

The Benefits of Linking Assignments to Online Quizzes in Introductory Biology Courses

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Abstract

Assignments with linked, online multiple-choice quizzes were developed for a non-majors introductory biology course. The assignments consisted of readings or websites and accompanying questions to help students comprehend the links between these sources and the key concepts discussed in lecture. Students were then given two attempts to take an online quiz to test their comprehension of the assignment. Students indicated that the assignments and quizzes were helpful in understanding the material. Students who took at least 10 minutes to review the assignment between quiz attempts increased their quiz scores more than those who took less than 10 minutes. Linking assignments with online quizzes is an effective way to introduce homework into large lecture courses without burdening instructors with excessive grading.

Keywords: course management, homework, grading, assessment, student engagement

Introduction

Instructors often integrate case studies, assignments and quizzes into their classes for many different reasons. Case studies and assignments can help students apply information previously learned in class to solve new problems. Through the analysis of data, interpretation of results and reading of specific articles, students may probe deeper into a particular topic than through lecture alone. Research indicates that understanding is more likely to develop when students engage in activities such as analysis, evaluation, interpretation, prediction, and explanation (Bransford, Brown & Cocking, 1999; Coleman, 1998; Coleman, Rivkin & Brown, 1997). Quizzes are also often used as an incentive for students to keep up with the material between exams and can provide students with valuable formative feedback on what concepts they need to review. Moreover, assignments and quizzes can be used by faculty for assessment of student learning and identification of misconceptions. However, the time required to grade quizzes may impede an instructor's ability or desire to give assignments and quizzes, especially in larger introductory courses. The objective of this project was to create homework assignments for large classes that could be evaluated through the use of online quizzes with minimal effort by the instructor. Moreover,

we monitored student use of online quizzes, allowed students to retake quizzes, and evaluated the relation of improvement in quiz scores and time between attempts.

Literature Survey

Most instructors teaching courses in the life sciences would like to engage students in learning outside of class through reading assignments and other activities. However, large class sizes, especially in introductory biology courses, make instructors reticent to assign homework because of the inordinate amount of time required to grade and assess assignments. Computer-based assignments and assessment offer a mechanism to minimize the time required by instructors to evaluate student performance.

Recent research has focused on comparing the effectiveness of online and traditional lecture or paper-based teaching methods. Much of this work has been done in the physical sciences (astronomy, chemistry and physics) where students can be given numerical problems to solve, or explain phenomena using equations. In several studies there was no difference in scores between homework assignments given in a traditional paper-based format versus those given online (Cole & Todd, 2003; Bonham *et al.*, 2003; Allain & Williams, 2006, Bunce, *et al.*, 2006). However, Dufresne *et al.* (2002) reported a slight increase in test scores by students completing assignments online. Hence, these results suggest that completing homework online is neither inferior nor superior to traditional paper-based assignments. However, online homework may offer a substantial advantage to the instructor through a reduction in the amount of time required in grading.

A challenge of online quizzes in the life sciences is that the issues being discussed cannot always be reduced to numerical answers or equations and are often much more conceptual or descriptive than those in the physical sciences. As a result, online quizzes may become tests of rote memorization and factual recall. One solution to this problem is to give students open-ended assignments and homework questions, and then give an online quiz to assess student completion of the homework assignment and understanding of the material. Moreover, this permits instructors to show connections between biological concepts and news stories in the popular press, which allows students to see how the theoretical concepts they are learning in class are applied in the real world. Such issues-based biology courses are becoming more common, especially for non-majors (Stover & Mabry, 2005).

Methods

The authors linked class assignments with online quizzes in a 14-week non-majors introductory biology course which had two to three lecture sections with 80 to 120 students in each section. During the semester, students completed 18 to 20 assignments (Table 1) and online quizzes on the content from each assignment. Students were allowed two to five days to complete the assignment and quiz. Each quiz consisted of five multiple-choice questions chosen randomly from a pool of 10 to 20 questions based on the assignment. Once a student began a quiz, they had five minutes to complete it. This time limit was intended to minimize students' ability to look up answers rather than recalling the information. Students were allowed to take each quiz twice, and their highest score was recorded. Because the questions were generated randomly, the second quiz differed from the first. Students immediately saw their quiz results upon completion, although the correct answers to questions were not revealed. Students then had the option of reviewing the assignment before taking the quiz a second time; students could re-take the quiz immediately or delay taking the quiz up until the deadline for the assignment. Providing students with a second chance to learn from their mistakes is an effective way to increase proficiency using online assignments (Hall *et al.*, 2001). The quizzes were automatically generated, scored, and grades were recorded by a web-based course management system, Desire2Learn (D2L). Students were asked to complete course assignments and online quizzes once or twice per week. After creating the assignments and writing the quiz questions, instructor oversight was minimal. The D2L system also recorded the time each student took each quiz and the answers they choose, which can be useful assessment information for instructors.

The designs of the assignments varied, but all assignments included a set of questions for students to consider after they read an article or analyze data. In addition, each assignment addressed a topic being covered simultaneously in lecture. The online quizzes then tested the students' understanding of the assignment and the associated questions they were asked to answer. The students did not turn their assignments in to the instructor, and the instructor did not manually grade quizzes.

Our assignments were based on diverse sources (Table 1), including articles from the popular press (New York Times, etc.), Scientific American and readings from the textbook. Several assignments were linked to websites that included simulations or data sets, while other assignments required students to use both text and online material. Thus, one of the strengths of this approach is that instructors can incorporate a variety of material from different sources into assignments.

Table 1: Topics for General Biology Assignments and Quizzes

Quiz	Topic	Assignment – Article	Assignment - Website
1	Scientific Method	Graduate Student Experiment	AquaRush
2	Populations		US Census, Nationmaster
3	Community Interactions	NYT article on “In the Rockies, Pines Die and Bears Feel It”	
4	Nutrient Cycles	Discover article on “The Nitrogen Bomb”	
5	Obesity Epidemic		Centers for Disease Control, National Heart, Blood and Lung Institute
6	Biological Molecules	NYT article on “Science's Quest to Banish Fat in Tasty Ways”	Cells Alive, Wisc-Online
7	Enzymes and Energy	From textbook, “Missing Molecule Makes Mischief” on PKU.	Newborn screening tests, Enzyme Activity.
8	Respiration and Metabolism		Centers for Disease Control, Ben's Bad Day
9	Photosynthesis	From textbook, why chlorophyll is green, meat is red and blood from mussels is blue.	Fall Colors.
10	Meiosis	From textbook, what determines gender	PBS
11	Mitosis	NYT article “Your Body Is Younger Than You Think”	
12	Genetics	Hemophilia case study from SUNY	SUNY
13	Molecular Biology	From textbook, cystic fibrosis	OMIM, Hemophilia background, Cystic fibrosis background
14	Biotechnology	Scientific American article “The Land of MILK & MONEY” NYT article “Embryonic Cells, No Embryo Needed: Hunting for Ways Out of an Impasse”	
15	Evolution	Excerpts from “The Panda's Thumb” out of <i>The Panda's Thumb: More Reflections in Natural History</i> by Stephen Jay Gould, W.W Norton & Company, New York, 1980.	
16	Natural Selection		Natural Selection Simulation
17	Speciation		Speciation Simulation
18	Human Evolution	Scientific American article “Lucy's Baby”	

Results

Because the quizzes and assignments were linked and were developed simultaneously, there was not any direct pre- and post-assessment of student learning. Instead the goal of this project was to find a reasonable method to create graded homework assignments for large classes and monitor student use of the quizzes. The “online attendance” of 240 students taking 18 quizzes over three semesters was 95.7% and decreased slightly over the course of the semester (Figure 1).

Students were asked to rate six different teaching methods used in the class by evaluating the following statement “The _____ helped me to understand the material.” as strongly disagree, disagree, neutral, agree, or strongly agree (Figure 2). Results from 140 students surveyed indicated that lectures and lecture notes were ranked most favorably, while the textbook and in-class activities were ranked least favorably. Student evaluations of online assignments and quizzes were tied with personal response system questions, and the majority of the class either agreed or strongly agreed that these teaching techniques helped them to understand the material.

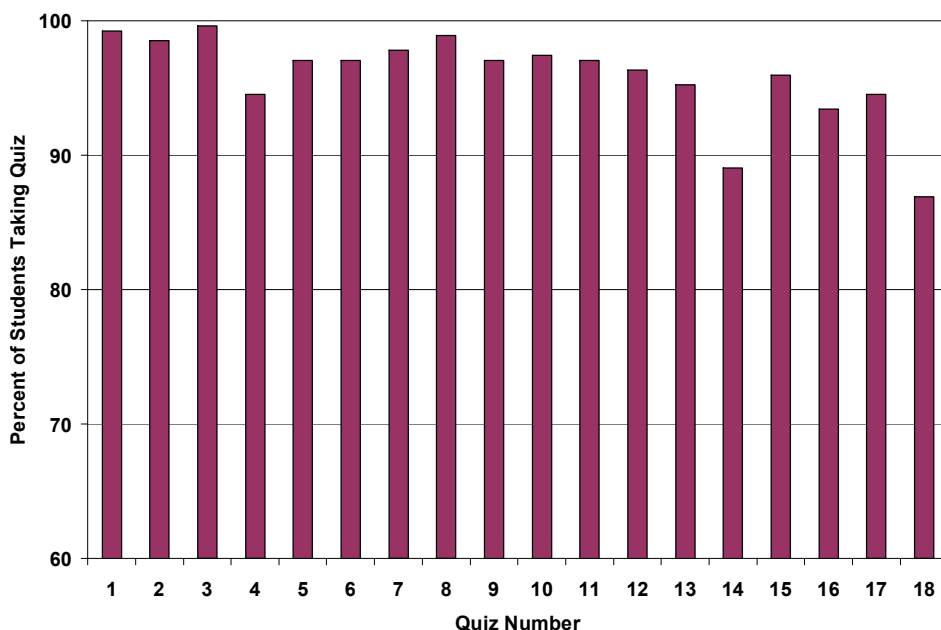


Figure 1. Percentage of students taking each quiz. Values are the mean number of students over three semesters (n=240).

Several interesting patterns were observed in student quiz-taking strategies and behaviors. Students were allowed to take the quiz twice, with a five minute time limit per quiz, and only the highest score was recorded. Students getting a perfect score were encouraged to take the quiz a second time for practice, yet only 19.6% took this advice. Students missing at least one question on the quiz were advised to take the time to review the assignment again before using up their second attempt. Of those who missed at least one question on their first attempt, 1.7% did not try again, 74.9% completed their second attempt within 10 minutes (average time = 4.6 minutes), and 23.4% completed their second attempt at least 10 minutes after their first attempt (average time = 21.6 minutes). Given the five minute time limit to take the quiz, it is unlikely that students had time to review the assignment in less than 10 minutes, and these students most likely took the quiz a second time immediately after their first attempt. On average, these students scored half a point better on their second attempt than their first, suggesting that getting some immediate feedback from the first attempt did improve their performance on the second attempt. However, students who took at least 10 minutes between attempts scored twice as well on their second quiz (Figure 3, $p=1 \times 10^{-6}$ by t-test), consistent with improved performance after reviewing the assignment.

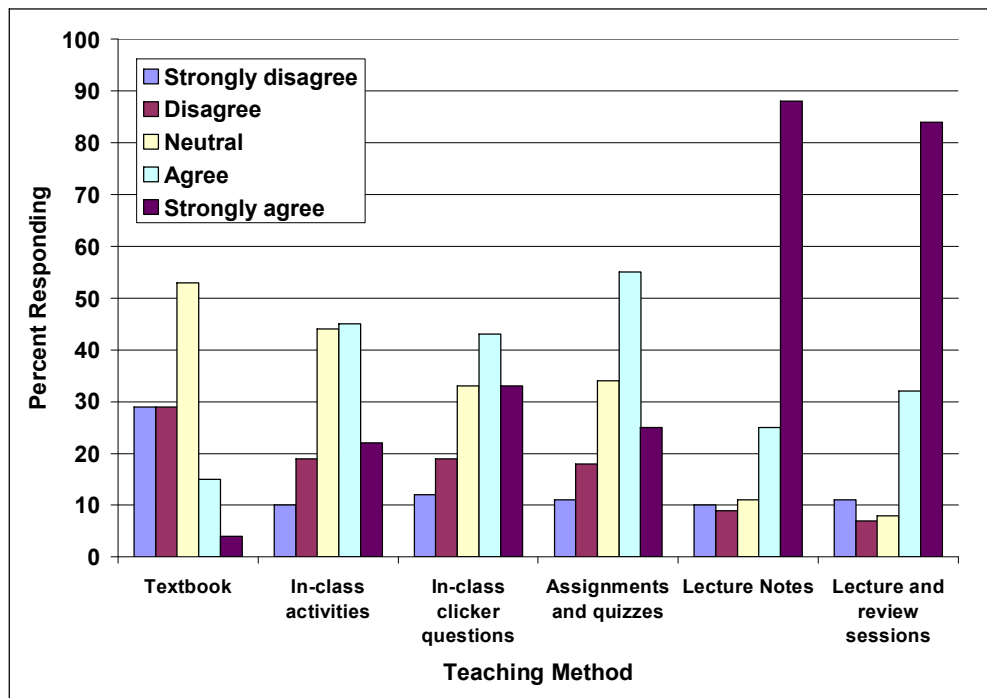


Figure 2. Introductory Biology student ratings of different teaching methods. Students were asked if each of the teaching methods helped them to understand the material using the scale indicated in the legend. (n=140).

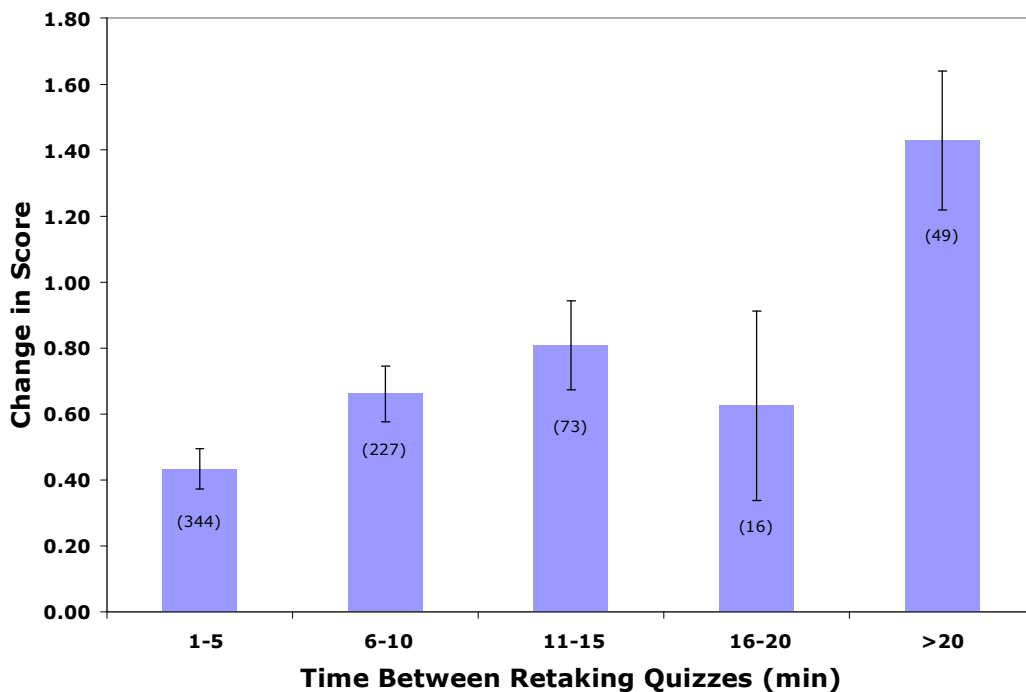


Figure 3. Time lapsed between quiz attempts vs. mean change in score between attempts. Numbers in parentheses indicate the number of students in each category.

Overall the instructors felt that the additional effort involved in generating the assignments with linked quizzes was worthwhile. The students seemed more engaged in the material, and were better prepared for problem-solving exam questions. The authors were also able to give students formative assessment by reviewing the quizzes in class each week, as the D2L site gives instructors information on how many students chose each answer for each question (Figure 4). In this way instructors can identify where the class was having problems, and which wrong answers were being chosen. This feedback could then be used in class, and any confusing topics discussed again.

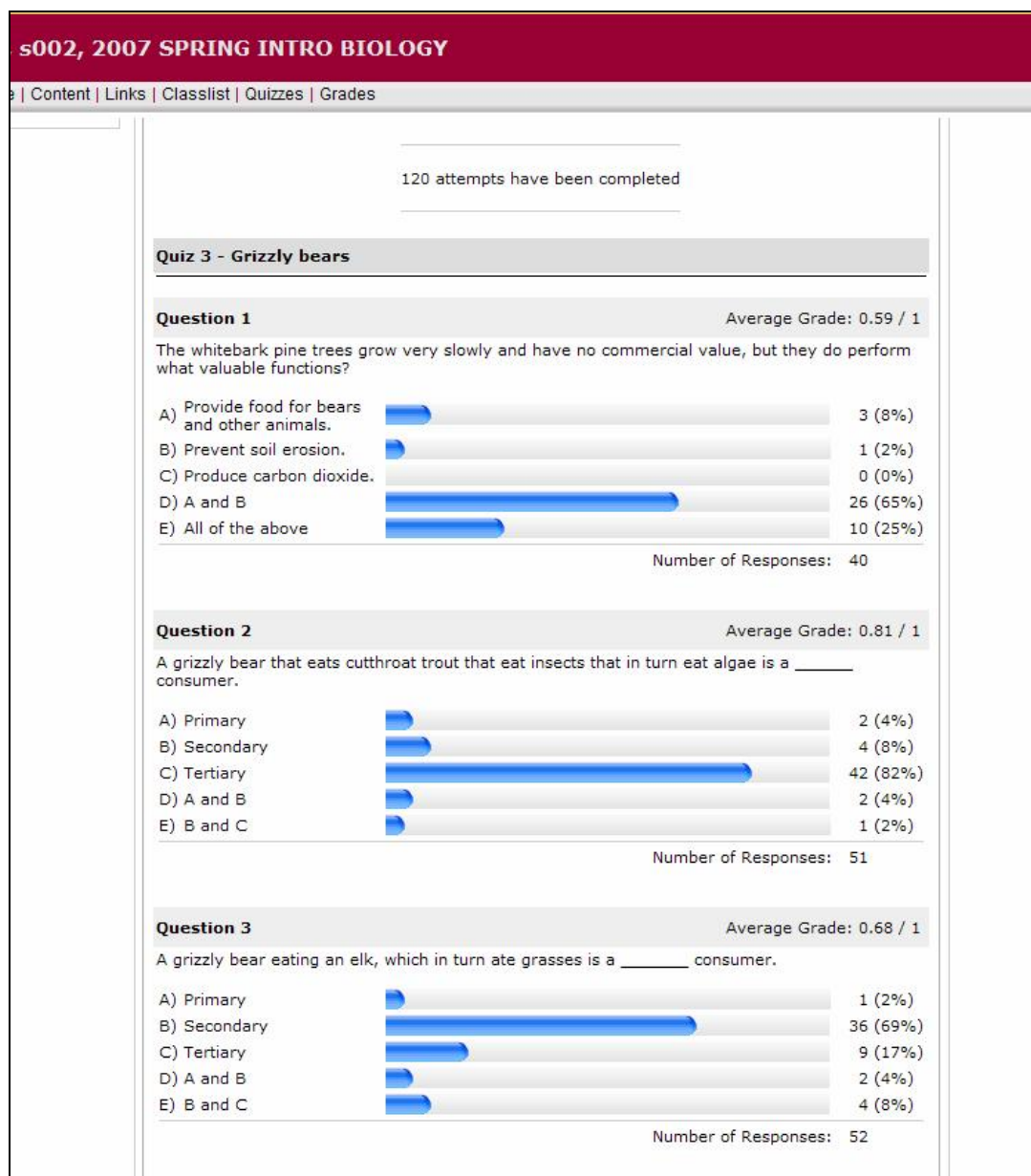


Figure 4. Quiz results based on the New York Times article, "In the Rockies, Pines Die and Bears Feel It." By Charles Petit, January 30, 2007.

Discussion

Benefits to the Students

The authors feel that the students benefit from the online assignments and quizzes in several ways. This approach requires the students to work with the subject material presented in lecture four to five times between exams. This reduces the amount of last-minute cramming that many first-year students rely on to prepare for exams. The “online attendance” of 95.7% in the current study was similar to other studies of student performance of online assignments. For example, Riffel & Sibley found that 93% of students participated online but only 78% physically attended class. Moreover, these online assignments and quizzes allow students to see how the concepts they are learning in lecture apply in the real world. The use of science articles from the popular press reinforces the concept that subjects covered in class appear in the news every day and, as an informed citizen, they should be able to read a newspaper article and understand it. Finally, the students get direct formative feedback of their progress in the class well before any exams. Formative assessment is more valuable than summative assessment, as students have time to learn from their mistakes and correct any misconceptions early on in their learning process (Cooper *et al.*, 2006).

Benefits to the Teacher

As teachers we frequently struggle with ways to engage our students in the subjects we teach. Instructors often strive to involve students in hands-on exploration, discussion, and writing. However, given large class sizes and other instructional responsibilities, such teaching strategies are difficult to implement. The use of online assignments, coupled with online multiple choice quizzes written to assess student understanding of the key points of the assignment, allows instructors to increase student engagement in an efficient manner. Most of the effort in this project was in creating the assignments and accompanying questions, writing the quiz questions, and programming this into D2L. Since then, the same assignments and quizzes have been used in multiple lecture sessions for three years. Each year a few of the assignments and quizzes are changed as new articles become available. The use of the assignments and quizzes has also allowed removal from lecture of some material that required only rote memorization by the students. Instead, students visit websites that contain this content, thus making time for in-class assignments and questions. One limitation of this approach is a reliance on multiple choice questions. Instructors can choose questions that require analysis of data, instead of reciting definitions or content.

Conclusions

Linking diverse assignments, including readings, case studies, analysis of databases and websites with an online quiz allows instructors to more fully engage students and encourages them to explore subject material in a more complex manner, while requiring only a modest increase in instructional effort. This allows an instructor to increase the frequency of assignments, keeping the students engaged in the material between exams. It also allows students to explore multiple topics in depth, which is especially useful in a broad introductory class. With the diverse format of the assignments, this method should be applicable in many different disciplines in both science and non-science courses.

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Manuscript received 30 May 2007; revision received 15 Aug 2007.



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