

MasteringChemistry

School Name [Butler University, Indianapolis, IN](#)

Course Name [General Chemistry II](#)

Course Format [Lecture and lab](#)

Key Results Average American Chemical Society exam percentiles increased when MasteringChemistry was used to help students develop study skills and gain content mastery.

Submitted by

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Course materials

Chemistry, McMurry and Fay (as of fall 2013)

About the Course

Butler University is a four-year college serving approximately 4,000 undergraduate students. The majority of students attend full-time, with a graduation rate of 74 percent within six years (for the 2007 cohort). Ninety-one percent of full-time degree-seeking freshmen starting in 2012 were still enrolled in 2013.¹

General Chemistry is a two-semester course taught on campus with a lecture and lab component. Students who enroll in these courses are primarily prepharmacy, health sciences, and biology majors; other majors include premed, education, engineering, physics, and psychology. General Chemistry II covers chemical kinetics, solution chemistry, acid-base chemistry, chemical equilibrium, thermodynamics, and electrochemistry. Successful completion of General Chemistry I with a grade of C or better is a prerequisite to General Chemistry II.

Challenges and Goals

Professor Robert Pribush has taught this course for many years. His main goal for students taking the course is to help them master chemistry concepts. Because he understands the importance of study skills for continued success, he also focuses on helping his students develop skills that will help them become better lifelong learners; become more precise, careful, and conceptual problem solvers; and learn to honestly assess their performances in timely but nonintimidating manners.

In 2006, Pribush was concerned with his students' performance on the American Chemical Society (ACS) national standardized general chemistry exam, which is used as the final exam for

General Chemistry II. Student performance seemed to have peaked, and he sought a way to enhance content mastery. He also observed that many students appeared not to have been challenged in high school, resulting in a naive work ethic and poor understanding of how to succeed in college. To address the issue, he began emphasizing the importance of being active and responsible learners and promoting effective study skills.

Pribush implemented MasteringChemistry in fall 2007 with the intention of evaluating the effectiveness of the online, graded homework system on both content and study-skills mastery. He posited that if MasteringChemistry was effective, average ACS exam scores would increase and students would identify the program as a positive influence on their course success. Enrollment averaged 72 students per academic year (AY).

Implementation

MasteringChemistry is a huge part of Pribush's course: it is used for graded homework and to glean diagnostic data on student performance and student misconceptions that Pribush uses to evaluate overall learning both during and at the end of the semester.

Each semester, students are assigned approximately 87 graded MasteringChemistry homework assignments of 10 problems each (800–900 problems), with an assignment due for most chapter sections. Assignments take approximately one hour each and are due two days after the material is covered in class. Homework is a formative assessment tool, so course credit is assigned accordingly.

Assessments

64 percent	Exams (four)
16 percent	Final exam
16 percent	MasteringChemistry homework
4 percent	Laboratory/participation

¹http://www.butler.edu/media/3430095/cds_b.pdf.

Results and Data

During the period of this study, the same ACS exam was given and its results compared (Figure 1). Pribush made changes to how he implemented MasteringChemistry during this period of time, along with departmental and administrative changes, as follows:

- In AY 2007/08, the first year MasteringChemistry was used, ACS percentiles increased: students who used the program for one semester averaged a two-percentile increase; two-semester MasteringChemistry users averaged a seven-percentile increase.
- In AY 2008/09, Pribush promoted use of MasteringChemistry's hints during problem solving by changing the default settings to decrease penalties for opening them. He used the same textbook and MasteringChemistry assignments as the prior year, and results show a seven-percentile increase on the ACS exam.
- In AY 2009/10, Pribush focused on the metacognition/self-efficacy exercises in MasteringChemistry. One week before each exam, students were sent the learning outcomes associated with each exam question. They were instructed to match the learning outcomes with a homework assignment. Then, for each learning outcome, the students predicted how they would perform on the exam, and their predictions were compared with actual exam results. The average ACS exam scores were two percentile points higher than the previous year.
- In AY 2010/11, to equalize course enrollments among sections, registration was changed so that instructor names were not listed with specific sections. Pribush believes that he is perceived as a more-challenging instructor and that therefore he may have gotten better-academically-prepared students who were looking for a more rigorous class. After the change, he had a more diverse group of students in his sections. Results of the ACS exam decreased from the prior year but remained two percentile points above the final year that MasteringChemistry was not in use.
- In AY 2012/13, a textbook change was made. In addition, Pribush observed that more students were less academically prepared than in the past. There was a decrease in student performance on the ACS exam during this year, which prompted a review of the course and a decision to make changes in textbook and homework assignments for the next year.

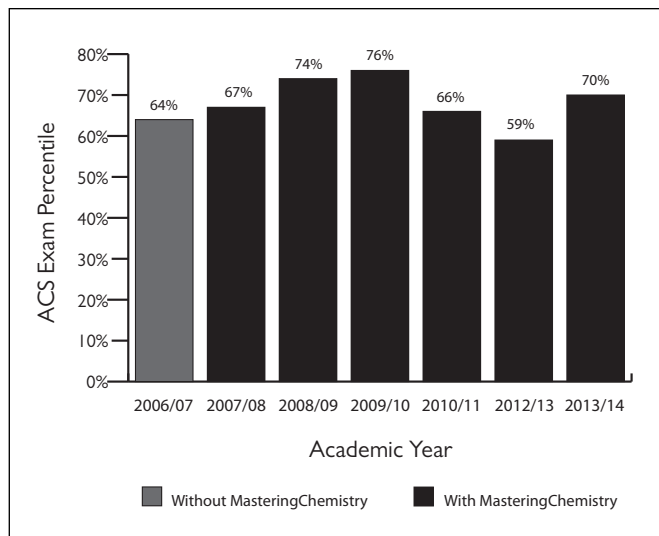


Figure 1. General Chemistry II American Chemical Society Exam Percentiles, Fall 2006–Spring 2011, Fall 2012–Spring 2014 ($n = \sim 504/\sim 72$ per academic year). No data was collected during academic year 2011/12 due to sabbatical.

- In AY 2013/14, the department switched to a textbook that more closely matched course goals and made a decision to make the higher-level chemistry courses more rigorous. As a result, students in the General Chemistry sequence needed to be better prepared in order to succeed in the more-advanced courses. Pribush began assigning higher-level MasteringChemistry problems in General Chemistry to develop students' critical-thinking skills in preparation for more-challenging courses. Results of the ACS exam show an increase of 11 percentile points over the prior year (six percentile points above the final year when MasteringChemistry was not in use).

Pribush believes that by addressing content needs for success in the program and by helping students develop the skills needed for learning, there has been a trend toward higher ACS exam scores since MasteringChemistry was implemented.

Student Resource	Rating
MasteringChemistry	1.3
Instructor	1.4
Lecture	1.5
Exams	1.7
Exam outlines	1.8
Learning objectives	1.9
In-class problem sessions	2.1
Lab lecture	2.5
Textbook	2.5
Solution manual	2.6
Working with classmates outside class	2.8
Lab experiments	2.8
Self-rating exercises	3.0
Group lab work	3.0
Online interaction with instructor	3.2
Lab assistant	3.3
Lab notebook reports	3.4
Instructor office hour	3.5
Former General Chemistry students	3.5
Other	4.2

Table 1. Student Ranking of Course Resources, AY 2009/10 ($n = 75$)
1 = Very Strong Impact, 5 = No Impact

The Student Experience

Students in General Chemistry II were asked to rate several course resources in terms of the impact they had on student understanding of course material, with 1 = a very strong impact and 5 = no impact. Students ranked MasteringChemistry as the highest resource out of 20 (Table 1).

Student comments about MasteringChemistry include:

- “MasteringChemistry can be a hassle sometimes, making sure that I do it every night, but overall it helps me out greatly by making sure I stay up-to-date with the class and that I am not falling behind.”

- “MasteringChemistry, as much as I hate it, has probably helped me the most. I hate it because you have to fully understand the concept to get a good grade. In high school I was one to do the absolute minimum to get the A, which unfortunately led to my not understanding the concepts. I appreciate that Dr. Pribush makes us do our assignments on MasteringChemistry, and I believe that this has helped me succeed the most.”
- “I know my grades are better! I also know that I don’t sit in class and wonder what’s up. Last year I took the course and thought I knew what was going on; this year I know when I don’t understand a concept because I can’t complete the homework assignment online. I use the hints on [the problems] I was having trouble with and I understand. It’s like having a personal tutor.”

Conclusion

By monitoring MasteringChemistry data both during and after each semester, Pribush can immediately address student misconceptions and areas of weakness in class, adjust his implementation of MasteringChemistry to enhance student learning, and more easily understand the impact of pedagogical changes on learning. The data enable him to compare his students’ performances on the ACS exam with the national average and to investigate what may have impacted those results. In addition, anecdotal responses from students reveal the key role of MasteringChemistry in modifying student work ethic and performance.

Pribush has begun a new study evaluating student performance based on time on task. Using data from MasteringChemistry, initial findings indicate that better students spend less time on MasteringChemistry homework because they are more efficient at preparing for homework by reading and using the resources as questions arise. Pribush believes that poorer-performing students wait until the last minute and spend more time trying to guess the answer to complete the assignment by the due date. As he continues to collect data in MasteringChemistry, he will test this theory and report the results.