MasteringMicrobiology

School Name	Shoreline Community College, Shoreline, WA
Course Name	Microbiology
Course Format	Winter–fall 2012: traditional lecture, winter 2013–winter 2014: flipped classroom

Key Results Assessment scores increased and more students earned As and Bs after a redesign of the course to a flipped format with MasteringMicrobiology to enhance student learning outside the classroom.

Submitted by
Judy Meier Penn, Professor

Course materials
Microbiology with Diseases by Body System, Bauman

About the Course

Shoreline Community College is a suburban school on a quarter system. The students who take Microbiology are primarily nursing and allied health majors, and are a mix of returning adult students and recent high school graduates representing a wide range of ages, cultures, skills, and life experiences. This five-credit lecture and lab course is a survey of microorganisms with a focus on health-care applications: disease process, microbial control, and immunology. Laboratory techniques covered in the course include isolation and identification of bacteria.

Challenges and Goals

Professor Judy Meier Penn reports that in her traditional lecture, she could interact with only a few students. She sought a way to increase student participation in class and ensure that students came to class prepared, to integrate more interactive learning, and to reduce the amount of time she lectured on basic concepts.

Thanks to improved lecture-capture technology, Penn also wondered if she could eliminate the face-to-face lecture and free up class time. She had used group activities in the past, and noticed that students (1) seemed to understand the associated material much better after those activities and (2) seemed able to move to higher levels of learning beyond memorization.

Implementation

Penn started using MasteringMicrobiology in fall 2009, class testing the beta version because she believed it provided resources that would facilitate accomplishing her course goals. It helped students prepare for class by having them do an activity outside of class in MasteringMicrobiology, and it helped her to better understand student comprehension of the materials prior to class meetings.

Previous to implementing MasteringMicrobiology in her course, Penn gave a paper-and-pencil pop quiz or other short in-class assessment to obtain real-time feedback. MasteringMicrobiology enables her to identify student issues and misconceptions *prior* to class meetings. She can now use valuable class time to review problem areas and focus on more-active learning.

MasteringMicrobiology enables [Penn] to identify student issues and misconceptions prior to class meetings.

In the winter 2013 quarter, Penn redesigned her course by flipping the classroom and changing her implementation of MasteringMicrobiology. Assessments include eight quizzes and one comprehensive final exam per quarter. She drops each student's lowest quiz score. The remainder of the course assessments are as follows:

- **Lecture:** MasteringMicrobiology homework assignments plus activities completed in class. MasteringMicrobiology assignments are a combination of end-of-chapter, tutorial, and Penn's own custom-written questions. These questions are designed to help students learn—she allows multiple attempts and there is no time limit.

- Lab: Prelab assignments are completed before each lab session and include (1) reading the exercise, (2) preparing a flow diagram of the procedure and preparing locations for recording results in lab notebooks, and (3) taking a prelab quiz in MasteringMicrobiology to ensure content mastery.

In addition, Penn offers two optional, not-for-credit MasteringMicrobiology assignments: a practice quiz (objective questions to practice for the graded quiz) and lab study questions (study questions to test understanding of course content and the application of it from lab).

Students receive the information they need before each class by reading, viewing a video lecture, and completing a MasteringMicrobiology assignment. During class time, they participate in group activities, such as working on application questions including case studies; pairing up with other students to practice explaining processes; and making models and diagrams that illustrate concepts.

When she moved to a flipped classroom, Penn identified the following best practices:

- *Introduce the format and activities with a positive attitude and show statistics that illustrate improvements in quiz or course grades.* If students understand the change can help them, they are more likely to move out of their comfort zone and fully participate in it.
- *To help students come to class prepared, give them low-stakes MasteringMicrobiology assignments after they have watched the lecture videos and done the readings.* Encourage students to complete assignments without looking up answers, so they can truly assess what they understood.
- To *make the most of group activities, do the following:*
    - Spend part of the first class asking students to brainstorm the qualities that make a good group member and discuss ways to involve all members in discussions.
    - During the 10 instructional weeks of the quarter, change groups only one or two times during the term and have students complete peer reviews.
    - Have students suggest two people they'd like to work with and put them with at least one of those people in subsequent group assignments.
    - When forming groups, include a mix of success levels, genders, and ethnicities, as well as at least one person who has the potential to be an effective leader. Provide an online group page in the school learning management system where they can share and discuss course content.
    - Make sure that group activity assignments are aligned with what students are tested on and how they are tested, e.g., the same level of Bloom's taxonomy and course objectives.

Assessments

55 percent	Quizzes (eight, the lowest is dropped)
25 percent	Lab
10 percent	Lecture assignments
10 percent	Comprehensive final exam

Results and Data

Penn compared student success rates from the traditional and flipped quarters and discovered that the biggest change was a five-percentage-point increase in As and Bs (Figure 1).

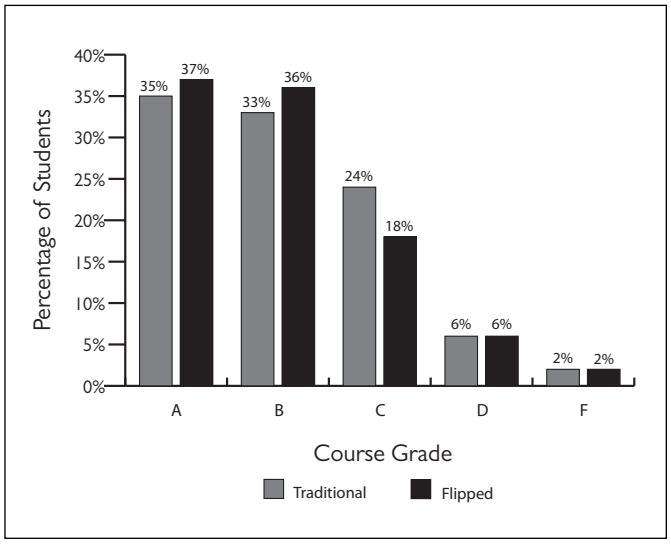

Figure 1. Comparison of Grade Distribution in Traditional and Flipped Classroom Settings, Fall 2012–Winter 2014 (Traditional, Fall 2012–Winter 2012, n = 54; Flipped, Spring, Winter, Fall 2013, Winter 2014, n = 132)

In the flipped format, students share strategies for reading, test taking, and problem solving; and they are more likely to form study groups and hold online study sessions.

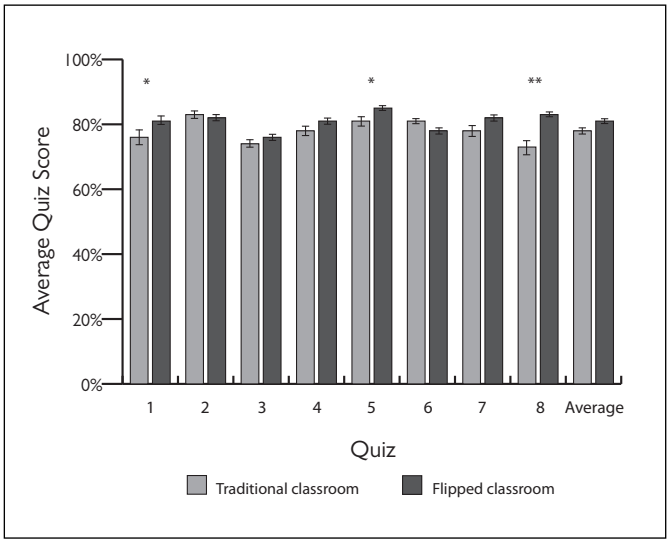

Figure 2. Comparison of Average Quiz Scores in Traditional and Flipped Classroom Settings, Fall 2013–Winter 2014 (Traditional, $n = 53$; Flipped, $n = 127$; Error Bars = Standard Error; Significance $*p < .05$; $**p < 0.01$)

After redesigning the course to a flipped format, Penn observed the following results:

- The mean final exam score increased from 73 to 75 percent.
- The averages of six of eight quizzes and the quiz average increased, three being statistically significant (Figure 2).
- Students performed better on the higher-level quiz questions.

The Student Experience

In an end-of-quarter survey, students were asked to rate MasteringMicrobiology assignments and practice items for their effectiveness in helping them to learn course content. The results show that the majority of students from the winter 2013 through 2014 quarters felt that MasteringMicrobiology assignments helped: on a three point scale with the highest being "significantly" and the lowest being "did not help", 51 percent said they helped "significantly," and 43 percent said they helped "somewhat" ($n = \sim 65$).

Penn also asked students for their feedback on the flipped-classroom approach. Student responses included the following:

- "The flipped class has helped me to not only learn the information, I retain it." (Winter 2013)
- "This is the first time I've taken a class where the easy parts (reading, viewing lecture) are done at home and the hard parts (learning and understanding) are done in class. It gave me time to interact with my instructor, which definitely benefited me during the quarter." (Spring 2013)

In the flipped format, students share strategies for reading, test taking, and problem solving; and are more likely to form study groups and hold online study sessions. As nearly all of Penn's students are planning careers in allied health, they also benefit from the interpersonal communication gains of these activities.

Conclusion

An April 2014 study looks at 225 published and unpublished studies that compare the results of experiments documenting student performance in courses with at least some active learning versus traditional lecturing. The study, published in Proceedings of the National Academy of Sciences online, found that the results of these 225 studies "document that active learning leads to increases in examination performance."[1] The results of this study show similar findings.

By using MasteringMicrobiology as a platform for learning outside the classroom, Penn has incorporated more active learning in the course, moving from a mostly traditional lecture format to a fully flipped format, and in fall 2014 she started using Learning Catalytics for some of the class activities. Now when she enters the classroom, students are often already talking about the content that was assigned for the day. She hears things like, "Did you understand...?" or "I think the hardest part was..." It is evident that they are engaged, working outside the class, and more prepared, which has resulted in higher levels of learning and success rates in the course.

[1]*Active learning increases student performance in science, engineering, and mathematics, Scott Freeman, University of Washington, Sarah L. Eddy, University of Washington, Miles McDonough, University of Washington, Michelle K. Smith, University of Maine, Nnadozie Okoroafor, University of Washington, Hannah Jordt, University of Washington, and Mary Pat Wenderoth, University of Washington. Edited by Bruce Alberts, University of California, doi: 10.1073/pnas.1319030111, http://www.pnas.org/content/early/2014/05/08/1319030111.*