td>ACS Organic Chemistry Standardized Exam (Spring 2012)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 237</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 338</td>
<td></td>
<td>two experimental results papers (Fall 2011)</td>
<td>lab safety quiz reported results from multi-week lab experiment</td>
<td></td>
</tr>
<tr>
<td>CH 340</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 343</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 341</td>
<td>embedded final exam questions (Fall 2011)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 342</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 348</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 349</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 413</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 424</td>
<td></td>
<td>service learning research project report (Spring 2012)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 461</td>
<td>pre-test/post-test questions related to protein structure (Fall 2011)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 462</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 463</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Methods: The University of Alabama conducts a Program Review of departments and their degree programs every eight years. The last program review for the Department of Chemistry was in 2006-2007. Internal committee members were selected jointly by Dr. David Francko, Dean of the Graduate School, and Dr. Robert Olin, Dean of the College of Arts and Sciences. The committee was tasked with reviewing the department’s mission, goals (i.e., 5-year plans), curriculum, teaching/research/service mix, quality of department and its programs, distinguishing characteristics of the department and its programs, and institutional effectiveness (i.e., department outcomes and assessment). The committee also analyzed the strengths of the department and its degree programs, areas of opportunity for the department and its degree programs, and recommendations to improve the department and its degree programs (in ranked order, low or no-cost, mid cost, and high cost improvements). The information below (measures and results) comes directly from the report of the Internal Program Review Committee.

The review committee consisted of Dr. J.W. Harrell (Physics and Astronomy), committee chair, Dr. Ernie Mancini (Geological Sciences), and Dr. Robert Taylor (Mechanical Engineering). The external reviewer was Dr. Gary Schuster (Provost and Dept. of Chemistry and Biochemistry, Georgia Institute of Technology). The committee began the review process by meeting with Assoc. Dean John Schmitt (Graduate School), Assoc. Dean Joe Benson (A&S), and Prof. Joseph Thrasher (Chemistry dept. chair), where Dean Schmitt provided an overview of the review. Documents provided to the committee included program review forms completed by the department chair, student satisfaction survey results, the previous departmental review report, the departmental academic profile, the departmental annual report for 2005-06, a list of individual grant awards for 2002-03 through 2005-06, and the department’s successful White Paper Graduate Enhancement Proposal from the late 1990s. Prof. Thrasher also provided the committee with a “State of the Department” PowerPoint type document and results of a 2006 Southeast Departmental Chairs Survey and a 2006 Council for Chemical Research (CCR) survey.

The committee met with Dr. Schuster, Dean David Francko (Graduate School), Dean Robert Olin (A&S), and Prof. Thrasher. It had numerous meetings with various clusters of chemistry faculty members. The meetings with interdisciplinary groups included faculty from other programs such as MINT, Biological Sciences, and Engineering. The committee also met with the chemistry staff and had separate meetings with graduate students and undergraduate students. All members of the committee contributed to writing the report and the report represents a consensus of the committee.
Finding(s) describing the extent to which the outcome is achieved

The report generated by the Internal Program Review Committee is extensive. Only those elements that are directly related to the current program outcome are presented: quality of program, strengths of degree program, areas of opportunities for the program, including recommendations to improve the degree program.

Quality of B.S. Degree Program:
Introductory 100-level courses include a standard two-semester course for science and engineering majors, a two-semester honors course, a course for Nursing and Human Environmental Sciences students, and a two-semester sequence for non majors. (The non majors sequence, CH 107/108, has not been offered for several years.) These 100-level courses include a laboratory and satisfy the university’s core curriculum natural science requirement. Two organic chemistry courses with a lab are offered at the 200-level. The 100 and 200-level courses are taken by a large number of non majors and contribute substantially to the total credit hour production of the department. Upper level undergraduate courses are designed and taken primarily by chemistry majors, and include courses in analytical chemistry, biochemistry, inorganic chemistry, organic chemistry, and physical chemistry. Students can also get course credit for research. Nineteen to 20 courses with a total of 64 to 67 sections were offered each fall semester from 2003 to 2005.

Recent changes in the undergraduate curriculum include the implementation of active learning in introductory general chemistry and organic chemistry courses through the use of student personal response systems (‘clickers’). A web-based homework system, which has been used in introductory general chemistry for several years, has been introduced in organic chemistry. A mandatory attendance system has been implemented in introductory general chemistry. The department uses the evening time period scheduled for common exams during the semester for weekly recitation sessions involving problem solving, and attendance at these sessions is expected. (This has in effect increased the contact time for the course without a corresponding increase in credit hours.) A pre-health track in the B.S. degree and a consumer chemistry course (CH 107/108) were started several years ago, although CH 107 and CH 108 have not been offered in recent years due to low enrollments.

All faculty members teach at least one course per semester at the undergraduate and/or graduate level, with the exception of the endowed chair professors who teach one course per year, and most direct several students in dissertation research. Most of the credit hour production is at the undergraduate level, with most of these hours in the 100 and 200-level service courses. However, the department has strong B.S., M.S., and Ph.D. programs and much of the teaching effort is directed toward these programs.

Undergraduates spoke highly of the department and are pleased with the program. Students requested a presence in Shelby Hall so they have an opportunity to be active participants in department activities. They also requested that a computer laboratory for undergraduates be set up either in Shelby or the new building for undergraduate teaching. They voiced concern
over the inactivity of the student chemistry society and the paucity of up to date quality equipment in the undergraduate laboratories. Overall the undergraduate program is solid and is growing. The time and energy directed to the undergraduate program by the faculty is paying dividends.

The Program Outcome improvement actions and measures indicated in this plan are derived from the findings and recommendations in the 8-year program review.
# Curriculum Maps #1 (In which courses are Student Learning Outcomes Addressed?)

Use “Introduce” when outcome is first address; “Reinforce” when outcome is reinforced; and “Master” when outcome is expected to be mastered.

<table>
<thead>
<tr>
<th>Course</th>
<th>Fundamental chemistry knowledge</th>
<th>Chemistry-related critical thinking skills</th>
<th>Written communication skills</th>
<th>Fundamental laboratory skills and safety knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH 101</td>
<td>Introduce</td>
<td>Introduce</td>
<td></td>
<td>Introduce</td>
</tr>
<tr>
<td>CH 117</td>
<td>Introduce</td>
<td>Introduce</td>
<td></td>
<td>Introduce</td>
</tr>
<tr>
<td>CH 102</td>
<td>Introduce</td>
<td>Introduce</td>
<td></td>
<td>Reinforce</td>
</tr>
<tr>
<td>CH 118</td>
<td>Introduce</td>
<td>Introduce</td>
<td></td>
<td>Reinforce</td>
</tr>
<tr>
<td>CH 223</td>
<td>Reinforce</td>
<td>Introduce</td>
<td></td>
<td>Introduce</td>
</tr>
<tr>
<td>CH 231</td>
<td>Introduce</td>
<td>Introduce</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 232</td>
<td>Introduce</td>
<td>Reinforce</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 237</td>
<td>Introduce</td>
<td></td>
<td></td>
<td>Introduce</td>
</tr>
<tr>
<td>CH 338</td>
<td>Reinforce</td>
<td>Introduce</td>
<td></td>
<td>Reinforce</td>
</tr>
<tr>
<td>CH 340</td>
<td>Reinforce</td>
<td>Reinforce</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 343</td>
<td>Introduce</td>
<td></td>
<td></td>
<td>Introduce</td>
</tr>
<tr>
<td>CH 341</td>
<td>Reinforce</td>
<td>Introduce</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 342</td>
<td>Reinforce</td>
<td>Reinforce</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 348</td>
<td>Introduce</td>
<td>Introduce</td>
<td></td>
<td>Introduce</td>
</tr>
<tr>
<td>CH 413</td>
<td>Reinforce</td>
<td>Reinforce</td>
<td>Reinforce</td>
<td>Introduce</td>
</tr>
<tr>
<td>CH 424</td>
<td>Introduce</td>
<td>Reinforce</td>
<td>Reinforce</td>
<td>Introduce</td>
</tr>
<tr>
<td>CH 461</td>
<td>Introduce</td>
<td>Introduce</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 462</td>
<td>Introduce</td>
<td>Reinforce</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 463</td>
<td>Introduce</td>
<td></td>
<td></td>
<td>Introduce</td>
</tr>
</tbody>
</table>

# Curriculum Maps #2 (What assessment measures will be employed in which courses for each SLO?)

<table>
<thead>
<tr>
<th>Course</th>
<th>Fundamental chemistry knowledge</th>
<th>Chemistry-related critical thinking skills</th>
<th>Written communication skills</th>
<th>Fundamental laboratory skills and safety knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH 101</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 117</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 102</td>
<td></td>
<td>embedded final exam questions in all course sections. (Spring 2014)</td>
<td>embedded final exam questions in all course sections. (Spring 2014)</td>
<td></td>
</tr>
<tr>
<td>CH 118</td>
<td></td>
<td>embedded final exam questions in all course sections. (Spring 2014)</td>
<td>embedded final exam questions in all course sections. (Spring 2014)</td>
<td></td>
</tr>
<tr>
<td>CH 223</td>
<td></td>
<td>ACS Analytical Chemistry Standardized Exam (Fall 2013)</td>
<td></td>
<td>lab safety quiz (Fall 2013) reported results from targeted lab experiments (Fall 2013)</td>
</tr>
<tr>
<td>CH 231</td>
<td></td>
<td>ACS First Term Organic Chemistry Standardized Exam (Fall 2013)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course Code</td>
<td>Description</td>
<td>Additional Details</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>-------------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 232</td>
<td>ACS Organic Chemistry Standardized Exam (Spring 2014)</td>
<td>embedded final exam questions in all course sections. (Spring 2014)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 237</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 338</td>
<td></td>
<td>two experimental results papers (Fall 2013)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 340</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 341</td>
<td></td>
<td>embeded final exam questions (Fall 2013)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 342</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 343</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 344</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 413</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 424</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 461</td>
<td>pre-test/post-test questions related to protein structure (Fall 2013)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 462</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 463</td>
<td></td>
<td>two experimental results lab reports (Spring 2014)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Optional Additional Narrative: