

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 realworld 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 Society. The Chemistry curriculum incorporates the integration of theory and prac

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Learning Goals

Millikin students thrive through our unique approach to performance learning. In addition to a solid foundation in the theory of a given field, Millikin students gain practical, hands-on experience in their fields of study. Students in the Department of Chemistry demonstrate performance learning in the three stages of an undergraduate research project. Our students learn how to plan and communicate their plan for research by writing a proposal. They learn to conduct

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 typically been above that number - as high as 18 in 2008 - in part due to our new science center. Approximately half of our graduates pursue advanced degrees.

The Department of Chemistry resides in the 83,000 -

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 p dm [(-)] TJ ET BT 1 0 0rbd

3. Use the resources and services on campus to assist in fulfilling their plans of study, and
4. Graduate in a timely manner.

At least once a semester, the student meets in person with the academic advisor to discuss fulfillment of the plan of study.

Assessment Methods

We decided that assessment of the four aspects of undergraduate research is the most informative way to assess the three learning outcome goals. The research project is the culminating event of each goal as well as the climax of each emphasis within the major. We have created rubrics for assessing the proposal, performance, and presentation of research. These rubrics are attached as Appendix 2.

Assessment Data

Department goal 1 will be assessed in CH 482 using the "Final Presentation" rubric. Department goal 2 will be assessed in CH 254 using the "Proposal" rubric. **Department goal 3 will be assessed in CH391/491 using the "Research" rubric.**

As noted above, each department learning goal will be assessed by evaluating student learning in one class. Five to 10 students from each class will be randomly selected for evaluation. As a general rule, one-half of a given class will be selected; for classes with fewer than 5 students, all students in the class will be evaluated; for classes with greater than 20 students, 10 will be randomly selected.

The grading rubrics used to assess each learning goal have three categories: Excellent, Adequate, and Nominal. The range of points possible on each rubric is 2-14. A student ranked "adequate" on all evaluative items would have a numeric score of 8. **All students should be ranked "adequate" (i.e., have a minimum score of 8 on each rubric) if the department goals are being achieved.** Realistically, however, there may be students, for a variety of reasons, who are ranked less than "adequate". Considering the small sample sizes typically available in a given class, **the following assessment criteria will therefore be used to evaluate student progress in achieving department learning goals:**

- "Green light" (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 ranked "adequate" or "excellent";
- "Yellow light" (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): 60% to 80% of the students ranked "adequate" or "excellent"; and

"Red light" (our current status or direction of change is unacceptable).

Immediate, high priority actions should be taken to address this area): fewer than 60% of the students ranked "adequate" or "excellent".

For reporting purposes, a rubric numeric score of 13-14 will be considered "excellent"; a score of 8-12 will be considered "adequate"; and a score less than 8 will be considered "nominal".

Assessment data are listed in the tables below.

Table 1.

Department Goal 1: Demonstrate the skills to solve problems and communicate through writing and speaking.

| Rubric Category | Percentage of students in category |
|----------------------------------|------------------------------------|
| Excellent | 50 |
| Adequate | 50 |
| Total of above (used for rating) | 100 |
| Nominal | 0 |
| Number of students evaluated | 6 |
| Average numeric score | 11.8 |

Rating for goal 1: "Green light".

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 communities.

| Rubric Category | Percentage of students in category |
|----------------------------------|------------------------------------|
| Excellent | 17 |
| Adequate | 67 |
| Total of above (used for rating) | 84 |
| Nominal | 16 |
| Number of students evaluated | 12 |
| Average numeric score | 10.4 |

Rating for goal 2: "Green light".

Table 3.

Department Goal 3. Develop the capacity to address realworld scenarios in which chemistry plays a role.

Rubric Category

Percentage of students in category

are reflected in the acceptable level of learning in the past six years for all three department learning goals.

On a less than positive note, we continue to observe that the quality of student writing remains dismal across the board. We recognize that despite the positive assessment of student learning, this is one area where we must and will continue to work with students to strengthen their skills.

As we noted in last year's report, the class of 2011 was one of the strongest groups we have had academically in many years. In addition to their academic success, 100% of the students who wanted to attend medical professional school were admitted to the school of their choice. As we also noted in last year's report, the class of 2012 was not as strong as the class of 2011. This is seen in Table 5 (vide infra). While by no means a weak class, a slightly smaller percentage of the class of 2012 passed the ETS exam on their first or second attempt, and a larger percentage did not pass the exam after three attempts. Nevertheless, four of the six students in the class of 2012 are headed for excellent graduate programs at Purdue University, Michigan State University, Florida State University, and the University of Michigan. Taken as a whole, we continue to be pleased with how well the class of 2012 thrived during their time at Millikin.

While we are pleased that our students achieved an acceptable level of learning on all three of our learning goals, we know that we cannot rest on our laurels. We continually evaluate our curriculum, keeping two areas foremost in our evaluation: 1. Are we delivering a quality education to our students? and 2. How well do our students learn?

Quality

We are confident in the quality of our program. Our program is accredited by the Committee on Professional Training of the American Chemical Society—the benchmark of a quality chemistry program. Our graduates leave Millikin and go onto successful and distinguished professional careers. Furthermore, the university recently undertook an internal self-study project. The results of that study ranked the

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- 3.) What, if anything, would you do differently if you had to complete your degree all over again?
- 4.) How would you advise a new chemistry student?
- 5.) What are the strengths of the chemistry program?
- 6.) What aspects of the chemistry program need improvement?

Students are open and honest in their responses to these questions. The overall message we receive from students is "keep doing what you have been doing". Even so, students often offer specific suggestions for improvements in the department, which we take to heart. Students have commented that our curriculum does not give students any historical perspective on the field of chemistry. We therefore modified CH482, Chemistry Seminar, to incorporate the reading of more historical texts. In recent years, we have read texts such as "Uncle Tungsten", "Einstein's Luck", "Collapse" and "Polio: An American Story." Students expressed a desire to have more exposure to forensic chemistry, so CH253, Intermediate Lab III, now includes one or two forensic chemistry projects each year.

However, quality is a two-way street. John Calipari, coach of the 2012 NCAA national champion in basketball, will coach the Dominican Republic basketball team in this year's Summer Olympics. Does anyone seriously believe the Dominican Republic team will win the gold medal?

Major Field Test in Chemistry. We find that our students typically score below the 50th

attempt. One of those two passed on the second attempt; the third student did not pass after three attempts. While our goal is 100% of the students passing the exam on the first attempt, we know this is not likely to occur. We will nevertheless continue to work with our students to help ensure a high pass rate.

In sum, our students are learning well. We must continue to do the things that have been successful for our students. We will therefore continue to do the same things we have done in the past with the "tweaks" identified above. We will, of course, continue to collect data in the coming years to

University Goals

1. Professional success

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. 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 connecting it to previous work. | |

Research: evaluation by faculty mentor using notebook

| | | | |
|----------|--|--|----------------|
| Quantity | Excellent [5 points] You work consistently over the entire research period with clear evidence of significant weekly work. You consistently report to faculty mentor. | Adequate [3 points] You work consistently most of | Nominal |
|----------|--|--|----------------|

Appendix 3: Student Learning Evaluation Forms

Millikin University Department of Chemistry Student Learning Evaluation

Evaluation of: Department Goal 1.

"Demonstrate the skills to solve problems and communicate through writing and speaking."

Item evaluated: Final Presentation (written and oral report of results)

Student name:

Date of evaluation:

Evaluation by: Faculty member teaching Chemistry Seminar and/or Faculty Mentor

Faculty name:

| Item | Criteria | | | Student Score |
|-------------------|--|--|--|---------------|
| | 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 the complete undergraduate chemistry experience | | [0 points] No reflection | |

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Department of Chemistry