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Mastering Biology educator study looks at required and extra credit homework at Santa Rosa Junior College

Key Findings

- The group of students with above average Mastering scores had a higher exam average than students with at or below average Mastering scores.
- Students who attempted all Mastering extra credit assignments had a significantly higher exam average than students who skipped one or more extra credit assignments.
- On an end-of-semester survey, 87% of students agreed that Mastering homework helped them do better on exams.
- The instructor recommends showing students the Mastering resources early in the semester during class to motivate students to use them.

Study Specifics

School name: Santa Rosa Junior College, Santa Rosa, CA
Course name: Introduction to Principles of Biology
Course format: Face to face
Course materials: Modified Mastering Biology for *Campbell Essential Biology with Physiology* by Simon, Dickey, Hogan, and Reece

Timeframe: Spring 2018
Educator: Charles Galt, Adjunct Faculty
Results reported by: Betsy Nixon, Results Manager

Setting

- Enrollment: 28,000
- History: Formed as a junior college in 1918
- Ethnicity (2016–17): White, 53%; Latino, 32%; Asian, 5%; African American, 3%; Other, 7%
- Course retention rate (2016–17): 87%
- Course completion rate (2016–17): 87%

About the Course

Charles Galt has been an adjunct faculty member at Santa Rosa Junior College for 11 years. After teaching marine biology, plankton biology, and general biology at California State University, Long Beach for 33 years, he retired to Petaluma and teaches the Introduction to Principles of Biology (Intro Bio) course at Santa Rosa.

The one-semester Intro Bio course is intended to introduce students to the following basic topics in biology: scientific inquiry, ecology and evolution, organismal form and function, chemistry of life, cell and molecular biology, genetics, and biodiversity. Students must have completed Elementary Algebra I or higher (or have a qualifying test score in Math) and College Reading and Writing (or have a qualifying test score in English).

Intro Bio is a general education lab science course taken by some students as their science elective. Other students, including pre-nursing and various allied health majors, are required to take the course before moving on to general biology. Students must earn at least a C to pass the course, and two course repeats are permitted if students have earned a grade of D, F, Not Completed, or Not Passed. For the nursing program, students should strive to earn an A or B to be competitive for admission. The course does transfer to four-year institutions.

Student Learning Outcomes for the course include:

- Apply the scientific method to investigating and evaluating biological phenomena
- Summarize the concept of evolution including historical development, evidence and mechanisms, and apply these to patterns of biodiversity
- Integrate basic principles as they apply to biological systems, such as cellular processes, anatomy, physiology, genetics, ecology, and evolution
- Investigate how humans are impacted by ecological processes and relationships and how humans affect these
- Perform laboratory techniques, including microscopy, with a high level of expertise without assistance or instruction

Challenges and Goals

Galt's goals for the course are to help students succeed so they can move on with their educational goals to the program of their choice. In addition, he wants to help them develop an appreciation for science and how it impacts their lives and the world around them. The department has used a version of the *Campbell Biology* text for many years and added Mastering™ Biology (MB) in 2010 to allow for auto-graded homework and to provide different resources to help students study and remediate as needed on their own time. He recently changed from MB to Modified MB which is integrated with the school's current LMS, Canvas.

Implementation

Galt's course comprises two weekly lectures and one lab, and the course components are as follows:

Lecture exams: Galt administers three paper-and-pencil midterm exams and one comprehensive final exam for the lecture portion of the course. The exams consist of two-thirds multiple-choice questions and one-third short-answer/short-essay questions. Content covers lecture notes, textbook readings, and related lab material, plus any other assigned or covered materials. The fourth exam is a comprehensive final and also includes multiple choice and short-answer/short-essay questions. Students must take the final exam to pass the course.

Lecture quizzes: These quizzes are administered in class on a weekly basis with students submitting their answers via clickers. During the semester, 16 quizzes are given, and the lowest six scores are dropped. Quizzes are derived from lecture content including prior clicker questions, textbook readings, textbook Checkpoints, end-of-chapter textbook content such as Summary of Key Concepts and Self-Quiz, the textbook website, and supplemental lecture pages in Canvas.

Mastering Biology: Galt assigns one required MB homework per chapter. The assignments are open and available from the beginning of the semester and are due approximately one week after the lecture on the corresponding chapter. Students will receive partial credit for assignments completed after the due date and, once completed for credit, they may access the assignments to review and redo for practice. Galt's goal in assigning homework is to keep students engaged with the class material, expose them to the many resources available in Mastering, enhance their understanding of the lecture content, prepare them for exams, and provide a way for students to earn points. His assignments contain a mix of approximately 20–25 questions including multiple choice and activities. In addition, for some of the chapters where Galt feels additional questions are needed to fully cover the concepts, he provides Mastering extra credit (EC) homework.

A summary of the course activities is as follows:

- Assigned reading from texts and other assigned sources (approximately 25 pages/week)
- Lab reports and/or essay assignments (2–4 pages)
- Lab exercises including scientific method of analysis and interpretation of data (approximately one per week)
- Miscellaneous lab and/or lecture homework assignments, including genetic problems
- Clickers with 3–8 short questions posed during each lecture that test on material just covered or questions to discuss with students, etc.
- Objective examinations including: multiple choice, short-answer and/or essay questions, lecture exams (three midterms, one final) and short-answer lab exams
- Demonstration of basic microscope skills (one microscope quiz per semester)

Because Galt wants students to appreciate science and understand how it impacts their every day lives, he also brings in news articles, current events, and other relevant material for class discussions and as part of lecture.

Assessments

30%	Lab exams (3)
22.5%	Lecture midterm exams (3)
10%	Lecture final exam
10%	Lecture quizzes (best 10 of 16)
10%	Mastering Biology assignments (21)
10%	Clickers
5%	Lab assignments (5)
2%	Attendance
0.5%	Chemistry assignments (5)

Results and Data

Spring 2018 data were evaluated to better understand student participation and performance on the Mastering homework and in the course. The average scores for the required MB homework and extra credit MB homework were calculated. The average of the four lecture exams (three midterms and one final exam) was used in this report as the exam average. The results are as follows:

- In Spring 2018, a majority (80%) of students attempted all 21 MB assignments. One student skipped five assignments, and one student skipped 10.

- The class average for the required MB homework was 89%. The group of 17 students who earned above average MB scores had a higher lecture exam average (80%) than the group of eight students who scored at or below the MB average, earning an average exam score of 75%, however, the difference between the two averages of the means was not statistically significant (p=.2144).

- Participation for extra credit homework shows that students skipped an average of one out of nine assignments. The group of 15 students who attempted all of the EC assignments had an exam average of 83%, while the group of 10 that skipped one or more had an exam average of 71%. It was statistically significant (p<0.05).

Table 1 highlights the differences in average lecture exam scores for students based on 1) MB Homework performance; 2) MB extra credit performance; 3) clicker performance; and 4) lecture attendance. It should be

noted that other variables, such as motivation and study skills, can impact student performance and are not accounted for in the analysis. In addition, the low number of students in the study may impact the ability to show statistical significance. Further analysis is recommended, and Galt plans to continue to evaluate his course results to identify long-term trends in performance, but the analysis shows that those who did more or scored higher on Mastering homework had higher average exam scores than those who did less or scored lower on Mastering homework.

Course Item	Class Average	Lecture Exam Average for students earning > Course Item Average	Lec Exam Average for students earning ≤ Course Item Average	Significant (p<0.05)
MB Required Homework	89%	80% (n=17)	75% (n=8)	No
MB Extra Credit Homework	87%	83% (n=15)	71% (n=10)	Yes
Clickers	85%	86% (n=13)	70% (n=12)	Yes
Lecture Attendance	96%	82% (n=15)	73% (n=10)	No

Table 1. Average Lecture Exam Scores Grouped by Performance on Various Course Components (n=25)

The Student Experience

An end-of-semester survey was conducted in Spring 2018 with 24 of 25 students (96%) completing the survey. Students were asked to select strongly agree, agree, disagree, or strongly disagree to the statements listed below in table 2.

Statement	Percent responding strongly agree or agree
Mastering gave me more tools to learn than paper-and-pencil homework.	88%
The Mastering homework helped me do better on exams.	87%
I would recommend Mastering to another student as a good resource for the course.	83%
Doing the Mastering assignments helped me understand what I know and what I need to study more.	79%

Table 2. Student Survey Responses (n=24)

Students were also asked what they liked about Mastering in an open-ended question. Responses included the following:

- *"The best feature is that it helps you understand why you picked a wrong answer and provided an explanation so that you could learn from the mistake."*
- *"It helped me study for exams and grasp topics that I was struggling with. it was kind of like a review of the chapter review — I liked it!"*
- *"Being able to answer more than once and hints given if answer wasn't correct."*

The survey also asked some questions relating to use of the optional study resources in the Mastering study area. In addition to using MB homework to help students learn and do better in the course, Galt wants them to utilize the available non-assigned resources to help them develop their understanding of the concepts. Responses to the question about use of these resources revealed that 50% of respondents did not visit the study area, with the main reason given that they did not realize it was available. One student said, "I enjoyed having homework [because] it helped me understand the chapters a lot better than just reading… *I just wish I had utilized the study area."* Based on the response, Galt took some class time at the start of the Fall 2018 and Spring 2019 semesters to show students the optional study resources available that weren't assigned as homework. He recommends to other instructors that a best practice is to talk about these resources early in the semester to make sure students realize what is available and are encouraged to use these materials during the semester.

Conclusion

The Introduction to the Principles of Biology course at Santa Rosa Junior College is important for many students since they must successfully pass it with a C or higher to go on to their desired program of study. Galt's goals are to help students succeed in the course and to develop an appreciation of science in their daily lives. He uses Mastering Biology in his course to administer graded homework with automatic feedback and to provide students with additional resources for extra help and support. His initial analysis in Spring 2018 showed that students who did more required and extra credit MB assignments earned higher exam averages. In addition, students gave positive feedback about their experience with Mastering.

Galt's advice to other instructors based on his experience is as follows:

- Make sure to talk with students about the resources available in the Mastering study area early in the semester and show them that in addition to the regular assignments, resources include summaries, activities, videos/movies, practice quizzes, study guides, animations, MP3 summaries, flash cards, and more. He believes these are excellent aids for learning and understanding the often complex material covered in the course, and as Galt experienced, many students won't find the resources on their own.
- Modified Mastering is an effective way to integrate with a school's LMS and makes using Mastering easier to use for both faculty and students. With Modified Mastering, instructors only need to manage one gradebook (instead of two). Students go to one place for everything, and all grades are immediately available for them to track their progress. Galt said, "I can't emphasize enough how valuable the integration with LMS (Canvas) is!"

Galt plans to continue to evaluate performance using Mastering and make changes as needed.