COLLIN COLLEGE

Plano, TX

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,[1] 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. **Prelecture 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.

[1] *"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.

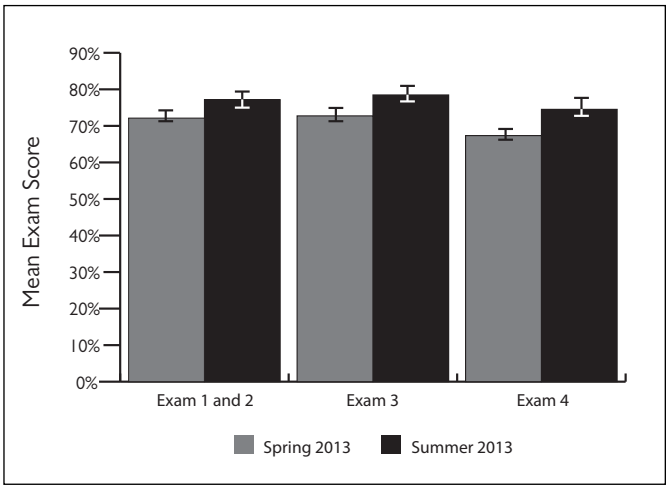

Figure 1. Effect of Adaptive Follow-Up on Exam 3 and Exam 4 Class Average (error bars indicate standard error). (Spring 2013: No Adaptive Follow-Up for Exam 3 and 4, $n=121$; Summer 2013: Adaptive Follow-Up for Exams 3 and 4, $n=37$)

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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.

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