

Millikin University
Student Learning in the Chemistry Major

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Executive Summary

The Department of Chemistry supports the mission of the university in preparing students for professional success, democratic citizenship in a global community, and a personal life of meaning and value by producing graduates who achieve the following three chemistry-specific learning outcome goals:

1. Demonstrate the skills to solve problems and communicate through writing and speaking.
2. Discover how to integrate and apply knowledge and skills both within the chemistry community and between chemistry and other disciplinary communities.
3. Develop the capacity to address real-world scenarios in which chemistry plays a role.

Our curriculum introduces each student to the five sub-fields of chemistry recommended by the Committee on Professional Training of the American Chemical

Report

Goals

The Department of Chemistry supports the mission of the university in preparing students for professional success, democratic citizenship in a global community, and a personal life of meaning and value. The mission of the department is to produce graduates who achieve the following three learning outcome goals:

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3. Develop the capacity to address real-world scenarios in which chemistry plays a role.

The successful graduate of the Department of Chemistry is not necessarily a professional chemist. For example, recent graduates are working in the chemical and pharmaceutical industry, practicing medicine or pharmacy, selling technical goods and services, running their own businesses, teaching, and working in the areas of government and law, among other things.

Snapshot

The Department of Chemistry is approved by the Committee on Professional Training (CPT) of the American Chemical Society (ACS). The department consists of five full-time faculty members representing the five major sub-fields of chemistry: analytical chemistry, biochemistry, inorganic chemistry, organic chemistry, and physical chemistry. All chemistry majors choose one of four emphases: biochemistry, business, research, or secondary education. Students complete 23 credits of common core courses plus additional courses specific to the emphasis. Our CH121-General Chemistry course serves approximately 200 students per year, including students majoring in chemistry, biology, nursing, elementary education, athletic training, physical education, psychology, and exploratory studies, *inter alia*. Our CH224-Inorganic Chemistry and CH301/302-Organic Chemistry courses each serve approximately 50-65 students per year, primarily chemistry and biology majors. In the decade from 1994 to 2004, approximately nine majors per year graduated with chemistry degrees. Since 2004, the number of majors has risen steadily to nearly double that number today, in part due to our new science center. Slightly fewer than half of our graduates pursue advanced degrees.

The Department of Chemistry resides in the 83,000-square-foot Leighty-Tabor Science Center, which opened in the spring 2002 semester. We also joined Midwestern University in a dual-acceptance pre-pharmacy agreement. In terms of curriculum, our most recent initiatives have been in course delivery, specifically the Block CH121, designed for students with limited chemistry backgrounds, that meets five days a week for half the semester. The block concept was extended to our CH203/205 Essentials of Organic and Biochemistry service course during the spring 2005 semester. Beginning

with the fall 2005 semester, we instituted a math proficiency requirement for CH121 enrollment. Beginning in 2008, ACS-CPT modified the curricular requirements necessary for program approval. A review of our curriculum indicates that our current curriculum meets the modified ACS-CPT requirements. Also in 2008, working in cooperation with the staff of Staley Library, we added two new resources for students to use in research: ACS Web Editions and SciFinder Scholar. ACS Web Editions allows students to search 34 ACS journals online. SciFinder Scholar allows students to search a multitude of scientific journals in all areas of science. In terms of staff, the department was reduced from 5.5 FTE to 5 FTE beginning in the fall 2004 semester.

The Learning Story

Three hallmarks characterize the typical learning experience provided through the chemistry major:

- 1. Do Chemistry as Chemists Do It**
Students use modern instruments from the first lab class in the first year; repeating experiments should be normal, not remedial. The desired outcome of an experiment is an accurate, reproducible, unambiguous result, not a predestined "right one."
- 2. Modern Chemistry is Integrated**
Chemists address problems with concepts and techniques that span the various sub-fields of chemistry. Moreover, biologists, nurses, psychologists, and physicians also regularly use these same concepts and techniques.
- 3. The Main Goal of Laboratory is Tackling a New Problem Capably**
We design experiments to develop maximum independence, not maximum coverage.

The curriculum map is included as Appendix 1. Our core curriculum introduces each student to four of the sub-fields of chemistry while providing a foundation in essential laboratory techniques. The additional courses in each emphasis then offer students more specialized technical training. Regardless of emphasis, undergraduate research is the capstone of the chemistry major at Millikin. It has four components, including the proposal, the research, a final written report, and a final oral presentation.

The proposal is part of the course CH254 Introduction to Research. The proposal must be a project suggested by a faculty member or an industrial mentor (with consent of a faculty member). The proposal includes a background section that shows careful reading of primary journals. Ideally, the research should be connected to a real-world problem.

In terms of the actual research, we look for consistent work over time. The student should try to do a project that might be presented at a meeting, especially the National Meeting of the ACS. The lab notebook is assessed to determine the quality and quantity of work. The best projects create new knowledge.

In CH482 Senior Seminar, the student writes the final report and presents the

sizes typically available in a given class, the following assessment criteria will therefore be used to evaluate student progress in achieving department learning goals:

an acceptable level or clearly heading in the right direction and not requiring any immediate change in course of action): 80% or more of the students

not an acceptable level; either improving, but not as quickly as desired or declining slightly. Strategies and approaches should be reviewed and appropriate adjustments taken to reach an acceptable level or desired rate of improvement)

le. Immediate,
high priority actions should be taken to address this area): fewer than 60% of the

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Table 2.

Department Goal 2. Discover how to integrate and apply knowledge and skills both within the chemistry community and between chemistry and other disciplinary

Analysis of Assessment Results

For the 2007-2008 academic year, student learning for all three of our learning goals was an acceptable level or clearly heading in the right direction and not requiring any immediate change in course of action). We are, of course,

Improvement Plans

As noted above, one area we intend to work on is improving short-term learning. We administer the ETS Major Field Test in Chemistry in our seminar course, CH482. In the past, we administered the test at the end of the course. Students merely had to take the

exam there was no incentive for students to do well on the exam, nor was there a penalty for doing poorly on the exam. This year, we administered the test near the beginning of the course. We also instituted a minimum score students were required to pass. If students did not pass the test on their first attempt, they were required to work with a faculty member on remedial proficiencies before taking the exam a second time. If students did not pass the exam on their second attempt, the cycle repeated, and students were allowed to take the exam a third and final time.

The ETS exam is scored on a scale of 120-160. Student results were as follows:

39% passed on first attempt;
22% passed on second attempt;
11% passed on third attempt; and
28% did not pass on their third attempt.

class, so these results were not surprising to faculty. Nevertheless, one of our goals for the future is to continue to re-examine our curriculum to make sure we provide the proper skills to our students to help them be successful on exams such as the ETS and ACS standardized exams.

Appendix 1: Curriculum Map for Chemistry

University Goals

1. Professional success
2. Democratic citizenship in a global environment
3. A personal life of meaning and value

Department Goals

1. Demonstrate the skills to solve problems and communicate through writing and speaking.
2. Discover how to integrate and apply knowledge and skills both within the chemistry community and between chemistry and other disciplinary communities.
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Curriculum Map (Lecture/Lab) (**Bold** = Chemistry core courses)

Year	Dept. Goal 1	Dept. Goal 2	Dept. Goal 3
1	CH121/151 CH224/CH152		
2	CH232/CH253 CH301/251 CH302/CH252		
3	CH303/CH351 CH304 CH432	CH254 CH331/CH354	CH391-392
4	CH353 CH406 CH420/CH352 CH482	CH482	CH470 CH491-492

Appendix 2: Evaluation Rubrics for Undergraduate Research

The proposal: grading done by faculty member teaching Introduction to Research

	Excellent	Adequate	Nominal
Process	5 points] A thorough explanation of previous work to a clear study question followed by analysis of previous work to synthesis into a coherent proposal.	[3 points] Shows some evidence of the process: explanation to conjecture to analysis to synthesis but incomplete.	[1 point] Restates some general ideas or issues but shows no evidence of analysis.
Connection	[3 points] A good proposal has a history.		

Final Presentation: written and oral report of results

	Excellent	Adequate	Nominal
Report	[5 points] A report having quality that might be submitted to a research journal. Includes background, data and methods, results, and discussion. Includes suggestion for further work.	[3 points] A good report but missing some aspect of an excellent report	[1 point] A report having minimal value
Oral Presentation	[5 points] Clear, confident presentation. Audience questions are answered in a way to illustrate a complete knowledge of the topic.	[3 points] A good presentation but lacking clarity or confidence.	[1 point] An awkward, weak presentation but a presentation made nevertheless.
Reflection	[2 points] A valuable reflection on the complete undergraduate chemistry experience.	[1 point] Some attempt at reflection but incomplete	[0 points] No reflection
External presentation	[2 points] Presented results at an off-campus conference or meeting	[1 point] Presented a good poster at the Millikin undergraduate research symposium	[0 points] No presentation

Millikin University
Department of Chemistry
Student Learning Evaluation

Evaluation of: Department Goal 2.

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Item evaluated: The research proposal

Student name:

Date of evaluation:

Evaluation by: Faculty member teaching Introduction to Research

Faculty name:

Item	Criteria			Student Score
	Excellent	Adequate	Nominal	
Process	[5 points] A thorough explanation of previous work to a clear study question followed by analysis of previous work to synthesis into a coherent proposal.	[3 points] Shows some evidence of the process: explanation to conjecture to analysis to synthesis but incomplete.	[1 point] Restates some general ideas or issues but shows no evidence of analysis.	
Connection	[3 points] A good proposal has a history. This includes your personal experience, it has a real-world context, and it has a connection to previous work both at Millikin and in the literature.	[2 points] Shows you understand the history of the proposal by examining some of your own experiences in the past as they relate to the proposal but otherwise incomplete.	[1 point] Minimal connections made.	
Readings	[4 points] In-depth synthesis of thoughtfully selected aspects of readings related to the proposal. The readings are significant and appropriate at the college level. While you may use data and primary texts collected from the internet, the majority of readings are from library sources. Makes <i>clear</i> connection between what is learned from readings and the proposal.	2 points] Goes into more detail explaining some specific ideas or issues from readings related to the topic. Makes general connections between what is learned from readings and the topic.	[1 point] You show some evidence of reading about the topic and are able to state some general ideas or issues from readings related to the topic. But there is no evidence of library research beyond the class textbook, secondary sources and the internet.	
Grammar	[2 points] No spelling or grammar errors.	[1 point] Few spelling and grammar errors.	[0 points] Many spelling and grammar errors, use of incomplete sentences, inadequate proof reading.	
Total Points (14 max.)				

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