



# BREAKTHROUGH

To improving results

## MyLab<sup>®</sup> & Mastering<sup>®</sup> Science and Engineering

Data-supported evidence of Mastering's positive impact  
on teaching and learning

2014

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*MyLab & Mastering Science and Engineering: Data supported evidence of Mastering's positive impact on teaching and learning*

Edited by Michelle D. Speckler

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## Solutions-based List of Case Studies

Although each institution, course, and classroom is unique, instructors in higher education today face a series of common teaching and learning challenges. To enable quick and easy identification of Mastering case studies that address your challenges, we've categorized them below by common goal.

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University of Kentucky .....	43
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Florida State College at Jacksonville .....	8, 82
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Collin College.....	40
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University of Mississippi .....	62
University of the Sciences in Philadelphia .....	66
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### Increase interactive learning/ flipped classroom

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# Pearson's Efficacy Program and Standards for Efficacy Research

At Pearson, we believe that learning is a life-changing opportunity, and that education should have a measurable, proven impact on learners' lives. It's what Pearson's efficacy program and tools are all about. They're how we measure and improve our likelihood of impact on learners and ensure we are doing all we can do to equip learners to succeed.

## What Pearson Means by *Efficacy* and *Effectiveness*

- *Efficacy* describes whether a product or intervention has a positive effect on learning, such as reducing wrong answers, increasing retention rates, or raising final exam scores.
- *Effectiveness* measures the size of the educational improvement from a product or educational intervention.

## Why Pearson Is Interested in Efficacy Studies

To deliver the best educational experience for students, we need to understand how Pearson's content is performing and to verify the learning gains associated with the use of our products. Toward that goal, we actively seek out educators who wish to explore educational research questions and investigate the efficacy of MyLab & Mastering products.

## Pearson's Efficacy Research Team

Our research team includes PhD-level statisticians who provide practical advice about tracking and analyzing student data after the redesign of a course to incorporate technology. Our research team also includes experts in psychometrics, educational statistics, and journal publications. These individuals support instructors who want to (1) conduct efficacy studies, (2) provide our editorial staff with detailed reports on the quality of our online content, and (3) advise our software engineers of new methodologies for collecting and processing student learning data within MyLab & Mastering products.

## How Pearson and Instructors Work Together

Every research project is unique. The process takes time—generally a semester or longer. Instructors interested in conducting studies should expect an interactive and rewarding partnership.

## How Pearson Can Help Instructors Get Started

Pearson can provide templates, guidelines, checklists, and samples on course redesign, efficacy studies, data collection, and more. To maintain objectivity, Pearson does not offer compensation for participation in efficacy studies.

## Research Standards

Pearson adheres to Software & Information Industry Association guidelines for evaluation of educational technology products. The key guidelines are:

- Ask the right question
- Support the implementation of the product or service
- Plan a study of sufficient size and duration to demonstrate an effect
- Plan for plausible causal claims
- Avoid (the appearance of) conflicts of interest
- Provide a comprehensive and detailed research report
- Make the research findings widely available
- Accurately translate research for customers

Contact [betsy.nixon@pearson.com](mailto:betsy.nixon@pearson.com) for more information.

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## Welcome Letter

WE ARE PLEASED TO PRESENT *MyLab & Mastering: Science and Engineering*, our most recent compendium of Mastering efficacy studies from the science and engineering disciplines. In the pages that follow, you'll find both quantitative data and qualitative observations from courses across the United States, Canada, the United Kingdom, and even Asia—47 comprehensive case studies that share how instructors are using Mastering to enhance their teaching and improve learning outcomes.

Each successful case study provides insight into the experiences of instructors and their students. You'll learn how these instructors addressed today's most common academic challenges, including low pass and retention rates, the need to maintain course quality with fewer resources, the need for more-frequent assessment, and academic dishonesty. And you'll discover how their students responded, including specific actions they're taking to achieve success and their levels of satisfaction as they pursue their academic goals and take steps toward fulfilling their dreams.

You'll also find brief summaries and links to published conference proceedings and journal articles about Mastering. Each study employed strict analytical protocols and was published by a non-Pearson source (pages 99-101).

Finally, we've provided you with a comprehensive list of 11 best practices to help you get the most out of your Mastering implementation (page 102).

We extend our deepest gratitude to all of the contributing instructors (page 104). Every case study was submitted voluntarily and without compensation; instructors submitted their stories and then graciously remained available for questions about their results and best practices. Their efforts are invaluable.

We invite you to contact us with any questions about the studies in this report as well as to inquire about how you can get involved in our next edition.

Pearson is happy to provide both consultation and data collection tools to help you measure the impact of a MyLab & Mastering product in your course.

We look forward to hearing from you!

Betsy Nixon  
*Efficacy Manager, Science and Engineering*  
Pearson Education  
[betsy.nixon@pearson.com](mailto:betsy.nixon@pearson.com)

Product Name **MasteringA&P**

Course Names **Anatomy & Physiology I and II**

Credit Hours **Four (each)**

**Key Results** After changing MasteringA&P assignments from optional to required, success rates (A/B/C) and exam scores increased in both Anatomy & Physiology I and II.

### Text

*Human Anatomy and Physiology, 9e*, Elaine N. Marieb and Katja Hoehn

### Implementation

Anatomy & Physiology I and II are taken primarily by students who are currently enrolled in or planning to apply to the college's nursing program. The courses cover the ten organ systems of the human body and include lecture and lab.

Although these courses are not prerequisites for admission to the nursing program, successful completion is a positive indicator to the admission committee. As a result, many students take these courses prior to applying to the program. Because a final course grade of C or above in each course is required in order to graduate from the program, success in these courses is key to achieving a student's nursing career goals.

Beginning with the fall 2010 semester, MasteringA&P was included with both courses' textbook packages. At that time I did set up MasteringA&P homework, but I did not require completion of the homework nor did I give credit for work done in MasteringA&P. Few students did the optional assignments and virtually none reported using the Study Area or any other MasteringA&P resources.

In spring 2012 I began requiring MasteringA&P homework as part of the course assessment. I now require one homework assignment per chapter. Assignments take about 30 minutes to complete, and I use a mix of question types. Each week, I review the gradebook diagnostics in order to identify missed questions and common misconceptions and then I review those concepts in class.

### Assessments

50 percent	Lecture exams (five)
25 percent	Lab practicals (four)
15 percent	MasteringA&P homework
10 percent	Paper-and-pencil chapter questions

*“MasteringA&P was a good reinforcement of the textbook. When I needed additional study options, they were at my fingertips.”*

—Student

### Results and Data

A review of success rates and exam scores indicates an increase in student gains since requiring MasteringA&P homework.

- Of those students who completed Anatomy & Physiology I in spring 2012, 100 percent earned an A, B, or C, compared to 85 percent and 77 percent respectively in fall 2011 and spring 2011 (when MasteringA&P was optional).
- The success rate (A/B/C) for those students who completed Anatomy & Physiology II has significantly increased since MasteringA&P was required (figure 1).
- During spring 2012 in Anatomy & Physiology I, in four out five exams, the mean exam score was higher than in semesters when MasteringA&P was not required (figure 2).
- In Anatomy & Physiology II, mean exam scores have consistently been higher over the course of multiple semesters since MasteringA&P homework has been required (figure 3).

In addition, Anatomy & Physiology I assessment data indicate a strong correlation between homework and exam scores (figure 4).



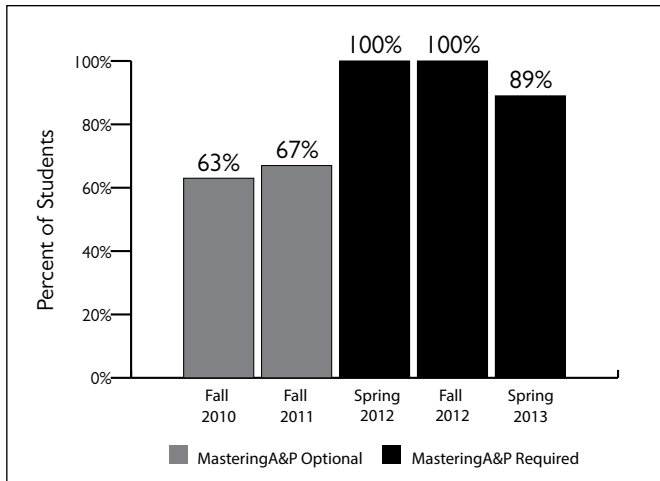


Figure 1. Anatomy & Physiology II Success (A/B/C) Rates, Fall 2010–Spring 2013 (Fall 2010 n=8, Fall 2011 n=9 Spring 2012 n=12, Fall 2012 n=12, Spring 2013 n=18)

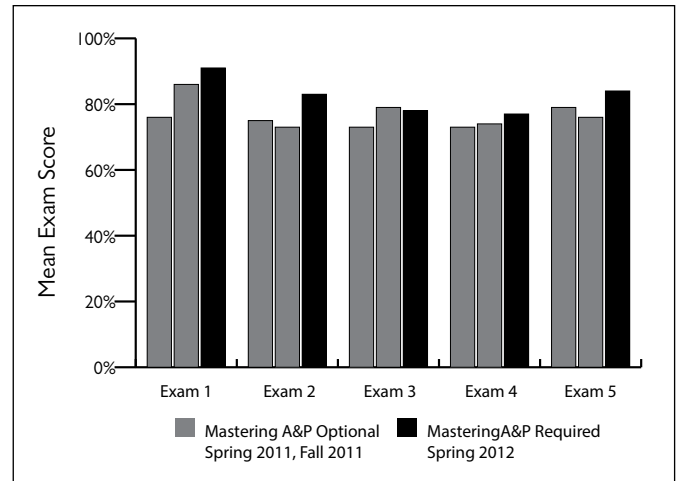


Figure 2. Anatomy & Physiology I Mean Exam Scores, Spring 2011–Spring 2012 (Spring 2011 n=13, Fall 2011 n=13, Spring 2012 n=9)

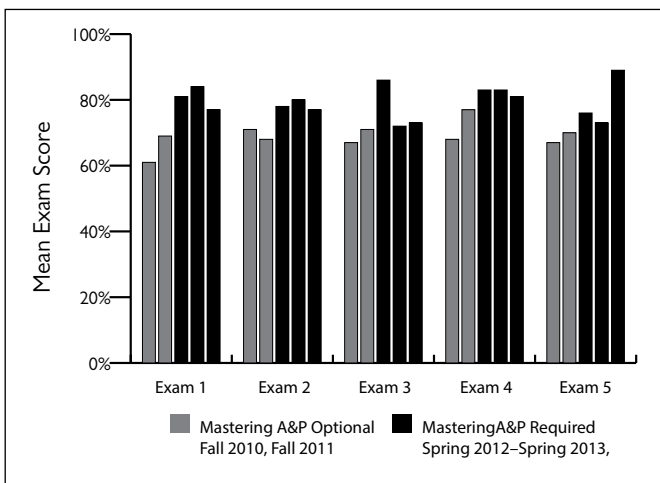


Figure 3. Anatomy & Physiology II Mean Exam Scores, Fall 2010–Spring 2013 (Fall 2010 n=8, Fall 2011 n=9 Spring 2012 n=12, Fall 2012 n=12, Spring 2013 n=18)

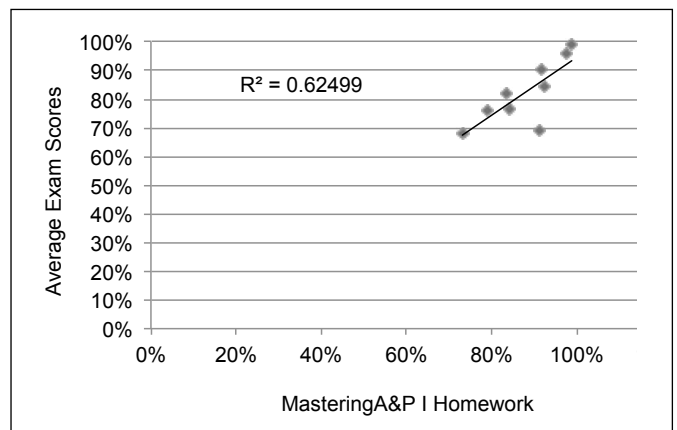


Figure 4. Correlation of MasteringA&P Homework to Exam Scores, Spring 2012

## The Student Experience

A spring 2013 survey of Anatomy & Physiology II students shows that the majority of students appreciate the value of MasteringA&P:

- 62 percent agreed or strongly agreed that MasteringA&P positively impacted their test scores.
- 69 percent agreed or strongly agreed that MasteringA&P increased their understanding of the course concepts.
- 69 percent agreed or strongly agreed that they would recommend Mastering for other courses.

Students tell me that because they are required to log into MasteringA&P to do weekly homework, they also spend time in the Study Area or using other MasteringA&P resources.

## Conclusion

Prior to requiring MasteringA&P homework, when I asked students what concepts they were struggling with they generally weren't able to tell me. Now that students complete required homework, both they and I can identify any concepts they don't clearly understand. Students are more likely to ask questions about what they don't know, and I am able to reinforce during class time those concepts that I've identified via the gradebook diagnostics as troublesome. Students' study efforts are more focused and, as a result, they're achieving more success in both Anatomy & Physiology I and II.

*Submitted by Amy Ryan  
Clinton Community College*

Product Name MasteringA&P

Course Name Human Anatomy & Physiology II

Credit Hours Four (lecture and lab)

### Key Results

Grade data indicate that use of MasteringA&P enhances student pass rates and improves student retention. Student feedback and faculty observations also suggest that MasteringA&P helps students better prepare for both lecture and lab and more fully engage in the curriculum.

### Text

*Human Anatomy and Physiology*, 9e, Elaine N. Marieb and Katja Hoehn

### Implementation

Human Anatomy and Physiology II (A&P II) is a mandatory pre-requisite for allied health majors, to include nursing students. It is a continuation of A&P I; students must earn a C or higher in A&P I to take A&P II. The course is a combined lecture-lab curriculum that reviews the cardiovascular system; the lymphatic system and immunity; the respiratory system; the digestive system and metabolism; the urinary system; fluid/electrolyte and acid/base balance; and reproductive systems.

I adopted MasteringA&P to enhance opportunities for critical thinking, improve student preparedness for lecture and lab, foster a more engaging laboratory experience, improve student success and retention, and facilitate a more efficient use of classroom time.

The curriculum is divided into four modules. Each module includes lecture and lab material, a homework assignment, laboratory quizzes, and a module exam. Lab quizzes and homework are delivered via MasteringA&P. Students are encouraged to research homework answers and to work in groups; lab quizzes are a more rigorous, individual effort.

Redesigning my course using MasteringA&P enabled me to infuse three layers of pedagogical practices that foster higher-order cognitive development: (1) priming of the mind with basic knowledge before a higher order academic task is approached in lab or discussed in lecture, (2) providing timely formative feedback that allows for real time student redirection and addressing of misconceptions, and (3) creating in-class opportunities for reflection focused on areas in which students have the most difficulty.

These practices were delivered via the following:

- *MasteringA&P homework assignments for each module due one week before the exam.* Each assignment takes about 90 minutes to complete and contains reading, tutorial, and activity questions. I review the item difficulty graph from the gradebook diagnostics with students during class. This enables me to identify the most commonly missed items and address misconceptions *before* an exam.

*I tell all of my peers to make sure, or at least hope, that their teachers have this program in their classes.”*

—Student

- *A MasteringA&P pre-lab quiz due by the lab session.* Quizzes are timed and open a week before lab. Questions are scrambled and include Video Tutor and lab questions. As with the homework assignments, we spend about 10 minutes reviewing the gradebook diagnostics from the quizzes together. This shifts the lab experience from a “cookbook” session to a more integrated and reflective experience. Students enjoy the labs more now and so do I; they feel empowered to investigate not regurgitate.
- *A MasteringA&P postlab assessment with application-based questions.*

### Assessments

53 percent	Lecture exams
18 percent	MasteringA&P homework
11 percent	MasteringA&P pre-lab quizzes
9 percent	Lab reports
9 percent	Cumulative, lab final exam

*“I wish MasteringA&P had been developed sooner. The practice tests and study tools it provides would have really helped me grasp A&P I.”*

—Student

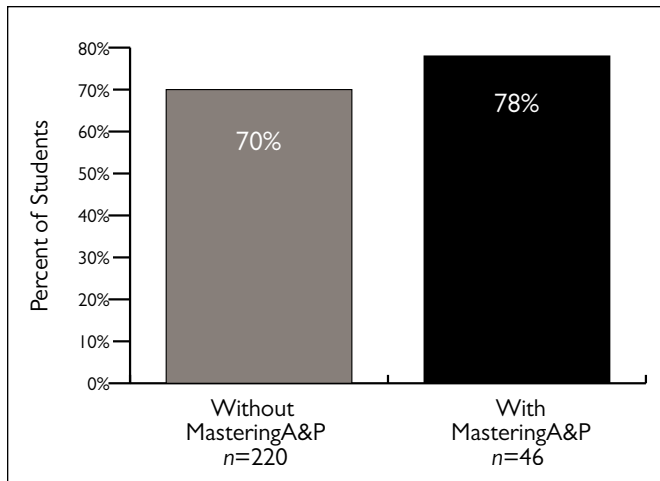


Figure 1. Average Student Success Rate (A/B/C) with and without the Use of MasteringA&P

## Results and Data

After implementing MasteringA&P, the student success rate (A/B/C) increased (figure 1). Note that homework and quizzes were always part of the course grades, so implementing MasteringA&P did not lead to grade inflation.

There was also a positive change in student retention. When MasteringA&P was implemented, the withdrawal rate fell from 6.8 percent to 6.5 percent—a 4.4 percent difference. At Florida State College, faculty can issue a failure-for-nonattendance grade (FN). My policy is that students with more than three absences earn an FN grade. After implementing MasteringA&P, the course FN rate fell from 5 percent to 4.3 percent (a 14 percent difference).

## The Student Experience

Student feedback for MasteringA&P has been overwhelmingly positive. In a spring 2013 survey, the majority of student respondents believed that assignments in MasteringA&P helped them to prepare for class, lab, and exams.

Responses to the spring survey also revealed the following:

- 100 percent of respondents agreed or strongly agreed that MasteringA&P helped them to think critically.

- 100 percent of respondents agreed or strongly agreed that MasteringA&P pushed them to prepare for both class and exams.
- 82 percent of respondents agreed or strongly agreed that MasteringA&P helped them to better prepare for lab.
- 82 percent of respondents agreed or strongly agreed that knowing they had a post-lab assignment pushed them to work to understand the lab.

Student comments about MasteringA&P included:

“I loved using MasteringA&P. It helped me in this class and in other classes, too. I tell all of my peers to make sure, or at least hope, that their teachers have this program in their classes.”

“I liked all of the study tools in MasteringA&P. Plus, it’s a great way to study, participate in practice/real quizzes, and keep track of my grades.”

## Conclusion

As instructors, we often ask ourselves what more we can do to help students learn. Sometimes the best answer is to make students do more on their own. MasteringA&P offers students multiple opportunities to understand course material and because feedback on homework is instantaneous, students can determine exactly what concepts they need help on earlier than when I hand-graded homework.

Students come to class more prepared and thereby are more able to focus on higher-order material. The enhanced student preparedness and engagement also frees class time so that my teaching time centers more on practicing the kind of critical-thinking skills that will help my students achieve their long-term goals.

In addition, the student learning outcome data gathered in MasteringA&P help me improve my craft as a teacher. By continually evaluating course results and student attainment of learning outcomes, I engage in a cycle of reflection and improvement that ensures that I’m meeting my course learning objectives.

*Submitted by Lourdes Norman-McKay, Ph.D.  
Florida State College at Jacksonville*

Product Name [MasteringA&P](#)

Course Name [Anatomy and Physiology I and II](#)

Credit Hours [Four](#)

**Key Results** Redesigning this course with MasteringA&P provided the resources and flexibility needed to more fully engage students and help improve student learning and success.

## Text

*Human Anatomy & Physiology, 8e*, Elaine N. Marieb and Katja Hoehn

## Implementation

Anatomy and Physiology I and II is a two-course sequence that studies the structures and functions of the human body. The nursing program requires successful completion of both courses as do some allied health majors.

In fall 2010, to accommodate physical space limitations and as a convenience for students in the four-county area, our Biology department decided to offer a hybrid option of Anatomy and Physiology I. The course requires three hours of lecture and three hours of lab each week. Hybrid sections meet for a three hour lab each week on campus and students are expected to work independently online for the remaining three hours. Both the traditional and hybrid sections cover the same topics and take the same paper-and-pencil exams.

In spring 2012, I developed and taught the first hybrid section of A&P II. I adopted MasteringA&P for the hybrid sections to help engage and teach students who don't meet face-to-face. Based on positive student feedback, the ability to customize material, and the extent of digital resources available in MasteringA&P, the department elected to make MasteringA&P available beginning in fall 2012 in all traditional and hybrid sections of both A&P I and II.

For both hybrid and traditional sections, I give one untimed MasteringA&P homework assignment per chapter using tutorials, PhysioX, and other activity questions; and one timed 15-minute MasteringA&P quiz per chapter using primarily end-of-chapter questions. I use the gradebook diagnostics throughout the semester to monitor student progress, identify struggling students, and understand common misconceptions that need to be addressed.

During the first class of each semester, the department holds an orientation for students in hybrid sections and conveys our expectations and the need for self-motivation in order to succeed in the hybrid format. In addition, I include the following digital content in my hybrid sections:

- Voice-over lecture PowerPoints broken down into five- to ten-minute segments in order to best address student engagement and time constraints
- Additional MasteringA&P tutorial questions added to the homework assignments
- Case studies
- Online discussions conducted via Blackboard

I make as many resources as possible available for mobile devices. I also build time into my evenings and weekends to check e-mail and address student questions. Students know I'm not available 24/7, but being flexible enables me to help students continue to move forward in the learning process.

Using MasteringA&P in my traditional sections enables me to free up class time for more real-time teaching, including working through problems on the white board and facilitating peer-to-peer learning via group activities.

Each semester since implementing MasteringA&P, I've evaluated my course results and continued to make changes to the course design.

## Assessments

40 percent	Exams (up to six)
40 percent	Lab exams (five)
10 percent	MasteringA&P homework
10 percent	MasteringA&P quizzes

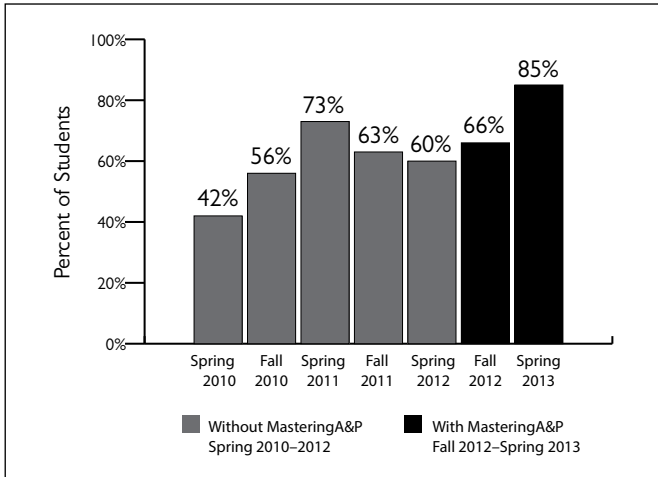


Figure 1. A&P I Hybrid Success Rates (A/B/C) with and without MasteringA&P, Spring 2010–Spring 2013 (Spring 2010  $n=19$ , Fall 2010  $n=18$ , Spring 2011  $n=23$ , Fall 2011  $n=35$ , Spring 2012  $n=20$ , Fall 2012  $n=41$ , Spring 2013  $n=20$ )

## Results and Data

I evaluated success rates (A/B/C) for both my traditional and hybrid A&P I sections and found that success rates in traditional sections using MasteringA&P were higher than in the two prior semesters without MasteringA&P. Hybrid success rates also increased: I saw a 12 percentage point increase in the second semester MasteringA&P was in use over the highest previous semester without MasteringA&P (figure 1).

I have no data to compare student success rates for the A&P II hybrid sections, since the course was developed using MasteringA&P. I've taught one seated section of A&P II with MasteringA&P, for which I saw a slight decrease in student success rates. I will continue to evaluate those results.

Using spring 2013 data, I examined the correlation between MasteringA&P scores and exam grades for those students who completed all exams and I found a strong correlation in both A&P I and II (figures 2 and 3):

- Hybrid A&P I students who earned final course grades of A averaged 95 percent on MasteringA&P homework.
- Traditional A&P II students who earned final course grades of A averaged 93 percent on MasteringA&P homework; hybrid A&P II students who earned As averaged 96 percent on MasteringA&P homework.
- Students who received final course grades of F in the hybrid section of A&P I averaged 41.8 percent on MasteringA&P homework.
- Students who received final course grades of F in the traditional section of A&P II averaged 54 percent on MasteringA&P homework.

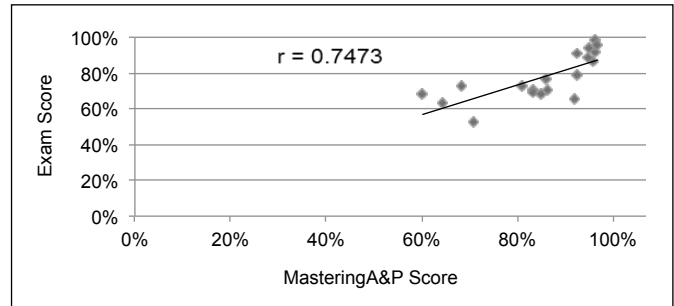


Figure 2. Correlation of MasteringA&P Homework Score to Final Exam Score, Anatomy and Physiology I Hybrid, Spring 2013 ( $n=20$ )

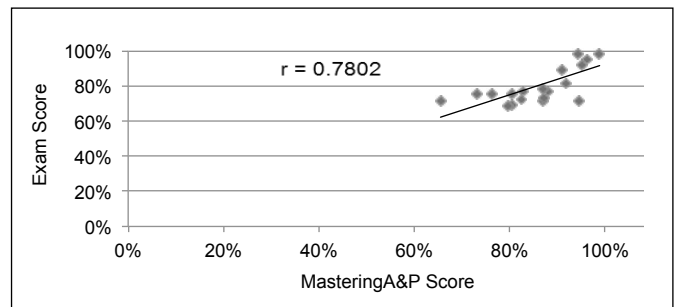


Figure 3. Correlation of MasteringA&P Homework Score to Final Exam Score, Anatomy and Physiology II Hybrid, Spring 2013 ( $n=21$ )

## The Student Experience

After piloting MasteringA&P in spring 2012, I asked students for feedback on their MasteringA&P experience. The majority of students gave positive feedback—they particularly liked the animations, which helped them visualize processes and concepts. They also liked the repetition and the opportunity for extra practice. The student feedback was a major factor in the department's decision to adopt MasteringA&P for both traditional and hybrid sections.

## Conclusion

MasteringA&P is an important component of our redesigned A&P courses—it provides digital resources to help students learn outside the classroom, it enables us to customize course content, and it has freed classroom time for more interactive learning. Course redesign is an ongoing process. By evaluating what I do each semester and making adjustments accordingly, I can continue to provide a learning environment that most effectively enhances student engagement and increases learning outcomes.

*Submitted by Gary Glaser  
Genesee Community College*

Product Name **MasteringA&P**

Course Names **Anatomy and Physiology I and II**

Credit Hours **Four (each)**

**Key Results** Adding prelecture MasteringA&P assignments facilitated increased student preparedness and engagement and enabled more time for interactive learning. As a result, final course grades of A and B significantly increased.

## Text

*Human Anatomy and Physiology, 9e*, Elaine Marieb and Katja Hoehn

## About the Course

Anatomy and Physiology I and II is a two-course sequence that provides students with an in-depth understanding of the principles of anatomy and physiology. The courses are primarily taken by health science majors, and A&P I is a prerequisite for several other programs. Those students must complete A&P I and II with a grade of C or higher to progress in their programs.

## Course Redesign

Our school serves many nontraditional students. The goal of the course redesign was to address the issue of underprepared students and to provide a resource for remediation outside the classroom.

We implemented the Supplemental model developed by the National Center for Academic Transformation. This model retains the basic structure of the traditional course and supplements lectures and textbooks with technology-based, out-of-class activities, or changes what goes on in the classroom by creating an active learning environment within a large, lecture hall setting. From our experience in this departmentwide redesign, we identified the following best practices:

- Involve faculty as part of the planning team.
- Communicate redesign goals and keep faculty communication channels open.
- Set a timeline and include benchmarks to ensure the process continues to move forward.
- Provide students with start-up guidance, information for technical support, and an explanation of the value of Mastering.
- Reinforce the value of doing assignments before lecture.

## Implementation

Starting fall 2012, we implemented Mastering in Anatomy and Physiology I and II, General Biology I and II, General Chemistry I and II, and Microbiology. We added Mastering to Introductory Physics in spring 2013.

Instructors are required to assign prelecture homework, but have flexibility with regards to the assigned content. The majority of instructors give weekly Mastering assignments that include both tutorial and end-of-chapter questions.

Instructors report that the automated grading in Mastering makes it easier to assign graded homework and to understand where students need help. Beginning spring 2013, we added student learning outcomes to our Mastering homework to (1) facilitate a better understanding of student course and program performance and (2) inform decisions on course changes.

## Assessments

50 percent	Lecture exams
15 percent	Final exam
15 percent	MasteringA&P homework
15 percent	Lab (participation, reports, practicals, exams)
5 percent	Other

## The Student Experience

Students like the opportunity to walk through content prior to lecture, are more engaged in learning, and are more prepared for class. In a fall 2012 student survey, students overwhelmingly reported that MasteringA&P was a beneficial component of the course. In addition, they would recommend MasteringA&P for courses in which it is available (table 2). Student comments included:

- “MasteringA&P helped bring my test grades up and taught me new things.”
- “It helped me see what I knew and what I needed to learn.”

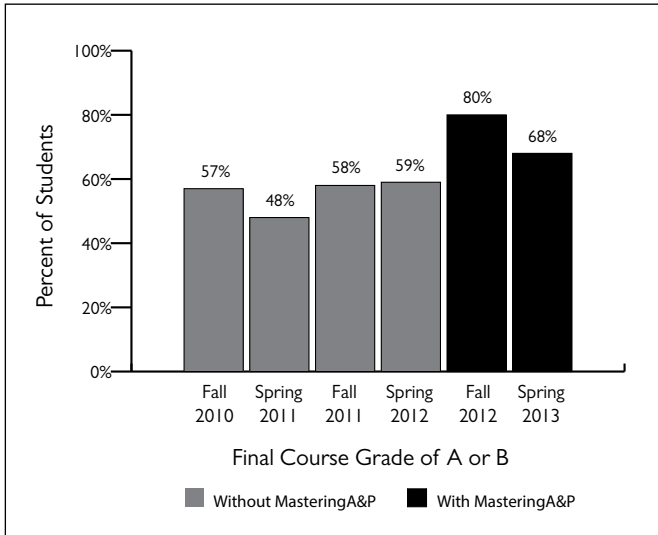


Figure 1. Anatomy and Physiology II Final Course Grades of A or B with and without MasteringA&P, Fall 2010–Spring 2013 (Fall 2010  $n=49$ , Spring 2011  $n=87$ , Fall 2011  $n=64$ , Spring 2012  $n=73$ , Fall 2012  $n=48$ , Spring 2013  $n=114$ )

Final Course Grade	Average MasteringA&P Homework Score	
	Anatomy and Physiology I	Anatomy and Physiology II
A	90%	90%
B	81%	85%
C	72%	80%
D	71%	NA
F	35%	17%

Table 1. Correlation between Final Course Grade and Average MasteringA&P Homework Score, Fall 2012

Questions	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
My understanding of the course material increased as a result of using Mastering.	24%	57%	13%	2%	4%
Use of Mastering positively impacted my exam scores.	19%	49%	25%	4%	3%
I would recommend use of Mastering in courses for which it is available.	32%	48%	13%	3%	4%

Table 2. Anatomy and Physiology I & II Student Survey Results, Fall 2012 ( $n=192$ )

## Results and Data

Data from Anatomy and Physiology I and II indicate that for students who successfully complete A&P I, the A/B rate in A&P II for the semesters using MasteringA&P is significantly higher than the rate for prior semesters not using MasteringA&P:

- For A&P I, the number of As increased four percentage points from spring 2012 (without MasteringA&P) to spring 2013 (with MasteringA&P).
- For A&P II, there was a 21 and 9 percentage point increase respectively for As and Bs during the two semesters in which MasteringA&P was used over the highest reported semester not using MasteringA&P (figure 1).
- Students who earned an A in A&P I or A&P II in fall 2012 averaged 90 percent on their MasteringA&P homework (table 1).

- Students who earned an F in A&P I or A&P II in fall 2012 averaged 35 percent and 17 percent respectively on their MasteringA&P homework (table 1).

## Conclusion

We redesigned our science courses adding Mastering to provide students with a tool to help them prepare for class and get help when they need it the most. Prelecture homework assignments engage students in course content outside of class and better prepare them for lecture. This in turn enables us to increase the amount of interactive learning and critical thinking activities during class.

*Submitted by Louis McIntyre, Science Department Chair  
Robeson Community College*



Product Name **MasteringA&P**

Course Name **Anatomy and Physiology I and II**

Credit Hours **Four**

**Key Results** After implementing MasteringA&P, more students earned As and Bs and fewer students withdrew from the course.

## Text

Visual Anatomy and Physiology, 1e, Frederic H. Martini, William C. Ober, and Judi L. Nath

## Implementation

Anatomy and Physiology (A&P) I is a study of basic biological chemistry, cellular structure and function, histology, and integumentary, skeletal, and nervous systems. A&P II is a study of the anatomy and physiology of the muscular, circulatory, immune, respiratory, digestive, excretory, endocrine and reproductive systems. Both courses are prerequisites for admission to all allied health programs except one, and the grades achieved in these courses are often used as a predictor for student success for admission to those programs.

Because of the importance of these courses, it is critical that students succeed in the course. Over the years, I became increasingly frustrated with students who did not read the textbook and then struggled in class. I implemented MasteringA&P in 2011 because the program enabled me to assign prelecture homework and thereby better monitor student reading and comprehension of the material.

Required homework consists of end-of-chapter questions and tutorials. I use the Gradebook's diagnostics to better understand where students are struggling. Also, I add my own essay review questions to the MasteringA&P homework in order to mirror questions on the exams. I develop complex content questions that cover multiple modules and promote critical thinking skills. Finally, I give feedback on the written homework questions before the exam review period to help students identify those concepts they need to study.

*After my first semester using MasteringA&P, the results showed an increase in the number of students earning an A or B in the course and higher lecture averages. More recent analysis shows that the trend of increased As and Bs continued in subsequent semesters for both A&P I and II.*

To better assist students who need help, I spend office hours in the learning center. I find that more students will meet with me in the learning center than in my office. In addition, I allow students to print assignments after the due date so they can use them as study tools—students often bring the printed assignments when they meet with me to reference specific items.

## Assessments

70 percent    Lecture  
*Five exams (83 percent), MasteringA&P (17 percent)*

30 percent    Lab



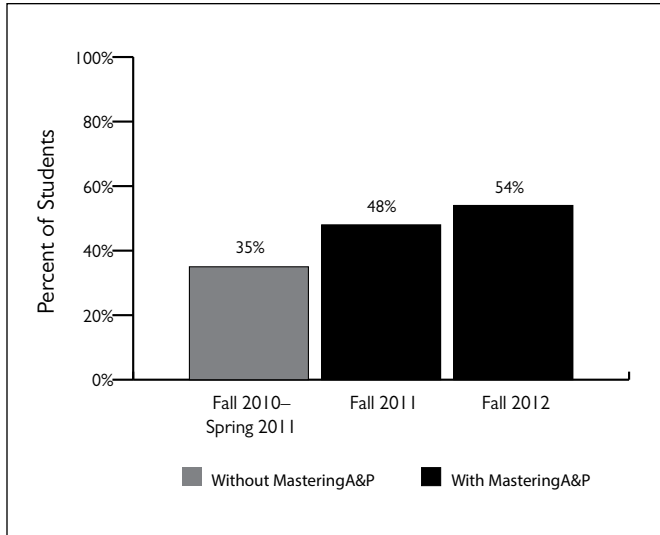


Figure 1. Anatomy & Physiology I A/B Rates with and without MasteringA&P, Fall 2010–Fall 2012 (Fall 2010–Spring 2011 n= 114, Fall 2011 n=25, Fall 2012 n=26)

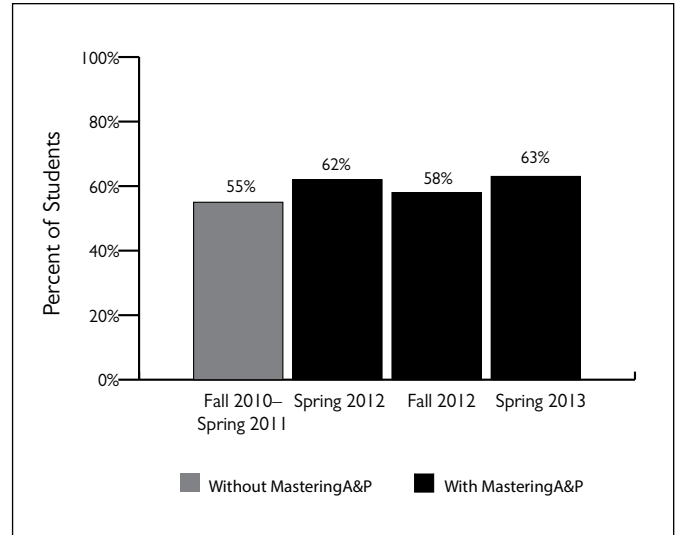


Figure 2. Anatomy & Physiology II A/B Rates with and without MasteringA&P, Fall 2010–Spring 2013 (Fall 2010–Spring 2011 n=50, Spring 2012 n=29, Fall 2012 n=24, Spring 2013 n=30)

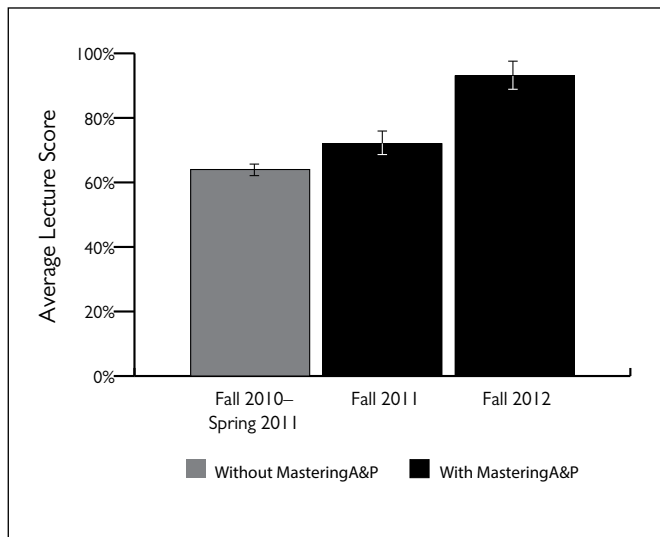


Figure 1. Anatomy & Physiology I Average Lecture Score with and without MasteringA&P, Fall 2010–Fall 2012

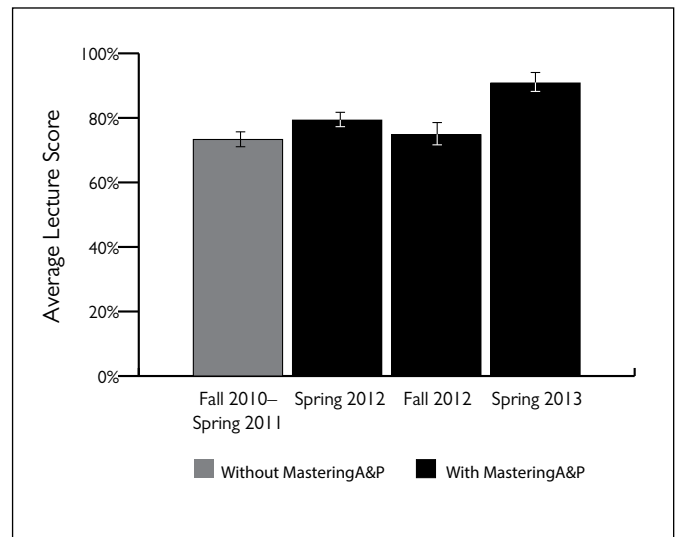


Figure 1. Anatomy & Physiology II Average Lecture Score with and without MasteringA&P, Fall 2010–Spring 2013

## Results and Data

After my first semester using MasteringA&P, the results showed an increase in the number of students earning an A or B in the course and higher lecture averages. More recent analysis shows that the trend of increased As and Bs continued in subsequent semesters for both A&P I and II (figures 1 and 2).

My initial analysis also showed significantly higher lecture grade averages (all exam scores and the MasteringA&P score, equal to one exam grade). I continue to see higher results for the lecture average for both A&P I and II (figures 3 and 4).

*continued next page*

In addition, I found the following:

- In A&P I, the withdraw rate dropped from 16 percent to 11 percent and 10 percent respectively in fall 2011 and fall 2012.
- In fall 2012, 79 percent of students earning an A or B in A&P I scored 80 percent or higher on their MasteringA&P homework. The average MasteringA&P score for all students earning an A or B in the course was 84 percent.
- In A&P II, 86 percent and 95 percent of students earning an A or B in the course scored 80 percent or higher on their MasteringA&P homework in fall 2012 and spring 2013 respectively. The average MasteringA&P score for all students earning an A or B in the course during those semesters was 87 percent and 92 percent respectively.

### The Student Experience

I have been teaching for 39 years. In my experience, students often will not ask for help when they need it, usually because they don't know where they need it or are too embarrassed to ask for help. From the start, I saw that MasteringA&P helped students understand what they were struggling with and that working in the program gave them the confidence to ask questions and get help. I continue to see this in students who ask about topics from their homework that they don't understand, both in class and during my office hours in the learning center.

*Because MasteringA&P provides feedback and hints, it helps students understand where to focus their efforts. The result is higher course scores and fewer student withdrawals.*

### Conclusion

MasteringA&P is a very useful tool that can help improve student learning, if a student uses it and uses it conscientiously. The burden for success is on the student and their effective use of Mastering's resources.

I find that the better I am at creating relevant assignments based on what I expect from the students, the better the students perform. Because MasteringA&P provides feedback and hints, it helps students understand where to focus their efforts. The result is higher course scores and fewer student withdrawals.

*Submitted by Bruce Fisher  
Roane State Community College*

Product Name **MasteringA&P**

Course Name **Anatomy and Physiology**

Credit Hours **Four**

**Key Results** Use of MasteringA&P's interactive features enhanced student enjoyment in the course and increased student understanding of course concepts. In addition, there was significant correlation between performance with the program and final course grades.

## Text

*Fundamentals of Anatomy and Physiology*, 8e, Frederic H. Martini and Judi L. Nath

## Implementation

Anatomy and Physiology is a traditional face-to-face course for first-year Sport and Exercise Science students. It comprises 36 hours of contact time over a 10-week period.

I introduced MasteringA&P in spring 2011 to encourage interactive online learning. I used the program as a visual, active-learning resource to complement the lectures. Students were encouraged to access the online tutorials, eBook, interactive activities, podcasts, animations, and self-study resources.

I also created three short, online assignments using multiple-choice questions from the MasteringA&P database. Assignments were required and contributed towards their cumulative grade. Students were informed of the dates to complete the online assessments and there was no time limit for completion. The assignments were automatically graded, and scores, completion time, and question difficulty were exported into an Excel document. The individual assignments took an hour on average to complete, although time spent online ranged from three minutes to more than three hours.

From January to June 2011, students had online access to all MasteringA&P resources, and assignments could be repeated for practice, but not regraded.

## Results and Data

- Aggregate scores of the three MasteringA&P assignments ranged from 23.3 to 91.1 percent.
- More than 80 percent of students completed the three MasteringA&P assignments with an average aggregate score of  $65.1\% \pm 14.2$ .

- There was a significant relationship between performance in the MasteringA&P multiple-choice questions and overall module grades achieved.

From the student perspective:

- 95.2 percent enjoyed completing the online assignments and found them "interesting and helpful."
- 92.1 percent said they would recommend MasteringA&P to a fellow student.
- 85.5 percent felt their understanding of the course material increased as a result of using MasteringA&P.
- 75 percent said they would prefer to learn this way in the future.
- 60.3 percent reported that they learned more through the online assignments than lectures alone.
- The most popular features were the Interactive Physiology option and postlecture quizzes.

## Conclusion

Use of MasteringA&P enhanced students' understanding of the topic and complemented my face-to-face lectures. Students consistently referred to the enjoyment they experienced from a more interactive, hands-on approach to learning.

From a facilitator's point of view, MasteringA&P was user-friendly, easy to manage, and comprehensible. Having access to a sizeable bank of questions ensured I could tailor the assessments to reflect the lecture content. It also provided an accessible-on-demand study tool for students and an alternative teaching and learning method that effectively accommodated different student learning needs.

*Submitted by Jo Barton  
University of Essex*

Product Name MasteringA&P

Course Name Anatomy and Physiology I

Credit Hours Four

### Key Results

Study results show that students who used MasteringA&P had higher mean test grades than students not using MasteringA&P. Those students with the highest GPAs demonstrated significant improvement in final grades using MasteringA&P.

### Text

*Human Anatomy and Physiology*, 9e, Elaine N. Marieb and Katja Hoehn

### Implementation

This is the first in a two-semester course sequence. It covers seven of the major organ systems that include the human integumentary, skeletal, muscular, circulatory, and respiratory structures and functions as related to health and movement. Students taking this course are primarily in the School of Health and Applied Human Sciences. The course includes a lecture and lab.

Our fall 2011 MasteringA&P pilot had students volunteering to use it. When we adopted MasteringA&P for the spring 2012 semester, we required its use for all students in A&P I. The results, documented in a case study published in 2013, showed that the percentage of F grades remained the same between the two groups, but there was a shift in the grade distribution such that the percentage of C and D grades decreased while the A and B grades increased.

We conducted a follow-up study analyzing course data by gender and GPA to better understand the impact of using MasteringA&P. We compared mean exam scores for students who did not use MasteringA&P in spring 2010, fall 2010, and spring 2011 ( $n=160$ ) to students who used MasteringA&P in spring 2012, fall 2012, and spring 2013 ( $n=147$ ).

### Assessments

62.5 percent Exams (five)

25.0 percent Lab

12.5 percent MasteringA&P homework

### Results and Data

For our study, which compared MasteringA&P homework scores and mean exam scores, we placed students into groups based on their incoming GPA (<2.81, 2.81-3.23, or > 3.23).

The analysis showed the following results:

- The highest GPA group (>3.23) demonstrated a significant ( $p<0.01$ ) improvement ( $80\pm6$  versus  $84\pm7$ ) in mean exam scores using MasteringA&P in the course (figure 1).
- Within MasteringA&P groups the highest and mid GPA groups had significantly higher MasteringA&P percent scores than the lower GPA group:  $90\pm5$ ,  $86\pm9$ , and  $80\pm13$ , respectively (figure 2).
- Females in the mid and high GPA groups using MasteringA&P had significantly ( $p<0.05$ ) higher mean exam scores ( $78\pm15$  and  $83\pm7$ , respectively) than those not using MasteringA&P ( $72\pm7$  and  $79\pm6$ , respectively).

### The Student Experience

Student feedback and results from a mandatory, end-of-course student survey support using MasteringA&P—students felt it helped to improve their mastery of course material (figure 3).

Students who participated in focus groups reported that the MasteringA&P content was helpful for learning the material and that it positively impacted their test scores.

*A further analysis of MasteringA&P course results indicated that students who used MasteringA&P had higher mean exam scores than students who did not use MasteringA&P.*

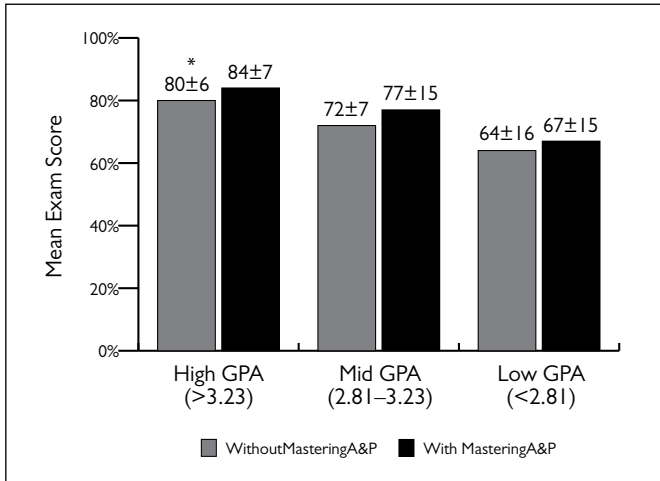


Figure 1. ANOVA Comparison of Students Using MasteringA&P and Students Not Using MasteringA&P by Grade Point Average (GPA) (\*p<0.01, Mean± standard deviation)(High GPA, w/o MA&P n=57, w/MA&P n=46; Mid GPA, w/o MA&P n=55, w/MA&P n=49; Low GPA, w/o MA&P n=48, w/MA&P n=52)

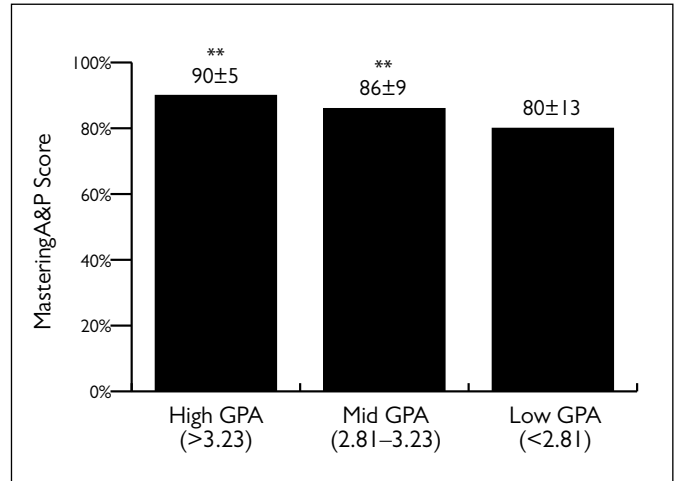


Figure 2. Comparison of MasteringA&P Score Based on Grade Point Average (GPA) (\*\*p<0.01=Significantly different from low GPA, Mean±standard deviation)

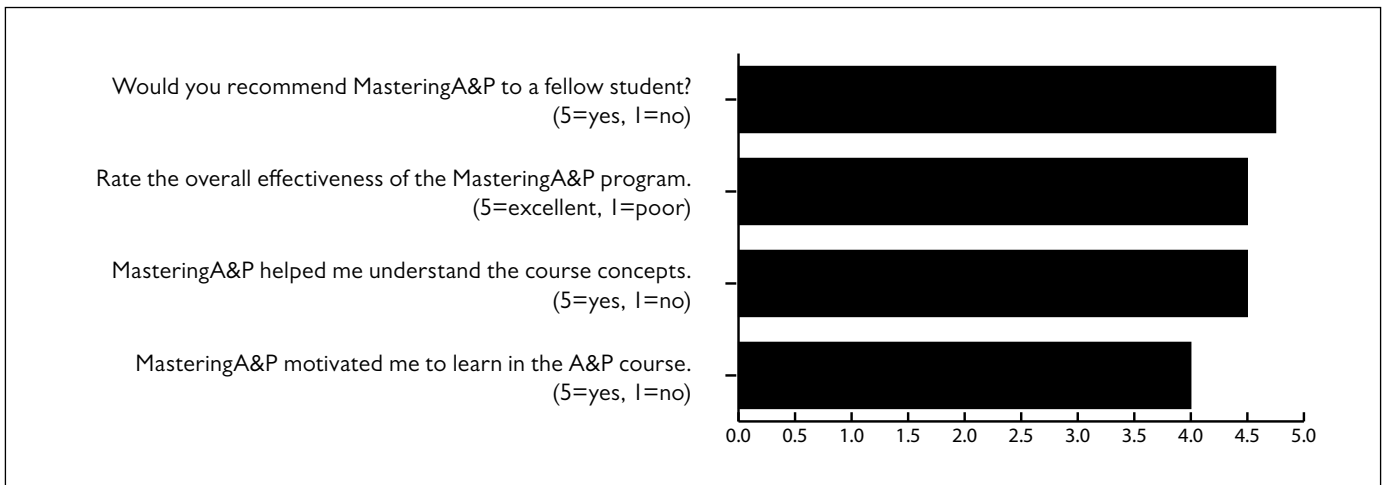


Figure 3. Student Survey Results (n=143)

### Conclusion

Further analysis of MasteringA&P course results indicate that students who used MasteringA&P had higher mean exam scores than students who did not use MasteringA&P. Students in the group with the highest GPAs benefitted the most from using MasteringA&P based on the increase in mean exam scores.

*Submitted by Robert Boyce, PhD, and Ariana Lipp  
University of North Carolina at Wilmington*

Product Name **MasteringA&P**  
 Course Name **Anatomy and Physiology I and II**  
 Credit Hours **Three (each)**

**Key Results** Adoption of MasteringA&P increased student engagement in course content outside of the lecture and the lab, students came to class better prepared, and they scored substantially higher on comprehensive final exams.

**Text**

*Human Anatomy and Physiology, 8e*, Elaine N. Marieb and Katja Hoehn

**Implementation**

This two-course sequence is a study of the structure and function of the human body. Traditional face-to-face and online sections are offered. The majority of students taking these courses are nursing or allied health majors, who are required to take both A&P I and II for completion of their program. A small percent of students will transfer to a four-year institution. The online students who used MasteringA&P during this study were part of the college’s online course program, versus an online degree program. There are lower enrollments in A&P II due to some students not passing A&P I, and others switching majors.

The department realized that many students were struggling in these courses, so we looked at the issues that were impacting student success—including poor time management, a lack of study skills, no course prerequisites, and an increase in non-traditional students who hadn’t been in a classroom in recent years. To address these needs, we redesigned the course with the goal of increasing students’ preparedness, exposure to and engagement with the course materials, and retention and student success.

My MasteringA&P assignments consist of prelecture homework of 15-25 questions for each chapter. I include activities and reading questions, but no testbank questions. These assignments are untimed, and students have two attempts to answer each question, but one attempt at the homework assignment overall. Assignments are designed to take approximately 30 minutes to complete. In addition, I assign a post-lecture, 10-question, 15-minute quiz for each chapter from a pool of testbank questions. Students have one attempt per quiz. Students may rework both homework assignments and quizzes for practice after their due dates.

I review the homework results and diagnostic charts in MasteringA&P prior to lecture so that I can spend time addressing any common misconceptions. Prior to the exam, I also spend class time reviewing any quiz questions that more than 40 percent of the class missed.

**Assessments**

- 60 percent Lecture tests (five)
- 20 percent Comprehensive final
- 20 percent Mastering A&P quizzes and homework

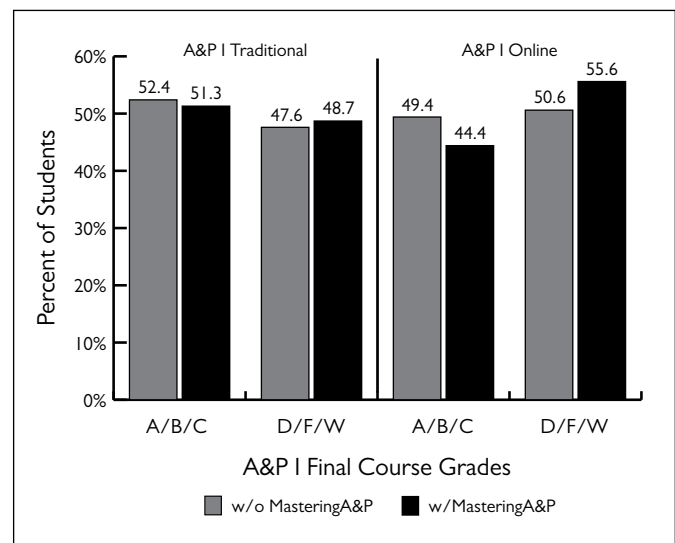


Figure 1. Anatomy and Physiology I Final Course Grades (Without MasteringA&P: A&P I n=759, A&P I Web n=85; both include fall 2010 and spring 2011. With MasteringA&P: A&P I n=876, A&P I Web n=63; both include fall 2011 and spring 2011.)

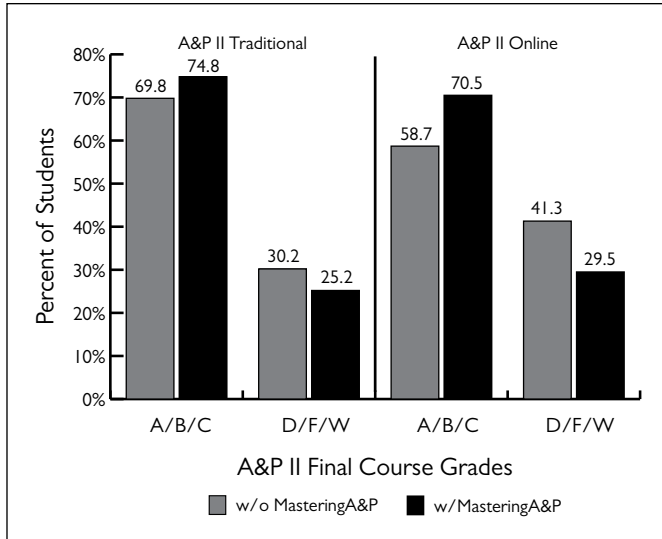


Figure 2. Anatomy and Physiology II Final Course Grades (Without MasteringA&P: A&P II n=427, A&P II Web n=63; both include fall 2010 and spring 2011. With MasteringA&P: A&P II n=473, A&P II Web n=44; both include fall 2011 and spring 2011.)

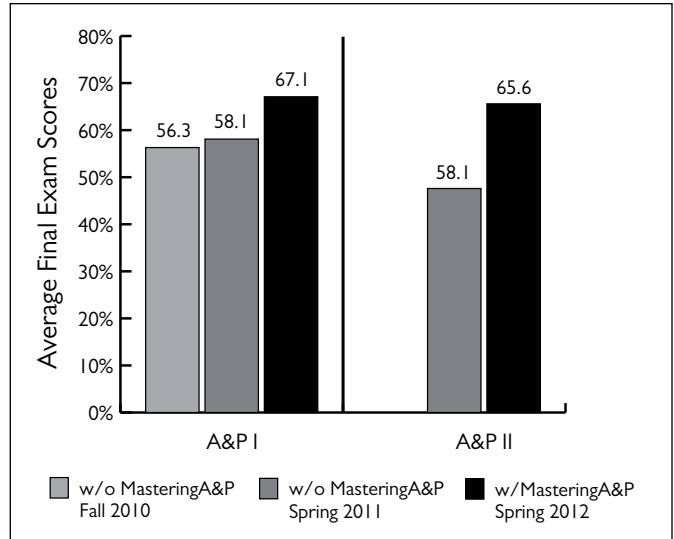


Figure 3. Average Divisionwide Final Exam Scores, Fall 2010–Spring 2012

## Results and Data

After my first semester using MasteringA&P in A&P I, I found that As, Bs, and Cs decreased, and Ds, Fs, and withdraws (D/F/W) increased. The results for A&P II showed the opposite—an increase in As, Bs, and Cs, and a decrease in the D/F/W rate (see figures 1 and 2).

I believe the results in A&P I are caused by multiple factors. Many of the students are freshmen and have poor time management and study skills. In addition, there are no prerequisites—many students may need to take (or may be taking) a developmental or remedial course in reading, math, and/or writing at the same time. With MasteringA&P, students need to fully understand the concepts—those who in the past edged into a higher grade by guessing may find they need to work harder to earn the higher grade. The higher grades in A&P II indicate that students who successfully complete A&P I do better in the more advanced course, likely because of an increased depth of knowledge and retention of the concepts.

I also looked at final exam results, as it is a comprehensive test that measures learning gains made throughout the semester. In both A&P I and II, students showed significant, positive increases in their final exam scores (see figure 3).

## The Student Experience

In student surveys, more than 50 percent of students report that MasteringA&P helped them improve their test grades, and that the program is an effective learning tool.

“Do you feel online homework/quizzes improved test grades?”

- 15% Significantly
- 45% Somewhat
- 22% Not at all
- 5% Actually decreased

“The online homework/quizzes...”

- 34% Were effective learning tools that improved my interest
- 24% Were effective, but too time consuming
- 17% Made studying more difficult because of the extra time required
- 10% Were time consuming and did not correlate well with course content

## Conclusion

After implementing the pre- and postlecture MasteringA&P assignments, students are coming to class more prepared and are more engaged in learning. They ask better questions and have a better understanding of what they don’t know. This means that class time can now be spent discussing more-challenging applications and concepts and giving students a better foundation to apply to future courses.

*Submitted by Abigail Goosie  
Walters State Community College*

Product Name **MasteringAstronomy**

Course Name **Astronomy 10: The Solar System, Astronomy 20: Stars and the Universe**

Credit Hours **Three (each)**

**Key Results** MasteringAstronomy provides a wide range of activities that cater to diverse learning styles. As a result, both online and on-campus students spend more time on class material and, most important, stay in class. Retention rates for both populations have increased an average of 10 percent.

## Text

*Essential Cosmic Perspective*, 5e, Jeffrey O. Bennett, Megan Donahue, Nicholas Schneider, Mark Voit

## Implementation

Both Astronomy 10 and Astronomy 20 are lecture/discussion courses with class sizes of approximately 50 students, and either held on campus in a planetarium or offered completely online with no required meetings. Neither have prerequisites, both qualify for general education credit in physical sciences, and both are typically taken in the first or second semester of a student's freshman year. Astronomy is one of the top two classes taken at Chabot College by nonmajors interested in transfer. Approximately 20–25 percent of students in the course also take remedial courses in mathematics and English, and a similar population of students are ESL students. Reading skills for some students are significantly limited.

Online homework assignments include a wide variety of MasteringAstronomy resources in an attempt to provide for our students' diverse learning styles. They're designed to last one hour or less, based on MasteringAstronomy's average student time statistics, and include ranking tasks, visual quizzes, tutorial problems, and animated tutorials. Assignments include five to eight questions, plus extra credit opportunities. The animated tutorials are typically allocated more credit as each takes between 10–15 minutes. I also include relevant media links in the assignments. Students are encouraged to suggest additional clips that they think may enhance the assigned questions. Students are not penalized for opening hints in the skill-building and self-paced tutorial questions, and they are given multiple chances at correct answers for every question.

Online reading quizzes for each chapter of our book are created from the available testbank questions and are offered with two chances at each question. Quizzes have 20–25 questions and are designed to take 30–45 minutes. All MasteringAstronomy

assignments are available 24/7, and have relatively gentle late penalties to encourage students to learn—even if they aren't able to complete the work by the deadlines.

Gradebook statistics for homework assignments are used in two ways.

1. I review the results on the day the assignment is due, and problems that have been missed most often, and/or reveal common misconceptions, are then clarified in lecture. I show the statistics to the students (without names) to reinforce that many in a class often make similar mistakes.
2. I use the results to modify the questions—add feedback, hints, or clarifying messages using MasteringAstronomy's editor—for assignment in subsequent semesters.

## Assessments

Students are graded on four elements: online homework, online reading quizzes for each chapter of the textbook, weekly participation discussion/research assignments, and two essay exams. The online homework and reading quizzes are required and administered with MasteringAstronomy.

## Results and Data

Since I've used MasteringAstronomy, I've increased both the length of online homework assignments and the breadth of questions selected for those assignments in response to students' comments that these resources help them learn. Students are definitely working harder, spending more time on their homework and on the quizzes, in addition to the weekly discussion topics. Before using MasteringAstronomy, I used class time for reading quizzes in the on-campus classes, had shorter homework assignments, and assigned animated tutorials on an "all or nothing" credit basis. Now, I have more time for lecture and discussion, have the students doing even more work engaging in key concepts, and have a better sense of what



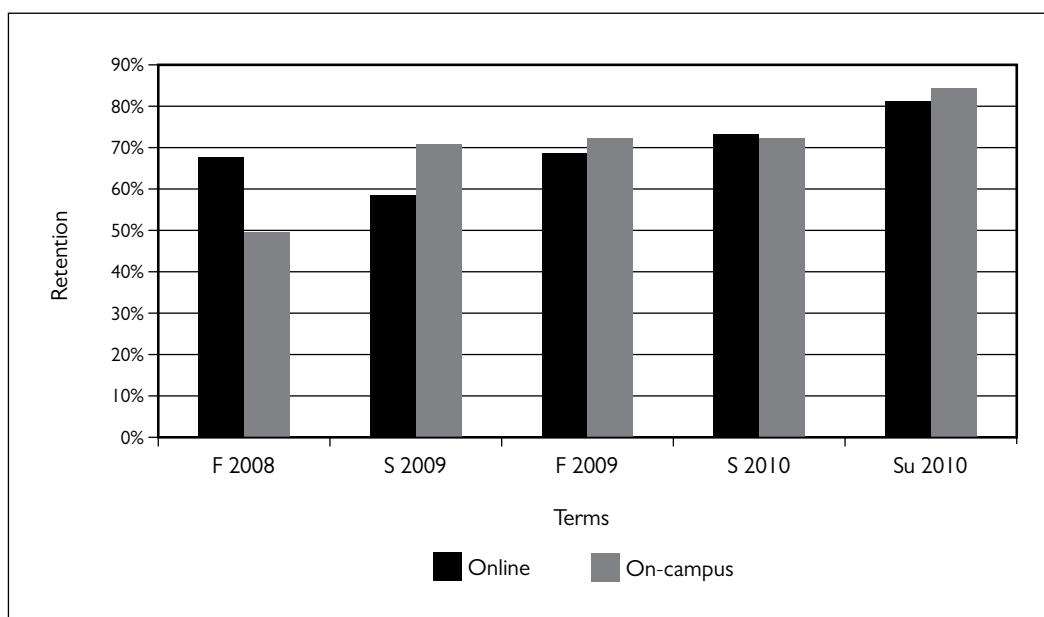


Figure 1. Average Astronomy 10 and Astronomy 20 Online and On-campus Retention Rates, Fall 2008–Summer 2010

they still don't understand through analysis of the program's statistics. Course completion rates (retention rates) in both my online and on-campus classes have increased approximately 10 percent (see figure 1).

### The Student Experience

- *“Fun! These interactive tutorials are very helpful.”*
- *“The tutorials are interesting and I like doing them. I would rather do them than just read and study the book. They add another level to learning Astronomy and I think they are something that should continue to be used.”*
- *“The explanations after solving each question are very useful!”*
- *“The hints are very useful [to coach me] step-by-step [on] how to approach [problems] and help guide me to get the correct answer.”*

### Conclusion

Students in both on-campus and online classes report that the animated tutorials tracked and scored in MasteringAstronomy are the single most effective media resources they use in the class, and that they like those resources even more than they do lectures. Students say that they routinely share the tutorials with friends and family members as they complete the weekly discussion assignments.

Students also report that having two attempts at quiz-question answers helps them to focus on learning by removing much of the stress of a traditional on-campus quiz. They spend time on the quizzes (averaging about 40–50 minutes based on MasteringAstronomy's usage statistics), undoubtedly in open-book mode searching for answers.

Any learning tool that students use and appreciate, that engages them in science outside of the classroom, and that provides me with one-click insight into their learning and misconceptions is a tool I'll continue to use.

*Submitted by Scott Hildreth  
Chabot College*

Product Name MasteringBiology

Course Name Biological Principles

Credit Hours Four

**Key Results** In a study conducted over two semesters, students who used MasteringBiology consistently outperformed students who were not using MasteringBiology.

## Text

*Biology*, 8e, Neil A. Campbell and Jane B. Reece

## Implementation

Georgia Institute of Technology offers two sections of Biological Principles each fall. Both sections comprise approximately 185 students, are cotaught by the same team of instructors, use the same syllabus, and use identical exams. Course content is organized into five modules: Evolution, Ecology, Metabolism, Genetics, and Molecular Medicine. The first four modules conclude with a one-hour exam. We use a mix of interactive tutorials, activities, and test bank questions for homework assignments.

In fall 2009, we conducted a study to test the effects of various interventions and learning enhancements. We repeated the study in fall 2010 and received nearly identical results.

For the study, students in both sections of Biological Principles were assigned MasteringBiology homework worth a total of up to five percent of their course grades. Students in the first section were assigned MasteringBiology homework for modules 1 and 3; students in the second section were assigned MasteringBiology homework for modules 2 and 4. At the end of the semester, we compared the mean exam scores of each section to determine whether the section with MasteringBiology assignments for a given module outperformed the section not given MasteringBiology assignments.

## Assessments

40 percent	In-class exams
25 percent	Final exam
25 percent	Laboratory
10 percent	Group activities
5 percent	MasteringBiology (extra credit)

## Results and Data

There was no significant difference in overall midterm exam score averages between the two fall 2009 sections ( $p = 0.248$ ). However the section that was assigned MasteringBiology homework consistently outperformed the section that was not assigned MasteringBiology homework in each of the four modules. This outperformance resulted in a small (2.65 points per module), but significant effect of MasteringBiology assignments on mean exam scores ( $p < 0.001$ ). See figures 1 and 2.

Repeating the experiment in fall 2010 yielded similar results. See figures 3 and 4.

## The Student Experience

In a fall 2009 survey ( $n = 232$ ), 90 percent of the students surveyed reported that MasteringBiology “increased my understanding of the course material.” Furthermore, 84 percent of the students surveyed reported that “MasteringBiology positively impacted my exam scores,” and that they “would recommend it to other students taking this course.”

Student comments included the following:

- “I wish every class had this type of study aid.”
- “[MasteringBiology] provided sound reinforcement to concepts out of the book and set up a good base for me to understand deeper concepts in lecture.”
- “MasteringBiology provided the tools I needed to get a better grasp on more-difficult concepts. I could actually see the processes happening in videos and activities.”

*“We adopted MasteringBiology as a way to engage students and motivate them to work harder. One of the benefits that we most appreciated was the program’s ability to automatically grade homework and provide instant feedback.”*

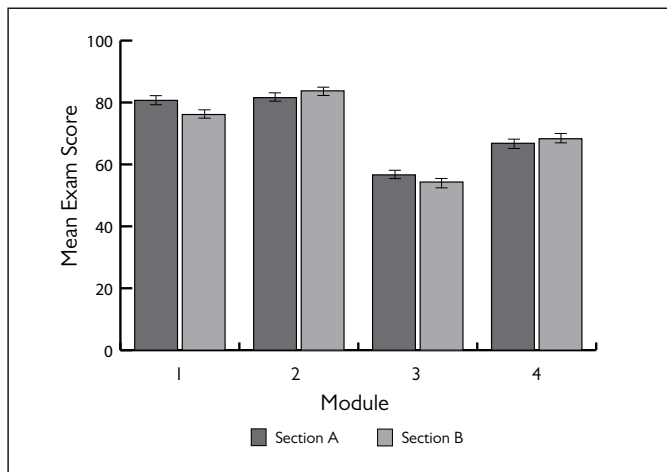


Figure 1. Midterm Exam Scores by Section, Fall 2009

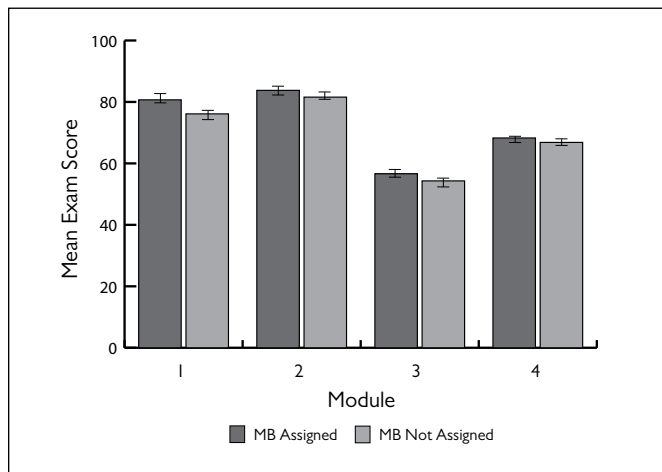


Figure 2. Midterm Exam Scores by Product Use, Fall 2009

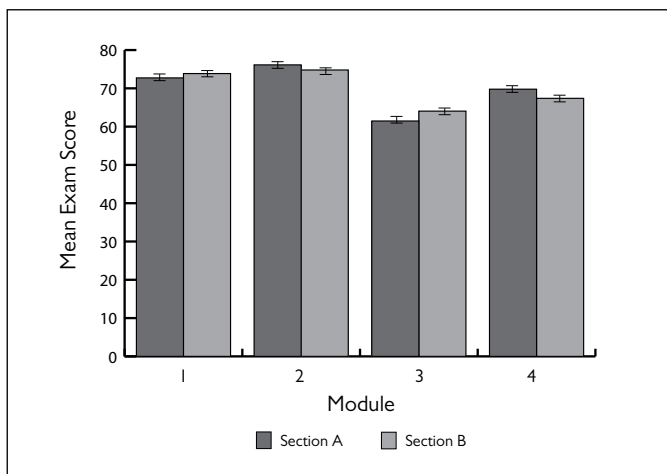


Figure 3. Midterm Exam Scores by Section, Fall 2010

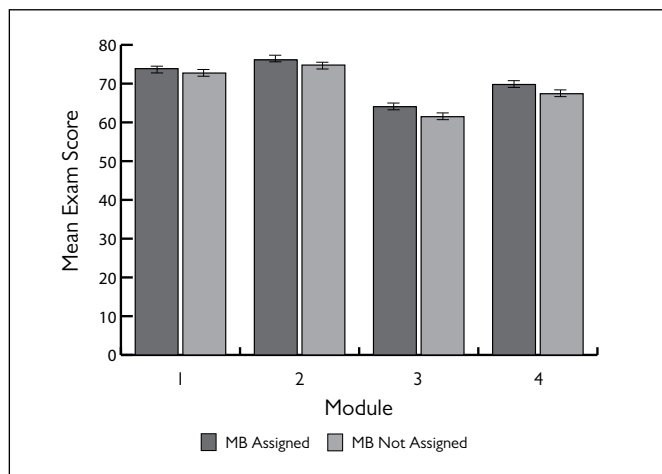


Figure 4. Midterm Exam Scores by Product Use, Fall 2010

## Conclusion

We have fully integrated MasteringBiology into the Biological Principles course beginning with the fall 2011 semester. We’ve adopted a “flipped” classroom model, which motivates students to engage in the content outside of the classroom, thereby enabling richer discussion and activities during class time.

*Submitted by Jung Choi, Tonya Shearer, and David Garton  
Georgia Institute of Technology*

Product Name **MasteringBiology**  
 Course Name **General Biology I**  
 Credit Hours **Four**

**Key Results** Since implementing MasteringBiology, success rates are higher—and have remained higher—and more students are earning final course grades of A.

### Text

*Campbell Biology, 9e*, Jane B. Reece, Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Robert B. Jackson

### Implementation

General Biology I is designed for science majors and includes both a lecture and lab. The course covers the scientific method, cellular and molecular biology, biochemistry, classical and human genetics, virology, and mechanisms of evolution. It is a transfer course, so nonscience majors may also take it. Only about 20 percent of students taking the course are biology majors.

I adopted MasteringBiology in fall 2010 to address the issue of underprepared students. These students' time management skills are poor, and many do not understand how to succeed in a college-level course

While working with students during office hours, I show them how to use MasteringBiology to more efficiently study. For example, I explain how the flashcard tool can be used to create a personalized set of flashcards, thereby saving them time and enabling them to better focus their studying efforts. I also show them how they can download the mp3 tutors so they can listen to a biology lesson on their way to work or in the gym.

My MasteringBiology assignments start with tutorials and coaching activities to get students engaged, and end with multiple-choice questions. They are untimed and some assignments cover multiple chapters.

### Assessments

52 percent	Exams (four, drop the lowest score)
48 percent	MasteringBiology homework

### The Student Experience

Students like MasteringBiology mostly because they can review past homework assignments in preparation for the exam. I show the Bioflix® in class, which really helps to support the lecture content, and students appreciate the opportunity to watch those videos again on their own time.

In addition, the tutorials and feedback in MasteringBiology help students identify and remediate the concepts they don't understand, thereby allowing them to learn when it's convenient for them.

One student reported the following on an end-of-semester survey: "I really like the MasteringBiology site. I think it's a great tool. The study area is awesome. I actually watch those videos to create a mental picture of all the concepts I have to know."

*“MasteringBiology makes it easy to assess student mastery. As a result, I can more accurately determine what to focus on during lecture.”*

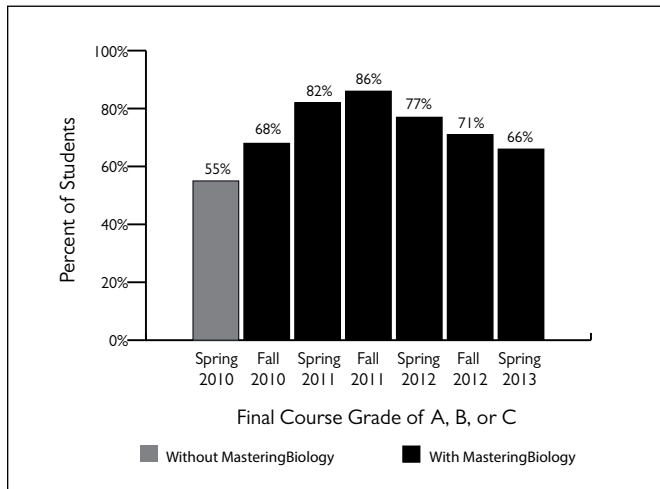


Figure 1. General Biology I Success Rates before and after Implementation of MasteringBiology, Spring 2010–13 (Spring 2010,  $n=119$ ; Fall 2010,  $n=85$ ; Spring 2011,  $n=60$ ; Fall 2011,  $n=58$ ; Spring 2012,  $n=60$ ; Fall 2012,  $n=59$ ; Spring 2013,  $n=59$ )

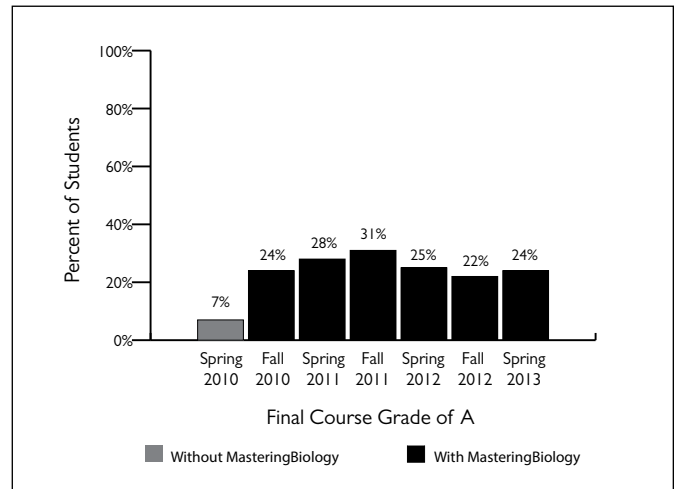


Figure 2. General Biology I Final Course Grade of A before and after Implementation of MasteringBiology, Spring 2010–13 (Spring 2010,  $n=119$ ; Fall 2010,  $n=85$ ; Spring 2011,  $n=60$ ; Fall 2011,  $n=58$ ; Spring 2012,  $n=60$ ; Fall 2012,  $n=59$ ; Spring 2013,  $n=59$ )

## Results and Data

Course results show that since implementing MasteringBiology in fall 2010, success (A/B/C) rates have consistently been higher (figure 1). In addition, the number of students earning an A in the course has significantly increased (figure 2), which indicates that students have a better understanding of the content, something that will help them in future science courses.

## Conclusion

MasteringBiology is a great tool—because it helps students engage in course material outside of the classroom, they can grasp the basic concepts on their own. This enables me to do higher-level interactive learning in the classroom and lab, thereby helping students develop a deeper conceptual understanding of the content. In addition, MasteringBiology makes it easy to assess student mastery. As a result, I can more accurately determine what to focus on during lecture.

*Submitted by Warner Bair  
Lone Star College–Cy Fair*

Product Name **MasteringBiology**

Course Names **General Biology I and II**

Credit Hours **Four (each)**

**Key Results** Adding prelecture MasteringBiology assignments facilitated increased student preparedness and engagement and enabled more time for interactive learning. As a result, final course grades of A and B significantly increased.

## Text

*Campbell Biology: Concepts and Connections, 7e*, Jane B. Reece, Martha R. Taylor, Eric J. Simon, and Jean L. Dickey

## About the Course

General Biology I and II is a two-course sequence that introduces students to the principles and concepts of biology. Upon completion of General Biology I, students should be able to demonstrate understanding of life at the molecular and cellular levels. Upon completion of General Biology II, students should be able to demonstrate comprehension of life at the organismal and ecological levels. The courses are offered both in a traditional, face-to-face, lecture-plus-lab format and fully online with students utilizing an at-home lab kit.

## Course Redesign

Our school serves many nontraditional students. The goal of the course redesign was to address the issue of underprepared students and to provide a resource for remediation outside the classroom.

We implemented the Supplemental model developed by the National Center for Academic Transformation. This model retains the basic structure of the traditional course and supplements lectures and textbooks with technology-based, out-of-class activities, or changes what goes on in the classroom by creating an active learning environment within a large, lecture hall setting.

From our experience in this departmentwide redesign, we identified the following best practices:

- Involve faculty as part of the planning team.
- Communicate redesign goals and keep faculty communication channels open.

- Set a timeline and include benchmarks to ensure the process continues to move forward.
- Provide students with start-up guidance, information for technical support, and an explanation of the value of Mastering.
- Reinforce the value of doing assignments before lecture.

## Implementation

Starting fall 2012, we implemented Mastering in Anatomy and Physiology I and II, General Biology I and II, General Chemistry I and II, and Microbiology. We added Mastering to Introductory Physics in spring 2013.

Instructors are required to assign prelecture homework, but have flexibility with regards to the assigned content. The majority of instructors give weekly Mastering assignments that include both tutorial and end-of-chapter questions.

Instructors report that the automated grading in Mastering makes it easier to assign graded homework and to understand where students need help. Beginning spring 2013, we added student learning outcomes to our Mastering homework to (1) facilitate a better understanding of student course and program performance and (2) inform decisions on course changes.

## Assessments

50 percent	Lecture exams
15 percent	Final exam
15 percent	MasteringBiology homework
15 percent	Lab (participation, reports, practicals, exams)
5 percent	Other

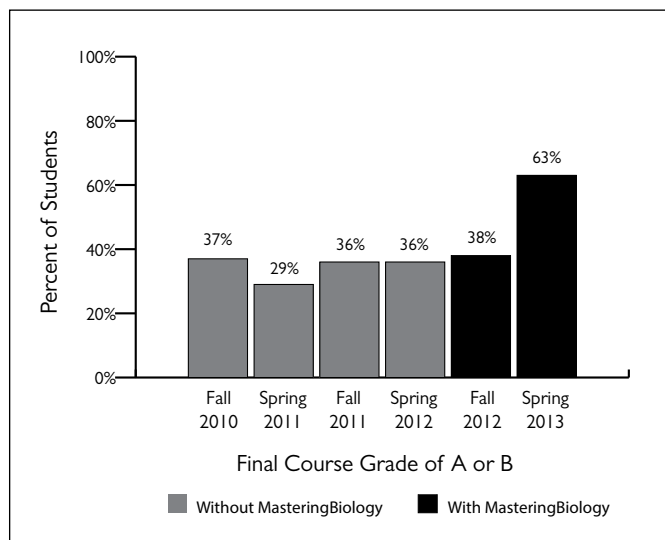


Figure 1. General Biology II Final Course Grades of A or B with and without MasteringBiology, Fall 2010–Spring 2013 (Fall 2010  $n=41$ , Spring 2011  $n=49$ , Fall 2011  $n=39$ , Fall 2012  $n=25$ , Spring 2013  $n=35$ )

## Results and Data

A class test with MasteringBiology was conducted in a few sections in the spring 2012 semester. MasteringBiology was implemented in all sections beginning fall 2012. Our results show that for students who successfully complete General Biology I, there is a higher rate of As and Bs in General Biology II for the semesters using MasteringBiology.

- The percentage of students earning an A or B in General Biology II increased to 63 percent in spring 2013, the first semester in which students used MasteringBiology for both General Biology I and General Biology II (figure 1).
- Students who received an A in General Biology I or II in fall 2012 scored an average of 93 percent and 100 percent respectively on their MasteringBiology homework (table 1).
- Students who received an F in General Biology I or II in fall 2012 scored an average of 41 percent and 58 percent respectively on their MasteringBiology homework (table 1).

Final Course Grade	Average MasteringBiology Homework Score	
	General Biology I	General Biology II
A	93%	100%
B	85%	95%
C	79%	91%
D	70%	78%
F	41%	58%

Table 1. Correlation between Final Course Grade and Average MasteringBiology Homework Score, Fall 2012

## The Student Experience

Students like the opportunity to walk through content prior to lecture, are more engaged in learning, and are more prepared for class. In addition, results from a fall 2012 survey of students in both General Biology I and II indicate the following:

- 78 percent recommended that Mastering be used in any course for which it is available.
- 77 percent believe that the use of MasteringBiology increased their understanding of the course content.

Student comments include:

- “The quizzes and assignments were just challenging enough for me to complete them and learn from them.”
- “I liked the videos. I learn better when I see how things work instead of just reading about it.”

## Conclusion

We redesigned our science courses adding Mastering to provide students with a tool to help them prepare for class and get help when they need it the most. Prelecture homework assignments engage students in course content outside of class and better prepare them for lecture. This in turn enables us to increase the amount of interactive learning and critical thinking activities during class.

*Submitted by Louis McIntyre, Science Department Chair  
Robeson Community College*

Product Name	MasteringBiology
Course Name	General Biology II
Credit Hours	Three (lecture), One (lab)

**Key Results** Increasing the use of MasteringBiology enabled more active learning opportunities, promoted more-efficient lectures and office hours, and resulted in higher exam scores.

## Text

*Campbell Biology: Concepts and Connections, 7e*, Jane B. Reece, Martha R. Taylor, Eric J. Simon, and Jean L. Dickey

## Implementation

This is the second course in a three-quarter (10 week) sequence. It is a fundamental biology course designed for non-biology majors, who have a science requirement. The course is a broad approach to the field of biology, with this session focusing on an introduction to anatomy and physiology of plants and animals. Approximately 350 students per year take the course, which includes both lecture and lab components.

To enhance the lecture I've incorporated active learning into the course, including MasteringBiology, iClickers, worksheets, "think-pair-share," and group activities. In academic year 2009/10, the first year I used MasteringBiology, I provided optional practice assignments that students could earn extra credit by completing. Starting in fall 2010, each quarter I required five to eight MasteringBiology assignments, which accounted for five percent of the students' final course grade.

When I noticed the impact MasteringBiology was having on student learning, I made additional course changes, including requiring one MasteringBiology homework assignment each week. I increased the weight of the assignments to 15 percent of the final course grade in 2011, and to 25 percent in fall 2012. In addition, up to 25 percent of the exam questions are pulled directly from the MasteringBiology study area.

### Assessments (AY 2011/12)

70 percent	Exams (four, the lowest is dropped)
15 percent	MasteringBiology homework (10, the lowest is dropped)
15 percent	Written homework (three)

## Results and Data

When I assigned MasteringBiology for bonus credit, few completed the assignments. When polled, they stated it was because "the assignments were optional." The following year, I required MasteringBiology assignments—and almost every student who completed the assignment earned 100 percent. But I still found that approximately 20 percent of the students didn't complete any of the assignments, and that less than 10 percent used MasteringBiology's other study resources.

In AY 2011/12, I changed my assignment design. In the previous years (2009 and 2010), students had unlimited time and three chances to get each question correct. Statistically, with three attempts and four answer options, students are highly likely to earn 100 percent simply by process of elimination—not by learning. When I allowed two attempts with unlimited time, the MasteringBiology grades averaged 88–93 percent, and, with the additional grade weight of the assignments, more students completed them. When polled, more than 40 percent of students reported also using the study area and eText on a regular basis. More than 70 percent of students said they used the study area and eText at least once during a given quarter.

To learn how MasteringBiology facilitates student learning, I evaluated the results of two exams: plant physiology and animal anatomy—often the most predictive of the students' final performance for the second course in general biology, and which include concepts that are built upon in the third course.

The results show a six to eight percentage point increase in exam grades as I required MasteringBiology assignments, increased the value applied to them, and included the program's study-area content on my exams—a significant difference in a student's final course grade (see figures 1 and 2). In addition to a general trend of increasing exam scores, another interesting change is a tightening of the exam scores and final averages, even with a wide range of student majors from across campus.



*“The results show a six to eight percentage point increase in exam grades as I required MasteringBiology assignments, increased the value applied to them, and included the program’s study-area content on my exams.”*

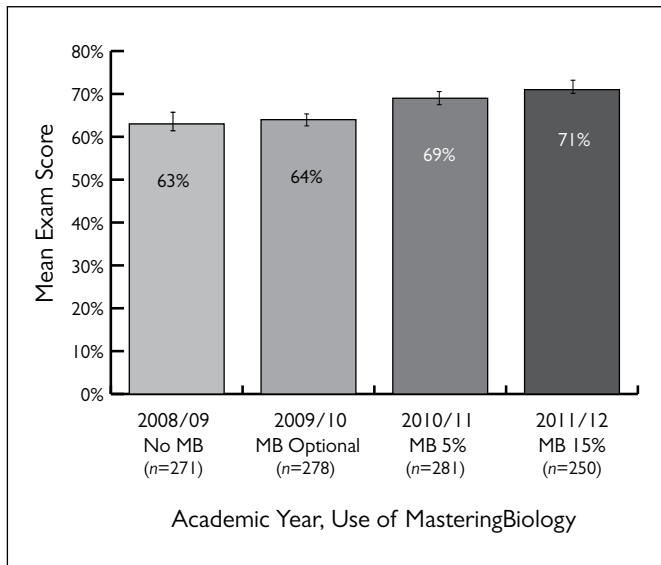


Figure 1. Mean Plant Physiology Exam Scores, General Biology II, 2008–2012 (Err Bars=St Err)

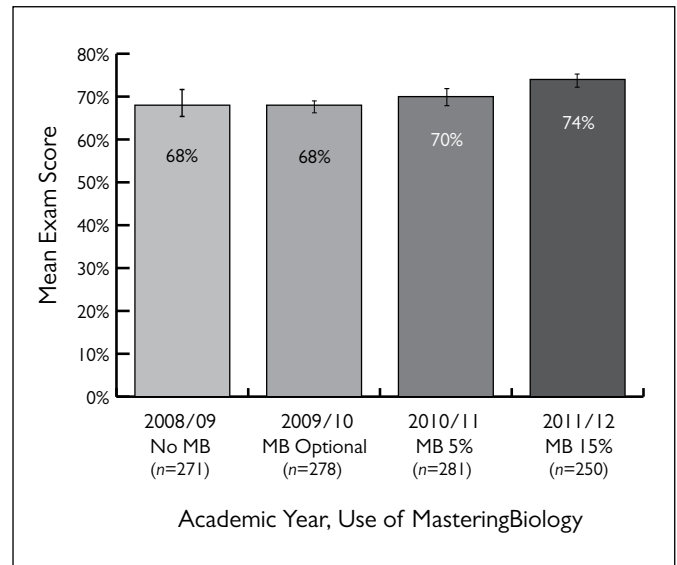


Figure 2. Mean Animal Anatomy Exam Scores, General Biology II, 2008–2012 (Err Bars=St Err)

## The Student Experience

Students like to review lecture content in a visual format, use MasteringBiology tutorials to practice the concepts, and appreciate the convenience of the study area resources and eText. Students spend more time in MasteringBiology after the first exam, and office hour questions are often based on content they are working in MasteringBiology, which makes office visits more efficient. Comments from students in written evaluations include:

- *“I wish our exams were as interactive as MasteringBiology. I love learning that way.”*
- *“The videos helped me grasp the materials. I wouldn’t have done as well on the test without MasteringBiology.”*
- *“I enjoy doing my MasteringBiology assignments, and prefer them to written homework.”*
- *“More MasteringBiology—’nuf said!”*

## Conclusion

MasteringBiology is a great addition to my course because of the benefits both my students and I experience. There has been an increase in exam averages every year, a tightening of scores, and an increased understanding of the materials—conceptually and through application. Students are more likely to ask questions, even in the large lecture hall, as they identify cumbersome topics. This, in turn, helps increase interest in and retention of the materials between courses. From an instructor viewpoint, MasteringBiology frees time I formerly spent grading multipage written homework and enables me to work directly with my students. What’s more, because students come to class better prepared, I’m able to implement more active learning in the classroom—and make learning in a large lecture setting more engaging, more effective, and more fun.

*Submitted by Sandra J. Connelly  
Rochester Institute of Technology*

Product Name [MasteringBiology](#)

Course Name [General Biology I](#)

Credit Hours [Six](#)

**Key Results** Students recognize the value of completing MasteringBiology assignments, resulting in more-engaging classroom discussions, more time for active learning, and consistently higher exam scores.

### Text

*Campbell Biology*, 9e, Jane B. Reece, Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Robert B. Jackson

### Implementation

General Biology I is the first of a two-course sequence for biology, biochemistry/molecular biology, and marine biology majors. It is a traditional course taught on campus and incorporates a course management system, MasteringBiology, lecture recordings, and online quizzing.

When I first started using MasteringBiology, all assignments were completed post-lecture. I noticed a slight improvement on exam and quiz scores, and the students reported that they enjoyed using the program. However, I assign homework to ensure that students have done the assigned reading and are prepared for class discussions and activities. Giving homework on material already covered in class didn't accomplish that, so I experimented with requiring that assignments be completed *before* lecture.

Today, a short (no more than 20-minute) assignment comprising tutorials and activities is due before every class, except when an exam is scheduled. To successfully complete the assignments, students must have done the reading and watched the animations and tutorial videos. Students now come to class with a basic understanding of the concepts and can work efficiently in groups utilizing this knowledge to solve problems posed in class.

I *always* consult the MasteringBiology diagnostics before class—not only to see what the students got wrong, but also to determine what misconceptions likely led to their incorrect answers. I often walk into class and say, “I saw your Mastering homework, and you all appear to understand concept x. Is that right?” If no one raises a question, we move on. I have

eliminated material from my class because student performance on the homework showed they already understood the material. Conversely, when the Mastering diagnostics indicate misconceptions or misunderstandings, I spend more time in class on those concepts until I am confident that the students have gained a stronger understanding.

### Assessments

61 percent	Quizzes (10), unit exams (three), and a comprehensive final
19 percent	Partial lab papers and research papers
10 percent	Pre- and post-lab assignments
10 percent	MasteringBiology homework

*“My students appreciate that I tailor the class sessions to meet their needs. I appreciate having more time for active learning exercises.”*

### Results and Data

Figure 1 illustrates consistent improvement in exam scores since MasteringBiology was implemented in 2008, and supports the hypothesis that MasteringBiology improves student learning. The improvement is most noticeable when the homework is assigned prelecture (2010–12). Note that the final exam for this class is a secure exam that changes very little from year to year.

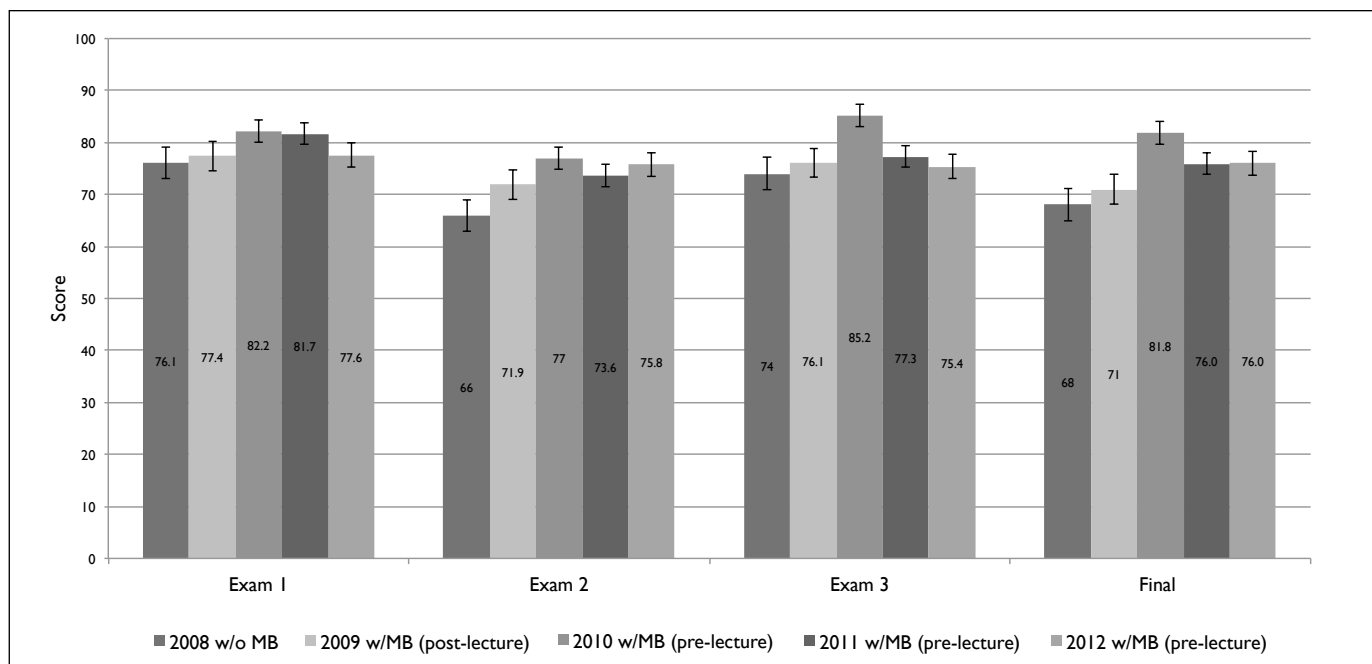


Figure 1. General Biology I Exam Scores before and after MasteringBiology Implementation, 2008–2012

	Strongly Agree		Agree		Disagree		Strongly Disagree		N/A	
	2009	2011	2009	2011	2009	2011	2009	2011	2009	2011
MasteringBiology homework assignments enhanced my learning in this course.	38%	49%	58%	44%	4%	7%	–	–	–	–
The MasteringBiology Study Area enhanced my learning in this course.	24%	44%	54%	43%	10%	2%	4%	–	8%	11%
MasteringBiology should be utilized in this course in the future.	48%	51%	46%	41%	2%	7%	4%	–	–	1%

Table 1. Student Survey Results, 2009 and 2011

## The Student Experience

MasteringBiology helps my students to work more efficiently. I utilize the drag-and-drop and sorting questions in the program as much as possible because they require that students analyze and evaluate information. In this way, they may be studying the same amount of time as other students, but their time is being used more effectively.

I conducted a student survey in 2009, the first year I used MasteringBiology. I administered the same survey again in 2011 when prelecture homework was part of the course assessment. The survey results indicate that the majority of students strongly agree or agree that the use of MasteringBiology

enhanced their learning and should continue to be utilized in the course. See table 1.

## Conclusion

MasteringBiology enables me to lecture less and teach more—I'm more efficient now at helping my students learn. It appeals to the students and enhances their learning. They actually tell me they want more homework! Anything that helps them do more biology and enjoy it is great in my book.

*Submitted by Eileen Gregory  
Rollins College*

Product Name [MasteringBiology](#)

Course Name [General Biology I: Organismal and Ecology](#)

Credit Hours [Three](#)

**Key Results** Students come to class better prepared and are more engaged after doing prelecture assignments in MasteringBiology. As a result, student success rates are significantly higher.

## Text

*Campbell Biology*, 9e, Jane B. Reece, Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, and Robert B. Jackson

## Implementation

General Biology I is the first course in a two-semester sequence in the College of Environmental Science and Forestry. The course explores introductory biological principles at the ecosystem, population, and organismal levels with an emphasis on the form, function, diversity, ecology and evolution of living organisms. A one-credit lab is offered concurrent to the course, which is primarily taken by science majors but may also include a mix of other majors.

In fall 2011, I adopted MasteringBiology to address the issue of student unpreparedness. Each semester, I assign 30 prelecture homework assignments and keep the top 25 grades. Each assignment is 10–20 questions, comprises a mix of question types and difficulty levels, and may include content from multiple chapters. Each assignment takes 25–60 minutes to complete; students have 5–10 days to submit each assignment.

I use the time and difficulty ratings in MasteringBiology to help me select homework problems. Prior to lecture, I use MasteringBiology's homework diagnostics to assess the most missed problems—this enables me to address any common misconceptions during classtime and ensure that all students clearly understand the concepts.

Two graduate teaching assistants and multiple undergraduate teaching assistants hold weekly course workshops, in which they review content in the MasteringBiology study area and show BioFlix. They encourage students to review prelecture assignments and to visit MasteringBiology's study area to watch the BioFlix, use flashcards, and do the practice cumulative exams on their own. Some of the questions from the study area are used on exams.

## Assessments

58 percent	Exams (four)
14 percent	MasteringBiology homework
14 percent	In-class assignments and quizzes
14 percent	Final exam

## Results and Data

Analysis of student course grades for 2010–2012 indicates that since adoption of MasteringBiology, A/B/C rates have increased and D/F/W rates have decreased (see figure 1). In just the first year of implementation, student success rates increased by 11 percentage points.

In addition, the number of students each semester who took the final exam and completed the course has increased by three percentage points.

*“End-of-course student survey responses indicate that [students] recognize and appreciate the value of using MasteringBiology.”*

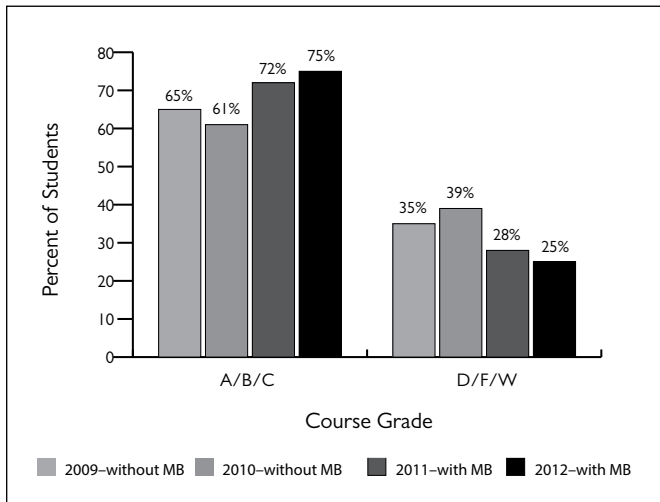


Figure 1. Student Success and Drop/Fail/Withdrawal (D/F/W) Rates with and without the Use of MasteringBiology, 2009–2012 (2009  $n=298$ , 2010  $n=266$ , 2011  $n=280$ , 2012  $n=306$ )

## The Student Experience

End-of-course surveys given in fall 2011 (192 students) and 2012 (240 students) revealed that students viewed their MasteringBiology experience as positive; 34 percent of students mentioned MasteringBiology as “the most effective part of this course.” A separate end-of-course survey administered via Blackboard indicated that 80 percent of students found MasteringBiology helpful.

When asked to complete the statement, “The preassignments on MasteringBiology...” 63 percent of students from the fall 2011 course responded: “Were extremely helpful and made a positive difference in my grade.”

After implementing prelecture homework assignments in MasteringBiology, students were more engaged in class and asked better questions. In addition, I could include more difficult concepts in lecture because students were more prepared. Student comments confirm that introducing them to content *before* the lecture was beneficial.

- “The preassignments were a big help. They enabled us to listen to the lecture with some prior understanding.”
- “I did MasteringBiology work before the lecture so I could go knowing what was going on. It helped my grade a lot.”

Students were also asked what advice they’d give to incoming students. Responses included:

- “Always do MasteringBiology homework. Even though it can be a pain, it really helps reinforce what’s taught in lecture.”
- “Don’t underestimate the difficulty of the class—it’s hard. But that doesn’t mean it’s impossible to pass. Use MasteringBiology—it can save you.”

## Conclusion

Millennial students won’t spend their time and energy on homework unless it is both required and counts toward their grade. Before adoption of MasteringBiology, I entered the classroom each period only to be met by a sea of faces that clearly had no idea what I was talking about. Since adoption of MasteringBiology and implementation of prelecture homework assignments, students are noticeably more engaged during lectures, and classes are more interactive.

MasteringBiology makes a positive difference. The increase in student success shows that students are learning more; end-of-course student survey responses indicate that they recognize and appreciate the value of using MasteringBiology.

*Submitted by Melissa Fierke  
State University of New York*

Product Name [MasteringBiology](#)

Course Name [Organismal Biology](#)

Credit Hours [Three](#)

**Key Results** Organismal Biology students who completed prelecture quizzes in MasteringBiology receive significantly higher exam scores than those students who do not complete them. In addition, requiring prequizzes has resulted in record-low D/F/W rates for the course.

### Text

*Biological Science*, 3e, Scott Freeman

### Implementation

Organismal Biology is a traditional lecture class taught on campus. There are two to three sections of the course per semester, each with about 230 students.

Each week before the first lecture, I administer a MasteringBiology reading quiz, which includes 5–10 multiple-choice questions. After each of the seven major units, students complete an assignment that involves the tutorials and activities based on that unit—questions span material from more than one chapter. The assignment is due at the end of the week that the last set of material covers.

MasteringBiology has changed the way I run my class. Now I can check the gradebook data—especially the quizzes taken before lecture—and if there is an area of common student misconception, I spend more time on that in my lecture. I also base my in-class pop quizzes on the content with which students are having trouble. Because classes are fairly large, I have students

work in small groups on the in-class assignments. In these groups, students may work together on questions in an open-book, open-note, open-discussion environment. Questions are on those topics that students need more time on, as indicated by the gradebook statistics.

I use approximately 90 percent of MasteringBiology’s tutorials and activities. The remaining 10 percent of my questions are topics I’ve modified to best fit my course.

For more involved activities, I assign from four to eight items, designed to take about two hours. Students are made aware of this in advance, told that the assignment is due on a particular date, and instructed to dedicate time to it in order to do well and derive the greatest benefit.

### Assessments

70 percent	Lecture exams
20 percent	MasteringBiology homework and quizzes
10 percent	In-class pop quiz, collaborative work, attendance, and participation

*“Gradebook statistics show me that students who complete the MasteringBiology assignments are better prepared—even those who aren’t the best students.”*

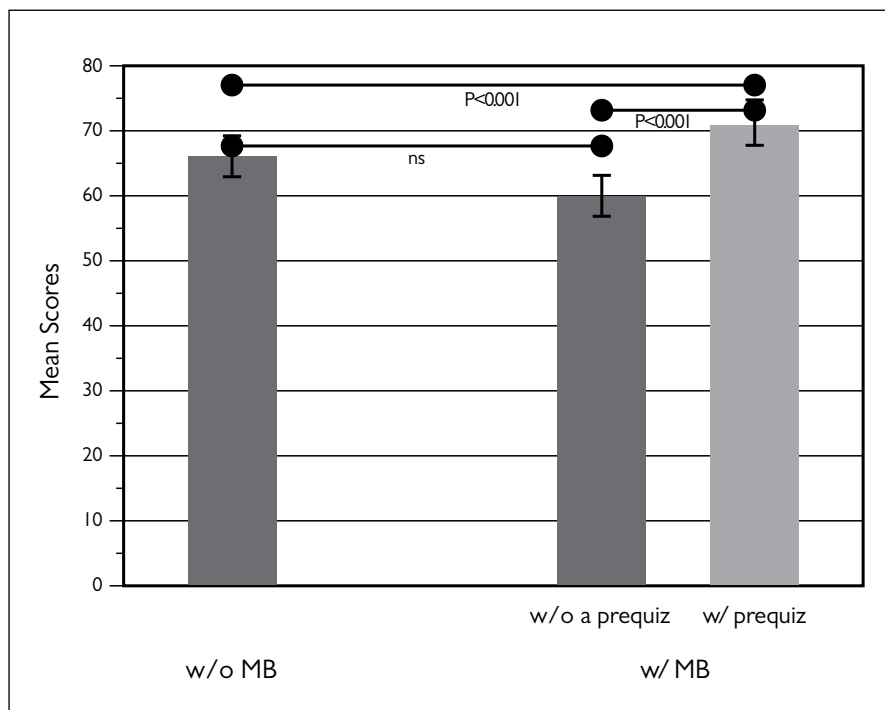


Figure 1. General Biology mean final grades with and without MasteringBiology

## Results and Data

Students are definitely working harder. This course has required MasteringBiology long enough now those students who took it in prior years advise present students that if they dedicate time to MasteringBiology, they’ll do better in the course.

Gradebook statistics show me that students who complete the MasteringBiology assignments are better prepared—even those who aren’t the best students.

The most significant improvement occurred when I started assigning prelecture assessments (see figure 1). Students who both did and did not use MasteringBiology showed no significant difference in final exam scores before I started assigning prelecture quizzes. However, final exam scores improved significantly once I implemented the prelecture assignments.

In addition, the course D/F/W rate has also dropped to a record low of 32 percent.

## Conclusion

I see two primary benefits from using MasteringBiology:

- Students read the textbook prior to attending lecture. This enables me to spend more time making the material’s conceptual connections.
- Using the gradebook diagnostics, I can quickly identify the concepts that students struggled with in the reading and spend more time on them in lecture.

I used to have a preconceived notion of what students find difficult and what I should focus on in class. I’m learning now that the concepts that one group finds difficult are not the same semester to semester, or class to class. MasteringBiology has helped me see that, and I know I am a more efficient teacher as a result.

*Submitted by Andrea Aspbury  
Texas State University*

Product Name **MasteringBiology**  
 Course Name **Molecular Cell Biology (first year)**  
 Credit Hours **Four**

**Key Results** MasteringBiology offers an interactive learning format that more effectively engages students with course materials and thereby helps them perform better in the course.

### Text

*Campbell Biology*, 9e, Jane B. Reece, Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, and Robert B. Jackson

### Implementation

Molecular Cell Biology is a first-year, first-semester course. The course is taught as a large, mostly noninteractive, group lecture—as such, some students simply don't attend. I found that students didn't regularly read the textbook and probably didn't review the course material until studying for exams. In fall 2009, I adopted MasteringBiology with the goal of motivating students to read the textbook and interact with the lecture material in a format that was more familiar to them, thereby making their learning more effective and enjoyable.

My MasteringBiology homework consists of assignments that open each lecture day and close one week later. Assignments comprise mostly activities and tutorials, and are designed to review what was covered in lecture in a more interactive way. Students may not view hints or answers until after the assignment due date, and there is no time limit on the assignment.

Each question is assigned a point value related to the number of minutes a student should take to complete it (e.g., 10 minutes=10 points). I try to get each assignment to equal 30 points. I monitor the gradebook when the assignments are open and e-mail and communicate with students through our institutional LMS 24 hours before the deadline to remind them of it. Once the deadline has passed, students who have not completed the assignment are given a 24-hour extension, and a reduced grade.

At the end of the term, I create no-credit, review assignments for each topic using multiple-choice testbank and end-of-chapter questions. Students may make multiple attempts and answers may be viewed. Once the assessment is completed, the original assignments are available to use for additional practice.

Homework consists of worksheets from three laboratory exams, plus the total score from ten MasteringBiology assignments. A multiple choice exam at the end of the semester, and a written, short-answer, and essay exam are the other components of the course grade.

### Assessments

33 percent	Written final exam
33 percent	Multiple-choice exam
25.5 percent	Lab worksheet homework
8.5 percent	MasteringBiology homework

### Results and Data

MasteringBiology has enabled the students to engage with the course materials and has had a positive impact on my students' learning in the course. Since using the program, I've seen an increase in the homework and course mean grades. In addition, both the multiple-choice and written, final exams have shown grade increases over the last two years using MasteringBiology. With no other changes to teaching or assessment, the mean course grade has increased by more than six percent since implementing MasteringBiology. See figure 1.

*“Since using the program, I've seen an increase in the homework and course mean grades.”*

I also have found that making the MasteringBiology assignments required—as summative assessments—is the best way to get the students to engage with the course material. At least 90 percent of students regularly complete a required assignment; usually only 30–60 percent of students complete an optional, extra-practice assignment.



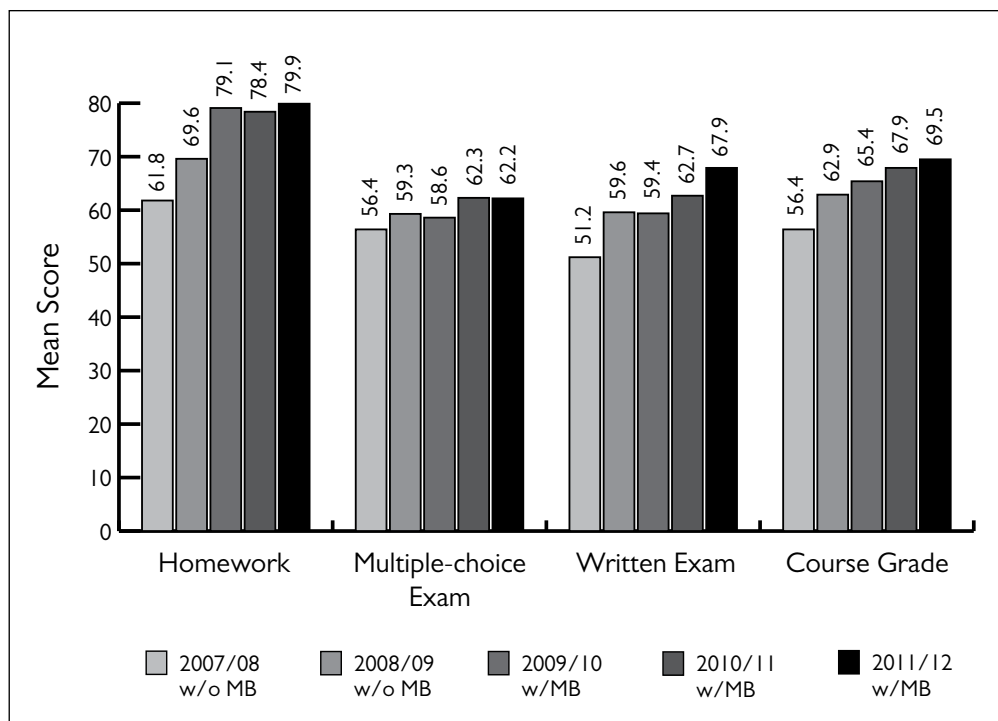


Figure 1. Mean Homework, Multiple-choice Exam, Written Exam, and Course Grade Scores with and without the Use of MasteringBiology, 2007–2012

## The Student Experience

I survey students about MasteringBiology by writing my own questions and adding them to the last required assignment in the program. Responses reveal that most students enjoy the work and find it helpful. Many admit that they probably would not have completed as many assignments if they hadn't been required. They also use some of the other study resources, such as the eText and self-study resources.

Some of the comments I received from students include:

- *“At first I was skeptical about having to buy the book new and paying full price. But I’ve just done the first three questions and have learned so much already.”*
- *“The online assessments are a fun and interactive way to learn biology.”*
- *“I found [MasteringBiology] helpful. I can now remember the majority of the functions and names without looking at the book.”*

## Conclusion

Students want to be engaged in the subject matter, and they welcome new technologies. Because modern students grew up with computers, some find books alien. We need to embrace this shift, rather than try to revert back to the old-school way of learning. MasteringBiology's online assignments offer students the flexibility to learn in their own space, at their own pace, and in a visual or 3D way that isn't possible from traditional textbooks.

*Submitted by Louise Beard  
University of Essex*

Product Name MasteringBiology

Course Name General Biology I

Credit Hours Four

**Key Results** An increase in exam scores was observed in this initial study when Adaptive Follow-Up was implemented in conjunction with MasteringBiology homework. Student feedback indicated that Adaptive Follow-Ups were beneficial in mastery of concepts and motivated them to work harder on MasteringBiology homework assignments.

## Text

*Campbell Biology*, 9e, Jane B. Reece, Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, and Robert B. Jackson

## Implementation

General Biology I covers the fundamental principles of living organisms, including physical and chemical properties of life, organization, function, evolutionary adaptation, and classification. Concepts of cytology, reproduction, genetics, and scientific reasoning are included. This course has both a lecture and lab component. Students taking this course are primarily science majors.

My use of MasteringBiology has evolved from an optional resource to a required component of the course. I recently completed a study on the effect of utilizing online testing as a learning event in the introductory (majors) biology classroom using MasteringBiology to deliver required quizzes for the study.

In this study, published in *CBE Life Sciences Education* September 4, 2013 12: 509-514,<sup>1</sup> analysis of exam grades earned by those who took 100 percent of pre-exam quizzes indicated that this group had a significantly higher exam average than the group of students who took 0 percent of the pre-exam quizzes. Additionally, those who take 0 percent of the pre-exam quizzes had a significantly lower exam average than the class average. Through detailed, statistical analysis, the benefit of quizzing was demonstrated to be significant for students of diverse academic abilities.

I continue to require pre-exam quizzes in MasteringBiology since quizzing has been shown to be an effective way to increase student performance on exams, and it allows class time to be utilized for teaching activities. My first MasteringBiology homework assignment each semester is due by the end of the first week of class to encourage all students to get started in MasteringBiology and, if necessary, make adjustments to optimize their use of it. My course generally consists of three different types of MasteringBiology assignments:

1. **Prefecture reading assignments (untimed homework).** These are short, ten multiple-choice question assignments designed to give students quick feedback regarding their initial comprehension of the material. Students are able to request hints, but are limited to two attempts to arrive at the correct answer. Diagnostics are utilized from these assignments to guide lecture discussion.
2. **Practice assignments (untimed homework).** These include tutorials, activities, BioFlix, and misconception questions, and are chapter specific. Each homework assignment requires an average of 30-60 minutes in order to complete the assignment. Students are able to request hints, and they have multiple attempts to answer correctly.
3. **Required quizzes (timed).** These are designed to give students a snapshot of where they are in their preparation for the upcoming exam. Quizzes are comprised of original content that has been uploaded into MasteringBiology. The topics and wording are designed to prepare students for the type of questions that will be on their exams. Students receive one of three versions of each quiz (assigned randomly), and quiz questions are randomized within each quiz to discourage group work.

<sup>1</sup> "Increasing Student Success Using Online Quizzing in Introductory (Majors) Biology," Rebecca Orr and Shellene Foster, *CBE—Life Sciences Education*, Vol. 12, 509-514, Fall 2013. <http://www.lifescied.org/content/12/3/509/full?sid=01bb2df8-239e-4c41-8406-bd40fc6e1d22>

## Use of Adaptive Follow-Up

In the Summer 2013 term, I tested a new feature in MasteringBiology called Adaptive Follow-Up. This option was made available to students after completing MasteringBiology practice assignments. The Adaptive Follow-Up questions are intended to focus each student on gaps in their own understanding of content, based on their performance on the MasteringBiology parent assignment. The Adaptive Follow-Up questions assigned to each student are generated based on their individual performance, so they will vary from student to student.

I give four unit exams every semester. In the Summer 2013 term, the MasteringBiology homework assigned was a streamlined version of that assigned in spring in order to increase item availability for Adaptive Follow-Up. Quizzes and exams were the same as in Spring 2013. For the third and fourth units, I added Adaptive Follow-Up assignments to each MasteringBiology practice assignment. Students could receive extra credit if they completed or tested out of the Adaptive Follow-Up assignment. Participation in Adaptive Follow-Up was not required.

When assigning Adaptive Follow-Up, instructors select the level at which test out occurs based on performance on the MasteringBiology parent assignment. For my class, students had to earn at least 95 percent on their MasteringBiology parent homework to test out of the Adaptive Follow-Up assignment and receive the extra credit. Anyone scoring less than 95 percent received extra credit only if they completed the Adaptive Follow-Up assignment.

### Assessments

#### Course Grade

75 percent Lecture

25 percent Lab

#### Lecture Grade

80 percent Exam average

10 percent MasteringBiology quizzes  
100 total points

10 percent MasteringBiology homework  
1,500 total points

## Results and Data

To compare overall ability of my students in Spring 2013 versus those in Summer 2013, I averaged the scores for exam 1 and exam 2. The Summer 2013 average was 5.06 points higher than the Spring 2013 average, a significant difference ( $p=0.032$ ). Taking this into consideration, I evaluated the results for exams 3 and 4 after Adaptive Follow-Up was introduced.

For exam 3, the exam average for those offered Adaptive Follow-Up in the Summer 2013 term was 5.74 above those not having access to those resources in the Spring 2013 semester, with the one tailed T-test reporting the significance of the difference as  $p=0.025$ . In analyzing the gains made by the Spring 2013 class versus the Summer 2013 class, I observed that the Spring 2013 class average for exam 3 was 0.61 points higher than their exam 1/exam 2 average. In contrast, the Summer 2013 class average for exam 3 was 1.30 points higher.

By exam 4, the gap in exam averages of those students offered Adaptive Follow-up became quite pronounced. The Summer 2013 exam 4 average was 7.20 points above the Spring 2013 semester exam 4 average, a 44 percent increase compared to the originally observed gap (figure 1). The significance of that difference is  $p=0.010$ . When analyzing the specific gains made by the Spring 2013 student cohort versus the Summer 2013 student cohort, I observed that the Spring 2013 class average for exam 4 fell 5.40 points when compared to exam 3. In contrast, the Summer 2013 class average for exam 4 fell by only 3.95 points.

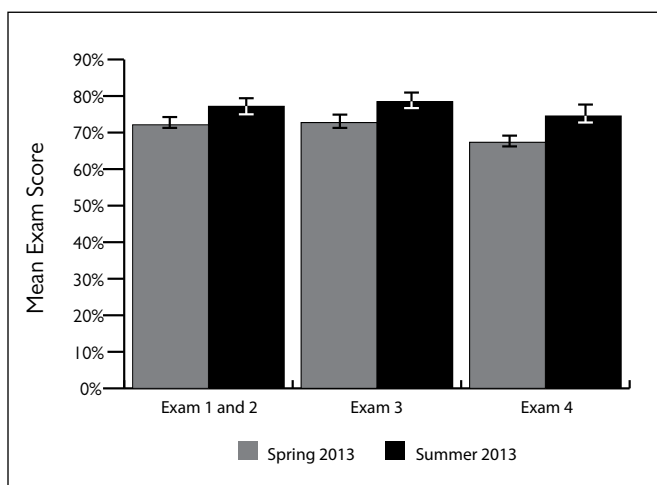


Figure 1. Effect of Adaptive Follow-Up on Exam 3 and Exam 4 Class Average (error bars indicate standard error). (Spring 2013: No Adaptive Follow-Up for Exam 3 and 4,  $n=121$ ; Summer 2013: Adaptive Follow-Up for Exams 3 and 4,  $n=37$ )

*continued next page*

Since the assignments were not required, participation rates for the Adaptive Follow-Up assignments were analyzed. The following were observed:

- Almost 92 percent of students either tested out of or actively worked on the first Adaptive Follow-Up assignment.
- Average participation rates observed over the course of Adaptive Follow-Up offerings were:
  - 16.7 percent tested out of Adaptive Follow-Up by scoring 95 percent or higher on the MasteringBiology parent assignment.
  - 58.1 percent chose to actively work on the Adaptive Follow-Up sets after completing the MasteringBiology parent assignment.
  - 25.2 percent did not participate in Adaptive Follow-Up.

### The Student Experience

At the end of the summer term, students were asked to provide feedback on their experience using Adaptive Follow-Up. Students provided the following comments:

- “I really like how it [Adaptive Follow-Up] takes me back to the basics so I know where I need to study to build my strengths.”
- “I originally thought that the Adaptive Follow-Up assignments were going to be a waste of time, but it actually is more of a benefit.”
- “It was helpful, plus I felt confident when taking the test.”

One unexpected benefit of allowing students to test out of the Adaptive Follow-Up assignment is that students reported putting more effort into the MasteringBiology parent homework. Many reported this as motivation to earn the extra credit without doing the work on the Adaptive Follow-Up. In the end-of-class survey, I received this comment from one student:

“...Adaptive Follow-Up questions served as motivation to learn the material better. I even went back and did them [MasteringBiology parent homework questions] again, which I hadn't done before. I really think it's just the idea of “testing out” of something that makes me feel smarter and encourages me to get a better grade on the [MasteringBiology parent] homework. My grade on the [MasteringBiology parent] homework assignments for Chapters 9, 10, and 12 were much higher than previous assignments, and I have these Adaptive Follow-Up assignments to thank.”

### Conclusion

Students struggle with the complex concepts to be mastered in our freshman majors biology course. This is particularly problematic since early concepts often serve as foundations for more complex concepts presented as the semester progresses. When concept gaps are not detected and closed, student success becomes limited. With MasteringBiology and Adaptive Follow-Up, students have the opportunity for personalized learning and remediation. If Adaptive Follow-Up can successfully detect, target, and close these gaps, one would predict an increase in student comprehension and mastery of more advanced content built on their premise.

From my initial study using Adaptive Follow-Up in conjunction with MasteringBiology homework, results indicate that the Adaptive Follow-Up may increase student success, as evidenced by an increase in the gap between exam averages when compared to those not given Adaptive Follow-Up. The increasing strength of the significance in this gap should also be noted. That the increase in exam average grew over time may be due to an additive effect of Adaptive Follow-Up, as content comprehension gaps are filled by the remediation. In addition, anecdotal observations indicated that the test-out “carrot” may motivate students to work harder on the MasteringBiology parent assignment. I am continuing to study the impact of Adaptive Follow-Up during the Fall 2013 semester to determine if these initial findings are supported by a larger sample size of students.

*Submitted by Rebecca Orr, Collin College  
Statistical Analysis by Shellene Foster, Collin College*

Product Name **MasteringChemistry**Course Name **General Chemistry**Credit Hours **Three**

**Key Results** Use of MasteringChemistry contributed to a positive shift in grade distribution and significant decrease in D/F/W.

### Text

*Chemistry: A Molecular Approach*, 1e, Nivaldo J. Tro

### Implementation

General Chemistry is a traditional lecture course, serving approximately 2,000 students annually, mostly science, math, and engineering majors. Lab is taken concurrently, but as a separate course.

We require students to complete the Introduction to MasteringChemistry assignment, a Math Review assignment using the math tutorials available in the item library, and 10 additional assignments—one for each of the chapters we cover. We use a mix of tutorial and end-of-chapter problems, and we target our chapter assignments to take about three hours to complete, based on the database median time-to-completion statistics. We allow students four attempts for each problem.

We review the available diagnostics, particularly student time, item score, and student score, to monitor student progress and engagement, as well as to identify common misconceptions that may need clarification.

### Assessments

60 percent Exams (three)

25 percent Final exam

10 percent MasteringChemistry homework

5 percent Participation (via classroom response system)

### Results and Data

Students' course grade distribution shifted noticeably after we implemented MasteringChemistry. As shown in figure I, we had a significant increase in the percentage of students earning an A or B, and far fewer Ds and Fs. The drop/fail/withdraw (D/F/W) rate fell dramatically from 41.6 percent before implementation of MasteringChemistry to 30.2 percent after.

### Conclusion

I credit the shift in grade distribution and the decrease in the D/F/W rate to three factors: use of MasteringChemistry, adoption of a Pearson textbook, and instructor effort. I believe students are learning more with the new system. We were initially concerned because fewer students were coming to office hours for help, but quickly recognized it was because they were receiving tutorial help from MasteringChemistry. In addition, student comments about the program have been very positive. But perhaps the strongest endorsement is the lack of student complaints.

We'll be redesigning our general chemistry sequence for the 2012/13 academic year with more emphasis on recitation, but MasteringChemistry will remain 10 percent of the overall course grade.

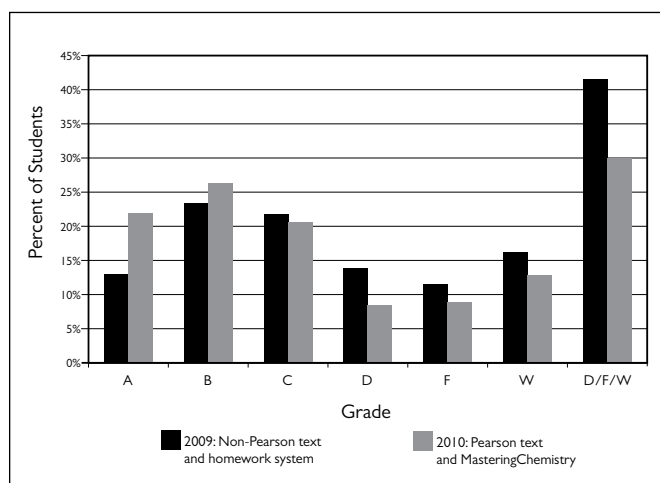


Figure I. General Chemistry Grade Distribution and D/F/W rates, 2009–2010

Submitted by Stephen Testa  
University of Kentucky

Product Name MasteringChemistry

Course Name Organic Chemistry I and II

**Key Results** By using English-language textbooks with MasteringChemistry, Chinese instructors are better able to assess those students who are developing chemistry skills in both English and Chinese.

## Text

*Organic Chemistry*, 8e, Leroy G. Wade

## Implementation

Organic Chemistry I and II is a required, two-course sequence for Chemistry majors that covers the basic reactions of organic chemicals. The sequence is taught as a bilingual course with two main goals. First, from a professional standpoint, imported English textbooks offer the most up-to-date content, a logical arrangement, and precise concept descriptions. These textbooks are supplemented with Chinese chemistry books, thereby enabling students to grasp the basic chemical concepts and fundamental theories, while still learning about the trends and developments in the field of chemistry. Second, from an educational standpoint, the university's goals are to help students build the skills needed for international exchange and to compete in the science and technology field.

The bilingual courses benefit students in a variety of ways: they improve their English listening, speaking, reading, and writing skills; as well as their English thinking and problem-solving skills in chemistry. In addition, because bilingual teaching courses are based on Western practices, they help students widen their scope of thought, develop more independent thinking skills, and improve their ability to apply chemical concepts in real applications.

Our first objective is to establish learning goals and elicit study interests. With English textbooks, students learn about international standards and have a greater passion to study, both of which can help lead them toward careers in research. After taking the course, many students become actively involved in the bachelor scientific research team.

Step-by-step teaching is important in this course. I do that by using English chemical terms and chemical equations and encouraging students to express chemical concepts and definitions in English. Because of the students' level of English-language skill, I start the course in Chinese and gradually add English until I am teaching almost solely in English. By the end of the courses, students can answer chemical problems in English.

We cover theory before detailed chemical compounds, thereby enabling students to manipulate complex compounds in later lessons. A series of tutorial groups are set up and students are asked to present organic chemistry topics in English.

### Use of MasteringChemistry

The multimedia resources in MasteringChemistry help students better prepare for class and become accustomed to learning course content in English. MasteringChemistry's diagnostics enable me to pay special attention to student performance. They also help me identify which concepts students find difficult and where I need to provide help.

Another focus of the course is concepts from daily life and high-tech industry. Instructors hold tutorials and give students opportunities to discuss and present in English the concepts they've learned. Because students feel that this helps them improve their professional English-speaking skills and broaden their knowledge of chemical concepts, it creates enthusiasm for learning organic chemistry.

Other course activities include organic experiments, open discussions, and guest lectures by famous foreign professors.

Exams are closed book and the difficulty of class exercises and student interview is gradually increased to promote self-motivation.

*“Students who steadily work with MasteringChemistry tend to have better course grades.”*

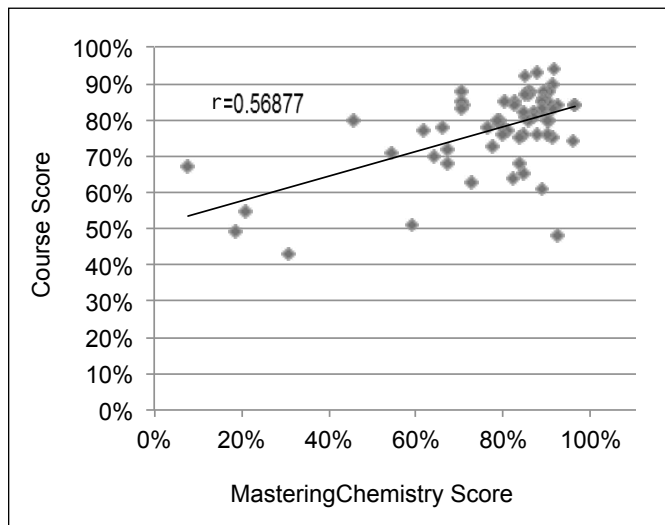


Figure 1. Correlation between MasteringChemistry Score and Course Score

#### Assessments

50 percent	Final exam
30 percent	Midterm exam
10 percent	MasteringChemistry homework
10 percent	Paper-and-pencil homework

#### Results and Data

I compared MasteringChemistry homework scores to the total course scores and found that there is a correlation between how well they do on daily MasteringChemistry assignments and how well they do in the course. Students who steadily work with MasteringChemistry tend to have better course grades (figure 1).

#### The Student Experience

I surveyed the students who used MasteringChemistry, and the overall feedback was positive, with a majority of students recommending MasteringChemistry be used in future classes:

- 83 percent    Students who recommended instructors use MasteringChemistry for future classes.
- 77 percent    Students who reported that their experience using MasteringChemistry was excellent or good.
- 66 percent    Students who reported that MasteringChemistry helped them to achieve a higher course grade.

Although there were some student issues with connection speed and software, most students found MasteringChemistry to be helpful in learning basic concepts and improving problem-solving skills. Using MasteringChemistry makes it easier for me to follow the students' progress and understand their needs. I can then adjust my teaching to address those needs and intervene earlier with students who are having problems.

Student comments include:

- “[MasteringChemistry] is really helpful. It would not let me practice the question continuously until I answered it correctly. However, the hints make it easier—after using the hints to help answer the question, the answers showed. That made me think.”
- “MasteringChemistry is very good. It helped teach Organic Chemistry more visually.”
- “MasteringChemistry showed me the details I needed to know and challenged me because it only uses English.”

#### Conclusion

We see improvement in student performance since using MasteringChemistry and will continue to use it as our online homework as a way to emphasize continuous assessment.

*Submitted by Zhonglin Lu  
Beijing Normal University*

Product Name MasteringChemistry

Course Name General Chemistry

Credit Hours Four

**Key Results** MasteringChemistry's hallmark advantages of immediate feedback and personalized learning facilitate greater student learning, as evidenced by increased exam scores; and time previously spent grading homework can be spent on hands-on teaching and research.

## Text

*Chemistry: The Central Science*, Theodore E. Brown, H. Eugene LeMay, Bruce E. Bursten, Catherine Murphy, Patrick Woodward

## Implementation

Each year, more than 2,500 students in sections of 250 take General Chemistry. Even with TA support, it is impossible to grade that amount of paper homework. In 2007 we adopted MasteringChemistry to ease the burden of grading. Today everything the students complete is automatically graded. What's more, students receive tutoring with hints and answer-specific feedback while they do their work, so it's both more efficient and more effective.

My MasteringChemistry assignments have evolved over the years, from traditional end-of-chapter problems in the beginning, to tutorial problems that offer hints and answer-specific feedback. Tutorial problems are a strength of the program. In addition, we follow an atoms-first approach and tend to skip around the book a bit. The program's authoring tools enable us to put in a few problems of our own.

I use MasteringChemistry's national database of problem length and relative difficulty to build homework assignments of approximately 60–90 minutes per assignment. It means I no longer field complaints about homework that takes too long to complete. Throughout the semester, I review MasteringChemistry's diagnostic tools to see how well students are learning—and how well I'm teaching—particular concepts.

## Assessments

- 70 percent Exams (three midterms and a final)
- 10 percent MasteringChemistry homework
- 7.5 percent In-class clicker quizzes
- 7.5 percent Recitation sections (in-class work)
- 5 percent Weekly online exams

## Results and Data

I believe that MasteringChemistry has improved our students' understanding of general chemistry. When I gave my students the same exam that I had given the semester before I implemented MasteringChemistry, their scores increased and the improvement in scores increased as the term progressed. That experience has been repeated every time we used duplicate exams. Today the exams are modified, but scores continue to be high. See figure 1.

What I find most compelling is MasteringChemistry's impact on students' *perception* of the course. This is a general education course—a service course—that nonmajors take. These students are a reluctant audience: they don't like chemistry, and they see it as a barrier. Using MasteringChemistry helps them to feel that they have a fair chance of learning it—that's a big part of the battle.

I survey students every semester—I ask them which course components are the most helpful to their learning of general chemistry. Students rate each component on a scale of 1–5, with 1 being Not Very Helpful and 5 being Extremely Helpful. I've done this every semester over the 4 or 5 years I have taught the course. MasteringChemistry always ranks at or near the top—better than my lectures and better than the quizzes and the text (see figure 2). The only components that come close are the recorded lectures, which students access online, and the weekly microquizzes, which they can take as many times as they want and are somewhat modeled after the MasteringChemistry tutorial problems.



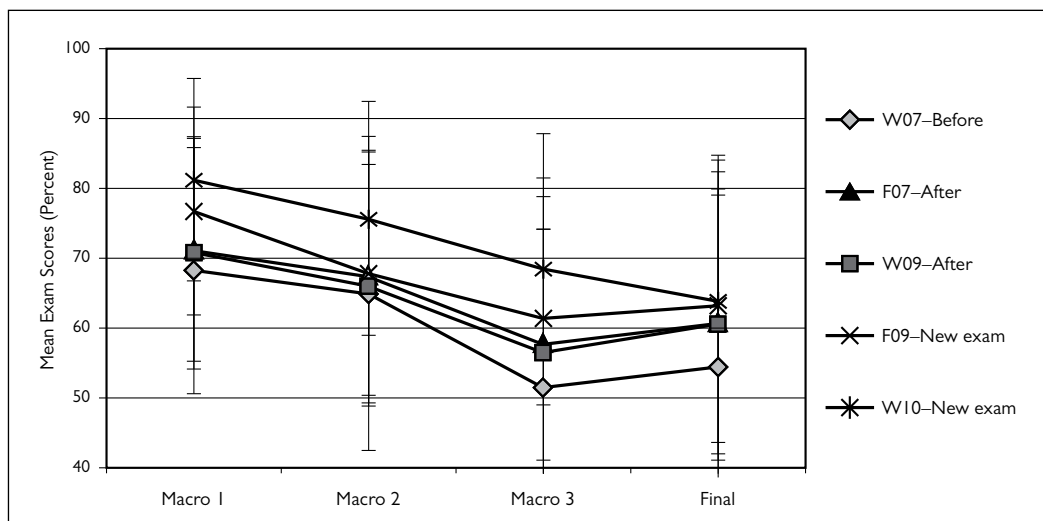


Figure 1. Mean Exam Scores before and after Implementation of MasteringChemistry

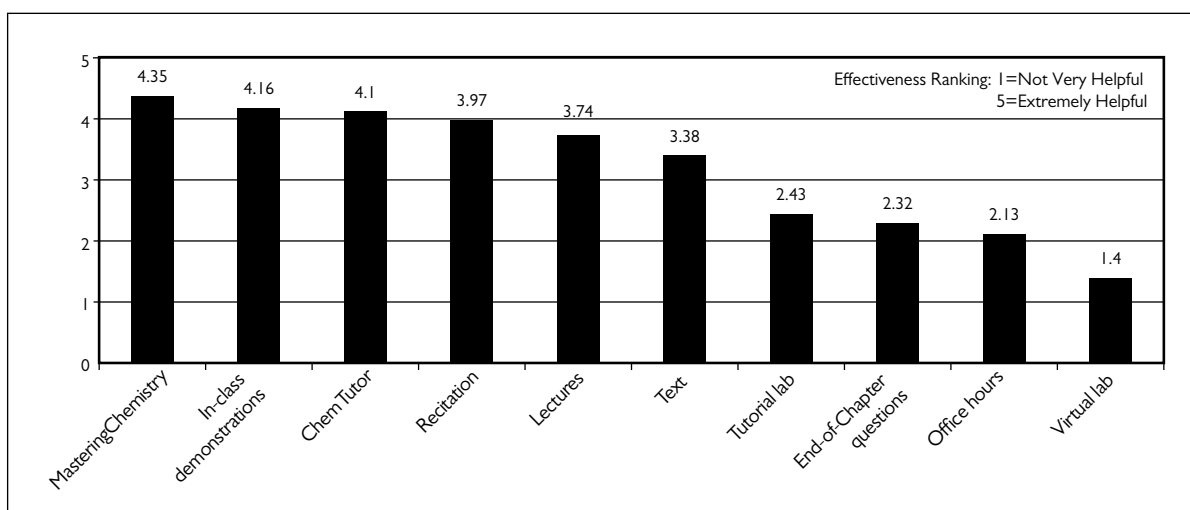


Figure 2. Results of the Student Survey Question: How helpful to you is each of the following [course components] in learning general chemistry? ( $n \approx 450$ )

## Conclusion

Students who use MasteringChemistry are more likely to do their homework—they know it counts toward their final grade and they receive immediate feedback from it, including specifically where they made mistakes. And because students get tutored while doing MasteringChemistry homework, they come to class better prepared and ask much better questions. This enables me to be more flexible in lecture.

We recently completed a textbook adoption cycle during which we reviewed other homework systems. One of the reasons we remained with the Pearson text is that we believe

MasteringChemistry is the best of all the online homework systems we explored. Although other systems may approach parity with the program, MasteringChemistry is ahead of the curve for two reasons: 1) the tutorial problems and the way the students are coached, and 2) the gradebook and better diagnostics data.

In short, I'm a believer. I definitely like this way of teaching—it enables me to spend more time doing research and helping students instead of grading homework.

*Submitted by David V. Dearden  
Brigham Young University*

Product Name [MasteringChemistry](#)  
Course Name [General Chemistry \(two semesters\)](#)  
Credit Hours [Five \(per semester\)](#)

**Key Results** The class average ACS exam score increased from the 64th percentile to the 76th percentile after requiring MasteringChemistry. Students cite MasteringChemistry as the most significant contributing factor to their success.

## Text

*Chemistry: The Central Science*, 11e, Theodore E. Brown, H. Eugene H LeMay, Bruce E. Bursten, Catherine Murphy, Patrick Woodward

## Implementation

General Chemistry is a traditional course taught on campus. It consists of four lecture hours and three lab hours per week over the course of a 15-week semester. MasteringChemistry is a huge part of my course—I spend a minimum of one hour a night designing lessons, monitoring student work, and interacting with students, so I classify the course as hybrid.

I'm what you'd call a *power user* of MasteringChemistry. I've been a MasteringChemistry disciple since I beta tested the program for its 2007 release. It's the best technology implementation I've used in all of my 38 years of teaching.

I want my students to use their textbook, so I cover material in the order that it's presented in class. For every section covered, there's an assignment that clearly directs students to a corresponding textbook section. I try to keep my assignments to 10 problems or fewer and one hour or less per textbook section. Because MasteringChemistry has an amazing database that gives median time-on-task and relative difficulty level based on actual student usage, it's easy to see the time required to complete the assignment. Considering that I cover about 10 chapters per semester, and each chapter has about eight sections that require mastery, my students do about 800 problems per semester. To keep the students on task, I give them two days to complete the assignment without penalty. After that, they lose 25 percent each day they're late.

My assignments begin with tutorials that contain hints and a Socratic approach to helping students who need extra help. Important: I encourage students to use hints! I tell them that outright, and I neither give them extra credit nor penalize them for using or not using hints. This is contrary to the default

setting, but it makes a huge difference to do it my way. Tutorials are followed by several end-of-chapter (EOC) problems with randomization and unit features turned on when available. I give EOC problems for which the answers are not given in the textbook, and I no longer make solution manuals available in the bookstore.

Every night I check the gradebook and look for the students who are struggling, so I can talk to them one-on-one and encourage them to get additional help, ideally from me. When a student comes to me for help, whether during a live office hour or during my evening "office hours," I immediately refer to that student's MasteringChemistry work to make sure that the student has used the hints and to identify his/her misconceptions. The program's diagnostic tools make for much more effective and efficient office hours.

I also look at the class average on a given assignment. If the average falls below 90 percent mastery, I rethink my approach and often reinforce the concept the next day with different examples or graphics.

Another feature I use is the new learning outcomes feature. This is a powerful (and nearly effortless) way to document student mastery of skills that transcend chapters.

## Assessments

80 percent	Exams (five)
16 percent	MasteringChemistry homework
4 percent	Lab

The MasteringChemistry portion is enough credit to motivate students, but not enough to inflate their overall course grade. Almost all students will earn the same course grade with the MasteringChemistry grade included as they would based on exams alone. A few will earn half a grade higher due to the MasteringChemistry grade.

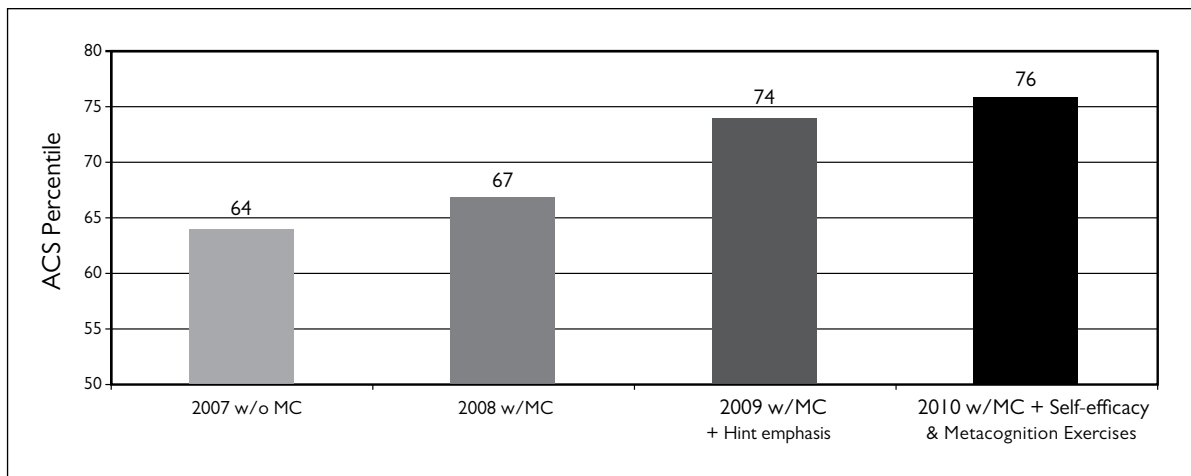


Figure 1. American Chemical Society Exam Score Percentiles before and after MasteringChemistry Implementation, 2007–2010

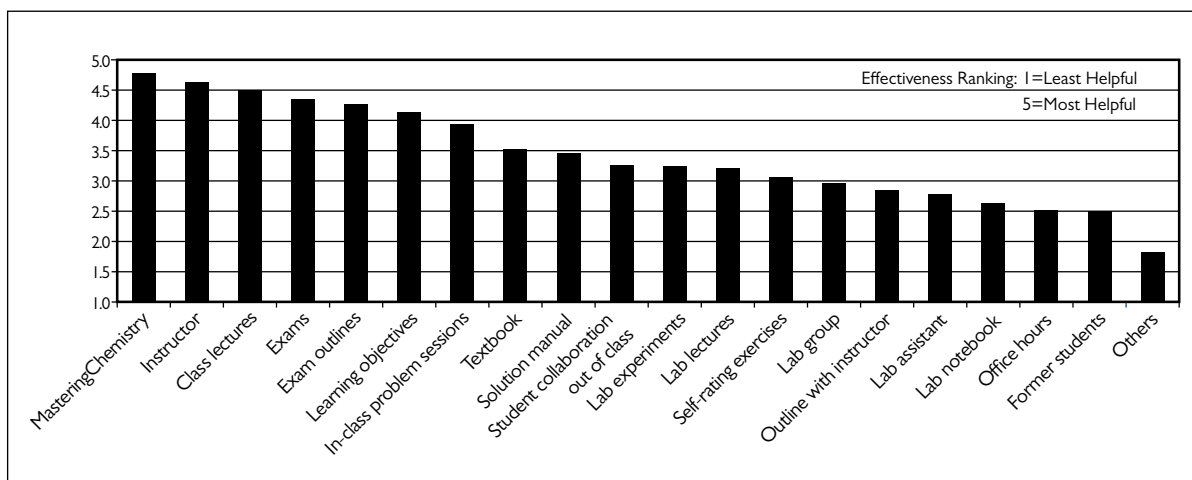


Figure 2. Results of the 2010 Student Survey question: How helpful to you is each of the following [course components] in learning general chemistry? ( $n=75$ )

## Results and Data

I've collected significant qualitative and quantitative data on MasteringChemistry's impact on American Chemical Society (ACS) exam scores, as well as on my students' perception of MasteringChemistry's effect. I give the ACS standardized exam in General Chemistry as my final exam at the end of the second semester of the course. Since adopting MasteringChemistry, my class average has increased from the 64th percentile in 2007 to the 76th percentile in 2010 (see figure 1).

In a student survey that asked students to rate 20 factors that had the greatest impact on their success in the course, students rated MasteringChemistry as the most significant factor (see figure 2). Students definitely recognize that the program has a positive impact on both study habits and performance.

## Conclusion

MasteringChemistry's impact on my course is best illustrated by my favorite success story: A student dropped the class (and would have failed had she not dropped) the year before I used MasteringChemistry. She retook the class the first year I used the program—and earned an A! I had never experienced that kind of turnaround in repeat student performance, and it would not have happened without MasteringChemistry.

*Submitted by Robert Pribush  
Butler University*

Product Name [MasteringChemistry](#)

Course Name [Elementary Chemistry](#)

Credit Hours [Five](#)

**Key Results** Students' homework performance improved after MasteringChemistry was adopted. Homework completion rates are higher, and there is a strong correlation between homework grades and exam grades.

## Text

*Introductory Chemistry, 4e, Nivaldo Tro*

## Implementation

Elementary Chemistry covers the fundamental principles of chemistry, including basic chemistry and problem-solving skills that will help ensure student success in General Chemistry. It is primarily taken by science and engineering students, and is strongly recommended for students who either did not take high school chemistry or who earned a grade of C or less in the high school course. It includes both lecture and lab.

Homework has always been an important part of my course for two reasons: (1) it isn't possible to succeed in a chemistry course without completing a significant number of problems, and (2) the ability to correctly set up and solve problems is an integral component of success in chemistry.

Prior to adopting MasteringChemistry, I administered paper-and-pencil homework, which had to be hand graded. In fall 2009, I adopted *Introductory Chemistry* by Nivaldo Tro, and started using MasteringChemistry. I quickly discovered how beneficial both automated grading and immediate feedback were to my students.

I give one MasteringChemistry homework assignment for each chapter covered. Assignments include end-of-chapter exercises, tutorials, animations, and simulations, and are due one week after the completion of the material in lecture. In the future, I plan to use MasteringChemistry for prelaboratory reading quizzes and, when appropriate, prelaboratory videos on techniques and safety.

*“[MasteringChemistry’s] real-time guidance, when students need it most, has helped to increase both homework completion rates and homework scores.”*

I use the diagnostic information in the MasteringChemistry gradebook to review overall student homework performance and identify students who need encouragement or additional help. I also use the diagnostics to identify those items students find most difficult, as well as their most common misconceptions, to make sure I've addressed those concepts in class.

### Assessments

50 percent	Exams (four)
20 percent	Lab
15 percent	MasteringChemistry homework
10 percent	Problem solving (in-class)
5 percent	Quizzes

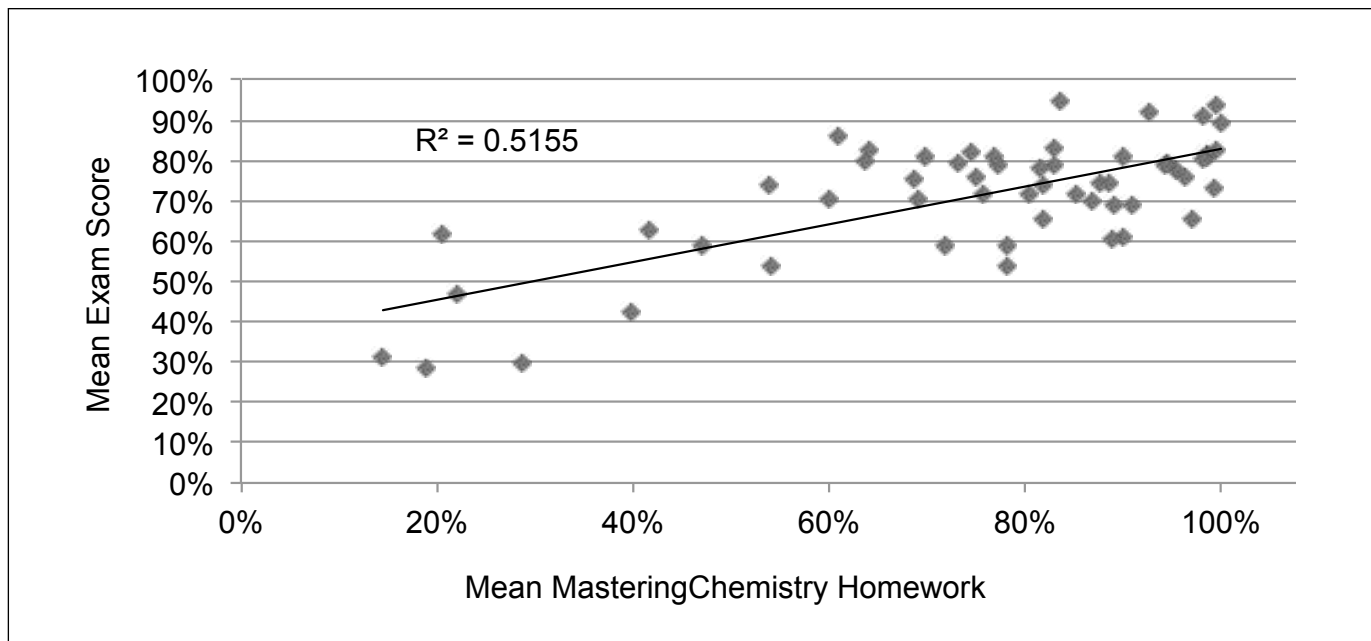


Figure 1. Correlation between MasteringChemistry Homework Scores and the Course Exam Grade, Fall 2011

### Results and Data

After I adopted MasteringChemistry, my students completed more homework, and performed better on their homework. I evaluated the homework results (all homework scores are normalized) and discovered the following:

- 47 percent of students scored at least 70 percent on paper-and-pencil homework (before MasteringChemistry).
- 58 percent of students scored at least 70 percent on MasteringChemistry homework.
- The mean MasteringChemistry homework score for students who received an A, B, or C in the course is 76 percent.
- The mean MasteringChemistry homework score for students who received a D or F in the course is 36 percent.

### The Student Experience

Students appreciate the technology that MasteringChemistry incorporates into the course—they receive immediate feedback, obtain assistance via the hints, and their assignments are automatically graded. This kind of real-time guidance, when students need it most, has helped to increase both homework completion rates and homework scores.

### Conclusion

Student performance has improved, due to the ability of MasteringChemistry to enable both better learning and better assessment than traditional homework. In addition, its automated grading saves me two to three hours a week because I no longer need to hand grade assignments, provide student feedback, and record scores in my gradebook. I spend my new-found time improving the course—reviewing student diagnostic information, modifying course content, and participating in professional development opportunities.

*Submitted by Guy Dadson  
Fullerton College*

Product Name MasteringChemistry

Course Name Introductory Chemistry, Fall 2007

**Key Results** Students demonstrated learning and knowledge transfer, as illustrated by decreasing problem difficulty relative to a problem's position in the assignment.

### Study Design

The students were assigned weekly MasteringChemistry homework. Twelve regular homework assignments were given (except the introductory assignment to MasteringChemistry) to the class, which consisted of about 260 students. The regular homework assignments had about 15 problems on average per assignment and the end-of-chapter (EOC) problems were always assigned after the tutorial problems within an assignment. A two-parameter item response model was fitted to the data scored dichotomously based on whether or not a student obtained the correct answer to a given part of a problem on the first attempt without requesting any help from MasteringChemistry, hence obtaining the difficulty and the discrimination parameters of the problem.

### Results and Data

The difficulty of the problems against its position in the assignment correlates at  $-0.32 \pm 0.09$  on average for 10 homework assignments in which a linear association between problem difficulty and problem order in the assignment can be identified. Thus, the problem difficulty decreases over a given assignment. In other words, problems given later in an assignment are easier than the ones given earlier. See figures 1 and 2.

It is highly plausible that the decrease in problem difficulty is due to an overall effect of learning within a given assignment. The instructor followed the best practice recommendations given in MasteringChemistry and selected a roughly equal number of tutorials and EOCs as much as feasible within an assignment. The tutorial and EOC problems were selected so that they covered important parts of each chapter. Although the 1 (easy) through 5 (hard) difficulty scale was not used by the instructor in selecting the problems from the MasteringChemistry's item library, the problems selected mainly fell in the difficulty range 1–3. Even if the EOC problems (that were assigned at the end of an assignment) were inherently easy, the general negative correlation does not explain the decrease in difficulty we see among the tutorial problems along the order.

Since the instructor did not consciously select problems in decreasing order of difficulty within an assignment, it is reasonable to infer that on average we see a learning effect from one problem to the next within an assignment. The average decrease in difficulty per problem within an assignment is  $-0.26 \pm 0.13$ . Thus, the difficulty of the next problem within an assignment effectively decreases by about 0.26 standard deviations. Since the student skill and the problem difficulty are placed on the same standard deviation scale in an item response model, this also suggests that the increase in skill from one problem to the next within an assignment is about 0.26 standard deviations.

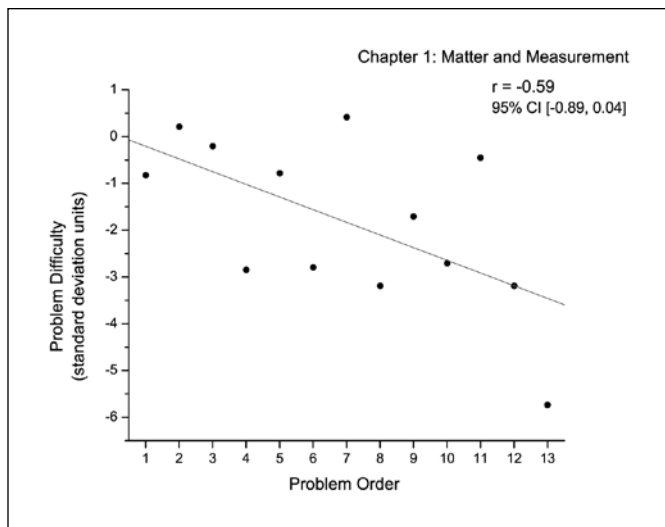


Figure 1. The difficulty of the problems decrease along the order in the assignment: Chapter 1 of Brown/LeMay/Bursten (Introduction: Matter and Measurement). The problem difficulty is reported on a standard deviation scale. A single-part problem with difficulty -1 means that a student who is one standard deviation below average in skill has a 50% chance in successfully answering the problem on first attempt.

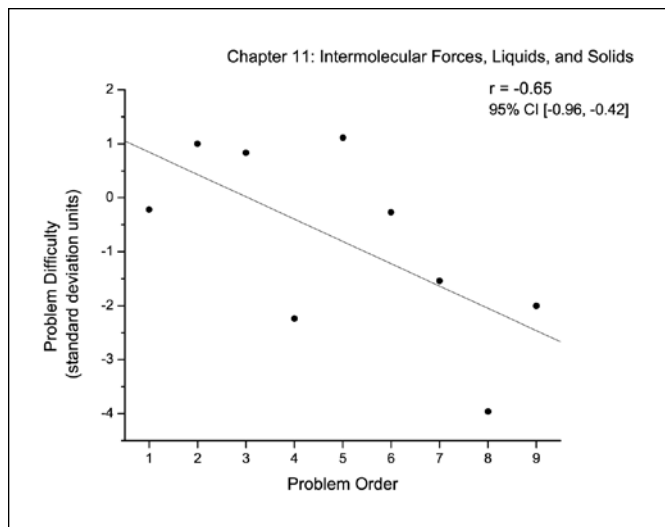


Figure 2. The difficulty of the problems decrease along the order in the assignment: Chapter 11 of Brown/LeMay/Bursten (Intermolecular Forces, Liquids, and Solids). The problem difficulty is reported on a standard deviation scale. A single-part problem with difficulty -1 means that a student who is one standard deviation below average in skill has a 50% chance in successfully answering the problem on first attempt.

With acknowledgments to Prof. Randall W. Hall and Prof. Leslie G. Butler, Louisiana State University.

## Conclusion

In 10 of the 12 regular assignments given in MasteringChemistry, a linear decrease in problem difficulty occurs, with the earlier problems in an assignment being more difficult than the later problems. The average correlation between the problem difficulty and its order within an assignment is  $-0.32 \pm 0.09$  while the decrease in difficulty from one problem to the next is  $-0.26 \pm 0.13$  standard deviations. Hence, the learning effect attributable to a problem is about 0.26 standard deviations.

Product Name **MasteringChemistry**

Course Name **General Chemistry II**

Credit Hours **Four**

**Key Results** Students are able to tackle more-complex problems using MasteringChemistry. This, in turn, helps them to achieve higher rates of success both on ACS standardized exams and in the course.

## Text

*Chemistry*, 5e, John E. McMurry and Robert C. Fay

## Implementation

General Chemistry II is a continuation of General Chemistry I and is primarily taken by science and engineering majors who plan to transfer to a four-year school. Topics covered include solution chemistry, thermodynamics, kinetics, acids and bases, chemical equilibrium, electrochemistry, nuclear reactions, and coordination chemistry. Laboratory experiments are designed to correlate with lecture material. I administer the national American Chemical Society (ACS) second semester (ST) and the full term (GC) examinations as the final examination for the course.

I've found issues with giving paper-and-pencil homework, such as students copying the answers from the solutions manual or being unsure how to start a problem so they don't attempt it. I adopted MasteringChemistry to provide homework with guided help, hints, and instant feedback so students would know how they are doing and where they need to focus their efforts.

My MasteringChemistry homework is a mix of tutorials and end-of-chapter problems. I divide the lecture for a chapter into two class periods and give one homework assignment at the beginning of a chapter and an additional homework assignment to cover the end of the chapter. I'm able to assign problems of various levels of difficulty and offer harder problems for extra credit, which enables stronger students to advance their skills.

## Assessments

38 percent Exams

22.5 percent Quizzes

20 percent Final exams

13 percent Lab

6.5 percent MasteringChemistry homework

## Results and Data

Since implementing MasteringChemistry in 2010, I've seen positive results in several areas. Our success rate (A/B/C) from 2001 to 2009 in General Chemistry II averaged 62 percent. During the three years we've been using MasteringChemistry, the success rate has increased to 74 percent (see figure 1).

In addition, scores on the both of the ACS standardized exams have increased, resulting in students achieving a much higher exam percentile in 2011 and in 2012 (see figures 2 and 3).

I also compared the average student grade point average to the ACS exam percentile achieved, and discovered that the ACS exam-percentile increases have outpaced average student-GPA increases over the same period (see figure 4).

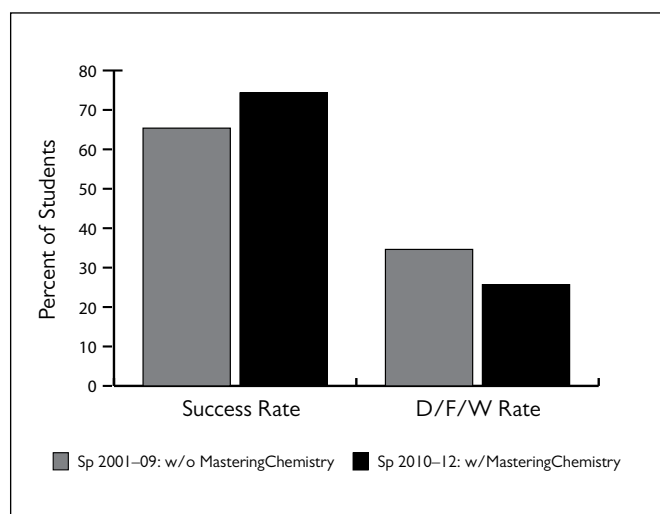


Figure 1. General Chemistry II Success and D/F/W Rates before and after MasteringChemistry Adoption, Spring 2001–Spring 2012



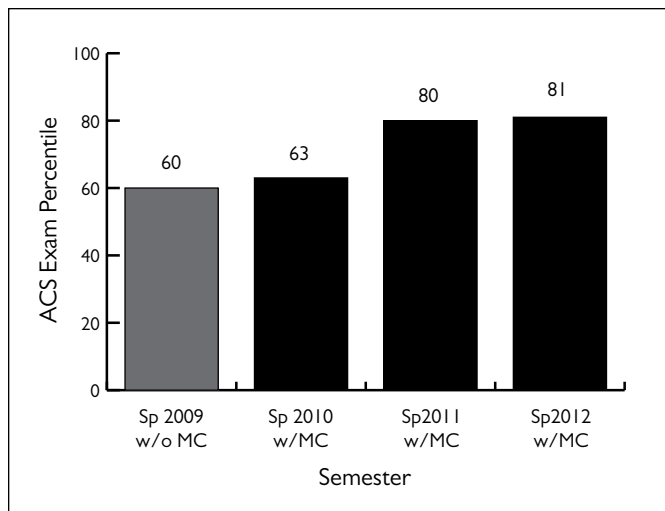


Figure 2. ACS Second-Term General Chemistry II Exam Score Percentiles before and after MasteringChemistry Adoption, Spring 2009–Spring 2012

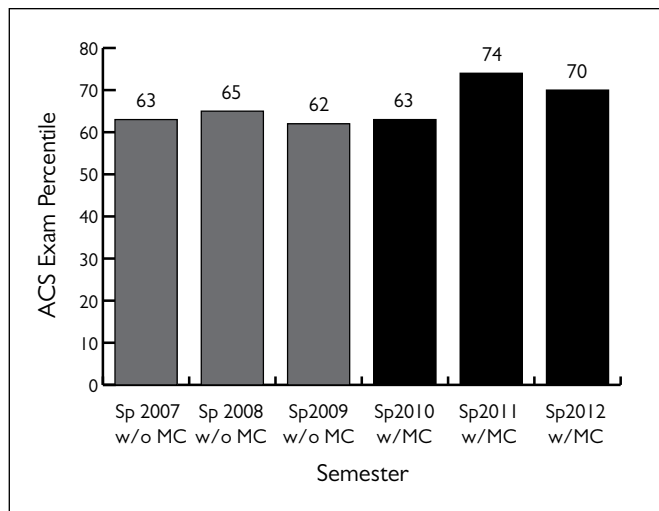


Figure 3. ACS Full-Year General Chemistry II Exam Score Percentiles before and after MasteringChemistry Adoption, Spring 2007–Spring 2012

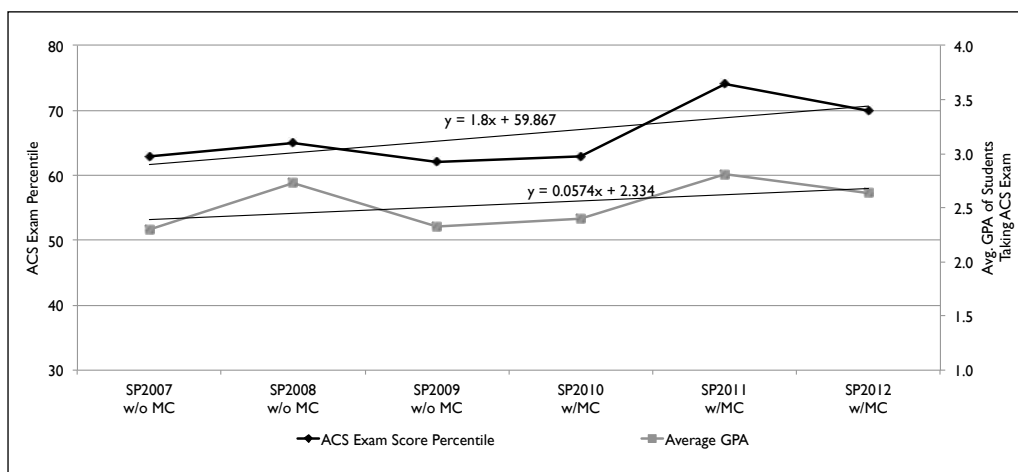


Figure 4. Correlation between ACS Full-Year General Chemistry II Exam Score Percentile and Course GPA before and after MasteringChemistry Adoption, Spring 2007–Spring 2012

## The Student Experience

Students believe that MasteringChemistry helps them to succeed in the course. Some of the feedback I have received includes:

- *“I really enjoyed [MasteringChemistry]. It seemed like there was a natural progression to the ideas presented that made going from one problem into the next less daunting. It made partial problems out of the steps in calculation so I always felt I was on the right track.”*
- *“I actually really liked it! The homework allowed me to better understand the lecture material, and the program’s repetition proved beneficial when I was trying to master concepts.”*

## Conclusion

MasteringChemistry helps students grasp the more-complex problems and concepts they’ll need in an advanced general chemistry course. Students like how the program walks them through complex problems and offers help when and where they need it. Because students utilize these resources to gain a deeper understanding of course content they do better both in the course and on the ACS exams, which helps set them up for success as they continue on their educational path.

*Submitted by Steven Socol  
McHenry County College*

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
<b>TOTAL</b>	<b>1,200</b>	

## 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.

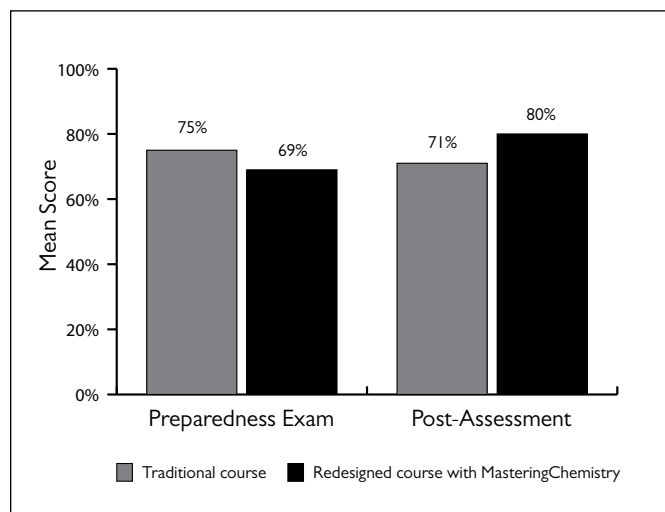


Figure 1. General Chemistry I Mean Preparedness Exam and Post-Assessment Scores in the Traditional and Redesigned Course Formats, Fall 2012.

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.

*Submitted by Klaus Woelk and Emma Lou Satterfield  
Missouri University of Science and Technology*

Product Name **MasteringChemistry**

Course Names **General Chemistry I and II**

Credit Hours **Four (each)**

**Key Results** Adding prelecture MasteringChemistry assignments facilitated increased student preparedness and engagement and enabled more time for interactive learning.

### Text

*Principles of Chemistry: A Molecular Approach*, 2e, Nivaldo J. Tro

### About the Course

General Chemistry I and II is a two-course sequence that covers the fundamental principles and laws of chemistry. Upon completion, students should be able to demonstrate an understanding of fundamental chemical laws and concepts as needed to pursue further study in chemistry and related professional fields. These are college transfer courses that include both lecture and lab components.

### Course Redesign

Our school serves many nontraditional students. The goal of the course redesign was to address the issue of underprepared students and to provide a resource for remediation outside the classroom.

We implemented the Supplemental model developed by the National Center for Academic Transformation. This model retains the basic structure of the traditional course and supplements lectures and textbooks with technology-based, out-of-class activities, or changes what goes on in the classroom by creating an active learning environment within a large, lecture hall setting.

From our experience in this departmentwide redesign, we identified the following best practices:

- Involve faculty as part of the planning team.
- Communicate redesign goals and keep faculty communication channels open.
- Set a timeline and include benchmarks to ensure the process continues to move forward.

- Provide students with start-up guidance, information for technical support, and an explanation of the value of Mastering.
- Reinforce the value of doing assignments before lecture.

### Implementation

Starting fall 2012, we implemented Mastering in Anatomy and Physiology I and II, General Biology I and II, General Chemistry I and II, and Microbiology. We added Mastering to Introductory Physics in spring 2013.

Instructors are required to assign prelecture homework, but have flexibility with regards to the assigned content. The majority of instructors give weekly Mastering assignments that include both tutorial and end-of-chapter questions.

Instructors report that the automated grading in Mastering makes it easier to assign graded homework and to understand where students need help. Beginning spring 2013, we added student learning outcomes to our Mastering homework to (1) facilitate a better understanding of student course and program performance and (2) inform decisions on course changes.

### Assessments

50 percent	Lecture exams
15 percent	Final exam
15 percent	MasteringChemistry homework
15 percent	Lab (participation, reports, practicals, exams)
5 percent	Other

*“I like the hints... sometimes I just need a nudge to get the right answer.”*

—Student

## Results and Data

I analyzed the course results for General Chemistry I and II and found the following:

- For the fall 2012 General Chemistry I class, 21 percent of students using MasteringChemistry earned a final course grade of A, compared to 17 percent and 0 percent the prior two semesters without MasteringChemistry (fall 2012,  $n=39$ ; spring 2012,  $n=16$ ; fall 2011,  $n=27$ ).
- For the fall 2012 General Chemistry I class, students who earned an A or B in the course averaged 95 percent on their MasteringChemistry homework.
- For the fall 2012 General Chemistry I class, students who earned a C, D, or F in the course averaged 60 percent on their MasteringChemistry homework.
- For the spring 2013 General Chemistry II class using MasteringChemistry, 65 percent of the students earned an A or B in the course, compared to 50 percent the prior semester without MasteringChemistry (spring 2013,  $n=20$ ; spring 2011,  $n=22$ ).

## The Student Experience

Students like the opportunity to walk through content prior to lecture, are more engaged in learning, and are more prepared for class. Students also feel that Mastering helped them understand the course material.

Student comments include:

- “I liked the extra attempts it allows to complete a question as well as the hints section. If you understand the problem but need assistance with one step, the hints option breaks down the process of the step you may not understand.”
- “What I liked about Mastering was that I could look at what information I needed to before any and all tests. I could learn at my own pace.”

## Conclusion

We redesigned our science courses adding Mastering to provide students with a tool to help them prepare for class and get help when they need it the most. Prelecture homework assignments engage students in course content outside of class and better prepare them for lecture. This in turn enables us to increase the amount of interactive learning and critical thinking activities during class.

*Submitted by Louis McIntyre, Science Department Chair  
Robeson Community College*

Product Name **MasteringChemistry**Course Name **General Chemistry, Fall 2008**

**Key Results** Assigning MasteringChemistry had a significant, positive impact on student performance as measured by exam scores. The improvement was seen for students at each of the score quartiles.

### Study Design

In the years 2004–07 online homework was not used in General Chemistry courses. In fall 2008 MasteringChemistry was introduced for credit for online homework in the course. Historical comparisons were feasible since the course coverage and instructional components were comparable over the years. Fall semester final exam scores for the years 2004, 2005, 2007 (without MasteringChemistry), and 2008 (with MasteringChemistry) were compared for students who completed the course within a given semester.<sup>1</sup> The number of students in the course in a given year ranged from 912 to 1,125.

### Results and Data

Students who used MasteringChemistry in fall 2008 showed an improvement of 0.5 in effect size in the final exam in comparison to the years 2004, 2005, and 2007, in which MasteringChemistry was not used. The average student who used MasteringChemistry in 2008 is at the 69th percentile. In terms of percentile points, there is a 19-percentile-point improvement in the final exam score, on average, when students were assigned homework in MasteringChemistry.<sup>2</sup> See figure 1.

More remarkable, students at each of the score quartiles (25th, 50th, and 75th percentiles) were positively affected by the use of MasteringChemistry in fall 2008 relative to the previous

years. In particular, the probability that a student at the 25th percentile of the class would obtain a final exam score of 50 or above is 81%. That probability is less than 50% in the previous years (42% in 2004, 26% in 2005, and 17% in 2007) in which MasteringChemistry was not used. See figures 2–4.

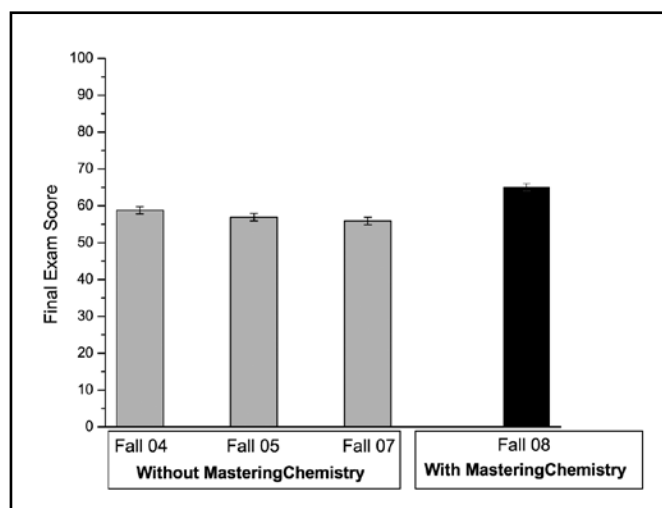


Figure 1. The final exam score (historical) comparisons of students who did not use MasteringChemistry in the years 2004, 2005, and 2007 to students who used MasteringChemistry in 2008. The errors shown are the 95% confidence interval of the standard error of the mean. The final exam scores are scaled to a maximum of 100%.

<sup>1</sup> The difficulty levels of the final exams across the years were assumed to be comparable. This is a reasonable assumption though it cannot be rigorously proven. The fall 2006 final exam scores were lower by about 0.6 standard deviations compared with the other non-MasteringChemistry years 2004, 2005, and 2007, and hence are not included in the analysis. According to the instructor, this may be due to an ice storm that hit the campus area on the day of the first exam, which led to its cancellation. This also deprived students from study for about two weeks. Though the ice storm did not occur

during the final exam, it may have had a ripple effect as reflected in the low final exam scores. The lower scores in 2006 may further support the argument that the final exams had comparable difficulties, since an easier exam to compensate for the ice storm would not have resulted in such a decrease.

<sup>2</sup> It is difficult to adjust the observed effect size (0.5) for individual teacher influences in 2008 over and above teacher effects for the years 2004, 2005, and 2007. According to some research findings an effect size of about 0.2 is attributable to the teacher in a traditional

classroom setting, while various other teacher influences such as reinforcement, peer tutoring, class environment, and questioning would result in an average effect size of about 0.4 (Ref: Influences on student learning, J. Hattie, Inaugural Professional Lecture, University of Auckland). Thus, if the latter teaching methodologies were employed in 2008 in addition to the traditional settings in the previous years the teacher effect would account for 0.2 of the observed effect size. The resulting effect size attributable to MasteringChemistry would then be about 0.3, which would place the average student at the 62nd percentile.

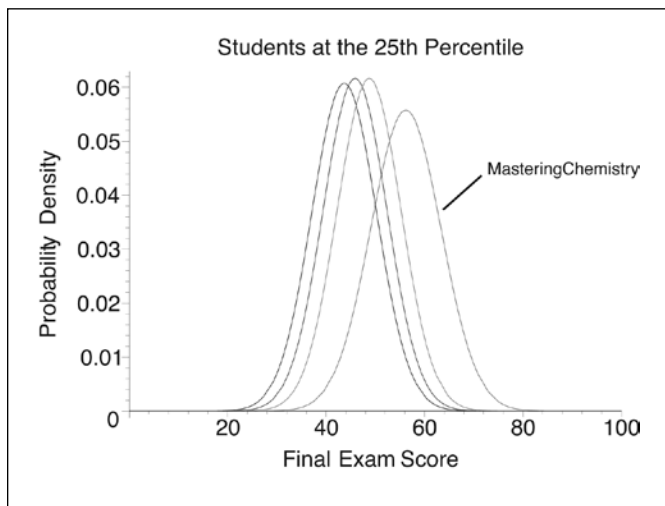


Figure 2. The final exam score (probability) distributions for a student at the 25th percentile. The probability that a student at the 25th percentile of the MasteringChemistry class in 2008 would obtain a score of 50 or above is 81%. That probability is less than 50% in the previous years (42% in 2004, 26% in 2005, and 17% in 2007) in which MasteringChemistry was not used. Graph legend: MasteringChemistry (2008) is on the far right. The remaining years (2004, 2005, and 2007) are on the left.

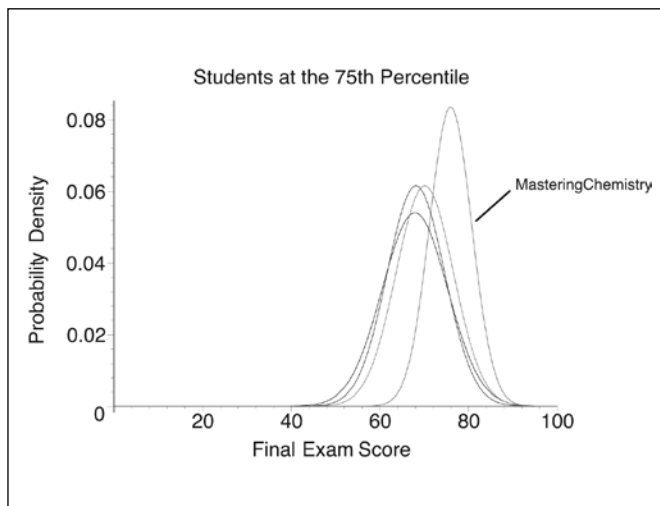


Figure 4. The final exam score (probability) distributions for a student at the 75th percentile. The probability that a student at the 75th percentile of the MasteringChemistry class in 2008 would obtain a score of 85 or above is 3%. That probability is three times as less in the previous years (1% in 2004, 0.5% in 2005, and 1% in 2007) in which MasteringChemistry was not used. Graph legend: MasteringChemistry (2008) is on the far right. The remaining years (2004, 2005, and 2007) are on the left.

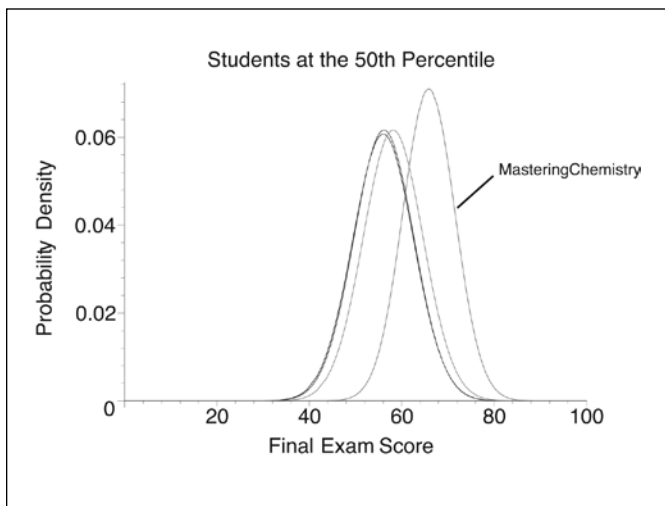


Figure 3. The final exam score (probability) distributions for a student at the 50th percentile. The probability that a student at the 50th percentile of the MasteringChemistry class in 2008 would obtain a score of 70 or above is 23%. That probability is less than 10% in the previous years (3% in 2004, 2% in 2005, and 2% in 2007) in which MasteringChemistry was not used. Graph legend: MasteringChemistry (2008) is on the far right. The remaining years (2004, 2005, and 2007) are on the left.

## Conclusion

The use of MasteringChemistry in the General Chemistry course in fall 2008 resulted in 0.5 effect size score gains in the final exam. The average student who used MasteringChemistry can be placed at the 69th percentile in relation to the previous years' score distributions in which MasteringChemistry was not used. Through an observational study, the attribution of score improvements to MasteringChemistry is supported by the observation that the final exam score distributions (mean and variance) remained stable in the years 2004, 2005, and 2007 in which MasteringChemistry was not used. Students at each score quartile were positively affected by the use of MasteringChemistry. For example, the probability that a student at the 25th percentile of the class would earn a final exam score of 50 or above is 81%. That probability is less than 50% in the previous years in which MasteringChemistry was not used. Thus, students who were less skillful or were at risk of failing the course were positively affected by the use of MasteringChemistry. Similarly, a student at the 75th percentile who has used MasteringChemistry has three times as much chance of scoring above 85 than a student at the same percentile level who did not use MasteringChemistry.

With acknowledgment to Prof. Valerie Frerichs, University at Buffalo, State University of New York.

Product Name **MasteringChemistry**

Course Name **Physical Chemistry I and II**

Credit Hours **Three**

**Key Results** Students practice more problems, come to class better prepared, and score higher on exams.

### Text

*Physical Chemistry, 2e*, Thomas Engel and Philip Reid

### Implementation

Physical Chemistry I and II is a two-semester sequence covering quantum chemistry and molecular orbital theory, thermodynamics and statistical mechanics, kinetics and reaction dynamics, and spectroscopy. The sequence is taken primarily by chemistry majors. A one-credit lab is taken concurrent with Physical Chemistry II.

I had two problems in both General Chemistry and Physical Chemistry: lack of teaching assistants (TAs) and lack of time to grade homework and provide individual assistance to students. I first used MasteringChemistry in General Chemistry and I loved it immediately. It provided my students with feedback and graded homework that they wouldn't otherwise get in these courses, particularly without TAs.

I assign one prelecture MasteringChemistry assignment a week. Assignments comprise a mix of tutorial and end-of-chapter questions. Since the homework is automatically graded and students receive feedback as they work through the problems, students come to class better prepared and with a clearer understanding of what they know and what they don't know.

In addition, the gradebook's diagnostics help me identify the concepts students struggle with the most, so I can cover them in more detail during lecture. I also assign problems in MasteringChemistry that address concepts important to future success, but that I don't have time to cover in class.

### Assessments

50 Percent	Exams (four)
30 Percent	Final exam
10 Percent	MasteringChemistry homework
10 Percent	Quizzes

### Results and Data

I analyzed the course results for both Physical Chemistry I and II before and after implementing MasteringChemistry and found the following:

- For the final course grade for Physical Chemistry I, there was a combined seven percentage point increase in As and Bs (see figure 1). Every Physical Chemistry II student earned a final course grade of A, B, or C.
- The average MasteringChemistry score for students earning an A on the final exam in Physical Chemistry I and II was 96 percent and 94 percent, respectively.
- The average MasteringChemistry score for students earning an F on the final exam in Physical Chemistry I was 62 percent.



*“[After implementing MasteringChemistry] every Physical Chemistry II student earned a final course grade of A, B, or C.”*

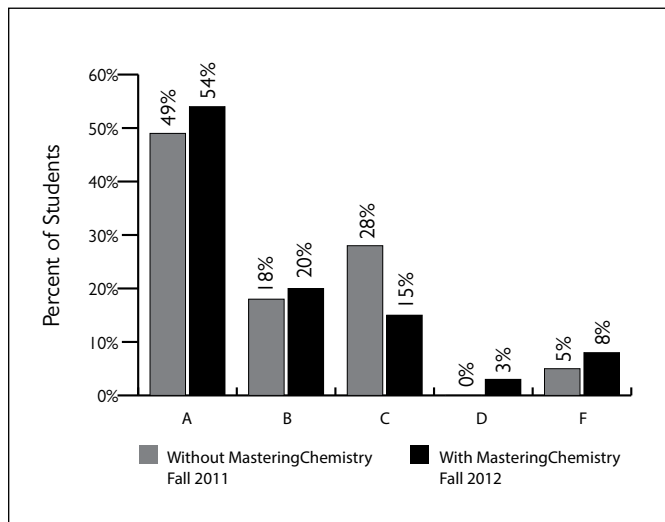


Figure 1. Physical Chemistry I Course Grade Distributions (Fall 2011  $n=39$ , Fall 2012  $n=39$ )

The results also show that more students earned an A, B, or C on the final exam in both Physical Chemistry I and II; no students earned lower than a C in Physical Chemistry II.

- 82 percent of students earned an A/B/C on the final exam in Physical Chemistry I with MasteringChemistry compared to 72 percent of students who earned an A/B/C without MasteringChemistry.
- 100 percent of students earned an A/B/C on the final exam in Physical Chemistry II with MasteringChemistry compared to 91 percent who earned an A/B/C without MasteringChemistry.

### The Student Experience

Students report that they like using MasteringChemistry for homework and that the program's interactive tutorials and immediate feedback help them stay focused on what they need to study.

### Conclusion

Frequent problem-solving practice with feedback is critical to student success. Since MasteringChemistry grades the homework and provides error-specific feedback, I'm able to offer students more opportunities to practice, to identify the content they need to study, and to learn the content I'm not able to cover in class.

*Submitted by Nathan Hammer  
University of Mississippi*

Product Name **MasteringChemistry**

Course Name **Principles of Chemistry**

Credit Hours **Three**

**Key Results** By completing MasteringChemistry tutorial homework assignments and timed end-of-chapter quizzes, students learned course content and improved their test-taking skills, resulting in an increase in As, Bs, and Cs.

### Text

*General Chemistry: Principles and Modern Applications*, 10e,  
Ralph H. Petrucci, F. Geoffrey Herring, Jeffrey D. Madura,  
Carey Bissonnette

### Implementation

This is a traditional face-to-face class with a lecture and lab. Nearly all science majors and a large portion of engineering students take this course. As a result, classes are a melting pot of experiences and attitudes—from chemistry majors to students who dread chemistry.

In 2007, my first semester teaching the course and my first semester using MasteringChemistry, I gave students 8 percent credit for MasteringChemistry homework. In 2009, I increased the course credit for MasteringChemistry to 10 percent.

I give one MasteringChemistry homework assignment each week and specifically choose tutorial-type questions, since I want struggling students to see the homework assignments as instructive and real practice. (Plus, some of them are fun!) Students don't lose points for hints, but can earn bonus points if they answer a question correctly without using hints.

From 2007 to 2009, I received complaints after the first midterm. Students said they did well on the homework assignments and did the practice exam, but didn't do well on the midterm. Looking over their midterms, I saw that these students lost significant points because they ran out of time. They hadn't learned time management as it pertains to testing versus studying and were unaware of how long it took them to complete a question.

I reviewed the MasteringChemistry time diagnostics with my students. Some were shocked to find out that they sometimes spent more than 20 minutes on a single problem (that other students finished in less than 10 minutes). Students were studying hard, but weren't taking into account the ticking-clock factor of timed tasks like the midterm.

In fall 2010, I changed the grading system on midterms and the final exam. I now use a "one-point-per-minute" rubric to indicate to students how they should budget their time. For example, a five-point problem should take the average student about five minutes to complete. For an 80-minute midterm, I assign 50 points to allow plenty of extra time for slower students or to review and revise answers. I also changed from giving three midterm exams to giving two.

My final change was introducing a MasteringChemistry timed quiz, approximately one and a half weeks before the first midterm. I simulate a dry-run for the test by selecting three problems from the end-of-chapter questions. Students have exactly 30 minutes to complete the quiz, which is made available for 24 hours on a predetermined date. I use the time diagnostic in MasteringChemistry to ensure that the average student can feasibly finish within that time frame.

I implemented the first timed quiz in October 2010. Student comments on the very next day were exactly as predicted—overwhelmingly, it was an eye-opening experience for them. The class average on the quiz was only 45.3 percent, with most completing the first question but getting only about halfway through the second. In 2011 in response to popular demand from students, I added a second timed quiz before the second midterm. This second quiz was treated like a real practice run for the second midterm.

### Assessments

30 percent	Final Exam
30 percent	Midterms
25 percent	Lab
10 percent	MasteringChemistry homework and quizzes
5 percent	Participation

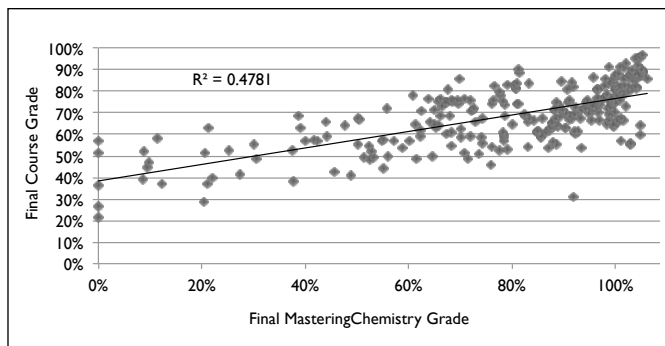


Figure 1. Correlation between MasteringChemistry Homework and Quiz Scores and Final Course Grades, 2007 ( $n=263$ )

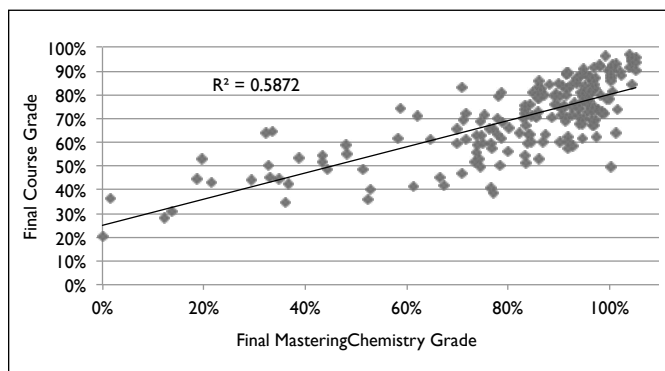


Figure 2. Correlation between MasteringChemistry Homework and Quiz Scores and Final Course Grades, 2011 ( $n=193$ )

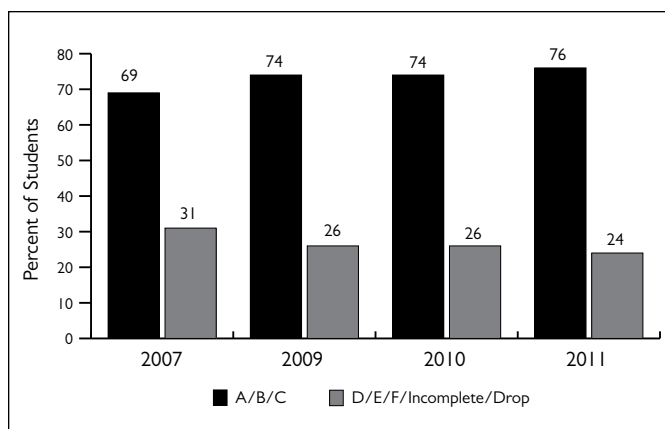


Figure 3. Principles of Chemistry Success Rates, 2007, 2009–11

## Results and Data

The combination of tutorial and timed end-of-chapter questions helps students learn, understand, and practice the course materials. The timed quizzes allow students to simulate actual test conditions and better prepare for the midterms and the final exam.

In analyzing the results from fall 2011, when students had both assigned MasteringChemistry homework and a timed MasteringChemistry quiz prior to each midterm, I found that the correlation of their MasteringChemistry grade to the final course grade was stronger than in prior years (see figures 1 and 2). In addition, during this period of time, I saw an increase in As, Bs, and Cs—a seven percentage-point increase in success rates, and a decrease in Ds, Es, Fs, and incompletes (see figure 3).

## The Student Experience

MasteringChemistry is an integral part of a course that is indispensable to my students. Student evaluation comments are largely positive towards the program—they mention its ease of use, the availability of hints, and the step-by-step breakdown of the questions. Their comments include:

- “MasteringChemistry assignments were quite helpful since they were a step-by-step way to go through all the subject matter during the week. The assignments were challenging enough, but not too strict in terms of marks.”
- “The timed MasteringChemistry quiz was a major wake-up call! I had no idea how long I was taking to solve problems. It really opened my eyes and helped me prepare for exams.”

## Conclusion

When I was hired to teach the course, MasteringChemistry was already in use by other faculty so I chose to “play along” and use it in my sections, as well. I quickly realized the value of the program.

I care deeply about my students’ performance and want each of them to succeed, but increasing class sizes make it impossible to have meaningful one-on-one contact with every single one. The most beneficial aspect of MasteringChemistry is its tutorial nature—students can read, learn, practice course problems, and seek help via hints when they are struggling. It’s as close as a computer program can get to me sitting beside them while they’re studying.

Submitted by Kathy-Sarah Focsaneanu  
University of Ottawa

Product Name **MasteringChemistry**

Course Names **General Chemistry I and II**

Credit Hours **Three**

**Key Results** Redesigning the general chemistry course to increase the level of student problem solving via the use of MasteringChemistry, clickers, and collaborative activities resulted in higher exam scores and increased student success rates.

## Text

*Chemistry: A Molecular Approach (Custom), 2e*, Nivaldo Tro

## Implementation

General Chemistry I and II are taken primarily by doctorate of pharmacy students, as well as by some biology, physical therapy, and other health science majors. General Chemistry I is offered in the fall; General Chemistry II is offered in the spring. A one-credit lab is taken concurrent with each course.

In 2002, we embarked on a redesign of the school's general chemistry courses. Our goal was to improve our students' problem-solving skills by providing more course structure via a combination of technologically enhanced learning and hands-on collaborative activities. To that end, we developed a model of instruction that introduced gradual increments of learning through activities and problem solving. Course changes have been implemented over time and include:

- 2002/03—Implemented mandatory group problem solving in recitation. Students were placed in mixed-ability groups assigned by the instructor. Homework was not mandatory.
- 2004/05—Made paper-and-pencil homework mandatory.
- 2006/07—Switched from paper-and-pencil homework to online homework and quizzes.
- 2010—Tested personal response system (clickers).
- 2010/11—Adopted MasteringChemistry for online homework, and implemented clickers as part of the participation grade.

We adopted MasteringChemistry because we believe that its tutorials engage students, help them learn the material, and remediate course concepts. In addition, our instructors can use its diagnostic feature to assign problems with increasing difficulty (instructional scaffolding).

The other piece of our redesigned model is a collaborative recitation activity in which students are put in preassigned groups of three to five students and asked to solve higher-level problems. General Chemistry I groups are determined by math SAT scores; General Chemistry II groups are determined by General Chemistry I grades. Undergraduate teaching assistants and instructors are available for guidance, but not answers.

## Assessments

Course assessments are established by the instructor and vary. Each of the three full-time instructors requires MasteringChemistry homework assignments that include both tutorials and end-of-chapter questions.

Depending on the instructor, the use of MasteringChemistry contributes 6–10 percent to a student's final course grade.

## Results and Data

After evaluating the data from each year a course change was implemented, we discovered the following:

- Exam averages improved from fall 2002 to spring 2011, while the difficulty level of exam questions increased. The largest increase occurred in 2010/11—the year we adopted MasteringChemistry and began using clickers (see figure 1).
- Exam grade distribution improved from fall 2002 to spring 2011—more students earned As, Bs, or Cs; fewer students earned Ds and Fs. The highest percentage of A/B/Cs was earned in 2010/11—the year we adopted MasteringChemistry and began using clickers (see figure 2).

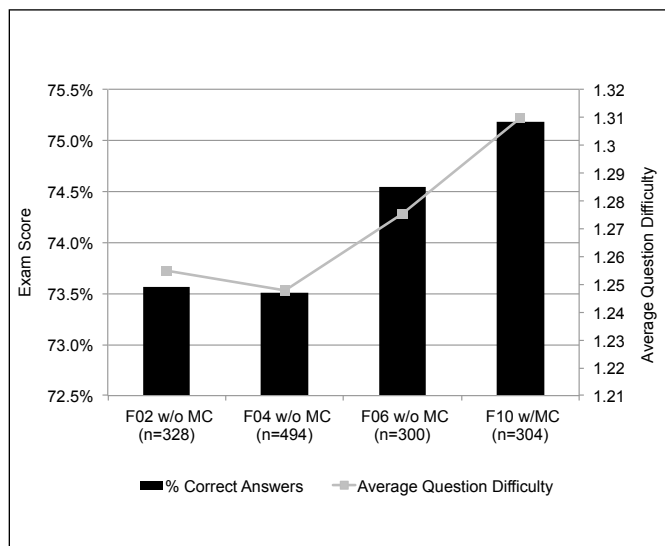


Figure 1. General Chemistry I Exam Score and Question Difficulty before and after MasteringChemistry Adoption, Fall 2002–Fall 2010

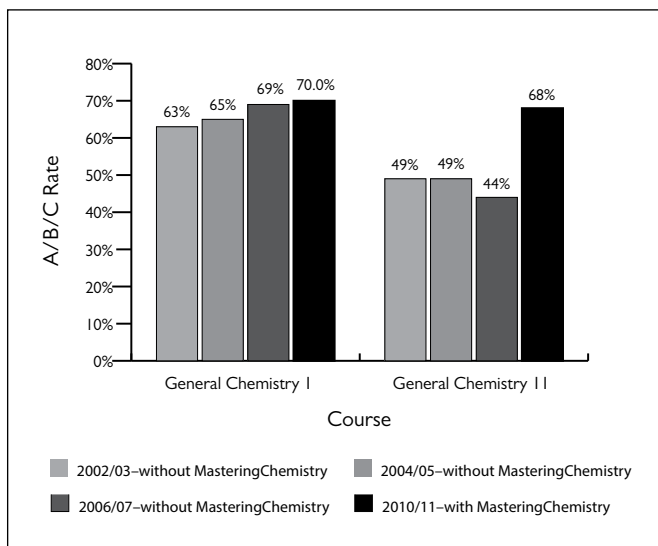


Figure 2. General Chemistry I and II A/B/C Rates, 2002–2011

## The Student Experience

We administered the Student Assessment of Learning Gains (SALG) survey at the end of fall 2010. The results were overwhelmingly positive.

- More than 80 percent of students perceived improvement in learning through the use of MasteringChemistry.
- More than 96 percent of students perceived improvement in problem-solving through the use of MasteringChemistry.
- Students reported that MasteringChemistry was the most helpful resource in the class (see figure 3).

Open survey comments included the following:

- “MasteringChemistry assignments helped me practice chemistry problems and retain the information better prior to the exams.”
- “The online lecture quizzes were nice. The questions pertained to the lectures, and the number of questions and time allotted to complete them was reasonable.”

## Conclusion

MasteringChemistry is helping us to build a learning scaffold and to engage students both in and outside of the classroom. We’ve seen our students’ problem-solving skills improve and are committed to continuing to improve them and other student learning outcomes.

As part of the ongoing evaluation of our redesign, future plans include reviewing individual-instructor implementation and assessment.

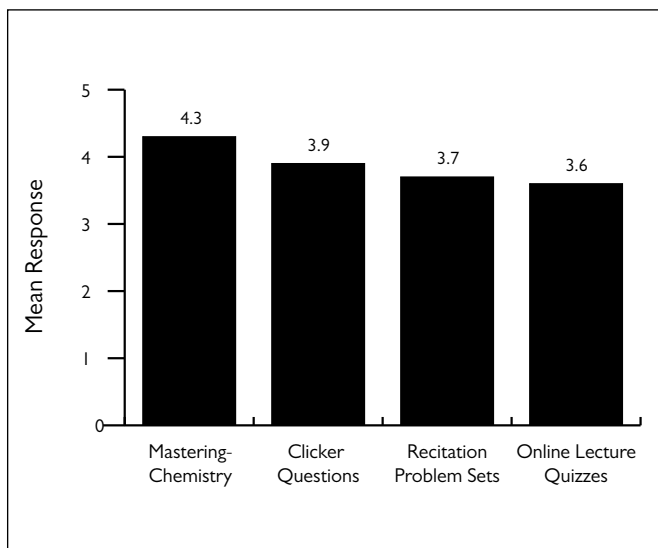


Figure 3. Mean Student Survey Responses to the Question, “How much did each of the following resources help your learning?” Fall 2010

1=Not Helpful, 5=Extremely Helpful

Submitted by Madhu Mahalingam,  
Elisabetta Fasella,  
and Elisabeth Morlino  
University of the Sciences in Philadelphia

Product Name **MasteringChemistry**

Course Name **General Chemistry I**

Credit Hours **Three**

**Key Results** Students' MasteringChemistry homework scores have a strong, positive correlation with final course grades. Retention has increased, and more students are earning a final course grade of A or B.

### Texts

*Chemistry: A Molecular Approach*, 1e, Nivaldo J. Tro (2010)

*Chemistry, The Central Science*, 11e, Theodore E. Brown, H. Eugene LeMay, Bruce E. Bursten, Catherine Murphy, and Patrick Woodward (2011)

### Implementation

This lecture course is an introduction to matter and energy, atomic structure, nomenclature, chemical equations, stoichiometry, gases, thermochemistry, quantum chemistry, bonding, molecular geometry, oxidation-reduction, liquids and solids, and solutions. Its corresponding lab may be taken in conjunction with the course or after course completion. The majority of students who take General Chemistry I also take General Chemistry II.

I started using MasteringChemistry in fall 2010 because I believe the goal of homework is to help students learn and study. In order to master course concepts and problems, students need practice and repetition—and MasteringChemistry provides that. In fall 2011, I modified the course by adding paper-and-pencil quizzes to help students practice writing down their work.

### Assessments

#### Fall 2010

51 percent Exams

27 percent MasteringChemistry homework

22 percent Final exam

#### Fall 2011

49.5 percent Exams

21 percent MasteringChemistry homework

16 percent Final exam

13.5 percent Quizzes

### Results and Data

An analysis of student outcomes without assigned MasteringChemistry (spring 2009) and with assigned MasteringChemistry (fall 2010, fall 2011) indicated the following:

- 96 percent of students who averaged 70 percent or higher on their MasteringChemistry homework successfully completed the class with a grade of A, B, or C. See figure 1.
- Those students who successfully completed the course earned an average score of 73 percent on their MasteringChemistry homework.
- Those students who did not successfully complete the course earned an average score of 37 percent on their MasteringChemistry homework. See figures 2 and 3.
- The drop/fail/withdraw (D/F/W) rate fell from 56 percent without the use of MasteringChemistry homework to an average of 44.5 percent the first two semesters that MasteringChemistry was in use. See figure 1.
- There was an increase in final course grades of A and B for both semesters using MasteringChemistry. See figure 1.
- There is a strong, positive correlation between homework scores in MasteringChemistry and the final course grade for both semesters using MasteringChemistry. See figures 2 and 3.
- There was a moderate, positive correlation between the paper-and-pencil quiz averages and the final course grade.

*“Previously, I only suspected that those students who used the homework to learn and to reinforce course concepts did better in the course. Now I have confirmation of it through data analysis.”*

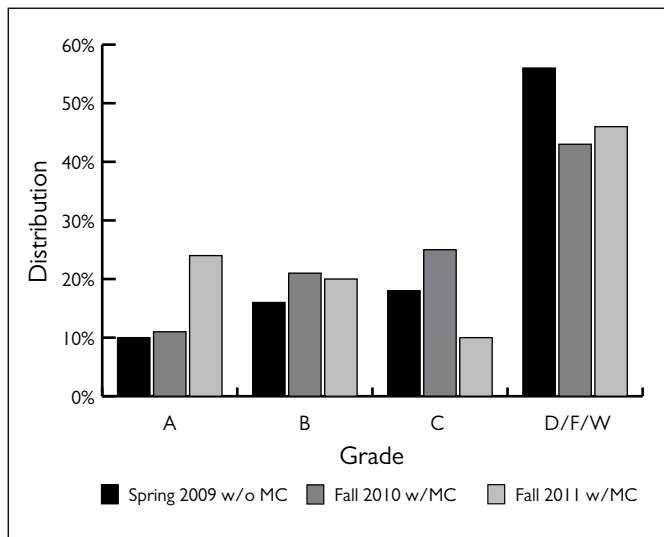


Figure 1. General Chemistry I Grade Distribution before and after Use of MasteringChemistry, Spring 2009, Fall 2010, and Fall 2011

## The Student Experience

I encourage peer tutoring. My students are forming study groups now and spending more time talking through the MasteringChemistry problems with each other.

Students who do better in the course are those students who use the program's hints to help them better understand problems and who appreciate the opportunity to rework the problems.

## Conclusion

I was very surprised by the extremely high correlation between students who successfully complete the class and score a 70 percent or higher on the MasteringChemistry homework. I felt that the students who were using the homework to learn and reinforce the concepts were doing better in the course, but having this confirmed through the data is very beneficial. I believe that MasteringChemistry will be an extremely helpful resource for a whole generation of students at Ventura College.

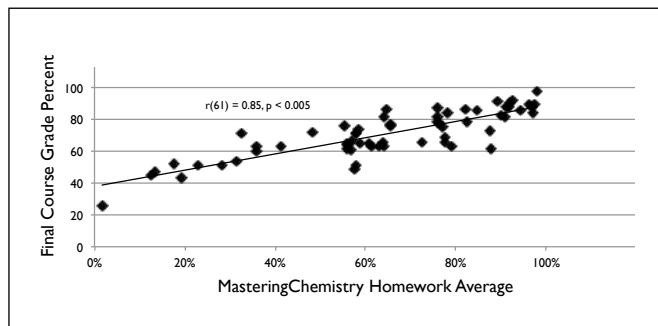


Figure 2. MasteringChemistry Homework Average Versus Final Course Grade, Fall 2010

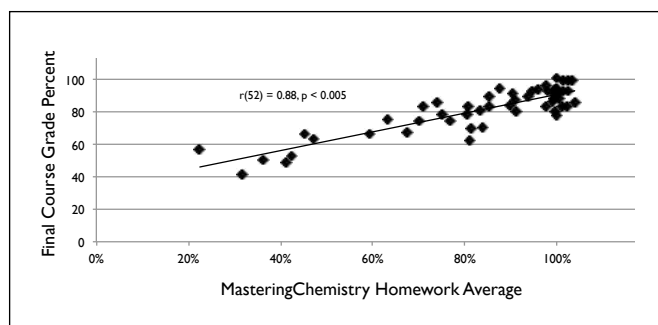


Figure 3. MasteringChemistry Homework Average Versus Final Course Grade, Fall 2011

Submitted by Malia Rose  
Ventura College

Product Name **MasteringEngineering**  
 Course Name **Engineering Statics**  
 Credit Hours **Three**

**Key Results** MasteringEngineering’s automatic grading and immediate feedback features engage students and help them better learn course concepts. Students complete more homework and, as a result, both exam scores and success rates have increased.

## Text

*Engineering Mechanics: Statics*, 13e, Russell C. Hibbeler

## Implementation

This course covers the principles of statics and their application to engineering problems including forces, moments, couples, friction, centroids, and moments of inertia. The course is taught every spring and is primarily taken by engineering majors.

Homework and problem solving are very important to success in this course. Prior to adopting MasteringEngineering, I gave students paper-and-pencil homework, which had to be hand graded. I adopted MasteringEngineering in spring 2013 because it enabled me to assign students automatically graded, online homework that also provides immediate feedback and helps students master course concepts. As one student said, “MasteringEngineering tells you right away if you’re right or wrong so that you can rework problems if you made a mistake.”

My MasteringEngineering homework assignments consist of 10 or 11 problems including tutorials and end-of-chapter questions. Assignments are due following lecture and comprise a substantial portion of the course assessment.

## Assessments

40 percent	Exams (four)
35 percent	MasteringEngineering homework
20 percent	Final exam
5 percent	Attendance

## Results and Data

After my first semester using MasteringEngineering, course results indicate that student success rates increased—more students earned an A, B, or C in the course (figure 1). The mean exam score increased from 53 percent to 77 percent (figure 2). Note that although I changed the number of exams from three in 2012 to four in 2013, the same content was covered on the exams for both semesters.

I also evaluated my homework completion rates before and after using MasteringEngineering. For purposes of this case, an incomplete homework is considered one that had a score of 0.

- In 2013, 59 percent of students either completed all of the MasteringEngineering homework or had one incomplete assignment out of 35 total assignments. Those students had a mean exam score of 81 percent, while students who had two or more incomplete homework assignments averaged 72 percent on their exams.
- In 2012 when assigning paper-and-pencil homework, only 29 percent of students completed all of the homework or had one incomplete assignment out of 31 total assignments. Their mean exam score was 59 percent, and the mean exam score for students having two or more incomplete assignments was 50 percent.
- In 2013, 88 percent of students completed at least 90 percent of the MasteringEngineering assignments. In 2012, approximately 53 percent of students completed at least 90 percent of the paper-and-pencil homework.



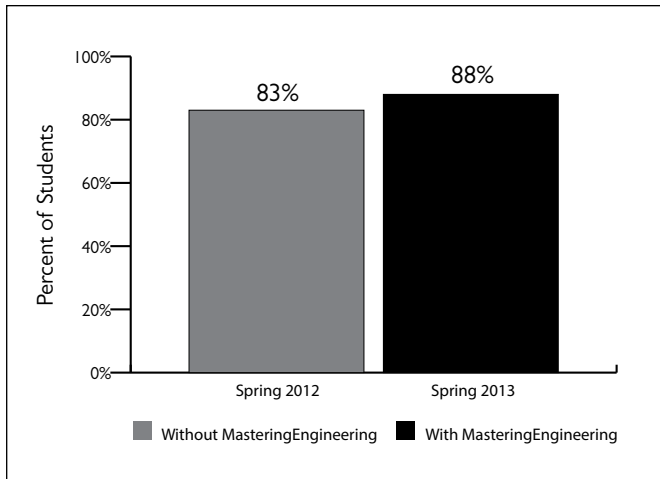


Figure 1. Statics Success (A/B/C) Rates, Spring 2012–Spring 2013  
(Spring 2012  $n=17$ , Spring 2013  $n=17$ )

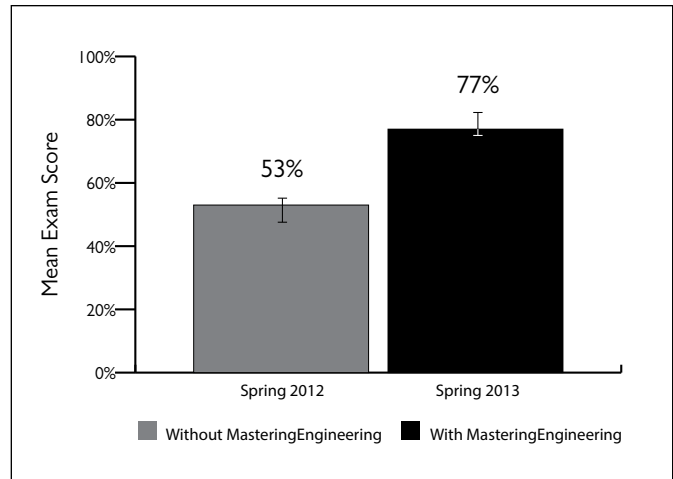


Figure 2. Statics Mean Exam Scores, Spring 2012–Spring 2013  
(Spring 2012  $n=17$ , Spring 2013  $n=17$ )

*“After my first semester using MasteringEngineering, course results indicate that student success rates increased—more students earned an A, B, or C in the course.”*

### The Student Experience

Responses to a spring 2013 survey indicate that students felt they had a positive experience using MasteringEngineering:

- 75 percent of students agreed or strongly agreed that their understanding of the course material increased because of using MasteringEngineering.
- 69 percent of students agreed or strongly agreed that using MasteringEngineering positively affected their exam scores.

Student feedback about MasteringEngineering included the following comments:

- “I liked the ability to have instant feedback on problems. By knowing whether the answer was right or wrong (and sometimes getting hints), I was able to more effectively learn from my mistakes.”
- “MasteringEngineering gave me a more in-depth understanding of the lesson taught in class, and also helped me get ready for the tests.”
- “I liked that MasteringEngineering gave me a step-by-step process to help solve difficult problems.”

### Conclusion

After using MasteringEngineering for one semester in Statics, I found that (1) students feel it is an engaging and effective way to do homework, and (2) results indicate an increase in both homework completion and student success rates. I will continue using MasteringEngineering for Statics and now am planning to adopt it for my Mechanics of Materials class, too.

*Submitted by Boon-Chai Ng  
Andrews University*

Product Name MasteringEngineering  
 Course Name Statics for Mechanical Engineers, Dynamics for Mechanical Engineers, Dynamics for Civil and Biological Engineers  
 Credit Hours Four (Mechanical), Three (Civil and Biological)

**Key Results** Because students are engaged by MasteringEngineering homework, they spend more time using it and develop more independent-learning skills. After only one semester, there was a strong correlation between homework scores and final exam grades, and student success rates improved.

**Text**

*Engineering Mechanics: Statics and Dynamics*, 13e,  
 Russell C. Hibbeler

**Implementation**

I teach Statics for Mechanical Engineers, and two Dynamics courses, Dynamics for Civil and Biological Engineers and Dynamics for Mechanical Engineers. Topics covered in the statics course include coordinate systems, work-energy, impulse-momentum, and selected topics from three-dimensional rigid bodies. The course includes the use of computational software to solve numerical problems.

In both of the dynamics courses, topics include Newton’s laws, the work and energy principle, and the impulse and momentum principle. Students use computational software to solve numerical problems. There is an additional contact hour for Dynamics for Mechanical Engineers that enables us to cover additional content in that course.

Using homework to practice problem-solving is an important part of all three courses. I adopted MasteringEngineering in spring 2013 because it provides an easy way to assign homework, provides instructors with a pool of questions from which to choose, and offers students immediate feedback and assistance on their own time, outside of class as they complete their homework assignments. Previously, I assigned students paper-and-pencil homework that needed to be quickly hand-graded and returned in order for students to learn where they needed more practice.

Today I assign weekly MasteringEngineering homework. The assignment is timed, and I primarily assign end-of-section problems to ensure students understand the reading and concepts. I use the gradebook’s diagnostics to determine how well students performed on the homework and what issues they encountered.

**Assessments**

- 35 percent Final exam
- 30 percent Exams (three)
- 30 percent MasteringEngineering homework
- 5 percent Attendance

**Results and Data**

After evaluating my results for all three courses taught in the spring 2013 semester, I found positive outcomes for each.

After implementing MasteringEngineering, final course grades in Dynamics for Civil and Biological Engineers improved (figure 1):

- The percent of As and Bs increased by 18 percentage points—from 20 percent to 29 percent for each grade.
- The number of Fs decreased by 20 percentage points—from 20 percent to zero.

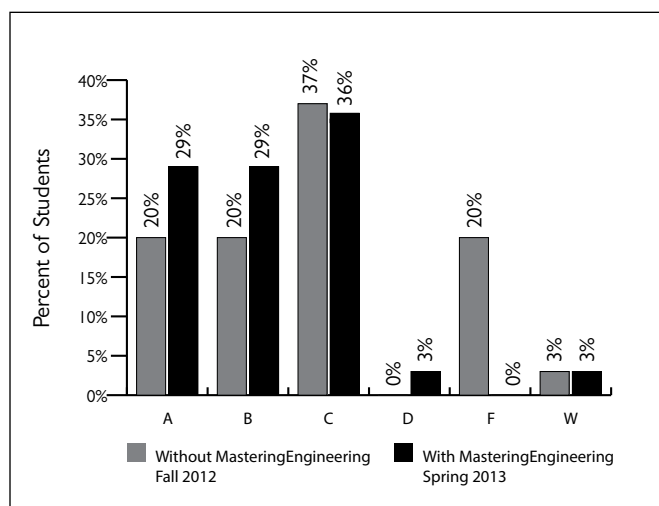


Figure 1. Grade Distributions, Dynamics for Civil and Biological Engineers, Fall 2012 (n=29) and Spring 2013 (n=31)

*“Since implementing MasteringEngineering, fewer students come to office hours and the majority of students come to class better prepared.”*

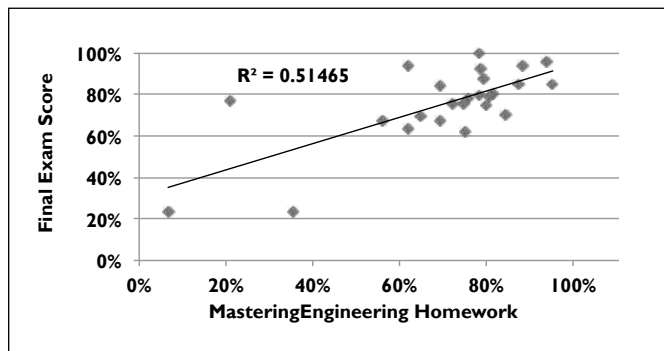


Figure 2. Correlation of MasteringEngineering Homework Score to Final Exam Score, Statics for Mechanical Engineers, Spring 2013 (n=25)

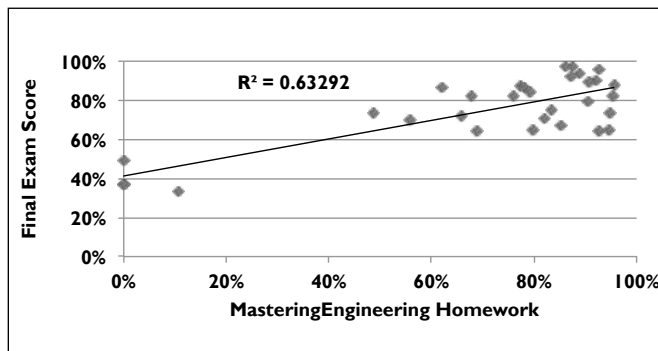


Figure 3 Correlation of MasteringEngineering Homework Score to Final Exam Score, Dynamics for Mechanical Engineers, Spring 2013 (n=32)

I don't have course grades from before implementation of MasteringEngineering for the Statics and Dynamics courses for Mechanical Engineers, but using my Spring 2013 results I was able to discover a strong correlation between a student's MasteringEngineering homework score and cumulative final exam score (figures 2 and 3).

### The Student Experience

I asked my students what they liked best about using MasteringEngineering. Their responses included:

- “The help it provides and having multiple attempts to solve a problem. If I get a question wrong, I have the opportunity to understand why I got it wrong and how to approach and solve the problem the next time I am faced with it.”
- “The online aspect of completing my work. It kept me on my toes as far as checking for new assignments (great business preparation).”
- “That it gave me feedback on answers to let me know whether or not I was on the right track.”
- “The calendar because it was easy to see when my assignments were due.”
- “How it explained conceptual material to me once I'd answered a problem.”

### Conclusion

Homework is an integral part of the Statics and Dynamics courses. Students seem to be more engaged with the course content when doing homework in MasteringEngineering and they appreciate the hints and immediate feedback. In addition, since implementing MasteringEngineering, fewer students come to office hours for help and the majority of students come to class better prepared. Because of the positive results I've seen in my first semester of use, I will continue to use MasteringEngineering.

*Submitted by Paul Akangah  
North Carolina Agricultural and Technical State University*

Product Name **MasteringEngineering**

Course Name **Statics (as part of Fundamentals of Engineering and Mechanical Engineering Science)**

Credit Hours **Three**

**Key Results** MasteringEngineering saves time for the instructor and significantly increases student satisfaction, engagement, learning, and success.

## Text

*Engineering Mechanics: Statics*, 13e, Russell C. Hibbeler

## Implementation

Statics covers a two-semester course sequence that draws a variety of students, often with a wide range of math competency. Student enrollment has increased exponentially in recent years from approximately 60 students to close to 200 currently.

The course format is mainly problem-based learning and was developed when enrollments were smaller. Prior to 2011, there were two or three paper-and-pencil assignments each semester, plus a weekly tutorial session, where it was intended that the students would work on the assigned questions. Tutorial sessions were poorly attended. As a result, the general level of understanding was low, which was reflected in exam and course scores. In 2011, I began giving weekly not-for-credit paper-and-pencil assignments in an effort to increase attendance at the weekly tutorial sessions.

I piloted MasteringEngineering in the 2012 academic year. The previous statics courses had two lectures and one tutorial hour per week. The tutorial hour now takes place in a computer lab, with myself and four teaching assistants.

I had several reasons for adopting MasteringEngineering. First, with nearly 200 students, automated grading saved time. I also wanted students to engage more with the course material and to gain a broader understanding of the subject. In addition, being able to look in the gradebook and see who has and hasn't done the assignments gives me an immediate snapshot of the engagement of the class. Plus, I wanted to update my teaching, and to have students feel that they were using technology for learning and were getting their money's worth for tuition paid.

Each week, I assign approximately four, not-for-credit questions in MasteringEngineering, making sure they are relevant to the lecture and include a mix of tutorials to increase understanding and test their knowledge. I often briefly go over each question in the lecture preceding the tutorial, so students know what to expect. The idea is that they start the work in the tutorial session and complete it by the end of the week. It is not mandatory, but I let them know that I check the results. Although these questions don't contribute toward the course grade, I email individuals who haven't attempted any. If students demonstrate specific problems with the questions, I work those in class.

For credit, students have online homework consisting of eight questions in MasteringEngineering that they have two weeks to complete, a paper-and-pencil assignment, and one traditional exam.

All of the problems that have been assigned over the year are available to the students until the end of exams. I encourage them to use this and the study area of MasteringEngineering to review for the exam.

## Assessments

80 percent	Exam
15 percent	Paper-and-pencil homework
5 percent	MasteringEngineering homework

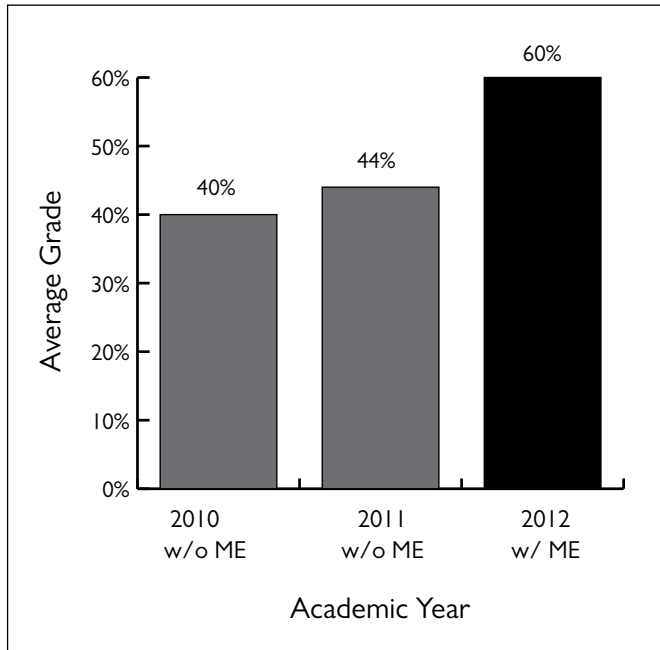


Figure 1. Statics Average Final Course Grade with and without the Use of MasteringEngineering, 2010–2012

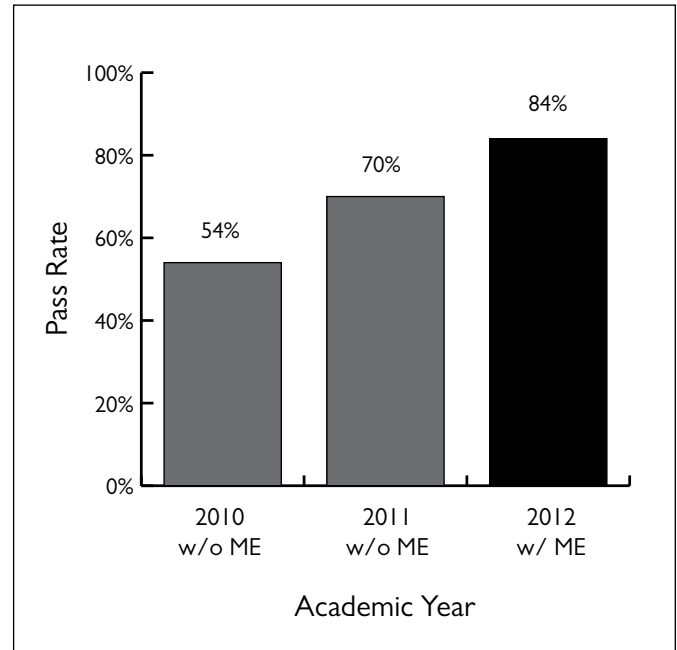


Figure 2. Statics Pass Rates with and without the Use of MasteringEngineering, 2010–2012

## Results and Data

Figures 1 and 2 show an improvement in student performance after the implementation of MasteringEngineering, as indicated by an increase in both average course grades and pass rates. What's more, there was an increase in student enrollment over this same period.

## The Student Experience

The students are more engaged with the course content, and appear to be tackling problems much earlier than in previous years. A number of students have commented to me that they found MasteringEngineering to be an extremely useful tool.

## Conclusion

MasteringEngineering is an excellent resource to improve student engagement and performance. Assigning tutorial problems weekly is a positive incentive to students, and instant access to students' progress is a good way for me to identify less-motivated students. In addition, the online assignments are ideal for large courses and make it possible to quickly assess the weekly assignments.

With careful planning, MasteringEngineering can augment lecture material and improve learning week by week. The first year of implementation presented a learning curve, but I now feel extremely confident with the program and look forward to tweaking the assignments this year.

*Submitted by Catherine Dobson  
University of Hull*

Product Name **MasteringGeography**

Course Name **Geography of the Global Village (World Regional)**

Credit Hours **Three**

**Key Results** Students who do MasteringGeography homework tend to do better both on the exams and in the course.

### Text

*Globalization and Diversity: Geography of a Changing World*, 3e, Lester Rowntree, Martin Lewis, Marie Price, and William Wyckoff

### Implementation

Geography of the Global Village is an introductory course in world regional geography that surveys the human and physical diversity of our planet. The purpose of this course is to discuss the regions of the world emphasizing the unfamiliar and introducing geographical concepts such as location, core-periphery, and diffusion. Successful student outcomes include: (1) increased knowledge of the cultural, regional, and ecological contexts of the world; (2) understanding of global diversity and globalization; (3) proficiency in map skills and international place names; and (4) grasp of the importance of intellectual pursuits that construct geographical ideas.

Because of large course enrollments, my homework before implementing MasteringGeography consisted of questions that were answered on a Scantron form while referencing a print Atlas. However, this method didn't provide an opportunity for the kind of visual interaction with maps that help students better understand the concepts. MasteringGeography provides resources that students can interact with to facilitate learning those concepts.

I tell my students that for every hour of lecture, they should anticipate two to three hours of study time outside of class. I assign regular, untimed MasteringGeography homework that correspond to the textbook chapters and include numerous MapMaster and Google Earth™ learning activities. Students can earn extra points by completing additional MasteringGeography activities.

### Assessments

50 percent Midterm exams (best two of three)

25 percent Final exam

25 percent MasteringGeography homework

### Results and Data

I analyzed homework completion rates for my fall 2012 course to determine how it impacts course performance. I did not evaluate the data based on the actual homework score. Rather, a MasteringGeography assignment was labeled as skipped if it showed a score of 0 and was counted as attempted if points were scored. I found the following results:

- 67 percent of students who completed the final exam attempted all 14 MasteringGeography homework assignments; 33 percent skipped at least one.
- Of the 33 percent who skipped at least one MasteringGeography homework, the average number of skipped assignments was 2.
- 46 percent of students who skipped MasteringGeography homework assignments skipped only one assignment.
- 83 percent of students who skipped MasteringGeography homework skipped between 1-3 assignments; 16 percent skipped 4-10 assignments, and 1 percent skipped all assignments.
- 92 percent of students attempted all homework assignments for exams 1 and 3, 96 percent attempted all homework assignments for exam 2, and 74 percent of students attempted all homework for the final exam.

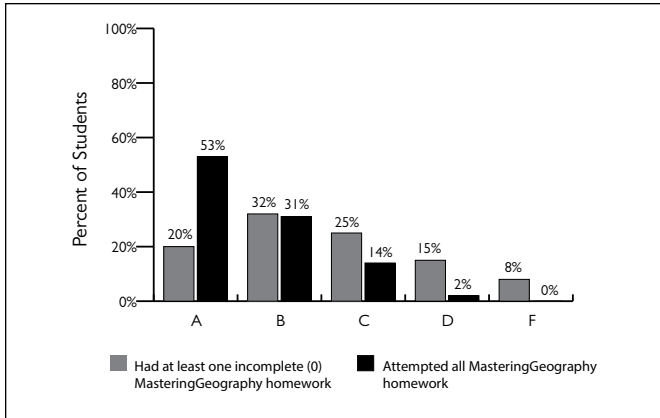


Figure 1. Relationship between Final Course Grade and MasteringGeography Homework Participation (Incomplete  $n=202$ , All  $n=411$ )

I evaluated the final course grade for both groups and found a significantly higher percentage of students who attempted all MasteringGeography homework earned an A in the course versus students who skipped one or more assignments (figure 1).

In addition, I looked at each group’s mean exam scores. Although I drop one midterm exam, I used all exam scores for this analysis. Figure 2 shows exam scores based on completion of MasteringGeography assignments for the applicable unit exam. Scores for the second and third midterm exams, and the final exam were significantly higher for students who attempted all MasteringGeography homework for that unit than they were for students who skipped at least one homework assignment for the unit exam.

Finally, I calculated the average MasteringGeography homework grade, including extra credit points, and found that students who do well on the homework tend to do better in the course (table 1).

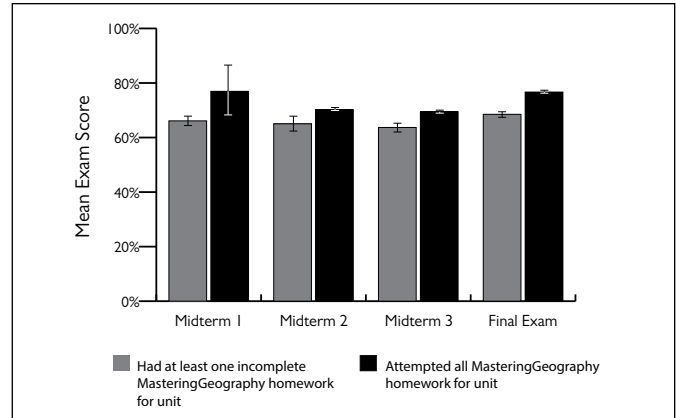


Figure 2. Relationship between Mean Exam Scores and MasteringGeography Homework Participation (Midterm 1: Incomplete  $n=50$ , All  $n=580$ ; Midterm 2: Incomplete  $n=23$ , All  $n=595$ ; Midterm 3: Incomplete  $n=48$ , All  $n=546$ ; Final Exam: Incomplete  $n=162$ , All  $n=451$ )

## The Student Experience

Student feedback is generally positive. Students are more engaged with the course content because of the opportunities for more visual and interactive learning.

Final Course Grade	Average MasteringGeography Homework Score with Extra Credit
A	92%
B	84%
C	76%
D	62%
F	31%

Table 1. Average MasteringGeography Homework Score per Final Course Grade

## Conclusion

With large enrollments, it’s hard to create in-class activities in which students are engaged and able to explore maps. MasteringGeography offers a more visual way to understand spatial reasoning and learn map-reading skills—concepts students must understand to do well in the course. When students put the time and effort into doing the MasteringGeography homework, they tend to do better on exams and, ultimately, in the course.

*Submitted by Erik Prout  
Texas A&M University*

Product Name MasteringGeography  
Course Name World Regional Geography  
Credit Hours Three

**Key Results** Students are more engaged with the interactive resources in MasteringGeography and explore the concepts more fully outside of class, resulting in higher levels of learning, retention, and student success.

### Text

*Diversity Amid Globalization: World Regions, Environment, and Development*, 5e, Lester Rowntree, Martin Lewis, Marie Price, and William Wyckoff

### Implementation

World Regional Geography is a survey of the world's regions emphasizing the spatial arrangements of resources, population, institutions, economic activities, and cultural landscapes, and their significance for distinctive regional problems. Students of any major may take this course. Both traditional face-to-face and online sections are offered. My goal in this course is to motivate students to explore course materials through self-guided learning, prompting more critical thinking and a deeper understanding of complex concepts.

I tested MasteringGeography during the summer of 2011 and adopted it for the fall 2011 semester. I like to use a wide range of activities to expose students to multiple approaches for learning course concepts—MasteringGeography provides the resources to accomplish that goal.

I make all MasteringGeography assignments available to my students at the beginning of the semester, and they are made unavailable two days before the corresponding exam. I give one homework assignment per chapter and include end-of-chapter, coaching, map, and video exercises. I use the item difficulty diagnostics to help select assignment problems.

### Assessments

80 percent Exams (four)

20 percent MasteringGeography homework

### Results and Data

Since we rotate teaching the course, I compared course results from fall 2011, my first full semester using MasteringGeography, to my last semester teaching the course without it in 2009. The results show that after using MasteringGeography, As and Bs increased and Cs, Ds, and Fs decreased. See figure 1.

*“It appears that effort and performance on MasteringGeography homework is a strong predictor of success in the course.”*

In addition, there is a strong correlation between students' MasteringGeography homework scores and their final course grades (see figure 2). It appears that effort and performance on MasteringGeography homework is a strong predictor of success in the course.

- More than 97 percent of students who scored at least 70 percent on the homework completed the course with an A, B, or C.
- Students who received a D or F in the course averaged a score of 50 percent on their MasteringGeography homework.



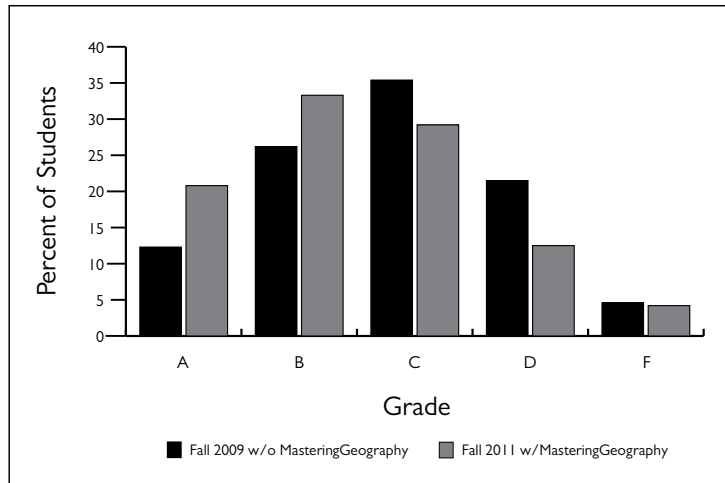


Figure 1. Grade Distribution before and after Implementation of MasteringGeography, Fall 2009 and Fall 2011

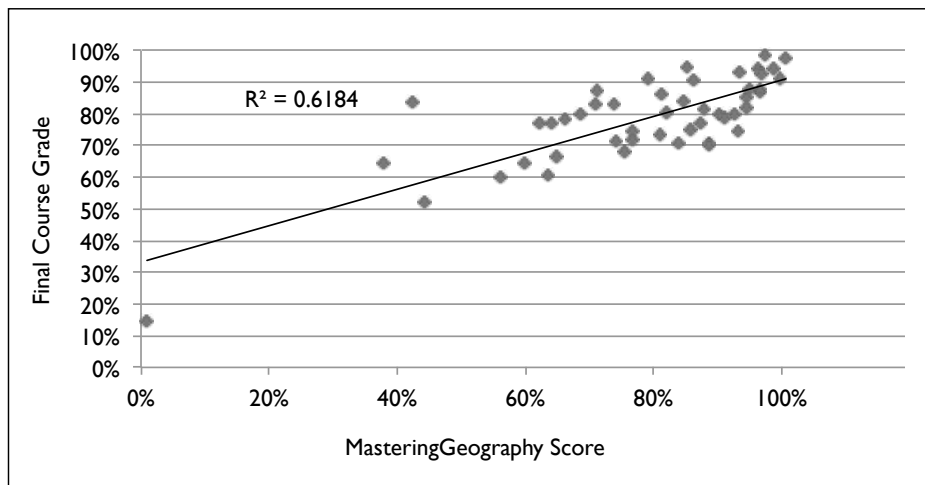


Figure 2. Correlation of MasteringGeography Homework Scores to Final Course Grade

### The Student Experience

I find that my students overwhelmingly enjoy learning with MasteringGeography. They like to be exposed to the content in different formats, and find the interactive videos and map exercises more engaging than looking at the content in a print book. After adopting MasteringGeography, I saw both student interest and retention improve, along with course grades.

### Conclusion

MasteringGeography facilitates self-guided learning as it's online and asynchronous, and students are able to work at their own pace. When students are able to spend time interacting with the course materials in different formats, they come to class better prepared. This, in turn, frees up class time because I needn't cover all of the concepts in lecture, and enables me to focus on more difficult concepts and to integrate more active learning.

*Submitted by Christopher Sutton  
Western Illinois University*

Product Name [MasteringGeology](#)

Course Name [Introduction to Geology](#)

Credit Hours [Three](#)

**Key Results** Students using MasteringGeology are more engaged and do more independent learning resulting in higher student success rates.

## Text

*Earth: An Introduction to Physical Geology*, 10e, Edward J. Tarbuck, Frederick K. Lutgens, and Dennis G. Tasa

## Implementation

Introduction to Geology covers physical geology, including its economic, social, and environmental aspects and is open to all nongeology majors.

I previously taught this course at another university where I'd used MasteringGeology. In fall 2012, when I first taught the course at Bowling Green State University, books had already been ordered by the time I arrived and MasteringGeology had not been included. I taught the course that semester without assigning any homework other than reading. In spring 2013, I required students to use MasteringGeology. I gave a weekly assignment, which covered one chapter and was due after I finished covering the topic in class. Using the estimated time ratings in MasteringGeology, assignments were designed to take about 40 minutes to complete. Questions included primarily tutorial and activity questions, such as animations and Google Earth™, to engage students and help them learn as they complete their homework.

I now use MasteringGeology each semester. I review the gradebook diagnostics as students complete the homework to identify issues or misconceptions, and then address those topics in the following class.

I'm a proponent of active learning and in-class activities. Using MasteringGeology, students can learn the basic concepts outside of class, so we can spend more class time doing interactive learning, such as discussion and writing exercises. For example,

one discussion was on the Mars Rover mission and included the type of data they were collecting and how it relates to what students were learning about sedimentary rocks and environments. After discussion, students were asked to write a short paper in class about sedimentary rocks on Mars—including the writing portion ensured that students were engaged and understood the concepts discussed during the class activity.

## Assessments

30 percent	Exams (three)
30 percent	MasteringGeology homework
20 percent	Comprehensive final
20 percent	Quizzes

## Results and Data

My student success rate (A/B/C) increased by 10 percentage points (figure 1) after I implemented MasteringGeology in spring 2013. In addition, there is a strong correlation between the students' exam and MasteringGeology scores (figure 2).

I also found that students who score higher on their MasteringGeology homework tend to do better in the course. Figure 3 shows the average MasteringGeology score for students earning each letter grade. Students who earned an A in the course scored an average of 94 percent on their MasteringGeology homework; students who earned an F in the course scored an average of 26 percent on MasteringGeology homework. This includes all students who received a final course grade. In addition, 74 percent of students who earned an A/B/C in the course scored an 80 percent or higher on their MasteringGeology homework.

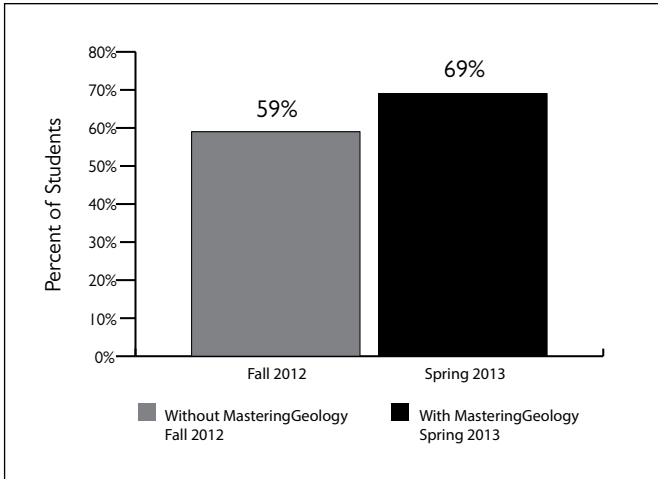


Figure 1. Student Success Rates (A/B/C) with and without the Use of MasteringGeology, Fall 2012–Spring 2013 (Fall 2012  $n=51$ , Spring 2013  $n=49$ )

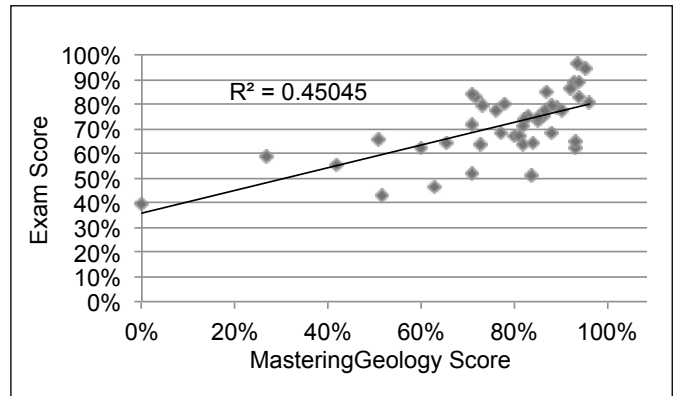


Figure 2. Correlation of MasteringGeology Homework Score to Exam Score, Spring 2013 ( $n=49$ )

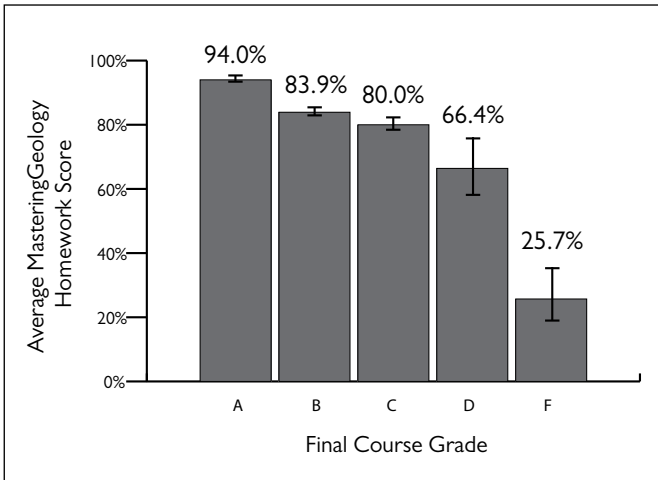


Figure 3. Average MasteringGeology Homework Score per Final Course Grades, Spring 2013 ( $n=49$ )

### The Student Experience

Once students start using MasteringGeology, they really like it. The videos and animations help them visualize what they read in the textbook, which in turn helps them better comprehend the course content. And because students do additional learning on their own, I'm able to do more in-class activities, which helps create a more engaging environment in the classroom.

### Conclusion

MasteringGeology enables me to engage students and helps them to learn outside the classroom so we can do more interactive learning in the classroom. The three-dimensional aspect of many geologic processes is difficult for students to understand via solely reading or lecture. The videos, animations, and activities in MasteringGeology help students to see and comprehend the processes. As a result, we can do more critical thinking activities in class, including applying the concepts to current events and their everyday lives.

Submitted by Daniel Kelley  
Bowling Green State University–Firelands College

Product Name **MasteringMicrobiology**  
 Course Name **Introductory Microbiology**  
 Credit Hours **Four (lecture and lab)**

**Key Results** Grade data indicate that use of MasteringMicrobiology enhances student pass rates and improves student retention. Student feedback and faculty observations suggest that MasteringMicrobiology helps students better prepare for both lecture and lab and more fully engage in the curriculum.

## Text

*Microbiology: An Introduction*, 11e, Gerard J. Tortora, Berdell R. Funke, and Christine L. Case

## Implementation

Introductory Microbiology is a mandatory prerequisite for allied health majors, including nursing students. The course is a combined lecture/lab course that focuses on bacteria, viruses, fungi, protozoans, and helminthes of medical and economic importance. The prerequisite for Introductory Microbiology is a C or higher in any college level chemistry course.

I adopted MasteringMicrobiology to enhance opportunities for critical thinking, improve student preparedness for lecture and lab, foster a more engaging laboratory experience, improve student success and retention, and facilitate a more efficient use of classroom time.

The curriculum is divided into four modules. Each module includes lecture and lab material, a homework assignment, laboratory quizzes, and a module exam. Lab quizzes and homework are delivered via MasteringMicrobiology. Students are encouraged to research homework answers and to work in groups; lab quizzes are a more rigorous, individual effort.

Redesigning my course using MasteringMicrobiology enabled me to infuse three layers of pedagogical practices that foster higher-order cognitive development: (1) priming of the mind with basic knowledge before a higher order academic task is approached in lab or discussed in lecture, (2) providing timely formative feedback that allows for real time student redirection and addressing of misconceptions, and (3) creating in-class opportunities for reflection focused on areas in which students have the most difficulty.

These practices were delivered via the following:

- *MasteringMicrobiology homework assignments for each module due one week before the exam.* Each assignment takes about 90 minutes to complete and contains reading, tutorial, and activity questions. I review the item difficulty graph from the gradebook diagnostics with students during class. This enables me to identify the most commonly missed items and address misconceptions *before* an exam.
- *A MasteringMicrobiology pre-lab quiz due by the lab session.* Quizzes are timed and open a week before lab. Questions are scrambled and include Video Tutor and lab questions. As with the homework assignments, we spend about 10 minutes reviewing the gradebook diagnostics from the quizzes together. This shifts the lab experience from a “cookbook” session to a more integrated and reflective experience. Students enjoy the labs more now and so do I; they feel empowered to investigate not regurgitate.
- *A MasteringMicrobiology postlab assessment with application-based questions.*

## Assessments

57 percent	Lecture exams
15 percent	MasteringMicrobiology homework
7.5 percent	Cumulative lab final exam
7.5 percent	Identification of bacterial unknown with comprehensive report
7 percent	MasteringMicrobiology pre- and post-lab quizzes
6 percent	Take-home, formal, written case study assignment

*“MasteringMicrobiology helps me interact with the material instead of just reading it out of the book. It challenges my mind.”*

—Student

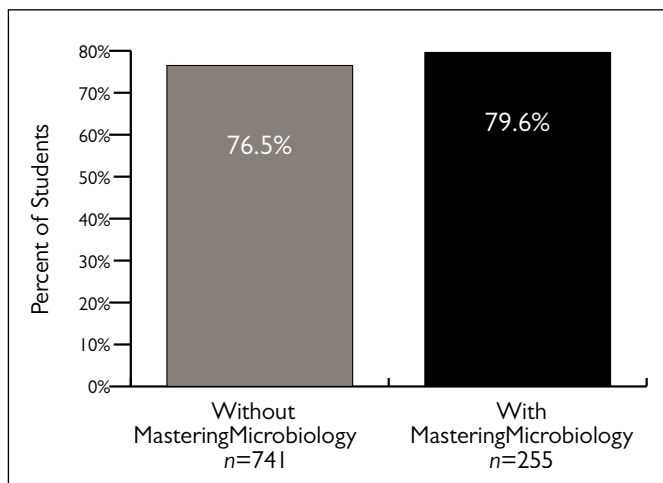


Figure 1. Average Student Pass Rate (A/B/C) with and without the Use of MasteringMicrobiology

## Results and Data

After implementing MasteringMicrobiology, the student pass rate (A/B/C) increased (figure 1). Note that homework and quizzes were always part of the course grades, so implementing MasteringMicrobiology did not lead to grade inflation.

There was also a positive change in student retention:

- After implementing MasteringMicrobiology, the **withdrawal rate fell from 8.9 percent to 7.8 percent**—a decrease of 1.1 percentage points and about a 12 percent decrease between pre- and post-Mastering implementation data.
- At Florida State College, faculty can issue a failure-for-nonattendance grade (FN). My policy is that students with more than three absences earn an FN grade. **Prior to implementing MasteringMicrobiology, the course FN rate was 4.2 percent. After implementation, the FN rate fell to 1.2 percent** (a 71 percent decrease between pre- and post-Mastering implementation data).

## The Student Experience

Student feedback for MasteringMicrobiology has been overwhelmingly positive. In a spring 2013 survey, the majority of students surveyed believed that assignments in Mastering helped them to prepare for class, lab, and exams.

Responses to the spring survey also revealed that:

- 93 percent of students surveyed agreed or strongly agreed that MasteringMicrobiology helped them to think critically.
- 80 percent of students surveyed agreed or strongly agreed that MasteringMicrobiology pushed them to prepare for class and for exams.
- 78 percent of students surveyed agreed or strongly agreed that MasteringMicrobiology helped them to be better prepared for lab.
- 73 percent of students surveyed agreed or strongly agreed that knowing that they had a post-lab quiz pushed them to work harder to understand the lab.

## Conclusion

As instructors, we often ask ourselves what more we can do to help students learn. Sometimes the best answer is to make students do more on their own. MasteringMicrobiology offers students multiple opportunities to understand course material and because feedback on homework is instantaneous, students can determine exactly what concepts they need help on earlier than when I hand-graded homework.

Students come to class more prepared and thereby are more able to focus on higher-order material. The enhanced student preparedness and engagement also frees class time so that my teaching time centers more on practicing the kind of critical-thinking skills that will help my students achieve their long-term goals.

In addition, the student learning outcome data gathered in MasteringMicrobiology help me improve my craft as a teacher. By continually evaluating course results and student attainment of learning outcomes, I engage in a cycle of reflection and improvement that ensures that I'm meeting my course learning objectives.

*Submitted by Lourdes Norman-McKay, Ph.D.  
Florida State College at Jacksonville*

Product Name	MasteringMicrobiology
Course Name	Medical Microbiology and General Microbiology
Credit Hours	Four

**Key Results** Exam scores and success rates improved as MasteringMicrobiology was increasingly integrated into both lecture and lab.

### Text

*Medical Microbiology: Microbiology with Diseases by Body System*, 3e, Robert W. Bauman

*General Microbiology: Brock Biology of Microorganisms*, 13e, Michael T. Madigan, John M. Martinko, Kelly Bender, Daniel P. Buckley, David A. Stahl

### Implementation

Medical Microbiology is a one-semester, lecture and lab course designed for health science majors. The course covers microorganisms, including basic cell structure, biochemistry, metabolism, nutrition, reproduction and genetics. Mechanisms of transmission, microbial entry, pathogenesis, prophylaxis, epidemiology and microbial control of selected human pathogens, plus basic body defense mechanisms and immunological responses to pathological conditions are also covered.

General Microbiology is a one-semester, lecture and lab course designed for science majors. It covers the morphology, biochemistry, physiology, and genetic and taxonomy of microorganisms with an emphasis on bacteria. The biological principles and relationships of microorganisms to man in agriculture, sanitation, industry, medicine, and the environment are also emphasized.

For Medical Microbiology, I tested MasteringMicrobiology in the spring 2011 semester with required homework assignments. From fall 2011 through fall 2012, MasteringMicrobiology homework was designed to help students prepare for the lecture exams. The assignments start with tutorials and coaching activities to get students engaged, and end with multiple-choice questions.

In spring 2013, I redesigned the course by adding pre- and post-lab MasteringMicrobiology quizzes to better prepare students for participation in lab and to ensure they understood the conceptual material for lab exams.

I piloted MasteringMicrobiology for General Microbiology in spring 2013 using pre- and post-lab quizzes. I plan to add traditional MasteringMicrobiology homework to this course in the future.

### Assessments

52 percent Exams (four lecture, two lab; lowest lecture exam score is dropped in General Microbiology)

48 percent MasteringMicrobiology

### Results and Data

Medical Microbiology final course grades of A and B increased after adding pre- and post-lab MasteringMicrobiology quizzes (figure 1). In addition, there was also a slight increase in mean lab exam scores (figure 2).

During my first semester using MasteringMicrobiology in General Microbiology, I saw an increase in student success rates (A/B/C) of 9, 21, and 22 percentage points respectively over the prior three semesters without MasteringMicrobiology (figure 3).

I also saw a five percentage point increase in the mean lab exam score for General Microbiology during the pilot semester. I plan to add regular MasteringMicrobiology homework to this course and will reevaluate all of my course outcomes as changes are made to see the impact on results.

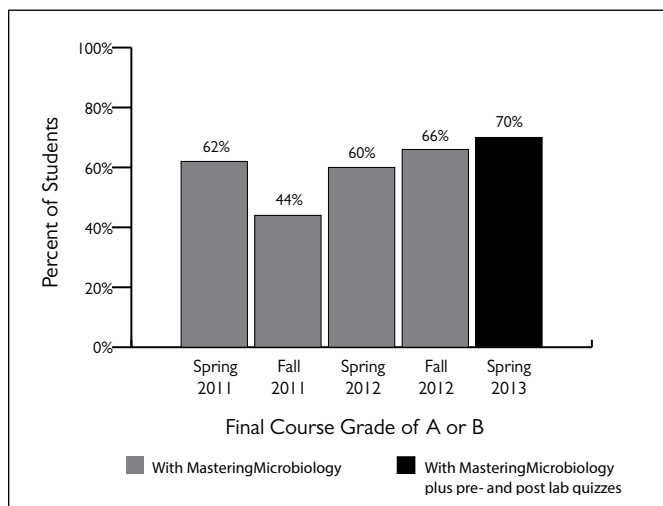


Figure 1. Medical Microbiology Percentage of Final Course Grades of A or B with and without MasteringMicrobiology Pre- and Post-Lab Quizzes, Spring 2011–Spring 2013 (Spring 2011,  $n=58$ ; Fall 2011,  $n=27$ ; Spring 2012,  $n=30$ ; Fall 2012,  $n=29$ ; Spring 2013,  $n=31$ )

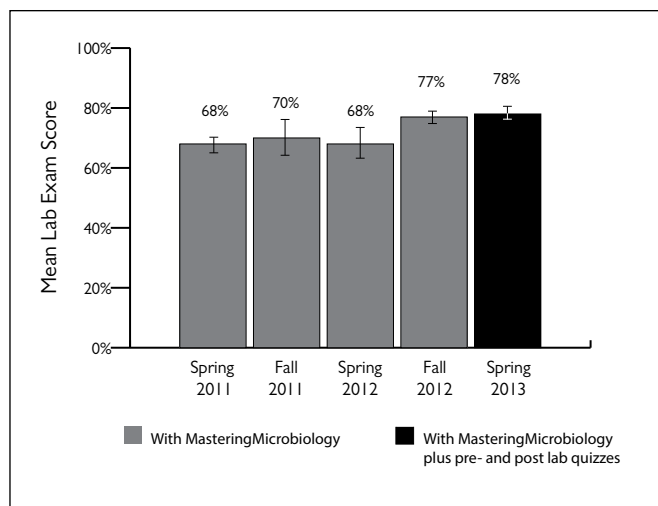


Figure 2. Medical Microbiology Mean Lab Exam Scores with and without MasteringMicrobiology Pre- and Post-Lab Quizzes, Spring 2011–Spring 2013

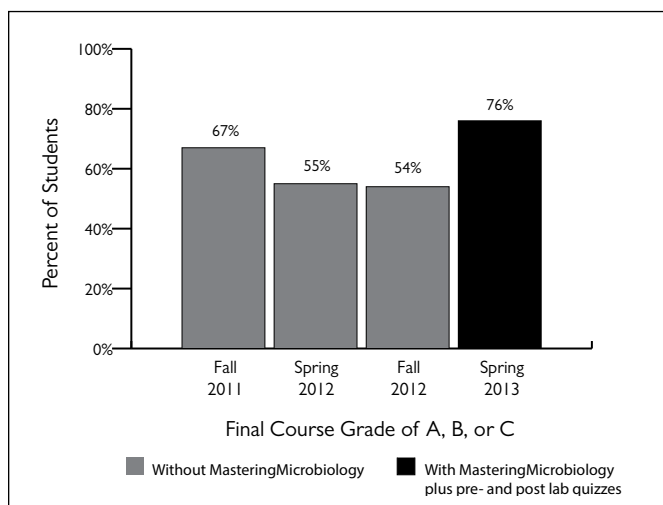


Figure 3. General Microbiology Success Rates with and without MasteringMicrobiology Pre- and Post-Lab Quizzes, Fall 2011–Spring 2013 (Fall 2011,  $n=27$ ; Spring 2012,  $n=29$ ; Fall 2012,  $n=26$ ; Spring 2013,  $n=29$ )

## The Student Experience

Student feedback on MasteringMicrobiology has been positive. End-of-semester student feedback included the following:

- “I like the MasteringMicrobiology site. It helps reinforce topics from class and lab.”
- “I love the Mastering site. The pre-, practice- and post-tests tell me where I am and where I need to be to get a better grade. Also, the interactive animations are pretty awesome because reading the book doesn’t always make things clear. Watching the videos helps me connect the dots.”

## Conclusion

MasteringMicrobiology is a great tool—it helps students engage in course material outside of the classroom so they can grasp the basic concepts on their own. This enables me to do higher-level interactive learning in the classroom and lab, thereby helping students develop a deeper conceptual understanding of the content. MasteringMicrobiology also makes it easy to assess student knowledge of the material, which means I can more easily determine what to focus on during lecture.

*Submitted by Warner Bair  
Lone Star College–Cy Fair*

Product Name [MasteringMicrobiology](#)

Course Name [Microbiology](#)

Credit Hours [Four](#)

**Key Results** Adding prelecture MasteringMicrobiology assignments facilitated increased student preparedness and engagement and enabled more time for interactive learning. As a result, student success rates increased and final course grades of A significantly increased.

### Text

*Microbiology, An Introduction*, 11e, Gerard J. Tortora, Berdell R. Funke, and Christine L. Case

### About the Course

This introductory Microbiology course is taken primarily by nursing students. It includes a lecture and a lab, and covers the principles of microbiology. Upon completion, students should be able to demonstrate knowledge and skills including microscopy, aseptic technique, staining, culture methods, and the identification of microorganisms.

### Course Redesign

Our school serves many nontraditional students. The goal of the course redesign was to address the issue of underprepared students and to provide a resource for remediation outside the classroom.

We implemented the Supplemental model developed by the National Center for Academic Transformation. This model retains the basic structure of the traditional course and supplements lectures and textbooks with technology-based, out-of-class activities, or changes what goes on in the classroom by creating an active learning environment within a large, lecture hall setting.

From our experience in this departmentwide redesign, we identified the following best practices:

- Involve faculty as part of the planning team.
- Communicate redesign goals and keep faculty communication channels open.
- Set a timeline and include benchmarks to ensure the process continues to move forward.

- Provide students with start-up guidance, information for technical support, and an explanation of the value of Mastering.
- Reinforce the value of doing assignments before lecture.

### Implementation

Starting fall 2012, we implemented Mastering in Anatomy and Physiology I and II, General Biology I and II, General Chemistry I and II, and Microbiology. We added Mastering to Introductory Physics in spring 2013.

Instructors are required to assign prelecture homework, but have flexibility with regards to the assigned content. The majority of instructors give weekly Mastering assignments that include both tutorial and end-of-chapter questions.

Instructors report that the automated grading in Mastering makes it easier to assign graded homework and to understand where students need help. Beginning spring 2013, we added student learning outcomes to our Mastering homework to (1) facilitate a better understanding of student course and program performance and (2) inform decisions on course changes.

### Assessments

50 percent	Lecture exams
15 percent	Final exam
15 percent	MasteringMicrobiology homework
15 percent	Lab (participation, reports, practicals, exams)
5 percent	Other



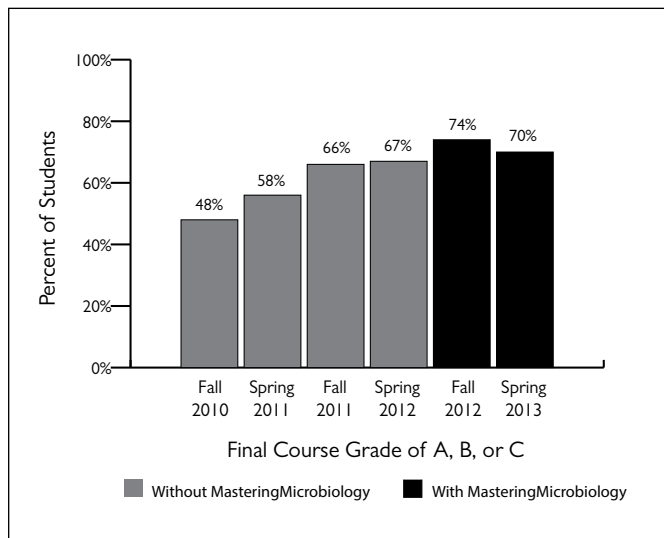


Figure 1. Microbiology Final Course Grades of A, B, or C with and without MasteringMicrobiology, Fall 2010–Spring 2013 (Fall 2010,  $n=69$ ; Spring 2011,  $n=72$ ; Fall 2011,  $n=58$ ; Spring 2012,  $n=57$ ; Fall 2012,  $n=31$ ; Spring 2013,  $n=57$ )

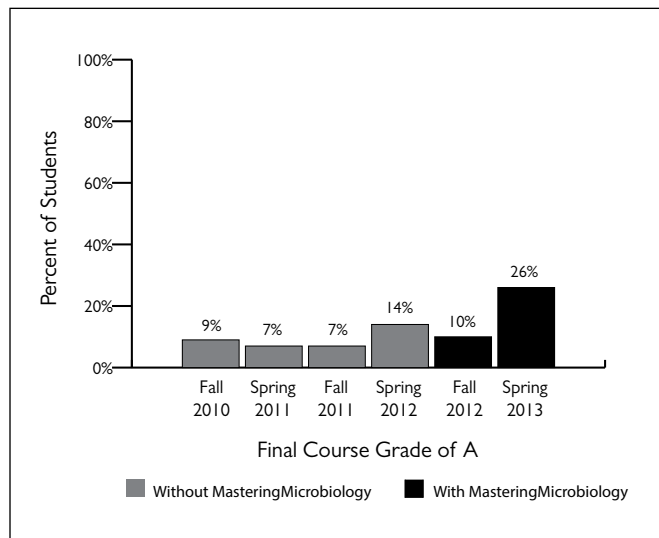


Figure 2. Microbiology Final Course Grade of A with and without MasteringMicrobiology, Fall 2010–Spring 2013 (Fall 2010,  $n=69$ ; Spring 2011,  $n=72$ ; Fall 2011,  $n=58$ ; Spring 2012,  $n=57$ ; Fall 2012,  $n=31$ ; Spring 2013,  $n=57$ )

## Results and Data

Analysis of student learning outcomes for Microbiology since fall 2010 show that success rates increased after implementation of MasteringMicrobiology (figure 1). The percentage of students who earned an A in spring 2013 was 12 percentage points higher than the highest reported semester in which MasteringMicrobiology was not used (figure 2).

In addition, the average MasteringMicrobiology homework score for students earning an A or B in the course is 86 percent, and the average MasteringMicrobiology homework score for students earning a C or D in the course is 68 percent.

## The Student Experience

Students like the opportunity to walk through content prior to lecture, are more engaged in learning, and are more prepared for class. They report that they like using the Study Area, getting automatic feedback while working, and having resources in different formats, such as videos.

Student comments include:

- “[MasteringMicrobiology] helped me better understand the chapters as I did the required assignments.”
- “I liked that all the information for the chapter I was working on was all in one place... The animations broke down the information really well.”

## Conclusion

We redesigned our science courses adding Mastering to provide students with a tool to help them prepare for class and get help when they need it the most. Prelecture homework assignments engage students in course content outside of class and better prepare them for lecture. This in turn enables us to increase the amount of interactive learning and critical thinking activities during class.

*Submitted by Louis McIntyre, Science Department Chair  
Robeson Community College*

Product Name [MasteringMicrobiology](#)  
 Course Name [General Microbiology](#)  
 Credit Hours [Five](#)

**Key Results** MasteringMicrobiology homework scores have a significant, positive correlation with final exam scores and student learning outcome results.

### Text

*Microbiology with Diseases by Body System*, 3e, Robert W. Bauman

### Implementation

The General Microbiology course was developed in 2010 and is designed for biology, preprofessional, and prenursing majors. It is a traditional course, and includes one lecture and two labs per week.

I adopted MasteringMicrobiology when the course was developed because I believe regular engagement with course material is important for students, and MasteringMicrobiology helps students know how they are doing.

Spring 2012 was the third semester that I taught the course. By then I was more familiar with the MasteringMicrobiology content and regularly assigned homework. My course consisted of a lecture, covering possibly multiple chapters, followed by a MasteringMicrobiology homework assignment comprising interactive tutorials and end-of-chapter questions, and lab time. I also added my course learning outcomes to the MasteringMicrobiology course.

### Assessments

47.5 percent Lab  
 30 percent Exams  
 12.5 percent Final exam  
 6 percent MasteringMicrobiology homework  
 4 percent Participation (clickers)

### Results and Data

An analysis of student final course grades from the spring 2012 semester showed that those students who did better on their MasteringMicrobiology homework also performed better in the course.

- 75 percent of those students who earned an A in the course averaged a score of at least 80 percent on their homework.
- 70 percent of those students who earned a B in the course averaged a score of at least 80 percent on their homework.
- Those students who passed the class with an A, B, or C in the course averaged a score of 80 percent on their homework.
- Those students who did not pass the class averaged a score of 31 percent on their homework.

The study also showed that student final exam scores had a significant, positive correlation with the MasteringMicrobiology homework scores. See figure 1.

An assessment based on the incorporated learning outcomes was given at the end of the semester in MasteringMicrobiology. This assessment also showed a positive correlation with final exam scores. See figure 2.

*“Once one student logs in and starts working in MasteringMicrobiology, more follow. It’s like positive peer pressure. They all want to succeed, and they know that MasteringMicrobiology can help them do so.”*

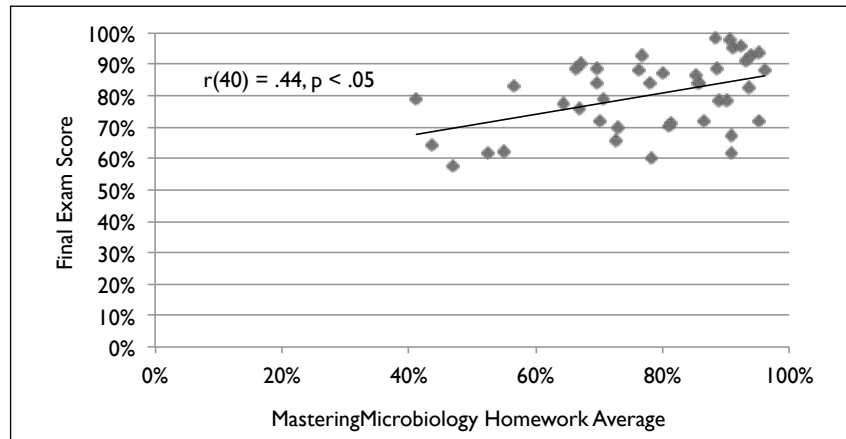


Figure 1. Comparison of MasteringMicrobiology Homework Averages and Final Exam Scores, Spring 2012

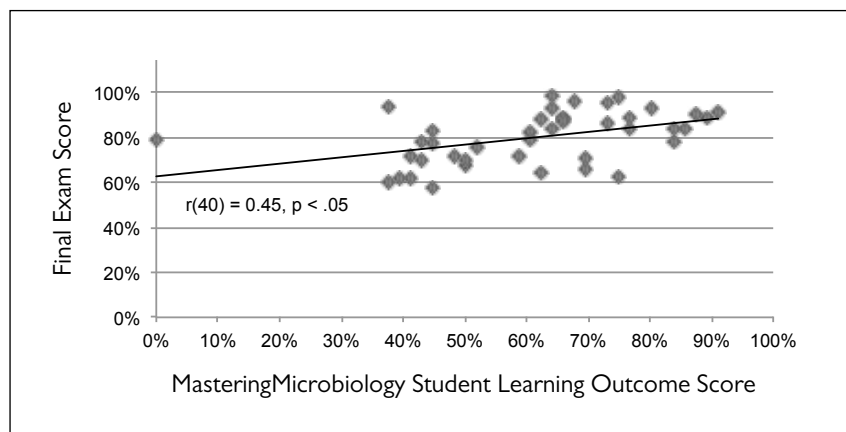


Figure 2. Comparison of MasteringMicrobiology Student Learning Outcome and Final Exam Scores, Spring 2012

## The Student Experience

Students have access to computers in the lab and use their extra time there to log into MasteringMicrobiology. They enjoy having a tool to help them be productive and use it to do homework and watch animations. Once one student logs in and starts working in MasteringMicrobiology, more follow. It’s like positive peer pressure. They all want to succeed, and they know that MasteringMicrobiology can help them do so.

## Conclusion

MasteringMicrobiology can predict a student’s success based on the effort that student puts into the MasteringMicrobiology homework. If a student completes the homework consistently, his or her homework scores and final grade will reflect the effort.

*Submitted by Denise Foley  
Santiago Canyon College*

Product Name [MasteringMicrobiology](#)  
 Course Name [General Microbiology](#)  
 Credit Hours [Three](#)

**Key Results** MasteringMicrobiology enabled additional content coverage and provided insight into students' mastery of course material.

### Text

*Microbiology: An Introduction*, 11e, Gerard J. Tortora, Berdell R. Funke, and Christine L. Case

### Implementation

General Microbiology introduces students to the diverse world of prokaryotic and eukaryotic microbes and viruses, their importance in the biosphere, and their roles in human and animal disease. The course is taken by microbiology and veterinary science majors, as well as by pre-med, pre-pharmacy, and pre-nursing students. Some students concurrently take a separate, one-credit lab.

I believe it's important to provide different types of resources to address diverse learning needs. I adopted MasteringMicrobiology when it was introduced in 2010 because I saw how its step-by-step approach could help students better grasp course content as they progress through the course. Students particularly benefit from its interactive feedback and embedded multimedia tutorials.

I focus on the comprehension questions in MasteringMicrobiology to help students develop the kind of critical-thinking skills they need to analyze information and work through a problem.

I assign weekly MasteringMicrobiology homework that includes approximately 20 primarily animation questions. Homework takes 1–2 hours to complete; I do not set a time limit. I see homework as a vehicle to review and reinforce what students have read in the textbook and heard in lecture.

I use the diagnostics in MasteringMicrobiology to determine what problems students are struggling with, and then discuss those concepts in the following week's lecture.

### Assessments

68 percent Exams (four)  
 17 percent MasteringMicrobiology homework  
 15 percent Clicker participation/written activities

### Results and Data

An evaluation of student data from spring 2010, fall 2011, and fall 2012 shows that MasteringMicrobiology homework grades are an indicator of student performance in the class—final course grades increase as the MasteringMicrobiology scores increase (table 1). Knowing this enables me to monitor student performance throughout the semester and help students to progress as needed to succeed in the course.

Final Course Grade	Average MasteringMicrobiology Homework Scores		
	Spring 2010	Fall 2011	Fall 2012
A	94%	94%	95%
B	89%	91%	93%
C	86%	86%	87%
D	79%	79%	77%
F	51%	54%	51%

Table 1. Average MasteringMicrobiology Homework Score by Final Course Grade, Spring 2010, Fall 2011, Fall 2012 (Spring 2010  $n=225$ , Fall 2011  $n=377$ , Fall 2012  $n=369$ )

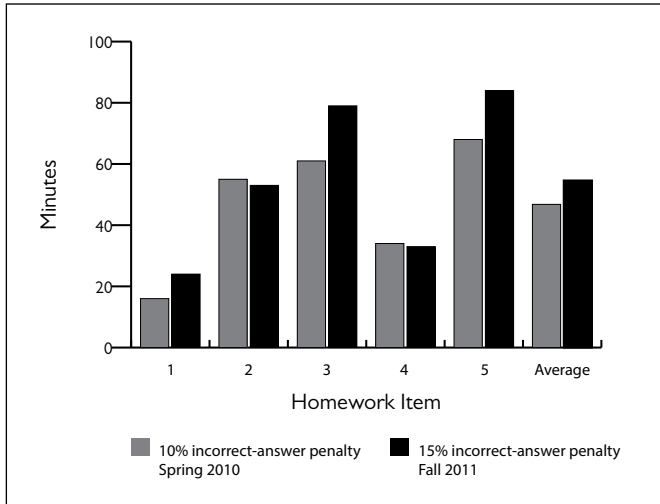


Figure 1. Minutes Spent on MasteringMicrobiology Homework Items 1–5 with a 10 Percent Incorrect-Answer Penalty and with 15 Percent Penalty, Spring 2010–Fall 2011

At the end of spring 2010, I surveyed students and asked if they would have studied more to answer MasteringMicrobiology homework questions correctly in fewer attempts if the penalty for each wrong answer was greater. Fifty-five percent of students agreed or strongly agreed to the statement. As a result, I changed my 10 percent incorrect-answer penalty to 15 percent for the following semester.

I compared the first five items assigned from the spring 2010 semester, which carried a 10 percent penalty to the same items from the fall 2011 semester, which carried a 15 percent penalty. The average score was about the same for each item, however, students spent an average of 19 percent more time—from 46.8 minutes to 54.6 minutes—working on the problems after the penalty increase (figure 1).

There are slight differences in the questions in each assignment for the two semesters. However, diagnostic analysis indicates that students generally spent more time on the problems before answering, which may indicate that they were reading the text, reviewing the content, or watching the animations prior to answering.

### The Student Experience

Responses from spring and fall 2010 student surveys indicate that students feel overwhelmingly positive about the use of MasteringMicrobiology.

- In spring 2010, 90 percent of students responded that MasteringMicrobiology was somewhat or very helpful to their understanding and retention of course content (figure 2).

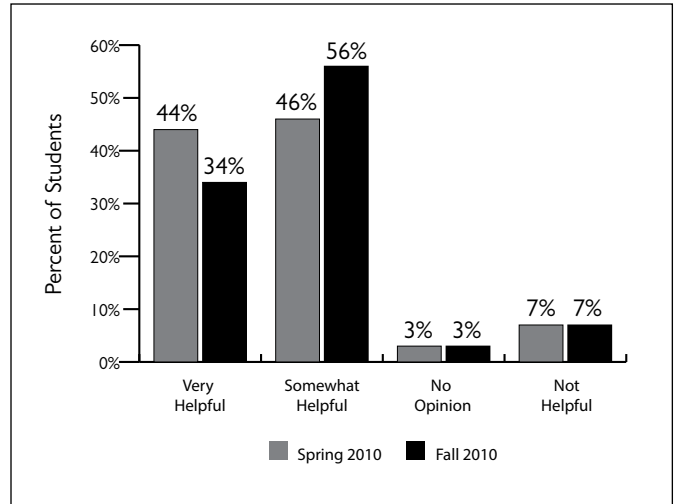


Figure 2. Average Student Response to the Question: How helpful are MasteringMicrobiology assignments to your understanding and retention of microbiology subject matters? (Spring 2010  $n=197$ , Fall 2010  $n=317$ )

- In fall 2010, 89 percent of students responded that MasteringMicrobiology was somewhat or very helpful to their understanding and retention of course content (figure 2).
- In spring 2010, 91 percent of students recommended that MasteringMicrobiology be used in the class moving forward.
- In fall 2010, 89 percent of students recommended that MasteringMicrobiology be used in the class moving forward.

### Conclusion

Students must succeed in this course in order to move forward with their educational goals, but there is too much content to cover in one semester. Now I can assign some content using MasteringMicrobiology and confirm via the program's diagnostic features that the students have successfully mastered the content. I use the time saved in lecture to focus on higher-level concepts.

Submitted by Zhongguo Xiong  
University of Arizona

Product Name [MasteringPhysics](#)  
 Course Name [General Physics: Mechanics](#)  
 Credit Hours [Five](#)

**Key Results** Force Concept Inventory (FCI) posttest scores have consistently risen with the use of MasteringPhysics, despite a decrease in FCI pretest scores during the same period of time.

## Text

*University Physics with Modern Physics*, 13e, Hugh D. Young, Roger A. Freedman

*“MasteringPhysics is the single best thing I’ve done to improve how I teach physics.”*

## Implementation

This is the first course of a 3- or 4-semester sequence of physics courses with calculus, designed for students in engineering, physics, geology, astronomy, chemistry, and some biological sciences. Students who take this course are generally planning to transfer to a four-year school.

In addition to requiring MasteringPhysics since 2005, I use the revised Force Concept Inventory assessment (I. Halloun, R.R. Hake, E.P. Mosca, and D. Hestenes), and consistently adhere to the following test protocol:

- The FCI is given on the first day of class to all students.
- The test is not graded until the end of the semester. I intentionally try not to “teach to the test.”
- Those students who remain in the class are given the same exam again during the last week of the semester.
- Both answer sheets are processed and compared, generating pre, post, difference, and normalized gain<sup>1</sup> scores.

In 2008 I started using video clips for homework assistance, customizing MasteringPhysics homework problems, and offering extra credit for posting YouTube videos that helped explain key concepts.

Since 2009 I’ve used MasteringPhysics to create exam-review problem sets and to hold in-class competitions in which students race to complete sample, conceptual exam problems as a team.

Since fall 2011 I’ve had students complete two MasteringPhysics assignments per week: an introductory, prelecture assignment; and a more-traditional, comprehensive homework assignment comprising a mix of MasteringPhysics tutorials and end-of-chapter discussion questions, exercises, and problems.

Most recently, in spring 2012, I added homework quizzes—brief, one-problem, in-class quizzes focusing on a single problem from the weekly assignment.

### Assessments

40 percent	Exams
20 percent	MasteringPhysics homework and quizzes
20 percent	Labs
12 percent	Discussion, group work, and class participation
8 percent	Research paper and presentation

1. Normalized gain is defined as the ratio of “corrected” answers compared to the total number of wrong answers on the initial pretest:  

$$ng = \frac{[(\text{posttest score}) - (\text{pretest score})]}{[30 - (\text{pretest score})]}$$

Using only posttest results to assess student success is misleading, as students may enter the course already knowing the material. By normalizing the results, we’re able to compare overall student success in learning what they apparently did not know before.

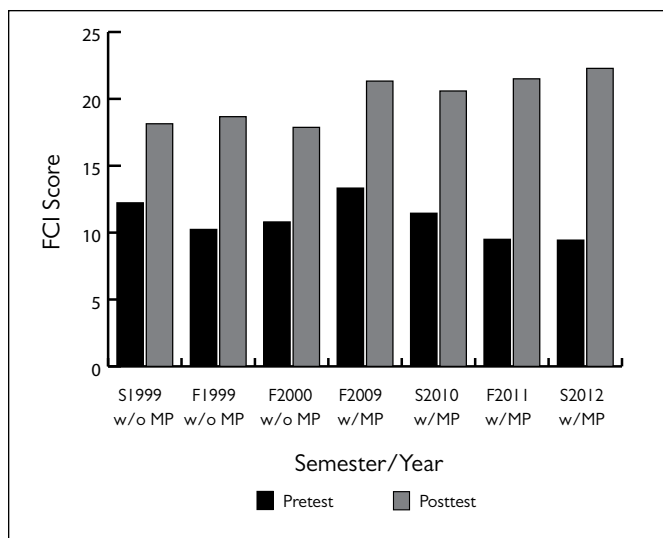


Figure 1. FCI Pre- and Posttest Scores

## Results and Data

During the last four terms, FCI pretest scores have been comparable, and may even be starting to trend lower. During the same period, posttest scores have consistently risen. As measured by the FCI, student understanding of basic mechanics has improved. See figure 1.

Students using MasteringPhysics achieved larger normalized gains than did those in earlier years (see figure 2), and they also achieved larger normalized gains than those students in physics classes in which MasteringPhysics was not used as extensively (although there were many differences in approaches, as well). In addition, my second- and third-term students show much more aptitude tackling complex problems, and course completion rates are up approximately 10 percent compared to courses offered 10 years ago, in which MasteringPhysics was not used.

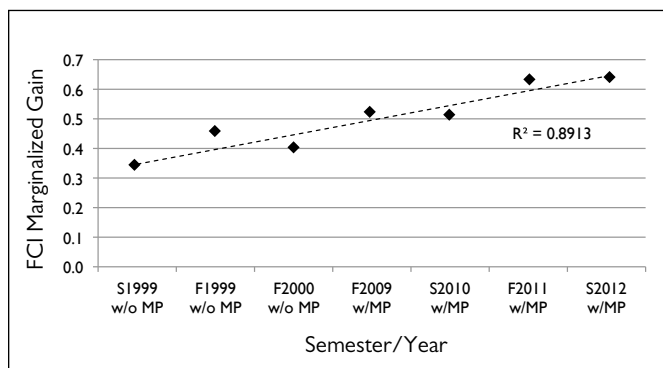


Figure 2. FCI Pretest to Posttest Marginalized Gains

Due to the small number of courses taught during the examined timeframe, and to course enrollments of only 25–50 students, significant conclusions about specific causes and effects are impossible to quantify. Additionally, the many variables involved—including types of students, textbooks, changes in labs, and changes in approaches—make it inappropriate to suggest that MasteringPhysics *alone* has produced the trends observed. That said, as I use the program more and more—for lecture problems, remediation, exam preparation, and collaborative group work—I repeatedly witness its very positive impact on my students.

## The Student Experience

Students report that the immediate feedback on homework assignments helps them feel more successful. In end-of-term anonymous surveys, more than 90 percent of students surveyed indicate that the use of MasteringPhysics is “important,” “very important,” or “most important” to their success.

Student comments include the following:

- “I used hints for some problems, and that helped me solve [for] the correct answer. I really like those hints that remind us to think about the sign or asks if a certain force or variable matters in the problem.”
- “The MasteringPhysics homework helped me to understand the material better and to manage my time better. I liked having more than one chance to answer a question and getting hints when I was unsure.”

## Conclusion

I’ve used MasteringPhysics for more than six years and I’m convinced that it has significantly improved both my teaching and my students’ learning. I now know what my students know, what they don’t know, and why. Time that was once spent grading homework now is used for improving my lectures and labs. Plus, I’ve seen better questions asked in lecture, more-active participation in labs, and slightly better exam scores. Perhaps most important, many more students seem to feel that they have the opportunity to succeed. I believe that is a direct reflection of the outstanding pedagogy inherent in the MasteringPhysics program.

*Submitted by Scott Hildreth  
Chabot College*

Product Name MasteringPhysics

Course Name Physics II: Electricity and Magnetism

Credit Hours Four

**Key Results** Students are more motivated to spend their time and effort on for-credit MasteringPhysics problems than they are on practice problems. The increased amount of engagement results in better performance in the course.

**Text**

*Physics for Scientists and Engineers: A Strategic Approach*, 2e, Randall D. Knight

**Implementation**

This second-semester, calculus-based course for Introduction to Physics covers electromagnetism, applications of electromagnetism, and light. Course goals include teaching students basic electromagnetism at the conceptual level and helping them develop problem-solving skills to apply to future studies. The course is primarily composed of engineering students, plus some science and a few physics majors; and comprises a lecture and lab.

We began using MasteringPhysics in fall 2004. We adopted MasteringPhysics because we believed the tutorials would help students learn needed problem-solving skills.

MasteringPhysics homework consists of a for-credit assignment corresponding to each class meeting. These assignments include tutorial questions and a few end-of-chapter questions. In addition, students are assigned a weekly, not-for-credit, practice assignment, which contains primarily end-of-chapter questions.

Because the practice homework is not for credit, some students assume that it is optional. We examined how much time students spend on for-credit MasteringPhysics homework compared to practice homework, and how well students who complete or attempt the MasteringPhysics practice homework perform compared to students who do not.

**Assessments**

- 50 percent Quizzes (weighted average of five)
- 25 percent Final exam
- 10 percent Laboratory
- 5 percent MasteringPhysics homework

- 5 percent Recitation
- 5 percent Class participation

**Results and Data**

We looked at the amount of time students spent on for-credit MasteringPhysics homework compared to the amount they spent on not-for-credit practice problems. Our analysis showed that students overwhelmingly spend more time on for-credit work than on not-for-credit work—and that those students who spend more time on MasteringPhysics homework perform better in the course. See figure 1.

We also looked at data from more than 3,000 students from 2004–2008 to see how well students did in the course based on the percent of practice homework assignments attempted.

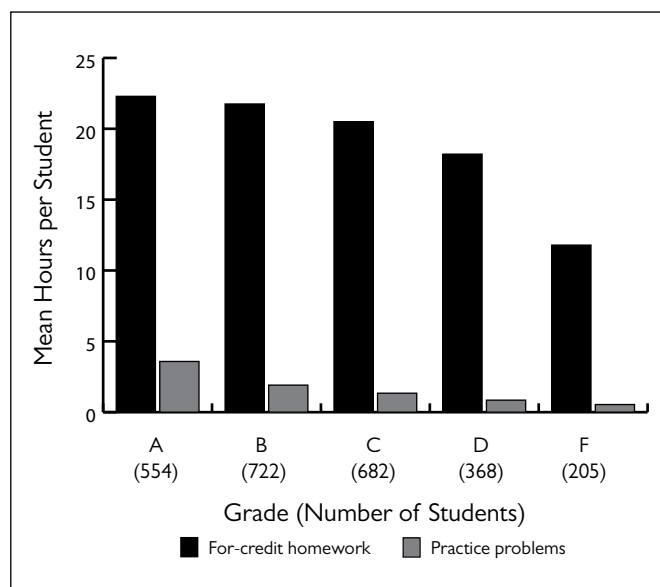


Figure 1. Comparison of Hours Spent on MasteringPhysics For-Credit Homework and Not-for-Credit Practice Problems, Fall 2004–Spring 2008 (n=2,531)



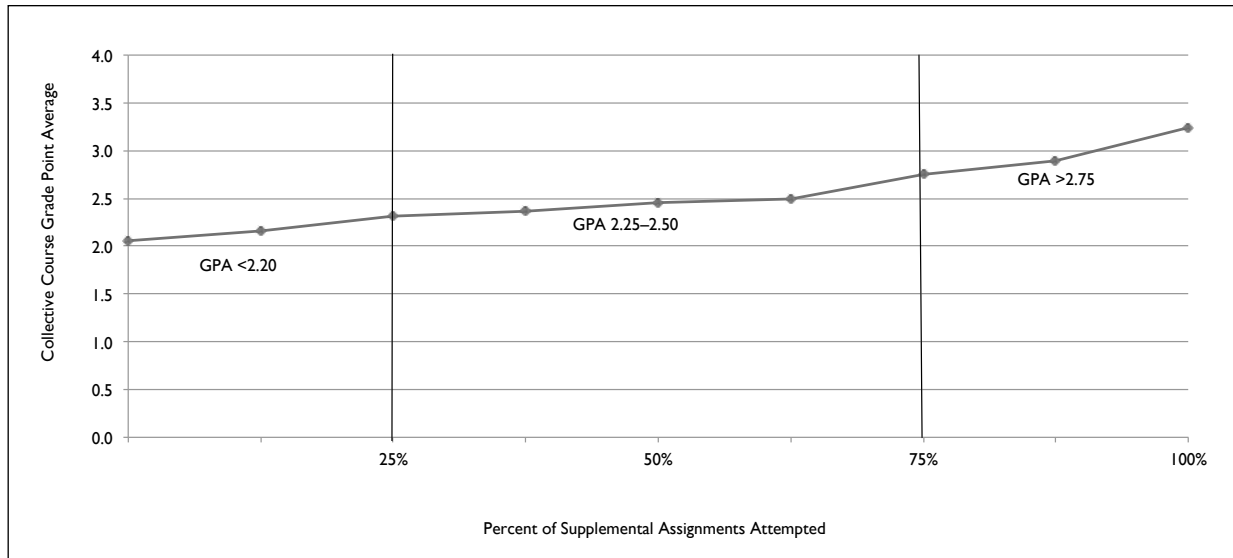


Figure 2. Correlation between Attempting MasteringPhysics Practice Homework and Final Course Grade Point Average, Fall 2004–Spring 2008 ( $n=3,614$ )

We did not look at the grade of the practice homework, but rather that it was opened and attempted. Our results show a positive correlation between the percent of practice homework attempted and the average course grade point average. See figure 2.

In this same analysis, we found the following:

- 51 percent of students attempted less than 25 percent of the practice problems. Of those 51 percent, 48 percent earned a final course grade less than 60, and only 17 percent earned a final course grade higher than 75.
- 18 percent of students attempted more than 75 percent of the practice problems. Of those 18 percent, 24 percent earned a course grade less than 60, and 40 percent earned a final course grade higher than 75.

### The Student Experience

Each year we ask those students who have achieved an A in Physics II to advise incoming students on how to succeed in the course. Below are some of their comments.

- *“Make sure that you do the homework in its entirety because it is the best way to reinforce and even learn the lecture material. We all know the answers to the homework questions are available online if you know where to look. Take some advice from someone who didn’t use those answers and earned an A in the class: the homework assignments are the most valuable learning tool provided to you; don’t*

*squander this tool by cheating just to finish a little early or to get a 100.”*

- *“I probably spent longer than most working on the homework, but that was how I learned everything.”*
- *“The homework definitely helped me a lot. It was great practice between tests, and that made studying for the actual tests a lot easier. As long as you seriously work through every problem by yourself (hints are helpful), you can learn and retain a lot of material.”*

### Conclusion

Students who put more time and effort into doing MasteringPhysics problems perform better in the course. We have found that, on average, students who ignore the not-for-credit, practice assignments can expect to score lower on both the quizzes and the final exam—and will likely earn a lower final course grade.

*Submitted by Eric Murray and Martin Jarrio  
Georgia Institute of Technology*

Product Name **MasteringPhysics**

Course Names **College Physics I and II**

Credit Hours **Four**

**Key Results** MasteringPhysics provides the kind of resources and feedback students need to practice and learn outside the classroom. As a result, more class time can be spent on hands-on, interactive learning.

## Text

*College Physics: A Strategic Approach*, 2e, Randall D. Knight, Brian Jones, and Stuart Field

## Implementation

College Physics I and II is an algebra-based, two-course sequence covering the fundamentals of physics. The experimental aspects of physics are emphasized in the classroom and the lab, and considerable time is devoted to problem solving. Course content includes measurement, vectors, kinematics, dynamics, gravitation, energy, momentum, rotational motion, wave motion, electricity and magnetism, electromechanical devices, geometrical and physical optics, and modern physics. Students are not required to take the lab concurrent to the lecture.

I believe that the key to learning and improving skills is repetition and practice accompanied by effective feedback. MasteringPhysics homework is one way to access that key. I adopted MasteringPhysics in 2009 because it offers students, via homework, an opportunity to practice and learn in a low-stakes environment with immediate, error-specific feedback.

Students are required to complete weekly MasteringPhysics homework assignments comprising a mix of tutorial and end-of-chapter questions. Assignments are due several days after lecture. To help students understand how to use their MasteringPhysics homework as a learning resource and way to develop problem-solving skills, I offer them the following advice:

- Do not expect to solve all physics problems on your first try. Persistence is the key.
- Starting your homework early in the week is crucial. You'll be far more successful (and less stressed) if you tackle homework an hour at a time over five days, rather than in one burst late in the week.
- Meeting regularly with a small study group is an excellent strategy. The only caution is to not submit answers that

you don't understand how to arrive at on your own. That will set you up for disappointment on exams.

- It is of the utmost importance to keep up with reading and homework assignments throughout the semester. Some students require more time than others to digest and comprehend the material and do the assignments. Only you can judge how much time you'll need to succeed.

In addition to MasteringPhysics assignments, students are required to complete a written warm-up exercise prior to each class (using Just-in-Time Teaching). The assignment comprises open-ended questions based on the reading and is graded on effort. I use the responses to the warm-up questions for class discussion.

I am a proponent of active learning and have designed my course to include highly interactive class activities. I use a mixture of traditional lecture, discussion, "clicker" questions, and interactive demonstrations. A classroom response system is used in a manner that follows the Peer Instruction model pioneered by Eric Mazur of Harvard. Students respond to difficult conceptual questions (sometimes predicting the outcome of a physical demonstration). They're invited to discuss their response with nearby students and then to respond again to the same question. Studies show that the discussion that takes place in this process is a huge learning opportunity—that it engages students and promotes a more-interactive class.

### Assessments

65 percent	Exams (two exams, one final)
20 percent	MasteringPhysics homework
10 percent	Warm-up exercises
5 percent	Peer instruction participation

## Results and Data

I give the Forced Concept Inventory (FCI) pre- and posttest in College Physics I and the Conceptual Survey of Electricity and Magnetism (CSEM) pre- and posttest in College Physics II. I evaluated gains for the FCI in College Physics I for spring 2011, with 76 percent of students having completed both the pre- and posttests, and the CSEM for fall 2011, with 83 percent of students having completed both the pre- and posttests, and found the following:

- Students earning an A in College Physics I averaged a gain of 56 percent from pre- to posttest and scored an average of 93 percent on MasteringPhysics homework.
- Students earning a D in College Physics I averaged a gain of 22 percent from pre- to posttest and averaged 58 percent on MasteringPhysics homework.
- Students earning an A in College Physics II averaged a gain of 28 percent from pre- to posttest and averaged 94 percent on MasteringPhysics homework.
- Students earning a D in College Physics II averaged a gain of 10 percent from pre- to posttest and averaged 60 percent on their MasteringPhysics homework.

I also evaluated MasteringPhysics homework scores compared to final course grades and found that a student's homework score is a strong predictor for that student's final course grade (table 1).

In the spring 2011 College Physics I and the fall 2012 Physics II classes, 94 percent of the students earning an A or B in the course scored 80 percent or higher on their MasteringPhysics homework. As I expected it would, analysis shows that students who put effort into the homework tend to do better in the course. This also is supported by student feedback:

- "Doing the [MasteringPhysics] homework and the warm-ups are pretty important in order to understand the sometimes mind-boggling material in class."
- "Do the warm ups and do MasteringPhysics. They definitely help prepare you for exams."

## The Student Experience

I survey my students for feedback on MasteringPhysics. Their responses are based on a five-point scale, with 1=very harmful and 5=very helpful. Mean responses from my College Physics II fall 2012 section are typical of all of my sections and show that students felt MasteringPhysics was very helpful to them (table 2).

Final Course Grade	College Physics I		College Physics II	
	Spring 2011	Spring 2012	Fall 2011	Fall 2012
A	92%	93%	95%	95%
B	90%	82%	89%	90%
C	79%	78%	85%	84%
D	61%	65%	60%	83%
F	42%	45%	NA	NA

Table 1. Average MasteringPhysics Homework Score by Final Course Grade, Spring 2011–Fall 2012 (College Physics I: Spring 2011  $n=59$ ; Spring 2012  $n=71$ ; College Physics II: Fall 2011  $n=80$ ; Fall 2012  $n=84$ )

Survey Question	Response Mean
How did MasteringPhysics impact your learning compared to traditional paper-and-pencil homework?	4.34
How did MasteringPhysics impact your learning compared to having no homework at all?	4.54
Overall, how do you feel about the helpfulness of the assigned MasteringPhysics homework?	4.15

Table 2. Student Survey Questions and Mean Responses Based on a Scale of 1 (Very Harmful) to 5 (Very Helpful), Fall 2012

When asked what advice they would give future students, student responses included the following:

- "Rework difficult problems and try to do them without help from the book the second time around."
- "Practice more by doing more problems than those assigned for homework."

## Conclusion

Despite the fact that I deliver a class with high standards and expectations, students consistently seek out my course as a place in which concepts rule and "equation hunting" is a failing strategy. I am passionate about the use of Just-in-Time teaching and integrate multiple learning opportunities into my course to help students succeed. Students take responsibility for their learning outside of class, which has resulted in a higher level of student engagement and active learning during class time.

*Submitted by Jeff Loats  
Metropolitan State University of Denver*

Product Name **MasteringPhysics**

Course Name **Dynamics (first year)**

Credit Hours **Three**

**Key Results** With MasteringPhysics, Dynamics students were more engaged, submitted more homework assignments, earned higher exam scores, and had increased pass rates.

## Implementation

All first-year physics students take Dynamics as a core course during their first semester. The students' previous knowledge and experience varies—some have not taken any mechanics classes; others may have taken as many as four or more.

Prior to 2006, Dynamics was taught in the traditional manner—two one-hour lectures per week, a weekly workshop, and small group tutorials. It suffered from relatively poor examination results and mediocre student feedback. In 2006/07, we changed the delivery of the course via student-centered teaching techniques, including modified Just-In-Time Teaching, e-learning, and e-assessment. For the latter, we used MasteringPhysics.

Qualifiable goals included increased student engagement and personal responsibility for learning; a change in student attitudes toward learning from wanting to be “spoon fed” to constructing their own understanding; and deep conceptual understanding rather than learning to pass exams. Quantifiable goals included increased student examination scores.

## Assessments

We replaced the two traditional lectures with one overview lecture at the beginning of each week that introduces students to the material they need to study that week. After the lecture, the students construct their own understanding by studying the course material online in our virtual learning environment. A rich suite of e-learning material is provided, including more than 50 “talklets” (mini PowerPoint presentations with voiceovers) and numerous “physlets” (Java applets). Once students feel that they understand the material, they complete a four- to six-problem MasteringPhysics assignment.

Students submit weekly assignments by 9 a.m. each Friday. We use MasteringPhysics to analyze student performance and identify concepts and problems with which they are struggling. From this, we select the content of the Just-in-Time Response and

Problem sessions. For these sessions, the cohort is divided into four groups, and the students work problems in the areas of difficulty revealed by the MasteringPhysics assignment. Students are encouraged to discuss problems, and each group is supported by an academic staff member and a postgraduate assistant.

## Results and Data

Students were not enamored with MasteringPhysics during the first year and student feedback was poor. By removing the American notation and adding hints to the end-of-chapter problems, we greatly enhanced student satisfaction.

- In a 2009/10 poll, 49 percent of students rated MasteringPhysics as the most valuable aspect of the course in terms of aiding their learning.
- Generally, more than 90 percent of students submit the weekly MasteringPhysics assignments—a significantly better submission rate than that obtained for the weekly tutorial work.

Examination performance has improved since the introduction of this integrated teaching approach.

- The average grade is approximately 10 percent higher.
- The failure rate has decreased significantly—from 32 percent to 5–14 percent in recent years.

## Conclusion

MasteringPhysics has enhanced the delivery of our Dynamics course. The weekly MasteringPhysics assignments help ensure that students keep up with course material as it is delivered, rather than leaving their learning until just before the final examination. The assignments offer students an opportunity to practice problem solving, in addition to their tutorial work.

*Submitted by Marion Birch and Niels Walet  
University of Manchester*

See also Birch, M. and Walet, N. (2008) “An integrated approach to encourage student-centred learning: A first course in dynamics.” *New Directions in the Teaching of Physical Sciences, The Higher Education Academy, Issue 4, 21–6.*

## Publications and Proceedings

Instructors and researchers from universities around the globe are using their own strict analytical protocols to assess Mastering. They're presenting their results at educational technology conferences and publishing their research in peer-reviewed, industry journals. If your Mastering experience has been presented or published, please contact your Pearson representative to have it added our list.

### Increasing Student Success Using Online Quizzing in Introductory (Majors) Biology

To determine the effect of utilizing testing as a learning event in the introductory biology classroom, instructors used MasteringBiology to give required quizzes throughout the course. Analysis of exam grades earned by those taking 100 percent of preexam quizzes indicates that this group had a significantly higher exam average than the group who did not take the preexam quizzes and a significantly higher exam average than the class average. The study concludes that preexam quizzing using MasteringBiology is a significant benefit for students of diverse academic abilities, an effective way to increase student performance on exams, and enables class time to be utilized for teaching activities.

*Increasing Student Success Using Online Quizzing in Introductory (Majors) Biology (2013)* CBE: Life Sciences Education, by Rebecca Orr and Shellene Foster, Collin College, vol. 12 no. 3 509-514.

<http://www.pearsonmylabandmastering.com/northamerica/results/files/CBE-Life-Sci-Educ-2013-Orr-509-14.pdf>

### Longitudinal Study of Online Statics Homework as a Method to Improve Learning

Students who completed MasteringEngineering homework showed an improvement of 0.7 ( $\pm 0.2$ ) in effect size on the final exam when compared to written homework, and scored an average of 79 percent on the final exam. In comparison, students who completed written homework scored an average of 70 percent on the same final exam. These results held for the subsequent mechanics course and were statistically significant.

*Longitudinal Study of Online Statics Homework as a Method to Improve Learning (2013)*, Manohar L. Arora, Colorado School of Mines; Yun Jin Rho and Claire Masson, Pearson Education, Journal of STEM Education, vol. 14, no. 1.

[http://www.pearsonmylabandmastering.com/northamerica/results/files/MB\\_GRayner\\_paper.pdf](http://www.pearsonmylabandmastering.com/northamerica/results/files/MB_GRayner_paper.pdf)

### Engaging Distance Students through Online Tutorials

Regular and consistent engagement with the online system was practiced by students achieving high course marks; students with lower course outcomes exhibited inconsistent and bundled usage patterns. There is also a strong statistical association between the marks achieved for the tutorial series and final course results. Clear differentiation between usage patterns of high- and low-achieving students, coupled with correlation between tutorial results and exam results, suggests that the online tutorial usage patterns of high-achieving students are more effective in terms of overall course achievement.

*Engaging Distance Students through Online Tutorials (2012)*, Jo Devine and Weena Lokuge, University of Southern Queensland, Toowoomba, Australia. Presented at Australian Association for Engineering Education 2012 Conference, Melbourne.

[http://www.pearsonmylabandmastering.com/northamerica/results/files/MEngineering\\_Arora\\_STEM\\_1700-5845-1-PB.pdf](http://www.pearsonmylabandmastering.com/northamerica/results/files/MEngineering_Arora_STEM_1700-5845-1-PB.pdf)

### Using Online Assessment to Provide Instant Feedback

The authors explain why they chose a commercial e-assessment tool, discuss the types of assignments available and which types of assessments were found most effective, the steps needed to create a positive experience for students, the important lessons learned regarding the mechanisms of quality control that underlie the use of online mathematical assessments, and further developments that would make this type of rich assessment even more useful.

*Using Online Assessment to Provide Instant Feedback (2012)*, Niels R. Walet and Marion Birch, University of Manchester, United Kingdom, STEM Annual Conference 2012, April 12-13, 2012, Imperial College Higher Education Academy.

[http://www.pearsonmylabandmastering.com/northamerica/results/files/MasteringPhysics\\_University\\_of\\_Manchester\\_Walet\\_Birch\\_ES.pdf](http://www.pearsonmylabandmastering.com/northamerica/results/files/MasteringPhysics_University_of_Manchester_Walet_Birch_ES.pdf)

### Patterns, Correlates, and Reduction of Homework Copying

Submissions to an online homework tutor were analyzed to determine whether they were copied. The fraction of copied submissions increased rapidly over the semester as each weekly deadline approached and for problems later in each assignment. The majority of students copied less than 10 percent of their problems and worked steadily over the three days prior to the deadline, whereas those who copied 30 percent of their submitted problems exerted little effort early. The patterns of copying, free-response survey questions, and interview data suggest that time pressure on students who don't start homework in a timely fashion is the cause of copying. Changes in course format and instructional practices that previous self-reported academic dishonesty surveys and/or the copying patterns suggested would reduce copying resulted in a reduction of copying from 11 percent of electronic problems to less than 3 percent. Since repetitive copiers have approximately three times the chance of failing, this was accompanied by a reduction in the course failure rate. Survey results also indicate that students copy almost twice as much written homework as online homework.

*Patterns, Correlates, and Reduction of Homework Copying (2010)*, Physics Education Research 6, 010104, David J. Palazzo, Massachusetts Institute of Technology and Department of Physics, United States Military Academy; Young-Jin Lee, Massachusetts Institute of Technology and University of Kansas; Rasil Warnakulasooriya, Massachusetts Institute of Technology and Pearson Education, Boston; David E. Pritchard, Massachusetts Institute of Technology. [http://www.pearsonmylabandmastering.com/northamerica/results/files/MasteringPhysics\\_Massachusetts\\_Institute\\_of\\_Technology\\_Palazzo\\_Lee\\_Warnakulasooriya\\_Pritchard\\_Patterns\\_Correlates.pdf](http://www.pearsonmylabandmastering.com/northamerica/results/files/MasteringPhysics_Massachusetts_Institute_of_Technology_Palazzo_Lee_Warnakulasooriya_Pritchard_Patterns_Correlates.pdf)

### Evaluation and Student Perception of MasteringBiology as a Learning and Formative Assessment Tool in a First-Year Biology Subject

This paper describes the implementation of MasteringBiology into a first-year biology course with the goal of assisting those students without prior biology experience. Positive outcomes include significantly higher grades on routine assessments for students completing MasteringBiology and higher final exam grades. Further, in spite of the increased workload, a high proportion of students engaged with the process of integrating textbook readings with prelecture, online assessment.

*Evaluation and Student Perception of MasteringBiology as a Learning and Formative Assessment Tool in a First Year Biology Subject (2008)*, Gerry Rayner, Monash University, Victoria, Australia. Proceedings, ATN Assessment Conference 2008: Engaging Students in Assessment, University of South Australia, Adelaide, Australia, pp. 1-11.

[http://www.pearsonmylabandmastering.com/northamerica/results/files/Engaging\\_Distance\\_Students\\_Through\\_Online\\_Tutorials.pdf](http://www.pearsonmylabandmastering.com/northamerica/results/files/Engaging_Distance_Students_Through_Online_Tutorials.pdf)

### Measuring Student Learning with Item Response Theory

An investigation of short-term learning from hints and feedback in a Web-based physics tutoring system. Both the skill of students and the difficulty and discrimination of items were determined by applying item response theory to the first answers of students who are working on for-credit homework items in an introductory Newtonian physics course. They show that after tutoring a shifted logistic item response function with lower discrimination fits the students' second responses to an item previously answered incorrectly. Student skill decreased by 1.0 standard deviation when students used no tutoring between their incorrect first and second attempts, while on average, using hints or feedback increased student skill by 0.8 standard deviation. A skill increase of 1.9 standard deviation was observed when hints were requested after viewing, but prior to attempting to answer, a particular item.

*Measuring Student Learning with Item Response Theory (2008)*, Physics Education Research 4, 010102, Young-Jin Lee, David J. Palazzo, Rasil Warnakulasooriya, and David E. Pritchard, Massachusetts Institute of Technology.

[http://www.pearsonmylabandmastering.com/northamerica/results/files/MasteringPhysics\\_Massachusetts\\_Institute\\_of\\_Technology\\_Lee\\_Palazzo\\_Warnakulasooriya\\_Pritchard\\_Measuring\\_student\\_learning.pdf](http://www.pearsonmylabandmastering.com/northamerica/results/files/MasteringPhysics_Massachusetts_Institute_of_Technology_Lee_Palazzo_Warnakulasooriya_Pritchard_Measuring_student_learning.pdf)

### Time to Completion of Web-based Physics Problems with Tutoring

The authors studied students solving multipart physics problems with interactive tutoring on the Web. They extracted the rate of completion and fraction completed as a function of time on task by retrospectively analyzing the log of student-tutor interactions. About 65 percent of the students solved the problem in real time after multiple interactions with the tutorial program, primarily receiving feedback to submitted wrong answers and requesting hints. This group displayed a sigmoidal fraction-completed curve as a function of logarithmic time. The authors argue that students who respond quickly (about 10 percent of the students) are obtaining the answer from an outside source, and that the remaining 25 percent of the students are those who interrupt their solution, presumably to work offline or obtain outside help.

*Time to Completion of Web-based Physics Problems with Tutoring (2007)*, Journal of the Experimental Analysis of Behavior 2007, vol. 88, 103-113 no. 1 (July), Rasil Warnakulasooriya, David J. Palazzo, and David E. Pritchard, Massachusetts Institute of Technology.

[http://www.pearsonmylabandmastering.com/northamerica/results/files/MasteringPhysics\\_Massachusetts\\_Institute\\_of\\_Technology\\_Warnakulasooriya\\_Palazzo\\_Pritchard\\_Time\\_to\\_Completion\\_\(2007\).pdf](http://www.pearsonmylabandmastering.com/northamerica/results/files/MasteringPhysics_Massachusetts_Institute_of_Technology_Warnakulasooriya_Palazzo_Pritchard_Time_to_Completion_(2007).pdf)



### Evidence of Problem Solving Transfer in Web-based Socratic Tutor

The authors demonstrate learning and problem-solving transfer within MasteringPhysics by considering time to completion, the number of hints requested, and the number of incorrect responses given. The group of students who were prepared by a prior related problem solves a related follow-up problem in ~14 percent less time on average compared to an unprepared group. In addition, the prepared group requests ~15 percent fewer hints and makes ~11 percent fewer errors on average than the unprepared group.

*Evidence of Problem-Solving Transfer in Web-Based Socratic Tutor (2005)*, Rasil Warnakulasooriya, David J. Palazzo, and David E. Pritchard, Massachusetts Institute of Technology. *Proceedings of the 2005 Physics Education Research Conference*, pp. 41-43.  
[http://www.pearsonmylabandmastering.com/northamerica/results/files/MasteringPhysics\\_Massachusetts\\_Institute\\_of\\_Technology\\_Warnakulasooriya\\_Palazzo\\_Pritchard\\_Evidence\\_of\\_Problem\\_Solving.pdf](http://www.pearsonmylabandmastering.com/northamerica/results/files/MasteringPhysics_Massachusetts_Institute_of_Technology_Warnakulasooriya_Palazzo_Pritchard_Evidence_of_Problem_Solving.pdf)

### Learning and Problem-Solving Transfer between Physics Problems Using Web-based Homework Tutor

Two equally skilled groups of students taking introductory mechanics use MasteringPhysics to solve related physics problem pairs in reverse order with respect to each other. For problems containing help in the form of requested hints, descriptive text, and feedback, twice as many students were able to complete problems correctly in real time compared to problems that did not provide any help. The group that did a problem second (prepared group) in a given related pair was able to solve it in ~15 percent less time on average compared to the group that did the same problem first (unprepared group). In addition, the prepared group requested 7 percent fewer hints on average than the unprepared group. The study concludes that learning and problem-solving transfer is facilitated by skill building and self-tutoring problems, which also are pedagogically superior to end-of-chapter problems.

*Learning and Problem-Solving Transfer between Physics Problems Using Web-based Homework Tutor (2005)*, Rasil Warnakulasooriya and David E. Pritchard, Massachusetts Institute of Technology; *EdMedia: 2005 World Conference on Educational Multimedia, Hypermedia, and Telecommunications*, pp. 2976-2983.  
[http://www.pearsonmylabandmastering.com/northamerica/results/files/MasteringPhysics\\_Massachusetts\\_Institute\\_of\\_Technology\\_Warnakulasooriya\\_Learning\\_and\\_Problem\\_Solving.pdf](http://www.pearsonmylabandmastering.com/northamerica/results/files/MasteringPhysics_Massachusetts_Institute_of_Technology_Warnakulasooriya_Learning_and_Problem_Solving.pdf)

### Time to Completion Reveals Problem-Solving Transfer

Two equally skilled groups of students taking introductory mechanics use MasteringPhysics to solve related physics problem pairs in reverse order with respect to each other. In tutorial problems containing help in the form of requested hints, descriptive text, and feedback, twice as many students were able to complete problems correctly in real-time compared to problems that did not provide any help. The prepared group in a given related pair was able to solve it in ~15 percent less time on average compared to the unprepared group. In addition, the prepared group requested ~7 percent fewer hints on average than the unprepared group. The study concludes that shorter completion times and problem-solving transfer are facilitated by tutorial problems.

*Time to Completion Reveals Problem-Solving Transfer (2004)*, Rasil Warnakulasooriya and David E. Pritchard, Massachusetts Institute of Technology. *Proceedings of the 2004 Physics Education Research Conference*, pp. 205-208.

[http://www.pearsonmylabandmastering.com/northamerica/results/files/MasteringPhysics\\_Massachusetts\\_Institute\\_of\\_Technology\\_Warnakulasooriya\\_Pritchard\\_Time\\_to\\_Completion.pdf](http://www.pearsonmylabandmastering.com/northamerica/results/files/MasteringPhysics_Massachusetts_Institute_of_Technology_Warnakulasooriya_Pritchard_Time_to_Completion.pdf)

### What Course Elements Correlate with Improvement on Tests in Introductory Newtonian Mechanics?

In a calculus-based, introductory Newtonian mechanics course at the Massachusetts Institute of Technology, the authors study the effectiveness of electronic and written homework, collaborative group problems, and class participation. They measure effectiveness by the slope of the regression line between a student's score on a particular course element and his normalized gain on various assessment instruments. The results show that interactive course elements are associated with higher gains on assessment instruments.

*What Course Elements Correlate with Improvement on Tests in Introductory Newtonian Mechanics? (2004)*, Elsa-Sofia Morote and David E. Pritchard, Massachusetts Institute of Technology; *American Journal of Physics*, vol. 77, no. 8 (August 2009).

[http://www.pearsonmylabandmastering.com/northamerica/results/files/MasteringPhysics\\_Massachusetts\\_Institute\\_of\\_Technology\\_Warnakulasooriya\\_Pritchard\\_Time\\_to\\_Completion.pdf](http://www.pearsonmylabandmastering.com/northamerica/results/files/MasteringPhysics_Massachusetts_Institute_of_Technology_Warnakulasooriya_Pritchard_Time_to_Completion.pdf)

## Best Practices: 11 Steps to Mastering Success

The institutions included in this report did more than simply add Mastering to their curricula. *How* they used the program significantly contributed to their positive results. Below you'll find 11 recommended best practices that will help both you and your students get the most out of your Mastering implementation.

- 1. Attend Mastering trainings and follow best practices.** Work with Pearson to ensure all users are trained. For peer-to-peer support, consult with an expert Mastering user via the "Ask an Expert Mastering User" link on your course home page. Implementing and following best practices will help you obtain the best results.
- 2. Communicate clear expectations to your students and help them get started.** Introduce your students to Mastering on the first day of class and walk them through the registration process. Talk to them about the importance of time on task and the correlation between time spent working in Mastering and higher grades. Persevere—many students put more time into Mastering after the first exam.
- 3. Require the Introduction to Mastering assignment.** This important introductory assignment teaches students how hints work, how to enter answers, and how they will be graded. The assignment automatically appears upon course creation.
- 4. Require Mastering for a minimum of 10 percent of the final course grade.** Pearson usage statistics and survey responses indicate that more than 90 percent of students complete assignments that contribute significantly to their grade. By contrast, typically fewer than 10 percent of students do optional assignments.
- 5. Assign a mix of tutorials and other items and employ personalized learning.** Studies show that personalized learning experiences maximize study efficiency and improve long-term retention. Achieve this by: assigning tutorials and coaching-type activities with immediate, answer-specific feedback and hints; adding an Adaptive Follow-Up (when available) to detect concept gaps and provide remediation before misconceptions take root; and encouraging practice with Dynamic Study Modules (when available).
- 6. Facilitate active class discussion and student preparedness by assigning prelecture homework.** Prelecture assignments introduce students to core concepts *before* lecture, thereby helping them identify misconceptions and activate prior knowledge. Instructors who assign prelecture homework have more class time for interactive learning and higher-level critical thinking activities, and their students are more engaged and more likely to participate.
- 7. Shorten assignments and increase their frequency.** Frequent, short assignments offer students more opportunities to practice and receive feedback, and encourage them to complete the assignments in a timely manner.
- 8. Offer both formative and summative assessments throughout the learning process.** Summative assessment (testing) alone is not sufficient—your students' success also depends on their motivation and commitment to learning. Formative assessments provide students with valuable feedback that can be used to guide and promote ongoing improvement.
- 9. Use Mastering's default grading policy.** Mastering's default grading settings are based on educational research and extensive experience from professors using the system.
- 10. Use Mastering's one-click Gradebook diagnostics.** Mastering can help you identify each assignment's most difficult topics and common student misconceptions. Instructors use this information to inform their lectures, quantifiably assess their students' skill levels and mastery of learning outcomes, and compare course performance to the system average.
- 11. Measure and track results.** Evaluate your course results after implementing Mastering, and before and after any course redesign. Contact your Pearson representative for help evaluating your course results—Pearson has resources to help you gain the most insight into the impact Mastering has on your students' learning and success and to show you how to take your results to the next level.



## Glossary of Terms Used in this Report

To ensure clear and consistent understanding of the terms used in this report, we have taken the liberty of defining several of them here. Please note that these definitions are simply for the purposes of this report and do not necessarily reflect either official or dictionary-true versions.

**Adaptive follow-up activities** are specifically selected for each student and are presented immediately following the regular Mastering (Parent) assignment. The activities are recommended on an ongoing basis based on a student's response to items in the current and previous assignments.

**Case study** is a data-supported report of success—such as increased exam scores, improved retention, or higher post-test gains—with supporting qualitative evidence of improved learning, engagement, or readiness.

**Completion rate** is the percentage of students who registered for a course and completed the course through the final exam, excluding those students who officially dropped (withdrew from) the course. This is also called the retention rate.

**Course redesign** is the process of restructuring how the content of a course is delivered. It involves redesigning a whole course (rather than individual classes or sections) usually to achieve better learning outcomes, often at a lower cost. This usually is done by taking advantage of the capabilities of technology. Course redesign is most effective in large-enrollment courses.

**Distance-learning course** is a course where students do not have regular face-to-face class meetings and do not have to maintain a regular presence on the particular campus that is granting the credit. Most if not all learning activities are conducted online. This type of course is also called an online course.

**Drop/fail/withdraw (D/F/W) rate** is the percentage of students who register for a course and at the end earn a grade of D, F, or W (drop, fail, or withdraw) in the course.

**Experimental study** is an observational or controlled study that was designed and conducted to quantify Mastering's impact on student learning. Attention has been paid to possible confounding factors in drawing conclusions.

**Hybrid course** is a course that has some face-to-face classroom activities and some online activities.

**Integrated use** refers to the fact that an instructor makes a Mastering product a part of the syllabus and assigns work to be completed by the student.

**Online course** is a course where students do not have regular face-to-face class meetings and do not have to maintain a regular presence on the particular campus that is granting the credit. Most if not all learning activities are conducted online. This type of course is also called a distance-learning course.

**Pass rate** is the percentage of students whose final grade is A, B, C, or D. This is not the same as the success rate, which does not include the grade of D.

**Prelecture assignments** are due before the course lecture and cover that lecture's content. They motivate students to familiarize themselves with basic concepts prior to class time, so that class can be spent on interactive learning or other higher-level thinking activities.

**Required use** means an instructor mandates the use of a Mastering product by students for an individual grade that is part of the final course grade. It is the opposite of optional use.

**Retention rate** is the percentage of students who registered for a course and completed the course through the final exam, excluding those students who officially dropped (withdrew from) the course. This is also called the completion rate.

**Subsequent success** refers to the success that students experience in higher-level courses due in part to their having first successfully completed other, lower-level Mastering-supported courses.

**Success rate** is the percentage of students who registered for a course and earned a final course grade of A, B, or C. Note that a final grade of D is not included in the success rate.

**Various formats** refers to institutions' using varied implementation models to teach with a Mastering product.

## List of Contributors

Paul Akangah, North Carolina Agricultural and Technical State University

Andrea Aspbury, Texas State University

Warner Bair, Lone Star College–Cy Fair

Jo Barton, University of Essex

Louise Beard, University of Essex

Marion Birch, University of Manchester

Robert Boyce, University of North Carolina at Wilmington

Leslie G. Butler, Louisiana State University

Jung Choi, Georgia Institute of Technology

Sandra J. Connelly, Rochester Institute of Technology

Guy Dadson, Fullerton College

David V. Dearden, Brigham Young University

Catherine Dobson, University of Hull

Elisabetta Fasella, University of the Sciences in Philadelphia

Melissa Fierke, State University of New York,  
College of Environmental Science and Forestry

Bruce Fisher, Roane State Community College

Kathy-Sarah Focsaneanu, University of Ottawa

Denise Foley, Santiago Canyon College

Shellene Foster, Collin College

Valerie Frerichs, University at Buffalo, State University  
of New York

David Garton, Georgia Institute of Technology

Gary Glaser, Genesee Community College

Abigail Goosie, Walters State Community College

Eileen Gregory, Rollins College

Randall W. Hall, Louisiana State University

Nathan Hammer, University of Mississippi

Scott Hildreth, Chabot College

Martin Jarrio, Georgia Institute of Technology

Daniel Kelley, Bowling Green State University–Firelands College

Ariana Lipp, University of North Carolina at Wilmington

Jeff Loats, Metropolitan State University of Denver

Zhonglin Lu, Beijing Normal University

Louis McIntyre, Robeson Community College

Eric Murray, Georgia Institute of Technology

Boon-Chai Ng, Andrews University

Lourdes Norman-McKay, Florida State College  
at Jacksonville

Rebecca Orr, Collin College

Robert Pribush, Butler University

Erik Prout, Texas A&M University

Amy Ryan, Clinton Community College

Emma Lou Satterfield, Missouri University of Science  
and Technology

Tonya Shearer, Georgia Institute of Technology

Steven Socol, McHenry County College

Stephen Testa, University of Kentucky

Madhu Mahalingam, University of the Sciences in Philadelphia

Elisabeth Morlino, University of the Sciences in Philadelphia

Malia Rose, Ventura College

Christopher Sutton, Western Illinois University

Zhongguo Xiong, University of Arizona

Niels Walet, University of Manchester

Klaus Woelk, Missouri University of Science and Technology

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# What Students Are Saying

Since 2001, more than 42 million students have used Pearson's MyLab & Mastering products. At Pearson, we believe that each one of those students has a story that can motivate, inspire, and encourage other students to succeed. We started the Student Speak program as a way to share those stories. Following are quotes from students who participated in the program and have used a Mastering product. All quotes were voluntarily submitted with the student's name. Read their full stories, and countless others, at [www.pearsonmylabandmastering.com/results](http://www.pearsonmylabandmastering.com/results).

## Increased Understanding

"When I was in high school, computers barely existed, the Internet was new, and there was nothing as concise and easy to learn from as Mastering. This just goes to prove you *can* teach an old dog new tricks!"

—Steve Mezzanatto, Santa Rosa Junior College, CA

"I'm not a strong or confident test taker, but as long as my classes use Mastering, I know I'll be prepared and capable of doing well on every exam."

—Chris Demczar, Rochester Institute of Technology, NY

"MasteringChemistry helped me understand concepts that would have taken me years to understand without it."

—Frank Ofori-Addo, Concord University, WV

"If not for MasteringChemistry, I might have failed General Chemistry. Today I have a vast knowledge of chemistry and can understand real-life situations that involve chemistry."

—Mohammed Ghadban, University of Ottawa, Ontario, Canada

## Instant Feedback

"Instant feedback is probably the best thing any student can ask for when doing homework or quizzes. It allows you to know right away what you missed and prevents the wrong information from getting stuck in your head."

—Kyle Koeneman, Walters State Community College, TN

"I'm taking an online class, so it's not always convenient to wait for the professor's reply when I need help. Hints help walk me through the problem and figure it out."

—Adana Nethery, Barton Community College, KS

## Effective Study Tool

"I have terrible test anxiety. By taking a few Pre- and Post-Tests, I reduced that anxiety by improving my grade on each attempt. It let me know what to study further by identifying the questions I got wrong and reviewing the right answer."

—Erika Breitwieser, Carrington College, NV

"Being able to use MasteringA&P this semester allowed me to work a little at a time, use the resources to study the content I needed extra help on, and do better in the course."

—Alex Langlois, University of North Carolina at Wilmington, NC

"MasteringChemistry allowed me to develop effective study habits that I will continue to build upon during the remainder of my collegiate career."

—Jake Tenewitz, University of North Florida, FL

"MasteringChemistry has helped me realize that studying is a part of life."

—Hussein Habib Al Lawati, University of Kentucky, KY

## Student Recommendations

"I still have several more science-based classes to complete. I hope they all incorporate MyLab and Mastering products."

—Allison Edwards, The University of Southern Mississippi, MS

"I definitely would recommend MasteringChemistry. The feedback is useful and it's a nice way to tackle detailed information."

—Maureen Honnessy, Lewis University, IL

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