

Product Name MasteringChemistry

Course Name General Chemistry I

Credit Hours Four

Key Results A redesign of General Chemistry I using MasteringChemistry resulted in an increase in post-assessment scores and a reduction in instructional costs.

Text

Chemistry: A Molecular Approach, 3e, Nivaldo J. Tro

Implementation

In 2010, in partnership with the National Center for Academic Transformation, the Governor of Missouri and Missouri's public four-year institutions established a major course redesign initiative. The goal of the redesign was to achieve improvements in learning outcomes and reductions in instructional costs via the redesign of large-enrollment, multisection courses using technology-supported, active-learning strategies.

General Chemistry I, the first in a sequence of two general chemistry courses with an enrollment exceeding 1,000 students, was targeted for redesign. The course offers general chemistry education to major and nonmajor students. For more than 75 percent of students, General Chemistry I is a required course in which they typically enroll during their freshman year. The lab is taught separately and was not included in the redesign.

The redesign addressed the following issues:

1. Incoming students have different chemistry backgrounds.
2. Students often lack successful learning strategies and resist adjusting their study skills as they transition from high school to college.
3. Student success relies too much on—or may be achieved by—rote memorization rather than the development of conceptual thinking and problem-solving skills.
4. Student engagement in recitation classes is inconsistent and often inefficient and lacking active-learning strategies.
5. Despite weekly faculty meetings, duplication takes place when instructors individually compile course content.
6. The department lost several faculty positions due to budget cuts and hiring freezes prior to 2012. As a result,

200- and 300-level courses are taught together, sacrificing the quality of upper-level education and preventing students from taking 300-level courses as electives if they were previously enrolled in the 200-level course.

The redesigned General Chemistry course uses the Buffet Model, which offers a menu of multiple learning opportunities for each student, thereby eliminating the one-size-fits-all approach to teaching. Students are given choices including face-to-face sessions, a fully online environment, or a mix of activities from both formats. To ensure engagement, students are required to develop learning strategies and discuss their study plans with teaching assistants (TAs) or instructors.

Structural changes of the course include:

- Moving from 6 courses and 48 recitation sections to 3 courses and 24 collaborative learning centers.
- Moving from six to two instructors.
- Moving from 12 TAs and 6 Peer Learning Assistants (PLAs) to 6 TAs and 6 PLAs.

MasteringChemistry is used to deliver tutorials, common homework assignments, online recitation, and exams that are mandatory for all students, enabling us to eliminate 12 graduate and undergraduate student graders.

The pilot began in fall 2012 with one instructor responsible for two General Chemistry I sections: one taught in the traditional format, one taught in the redesign model. Four common, intermediate exams were used to track student performance throughout the semester and the final exam was used to compare performance. To test the homogeneity of the two groups, a prior-knowledge test based on high-school-level chemistry problems and a preparedness test for math relevant to science in general, and chemistry specifically, was administered at the beginning of the semester.

Assessments

Students who earn at least 950 points (95 percent) before the final exam are eligible to receive an exam grade of A without taking the exam (although this eligibility may be forfeited due to lack of attendance or missed assignments).

Point values are illustrated in the below table.

Item	Possible Points	Points per Item
Exams (four)	400	100
Recitation	260 <i>(lowest two dropped)</i>	20
Final Exam	200	200
MasteringChemistry homework	200 (max.)	9
Clicker questions	100 (max.)	4 (per day)
MasteringChemistry reading quizzes	40 (max.)	3
TOTAL	1,200	

Results and Data

There was a considerable increase in post-assessment performance in the redesigned course compared to the traditionally taught course (figure 1). It is important to note that the results of the math and science preparedness test at the beginning of the semester indicate that students in the redesigned course were less prepared than those in the traditional course (figure 1), making the learning increase in the redesigned course even more impressive.

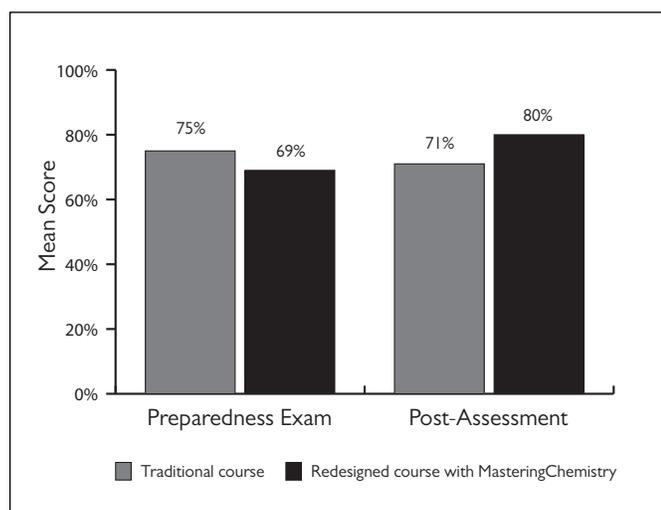


Figure 1. General Chemistry I Mean Preparedness Exam and Post-Assessment Scores in the Traditional and Redesigned Course Formats, Fall 2012.

There was no significant difference in the course completion rate: in the redesigned course, 77 percent of students received a grade of C or better compared to 78 percent in the traditional course.

In the pilot, the actual cost-per-student dropped 32 percent, a higher savings than originally anticipated. This was achieved primarily by the following:

- Increasing the section size from 200 to 400 students
- Reducing the number of sections offered per year from six to three
- Transferring some student experiences online

In addition to the cost savings, professors were released from their general chemistry teaching duties so now a more varied and improved curriculum for upper-level undergraduate and graduate instruction can be offered.

The Student Experience

The redesigned course allows students to select from a wide pool of instructional materials and strategies to match their own learning characteristics and needs. This flexibility enables students to prepare for challenges in subsequent courses. It encourages active learning versus memorization, and it helps individualize study plans in the large-enrollment basic science course and better serve the needs of diverse learners. Finally, the modular online exercises reinforce students' conceptual understanding and enable them to take control of their progress, thereby enhancing both student satisfaction and student success.

Conclusion

By redesigning General Chemistry I and implementing MasteringChemistry, we are able to provide our students with immediate feedback and individualized online tutoring. We have reduced instructional costs by 32 percent, increased the efficiency of the grading process, and are providing students with different learning resources. As a result, students are more engaged and the number of students achieving As and Bs has substantially increased.

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