

Use and Effectiveness of Online Quizzes as a Study Aid for an Introduction to Animal Science Laboratory Course¹

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Abstract

To allow students to better understand laboratory material presented in an Introduction to Animal Science laboratory course, online study quizzes were created for students to review material prior to a laboratory examination. Quizzes were created on four topics that were covered on two separate examinations during the spring of 2010. The grade received on the two examinations and the numbers of quizzes attempted were recorded for each student. In the present study, 93.8% and 86.7% of the students attempted the online quizzes at least once for the first and second examination, respectively. Examination score was influenced by the number of quizzes attempted for the first ($p < 0.0001$) and second examinations ($p < 0.0003$) where students who did not use the online quizzes scored lower than the remainder of the students on the examinations. Ninety-five percent of students surveyed said they liked the online quizzes as study aids and 89% of students surveyed said they believed their grade in the course was improved by using the online quizzes. By being well received by students and helping to improve letter grades on examinations, the online quizzes appear to be a viable study aid for an animal science laboratory course and will continue to be offered to students in future semesters.

Introduction

The majority of courses in Animal Science curricula are accompanied by laboratories. These laboratory exercises are designed to reinforce concepts introduced in lectures and to provide students interactive learning opportunities with live animals and animal specimens. It is these “hands-on” opportunities that are most often cited by students as the primary reason they decided to take the class or major in Animal Science. One of the challenges with laboratory courses is that during the laboratory, students are encouraged to participate in the interactive exercises which often makes note-taking difficult. As a result, after laboratory sessions have ended, student often feel that they do not have adequate resources in terms of notes and other opportunities to adequately prepare themselves for practical examinations. One possible solution is the use of online

quizzes. Online quizzes provide an avenue for the student to assess their personal learning and provide relevant and prompt feedback to help them direct their future study efforts.

Research on the effectiveness of online quizzes for enhancing student learning has focused almost exclusively on materials presented in lecture courses and has produced mixed results. Brothen and Wambach (2001) examined students enrolled in a developmental psychology course and found that students who spent study time taking online quizzes did not perform as well as their counterparts on examinations. In a follow-up study, Brothen and Wambach (2004) found improvements in examination grades when time limits were imposed on the online quizzes. Other studies have demonstrated that online quizzes significantly increased examination scores for undergraduate students (Derouza and Fleming, 2003; Grabe and Sigler, 2002). None of these studies involved a laboratory component, so the main objectives of this study were (A) to determine if online quizzes using digital images of animal specimens, equipment and anatomical pictures examined in laboratory courses would be utilized by students in an introductory Animal Science Laboratory course; and (B) to determine whether student use of online quizzes affected their performance on the laboratory practical examinations.

Subjects and Methods

The spring 2010 Introduction to Animal Science Laboratory course consisted of 113 students divided into four laboratory sections of roughly 30 students per section. This one credit-hour course met weekly on either Mondays or Wednesdays for three hours. Course material was presented in an instructor-directed format by the faculty member responsible for the course with the assistance of six undergraduate teaching assistants (three for each laboratory section). The course consisted of 400 total points of which 200 came from two laboratory examinations and 200 from weekly activities or assignments associated with each laboratory.

Four topics were selected for the creation of online quizzes as study aids. Two of these topics were covered on the first laboratory practical and two were

¹Prior to the beginning of the semester, all students signed a consent form agreeing to participate in the study.

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covered on the second laboratory practical. The first topic was digestive anatomy where students were expected to learn: anatomical parts of ruminant and non-ruminant digestive tracts from preserved specimens; various feedstuffs added to animals' diets to meet various nutritional needs; and how to determine an animals' food preference by examination of their teeth. The second topic was reproductive anatomy where students learned various anatomical parts of the male and female reproductive tracts from various species. The third topic was equipment used in management of domestic livestock. Students were expected to learn the name, use and species for each piece of equipment. Finally, the fourth topic was breeds and general livestock anatomy where students were expected to be able to identify selected breeds of various livestock species as well as the correct gross anatomy for sheep, cattle, swine, and horses.

At the beginning of each laboratory, students took a "pre-quiz." This quiz consisted of ten to twelve questions and was administered before students observed actual specimens. Each question required students to identify specific items on or answer questions about digital images. This quiz was designed to gauge what knowledge students had prior to the laboratory. A pre-quiz was not administered for identification of breeds of livestock, because there was not a single laboratory session in which all the breeds from the different species were discussed. Instead, this information was covered over five separate laboratories. In an attempt to adjust for this, students were provided this material weekly via laboratory handouts provided on the course web site. Following the pre-quiz, the laboratory session which normally lasted three hours was conducted during which students had the opportunity to observe live animals or specimens. The online quiz was made available to students at the conclusion of the laboratory class. The format of these questions was identical to those of the pre-quiz and also used digital images of animals or animal specimens.

Online quizzes were provided through the course management system, Blackboard™. A database of more than 100 questions was created for each study topic. Fifteen multiple choice questions were randomly chosen from this database every time a student attempted an online quiz. Each quiz attempt for every student was recorded by Blackboard™ and the instructor recorded scores for all students from two 100 point laboratory practical examinations. The questions on these examinations were fill-in-the-blank identification questions with no word bank provided to the students.

At the conclusion of the course, students were given a survey to determine if they enjoyed using the online quizzes and if they believed the quizzes were a useful learning aid.

Statistical analyses were performed using Statistical Analysis Software version 9.0 (SAS; Cary, NC). The number (i.e. frequency) of attempts for each of the four online quizzes for each student was

considered to be the independent variable and was placed into one of five categories; 0 quiz attempts; 1-5 quiz attempts; 6-10 quiz attempts; 11-15 quiz attempts; 16-20 quiz attempts; or greater than 20 quiz attempts. An arcsin transformation was performed on all percentage data prior to analysis. Two separate analyses were conducted. First, the effect of frequency of online quizzes on practical examination scores was evaluated using analysis of variance procedures for general linear models. The model included the main effect of frequency of use of the online quizzes and the pre-quiz scores for each student as covariates. When the main effect was significant Student-Newman-Keuls Multiple Range Test (SNK) was used to determine differences among number of quizzes attempted. For the second analyses, grades on the two examinations were converted to a letter grade where: A=90-100%; B=80-90%; C=70-80%; D=60-70%; and F= less than 60%. The data were subjected to a logistical regression analysis for ordinal response data. This procedure uses a proportional odds model to provide an odds ratio which is the multiplicative increase in the odds of improving from one letter grade to the next. These odds ratios were then used to calculate the probabilities of a student improving their actual grade by attempting more online quizzes. For example, a student that earned a 'D' on an exam could look at their odds ratio to determine what their odds are for getting a 'C' on the exam if they had increased their use of online quizzes. However, most students would probably like to know what the probability is that they could improve their grade, not just of getting a 'C' but an 'A', 'B' or 'C'. Therefore, probability tables were created to predict the probabilities of earning a certain letter grade or better for each of the quiz categories.

Results and Discussion

During the semester, two students withdrew from the course after the first examination and two students did not show up to take the second examination, therefore, their information was excluded from the analysis for the second examination. One student did not take either of the two examinations despite never officially withdrawing from the course and was excluded from all analysis. Therefore, 112 and 108 students' data were analyzed for the first and second examination, respectively.

A study in 2006 by Johnson examined the frequency of use of optional online quizzes as well as the enhancement of examination grades with increased use of these quizzes. Overall, 66% of the students used the quizzes at least once during the semester. However, the number of quiz submissions averaged only 3.7 and 2.7 out of the possible 14 for the true-false and short answer quizzes, respectively. Other studies have also shown low participation rates when online quizzes were provided as study aids (Brothen and Wabmach, 2001, Swan, 2004, Muchovej, 2009). Although the quizzes were not widely utilized, a significant increase

in examination scores was found with a greater use of the online quizzes. This suggests that the online quizzes were convenient and provided a prompt source of feedback. However, the low number of quiz submissions indicated that only the most highly motivated students utilized the online quizzes as a learning tool. Therefore, it may be difficult to determine whether improvements in examination scores are correlated with increased use of online learning tools or motivation of the student for learning. Results of the present study were not consistent with these findings. In contrast, 94.6% and 90.7% attempted the online quizzes at least once for the first and second examination, respectively. Prior to the first laboratory examination, 23 students (20.5%) attempted the online quizzes greater than 20 times. For the second examination, 19 students (17.5%) had greater than 20 quiz attempts. The range in number of quiz attempts by an individual student was zero attempts to 89 attempts, with an average of 13 attempts. A small number of students attempted the online quizzes as early as the same day as the material was presented which has been shown previously to be positively correlated with examination score (Hadsell, 2009). However, the majority of the students did not attempt the online quizzes until the week of the examination (this was not examined in the statistical model in this study). Overall the online quizzes were well received by the students. Over 95% of students surveyed said they liked the online quizzes as study aids for the examinations and 89% of students surveyed said they believed their grade in the course was improved by using the online quizzes. These results indicate that a vast majority of the students in the course utilized the online quizzes as study aids for the laboratory examinations.

Examination score was influenced by the number of quizzes attempted for the first ($p < 0.0001$) and second examinations ($p < 0.0003$). For both, students that did not attempt the online quizzes had significantly lower examination scores compared to all other students that had attempted the quizzes at least one time. For the first examination, scores were $75.2\% \pm 2.6$ for students that only attempted the quizzes 1-5 times compared to $89.7\% \pm 1.8$ for the students that attempted the quizzes greater than 20 times. For the second examination, scores were $80.1\% \pm 4.0$ for students that only attempted the quizzes 1-5 times compared to $92.6\% \pm 1.2$ for the students that

attempted the quizzes greater than 20 times. No differences were seen in letter grade between the students that attempted the quizzes 6-20 times for examination one or two.

As expected, the data vary slightly between the first and second examination. This could be explained by the material covered on each examination. The material covered in the first examination (i.e. digestive and reproductive anatomy) is typically more difficult for students to gain an understanding of compared to the second examination (i.e. equipment used for management and breeds of domestic livestock). This was evident by a lower mean on the first examination compared to the second examination (81.3% and 83.7%, respectively). Therefore, the increase in the probability of achieving a better letter grade is more obvious with the second examination compared to the first. Eighty students improved their examination score on the second examination compared to the first examination. Of these 80, 35 also increased their use of the online quizzes resulting in an average increase in percentage on the examination of 12.7% (Table 1). This means that 45 students improved their examination score without increasing their use of the online quizzes. This group of students only had an average of an 8% increase in examination score. Even though overall use of the online quizzes was decreased for the second examination, it appears as though the students that did use the quizzes may have had a higher percentage increase in examination score on the second examination contributing to the increased class average on the second examination.

The estimated probabilities of getting a certain letter grade or better for each category of frequency of

Table 1. Summary of Use of Online Quizzes and Subsequent Changes in Examination Scores

	Number of Students	Total Students
Used Online Quizzes		
Exam 1	106	112
Exam 2	98	108
Maintained or improved exam 2 grade compared to exam 1	80	108
Average number of quiz attempts		
Exam 1	12.9	--
Exam 2	11.6	--
Increased use of quizzes	35	80
Average % change in grade	12.7 \pm 8.6 [†]	35
Increased use up a category*	25	35
Did not increase use of quizzes	45	80
Average % change in grade	8.1 \pm 5.5 [†]	45
No improvement in exam 2 grade	28	108
Average number of quiz attempts		108
Exam 1	16.0	--
Exam 2	8.14	--
Increased use of quizzes	8	8
Increased use up a category*	4	8

* Use of quizzes categories: 0; 1-5; 6-10; 11-15; 16-20; >20. Moving up a category indicates the student increased their use beyond their original categorization.

[†] Data presented as average percentage \pm standard deviation.

attempts of the online quizzes are presented in Figure 2 and Figure 3 for the first and second examinations, respectively. For example, a student may ask what the probability is that they would get a 'B' or better (A or B) on the first examination if they do not utilize the online quizzes. Looking at Figure 2, the probability would be 0.53 (53%) that a student would earn an A or B when not attempting the online quizzes. The probability that this student would earn an A or B on the examination increases to 0.83 (83%) if they take the online quizzes more than 20 times. Using Figure 2, the estimated probabilities of earning other letter grades or better can be predicted. Interestingly, students attempting the quizzes 1-5 times had a numerically lower probability of earning a respective letter grade. This is most likely due to sampling error because the number of students in the '0' category was very small. It also does not appear as though increasing the number of online quiz attempts from 10 to 20 greatly increases examination grade since the curve appears to plateau. Overall, increasing online quiz attempts enhanced the probability of earning a higher letter grade on the first examination.

Similar results can be seen for the second examination where increasing the number of online quiz attempts from 0 to 15 improved the probability of earning a higher examination grade (Figure 3). Using the same student example from the first examination, there is a 51% probability that a student would get a B or better on the examination if they did not attempt the online quizzes and greater than 90% probability with 20 or more attempts. These data show a decrease in the probabilities of students improving their grades when attempting the online quizzes 16-20 times. This, again, is probably due to random variation or sampling error and no improvements in letter grade are seen when taking the quizzes 15-20 times.

Even though the probability of increasing letter grade increases with additional attempts at the online quizzes, one could speculate that there would be a saturation point at which additional quiz attempts would not provide any additional gain on the outcome for the student. In the present study, the category of greater than 20 attempts had wide variation in the number of quizzes attempted by students. For example, the student that attempted the practice quiz 89 times may have achieved the same letter grade on the examination if they attempted the quizzes fewer times. This particular student may have also experienced repetition in quiz questions. In 89 attempts, the student would have answered 1335 quiz questions. Being that there are only roughly 100 questions in the database, this student theoretically saw each question

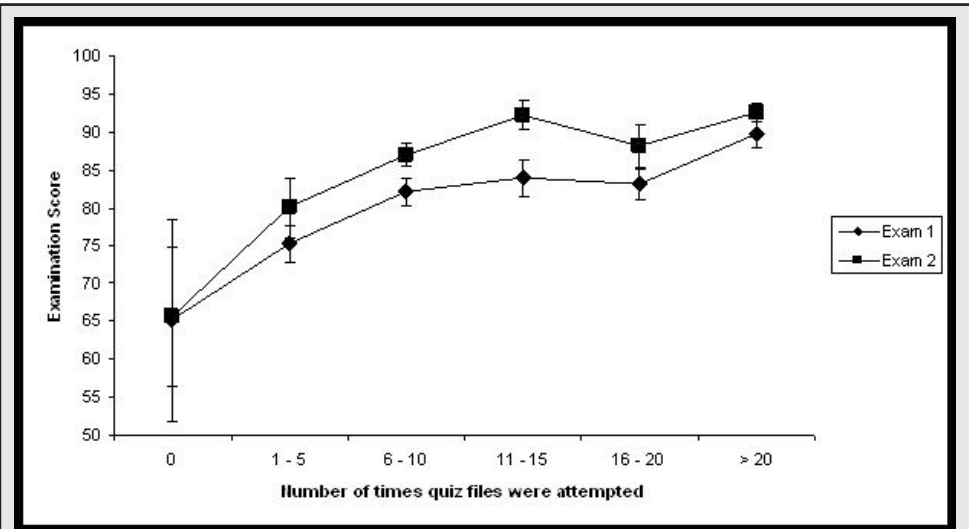


Figure 1. Scores on the first and second examinations for students in each category of use of online quizzes. Data is presented as the mean percentage with standard error bars. All percentage data was arcsin transformed prior to statistical analysis. a,b,c First examination scores without common letter differ by $p < 0.05$. x,y Second examination scores without common letter differ by $p < 0.05$.

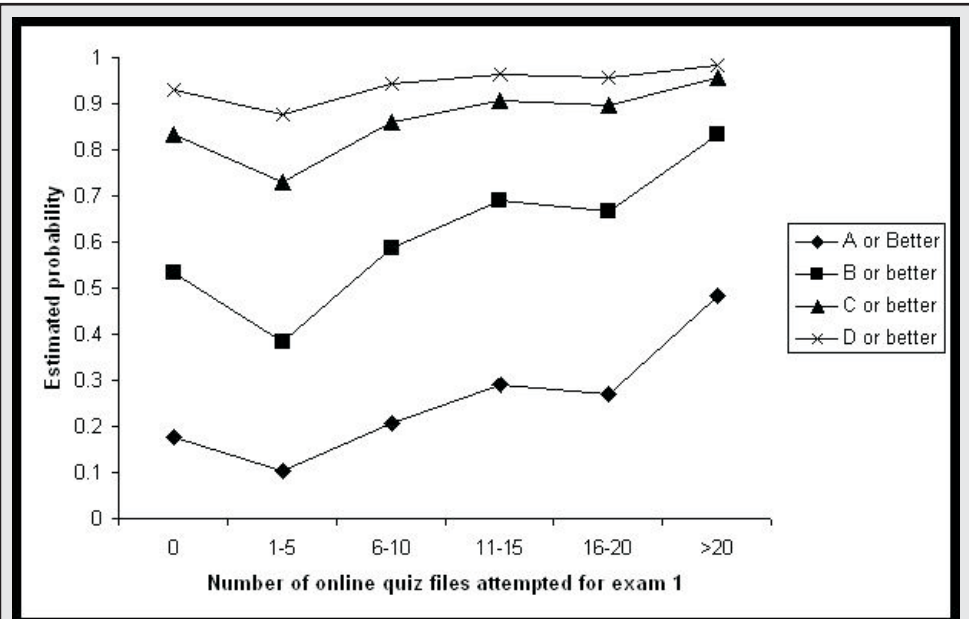
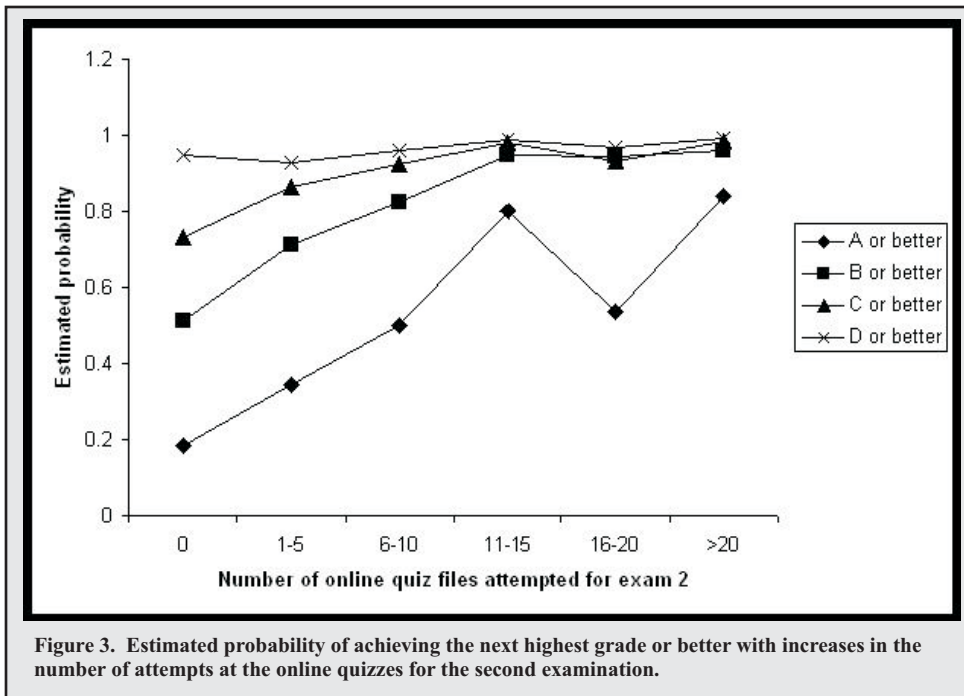


Figure 2. Estimated probability of achieving the next highest grade or better with increases in the number of attempts at the online quizzes for the first examination.



13 times. This saturation point could be different for different courses and different course materials. Looking at Figure 1, it appears as though this saturation point may be reached with 11-15 online quiz attempts for examination two. Examination one appears to have an additional increase with greater than 20 attempts. This variation could be due to the difficulty of the material covered on this examination.

Summary

Online quizzes were offered to students in and introductory Animal Science Laboratory course for use as study aids for the two laboratory examinations. Material covered on these four online quizzes represented four main topics of the course, with each exam covering two topics each. The students' use of the online quizzes and examination grades were monitored during the semester. Data collected was then used to predict probabilities of improving letter grades on examinations with increased use of the online quizzes. The probability of improving letter grades on both examinations increased with the increasing frequency of quiz attempts. The data suggest that differences in examination topics may influence the improvements in examination letter grade with increased use. For the first examination, no statistically significant improvements in letter grade were seen when increasing the quiz attempts from the category of 1-5 attempts to greater than 20 attempts. Similar results were seen in the second examination scores except that there was additional improvement in letter grade when more than 20 attempts were made at the online quizzes.

Overall, greater than 85% of all students used the online quizzes for both examinations. The

students liked the quizzes and thought that they helped improve their overall grade in the course. These study aids will continue to be available to students enrolled in the course in future semesters.

Literature Cited

- Brothen, T. and C. Wambach. 2001. Effective student use of computerized quizzes. *Teaching of Psychology* 28: 292-294.
- Brothen, T. and C. Wambach. 2004. The value of time limits on online quizzes. *Teaching of Psychology* 31(1): 62-64.
- Chickering, A.W. and Z.F. Gamson. 1999. Development and adaptations of the seven principles for good practice in undergraduate education. *New Directions for Teaching and Learning* 80: 75-81.
- Connolly, T. and M. Stansfield. 2007. Developing constructivist learning environments to enhance e-Learning. In: Buzzetto-More, N. (ed.). *Principles of effective online teaching*. Santa Rosa: CA: Informing Science Press.
- Derouza, E. and M. Fleming. 2003. A comparison of in-class quizzes vs. online quizzes on student exam performance. *Journal of Computing in Higher Education* 14: 121-134.
- Grabe M. and E. Sigler. 2001. Studying online: Evaluation of an online study environment. *Computers and Education* 38: 375-383.
- Hadsell, L. 2009. The effect of quiz timing on exam performance. *Journal of Education for Business* 84(3).
- Johnson, G.M. 2006. Optional online quizzes: College student use and relationship to achievement. *Canadian Journal of Learning and Technology* 32(1).
- Kashy, E.K., M. Thoennessen, G. Albertelli, and Y. Tsai. 2000. Implementing a large-scale on-campus ALN: Faculty perspective. *Journal of Asynchronous Learning Networks* 4.
- Muchovej, J.J. 2009. Online quizzes as a study tool for biology for non-science majors. *Education* 130(1).
- Swan, G.I. 2004. Online assessment and study. In: *Proceedings of the 21st ACILITE Conference*, Perth, Western Australia, 5-8 December.