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Do Weekly Quizzes Improve Student Performance on General Biology Exams?

KURT A. HABERYAN

Encouraging students to study on a regular basis is one of the great challenges of large lecture courses, yet keeping abreast is essential if a student is to avoid feeling overwhelmed at exam time. One solution may be to motivate students to study smaller units of knowledge on a more frequent basis, e.g., for weekly quizzes. In addition, if the quiz format is different from exam format, students may feel less disadvantaged than in a multiple-choice-only course.

Previous investigators have offered quizzes, which enhance attendance, reading, and student confidence (Ehrlich, 1995; Ruscio, 2001; Sporer, 2001; Wilder et al., 2001). In addition to encouraging more regular study (rather than 'cramming'), quizzes may provide feedback on where students should focus their effort at exam time, and may reduce student anxiety (Sporer, 2001). Quizzes have been demonstrated to have a greater positive impact than do definition-based homework assignments, especially in low-GPA students (Tuckman, 1996). In some applications, quizzes have little value in encouraging reading for comprehension (Johannessen, 1995). However, one serious limit of most of these studies is a lack of direct evidence that learning has improved.

To assess the impact of quizzes, I added a quiz component to two college-level General Biology classes. I hypothesized that weekly quizzes would improve student performance on regular hourly exams.

Methods

In the fall of 1998, I taught two sections of college-level General Biology (Bio 102), using only four exams to determine student grades. Exams consisted of 50 multiple-choice questions, except the final exam that included 12 additional comprehensive questions based on material from the entire course. Section 98-03 met for 50 minutes at noon on Mondays, Wednesdays, and Fridays, while Section 98-05 met for 75 minutes at 2 p.m. on Tuesdays and Thursdays.

Two years later, in the fall term of 2000, I re-used the same exams for two additional sections (Sections 00-03 and 00-05) which met at precisely the same time as their sister sections in 1998. Sections 98-03 and 00-03 were given one identical set of exams, while Sections 98-05 and 00-05 were given a different, but internally identical, set. In addition, the first exam and the final exam were identical for all four sections, to detect any intrinsic differences in the abilities of the sections.

The experimental sections (in 2000) experienced weekly quizzes beginning the week after the first exam, whereas the control sections (in 1998) experienced no

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quizzes. On scheduled days, quizzes were given at the beginning of class, and consisted of five to seven fill-in-the-blank questions, based on lecture material since the last quiz or exam, as well questions from assigned readings (from previous lectures, or for that day's lecture). Quizzes for the two sections were distinct, and students were allowed to drop the worst grade from their eight quizzes. For students with legitimate excuses for missing a quiz (e.g., excuse from physician, dean, or coach), missing quiz grades were replaced with their average of all remaining quizzes.

Each section was specifically given the identical lecture sequence, overheads, study material, and textbook, etc., to minimize inconsistencies. In addition, the companion labs were taught in the same sequence in both years, and attendance policy was identical and equally applied (I take attendance on days when it seems low, and alternate between +1 and -1 adjustments to the total course grade). The major difference between 1998 and 2000 sections was the method of delivery: In 1998, standard dry-erase boards were used, but in 2000 material was presented as a document camera display of my master notes. In both cases material was presented in outline format and was virtually identical.

A journal was also kept for the experimental classes, which were surveyed on their experience in December of 2000. The survey questions addressed how much time students spent studying for exams and for quizzes, and whether students felt that studying for quizzes helped on the exams. A final question asked if the students would have preferred the same course without quizzes.

For statistical analysis, I excluded all grades of students who missed one or more exams, leaving 54 to 59 students in each section. Only raw student grades were included. Averages of student grades were compared using students' *t*-tests, with $p=0.05$ and $n_1 + n_2 - 1$ degrees of freedom.

Results

Comparison of Sections

General Biology is primarily composed of non-majors. Freshmen were the most numerous academic class in one of the four sections (00-05), but sophomores were the most numerous group in the remaining three sections (Table 1). The Composite ACT scores for these sections varied little, based on a large subsample (82 to 100% of the class). However, performance on the first exam, which was identical for all four sections, varied markedly (from 64.6% to 68.9%), but no significant difference was found between any sister sections (i.e., between 98-03 and 00-03, or between 98-05 and 00-05).

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Table 1.

Comparison of the four sections compared in the study. Size refers to the number of students taking all four exams. ACT score refers to composite ACT score upon entering college and its 'n' indicates the number of student scores available.

SECTION	SIZE	PERCENTAGE COMPOSITION				ACT SCORE avg \pm std dev (n)	FIRST EXAM avg \pm std dev
		Fresh.	Soph.	Junr.	Senr.		
98-03	59	19	44	32	9	21.16 \pm 3.10 (51)	68.92 \pm 12.48
98-05	55	32	56	9	7	22.38 \pm 3.41 (45)	65.85 \pm 14.59
00-03	54	11	60	19	11	21.78 \pm 3.60 (54)	66.96 \pm 14.57
00-05	55	44	36	13	9	21.93 \pm 3.72 (55)	64.59 \pm 15.09

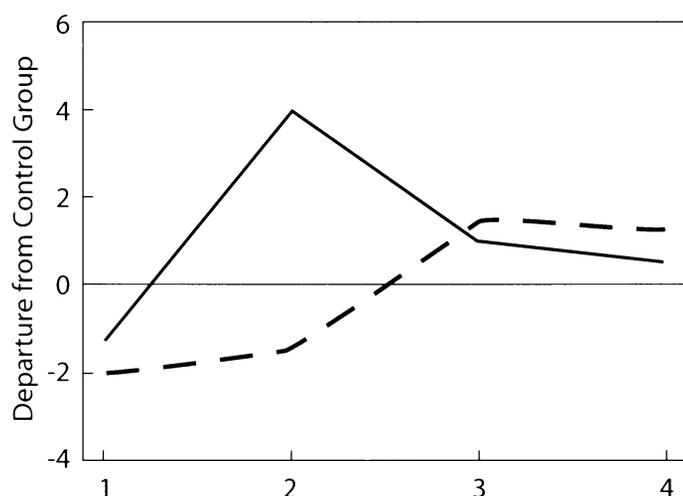
Table 2.

Student performance on the last three exams for each section.

Section	Second Exam avg \pm std dev	Third Exam avg \pm std dev	Final Exam avg \pm std dev
98-03	65.76 \pm 11.62	63.22 \pm 10.46	64.93 \pm 9.40
98-05	59.62 \pm 16.07	67.13 \pm 12.42	64.44 \pm 11.73
00-03	64.30 \pm 13.41	64.70 \pm 13.18	66.24 \pm 10.75
00-05	63.59 \pm 12.32	68.15 \pm 12.49	64.94 \pm 13.46

Figure 1.

Comparison of exam averages for the quizzed (experimental) sections relative to their respective unquizzed (control) sections. Dashed line refers to Section 00-03; solid line, Section 00-05.



These data suggest that the sections were composed of students of comparable abilities.

Exam Scores

Average exam scores for Exams 2 to 4 varied from 59.62 to 68.15 (Table 2). In general on these exams, the quizzed sections in 2000 tended to do somewhat better (except for 00-03 on Exam 2) than their sister sections in 1998, by up to 4% (Figure 1). None of these averages was significantly different ($p=0.05$).

Quiz Scores

Although irrelevant to the research hypothesis, students performed poorly on the first four quizzes (average of the first four quizzes was 54% and 45% for 00-03 and 00-05, respectively). Subsequent quizzes were less difficult and grades improved (average of the last four quizzes was 77% and 73%, respectively). Overall, the scores averaged 69% and 64% for quizzes in Sections 00-03 and 00-05, respectively.

Journal & Survey

Little unusual activity was noted in the experimental sections, except for one event in 00-05. On October 26, this section expressed displeasure at its low grades on quizzes and on exams, so we discussed the issue for half of the class period. Subsequent quizzes for both experimental sections were considerably easier, although exams remained identical to their sister section from 1998. During the first meeting in November, I polled the experimental sections to gauge their study time relative to the basic University expectation of one hour of study each week for each hour in class (aside from specific study prior to an exam). In 00-03, only 2 students (of about 50 present) indicated they study at least this much; in 00-05, only 4 of the 50 did.

The end-of-term survey revealed that students averaged about 4 to 5 hours of study for each exam, and about 1 hour for each quiz (Table 3). In both experimental sections, a majority of students (57 and

Table 3.

Results of the survey administered to the quizzed sections in 2000, excluding "no opinion" responses. The number of respondents varied from 40 to 47 for each item.

Section	Hours Studied for Each Exam	Hours Studied for Each Quiz	Felt Quiz Study Helped on Exams	Preferred Quizzes
00-03	4.81 ± 3.70	0.96 ± 0.87	67%	67%
00-05	3.59 ± 2.45	0.95 ± 0.78	57%	58%

67% for 00-03 and 00-05, respectively) felt that studying for quizzes helped prepare them for exams. A majority of students in each section preferred having quizzes (58 and 67%, respectively).

Discussion

None of the exams from the experimental (quizzed) sections was significantly (at $p=0.05$) higher than the same exam from the control (unquizzed) sections (Figure 1). The greatest difference was a 3.97% higher grade on Exam 2 for 00-05 as compared to 98-05, but the significance level exceeded 0.07. If quizzes have an impact, we might expect a greater impact later

in the term. In fact, the performance of Section 00-05 did not improve with time relative to 98-05; Section 00-03 did generally improve relative to 98-03, but not consistently. These observations confirm a previous study, which showed a slight but insignificant improvement in exam grades during random extra-credit quizzing intervals (Wilder et al., 2001).

One possible explanation for the lack of an impact is the use of weekly quizzes in the companion lab course, Bio 103. Labs are scheduled throughout the week and consist of students intermixed from all nine lecture (Bio 102) sections. Quizzes in lab form the primary component of a student's lab grade, but focus on concepts from lab. Because of the similarity between the lecture schedule and the lab schedule, study for a lab quiz might carry over to lecture exams, and therefore the addition of quizzes to lecture may not have enhanced learning or motivation. The synergism of lab and lecture sequencing deserves further study.

According to the survey, most students (58 and 67%) preferred having weekly quizzes; some certainly felt better able to keep up with their studies; and some certainly appreciated an alternate component to their

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course grade. Others may have felt less anxiety at exam time (Ehrlich, 1995; Sporer, 2001). However, the data from the current study do not indicate any measurable improvement in exam scores. Presumably, there was no difference in learning as well. There are no data from 1998 regarding time spent studying; it is certainly possible that students in these unquizzed sections were more prone to 'cram' rather than study in a frequent, low-dose pattern; whereas the quizzed sections in 2000 distributed their studying more evenly over several weeks.

Despite the rigor applied to maintaining the comparability of the sections, there were unavoidable differences that may have affected the outcome. For example, the varying composition of the classes (proportion that are freshmen) may affect student maturity level, motivation, and performance on exams. In addition, with the current data, it is not possible to compensate for the difference in lecture delivery (dry-erase boards in 1998 versus document cameras in 2000). The experimental sections experienced a more complete set of notes and may well have behaved differently than the 1998 sections. Specifically, the 1998 sections may have been more engaged by the delivery style, while the 2000 sections focussed more on copying down information. Although I did endeavor to remain as animated and as engaging in both terms, the potential impact of learning by docu-

ment camera cannot be disregarded. The impact of presentation technology (e.g., document cameras, PowerPoint, etc.) certainly deserves further analysis. It is possible that such an impact caused the depression of grades on the first exam, which was given before any quizzes (Figure 1). However, even if the remaining scores are adjusted accordingly (by 1.96 points for 00-03 and 1.26 for 00-05), only two of the six exams are significantly different (at $p=0.05$) from sister section scores from 1998 (specifically, Exam 2 for 00-05 and Exam 4 for 00-03).

The exam scores were not significantly improved in quizzed sections, but in terms of cost/benefit analysis, was even a minor improvement worth the effort? Instructor effort in support of quizzes included quiz preparation (approximately 20 minutes per week), administering (7 minutes per week, or about 4% of class time), and grading/recording (10 minutes per week). An additional duty involved tracking and dealing with excused absences, which became quite burdensome. Clearly, each instructor should evaluate these constraints in light of the insignificant improvement.

In conclusion, the available data do not suggest any enhanced learning when students are given weekly quizzes, although confounding influences cannot be disregarded. The increased burden on the instructor is an important consideration, but quizzes do not seem to improve performance. Therefore, this study suggests that weekly quizzes are not an effective way to improve student performance.

Acknowledgments

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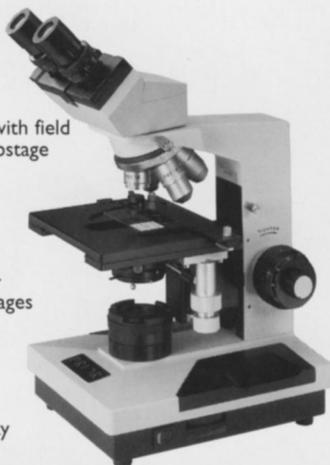
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