Low-Stakes vs. No-Stakes Practice Exams in Anatomy and Physiology Classes: Which One Works Better?

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Low-Stakes vs. No-Stakes Practice Exams in Anatomy and Physiology Classes: Which One Works Better?

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Abstract
Practice exams are a proven tool to increase retrieval of information long-term. Over a three-year period, students in Anatomy and Physiology I and II were offered practice exams as either no-stakes practice exams (years 1-2) and low-stakes practice exams (year 3). Students who took practice exams did significantly better on the actual lecture exams, leading to better grades and higher passing rates for our courses. There was no difference for gender and student population. Students earning credit (low-stakes) were more likely to take the practice exams but their scores on actual exams and their overall scores were lower than those of students who did not earn credit (no-stakes). https://doi.org/10.21692/haps.2020.010

Key Words: no-stakes testing, low-stakes testing, practice exams, Anatomy and Physiology

Introduction
Practice testing can be defined as a low- or no-stakes learning activity completed by students outside of class and/or any type of practice test students are able to complete on their own (Karpicke and Roediger 2007). Practice testing can enhance learning and long-term retention (Agarwal et al. 2012; Roediger and Butler 2011; Dunlosky et al. 2013), and the use of practice testing has been shown to promote learning and retention of content in a more efficient manner than other commonly used study techniques such as repeated reading and repetition (Roediger and Butler 2011). Testing slows forgetting and, consequently, improves the later retrieval of information (Arnold and Mcdermott 2013, Roediger et al. 2011; Utz and Bernacki 2018). Additionally, the attempts to retrieve content through a test may assist students in encoding even if the retrieval attempts were unsuccessful (Dunlosky et al. 2013).

Practice testing can vary in type to include textbook end of chapter reviews, the creation of the learner's own test questions, writing practice exams under exam-like conditions, flash cards, or teacher created practice tests. The widespread use of learning management systems (LMS) and the availability of free websites that allow users to create tests have made it easier for instructors to offer their students practice tests that are specific to the content taught in their classes. Irrespective of the type of practice test, these tests can be used to effectively enhance learning and long-term retention in students while also measuring the contents of memory (Karpicke and Roediger 2007). If students use the practice exams without earning points or extra credit toward their final course grade, the testing is called no-stakes. In low-stakes testing, students can earn points or extra credit to improve their grade on the actual exam or their final grade in the course.

Davis (2013) opined that using practice exams with multiple choice and true-false questions may be especially suitable for classes that focus on the lower levels of Bloom's taxonomy (recall, comprehension, and application) that require students to learn a great deal of new terminology and/or facts and figures.

We introduced no-stakes practice testing for both Anatomy and Physiology with Lab I and II courses in Spring semester 2013. Looking at the exam scores and final grades of our students at the end of the semester, it was apparent that students who had taken all four practice exams in preparation for the actual exams had scored higher on the exams. Consequently, they had higher overall scores and more of them earned a passing grade of A, B, or C (80.9% vs. 50.0% for students who did not take any of the practice exams).

Over the next few years, our lab instructors and I educated students about the benefits of taking the online practice exams using updated data from our courses. I presented posters and workshops on the topic on my own or together with co-authors, for example at the 2015 HAPS Conference in San Antonio, TX and the 2015 SoTL Commons Conference in Savannah, GA.

Unfortunately, despite all our efforts, only about two-thirds to three-quarters of students took all of the practice exams offered. Of particular concern was the fact that lower performing students took the practice exams at fairly low rates; sometimes less than one-third of students who scored lower than 70% on an exam had taken the practice exam.

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Finally, our lab instructors and I agreed to try using low-stakes practice exams in an effort to entice more students to take the practice exams, hoping that this would lead to better scores on exams, better grades, and higher passing rates. This article will review what happened when we switched to low-stakes practice exams and explore whether or not low-stakes or no-stakes practice exams led to better outcomes in terms of student grades.

Methods

Ethical research statement

The ethical review board (Institutional Review Board) of Florida Gulf Coast University (FGCU) research protocol approved this project prior to data collection (FGCU IRB Protocol 2014-63). Data collection followed all laws relevant to the survey of university student populations.

Data collection

For a two-year period, practice exams were offered as no-stakes, online practice exams for Anatomy and Physiology I (A&P I) and II (A&P II). These practice exams had the same number and type of questions as the actual exams, and the students were able to see more than one question at a time. Students were able to go back and change answers based on information gained from other questions before submitting the exam. The questions were testing the same areas as the questions on the actual exam and the exams had the same balance for the different course modules covered. The students were given the same time to complete the practice exams as on the actual test. They were allowed to retake the practice exams up to three times. After submitting the exam, students were able to see which questions they had answered correctly and which ones they had gotten wrong. However, they were not given the correct answers for questions they got wrong until after the third attempt at taking the practice exam. The practice exams opened ten days before the date of the lecture exam and closed the night before the lecture exam.

For the third year of the study, the practice exams were converted to low-stakes exams, using the same questions as before. The students earned 0.2 point for each correct answer compared to two points for each correct answer on the in-class exam. Students were allowed to take the practice exam up to three times; the LMS kept the highest score.

The practice exams and the actual exams were kept the same throughout the study. The content of the actual exams was well guarded to prevent cheating, but the practice exams could not be controlled in the same way since they were posted to the internet.

Data collection for this article was discontinued after year three due to significant changes in content delivery (some of the courses were offered as hybrid courses with virtual lectures) and course materials used (we switched to a new textbook and lab workbook).

Data analysis

A two-sample t-test was used in determining statistical significance for the average exam scores for students who took practice exams versus those who did not.

Results

The study population hardly changed over the three-year period data were collected. During years one and two, overall 1,328 students were enrolled in Anatomy and Physiology I courses, although only 982 (73.9%) students took all four exams. Three-quarters of students who took all exams were female (75.4%), one-quarter was male (24.6%). Sophomores made up the bulk of students (57.8%), followed by juniors (19.3%), freshmen (16.3%), and seniors (5.3%). Twelve students (1.2%) were non-degree or second-degree seeking students.

In Anatomy and Physiology II, 586 of 643 enrolled students (91.1%) took all four exams. The female-to-male ratio was similar to Anatomy and Physiology I (73.9% female and 26.1% male). Sophomore students made up slightly more than half the student population (53.2%) and juniors were again the second biggest group at 27.7%. Seniors (9.0%) and freshmen (8.4%) were almost evenly represented; non-degree or second degree seeking students accounted for 1.7%.

In year three, 537 of 706 students enrolled in Anatomy and Physiology I (76.1%) and 338 of 361 students enrolled in Anatomy and Physiology II (93.6%) took all four exams. Most of these students were female (74.5% in Anatomy and Physiology I; 78.1% in Anatomy and Physiology II). Sophomores still were the biggest group of students in both Anatomy and Physiology I (62.9%) and Anatomy and Physiology II (52.1%), followed by juniors (20.5% in Anatomy and Physiology I; 25.3% in Anatomy and Physiology II). Freshmen made up 11.4% of students who took all four exams in Anatomy and Physiology I and 3.1% in Anatomy and Physiology II. The percentages for seniors were 4.1% for Anatomy and Physiology I and 14.5% for Anatomy and Physiology II; for non-degree or second degree seeking students the percentages were 1.1% for Anatomy and Physiology I and 5.0% for Anatomy and Physiology II.

The percentage of Anatomy and Physiology I students taking no-stakes practice exams was almost constant for exam 1-3 at 71-75% but dropped below 65% for the final exam (Table 1). The corresponding percentages for Anatomy and Physiology II were lower throughout but did not drop as much for the final.

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As to be expected, almost 100% of Anatomy and Physiology I and II students took the low-stakes practice exams during year three and the percentage did not drop for the final (Table 1).

Students in both Anatomy and Physiology I and II who took all practice exams as no-stakes exams scored higher on the final exam and had a higher overall exam score than students with low-stakes practice exams. However, the difference in the overall exam score was not significant (Table 2).

		Exam 1	Exam 2	Exam 3	Final
No-stakes PE	A&P I (n = 982)	75.1%	71.3%	72.3%	64.9%
	A&P II (n = 586)	68.1%	64.0%	66.4%	62.6%
Low-stakes PE	A&P I (n = 537)	97.0%	98.1%	98.0%	96.1%
	A&P II (n = 338)	97.1%	97.1%	97.9%	97.9%

Table 1. *Percentage of students taking the practice exam for all exams in Anatomy and Physiology I and II as no-stakes or low-stakes practice exams (PE)*

		Score final exam	Overall exam score
No-stakes PE	A&P I (n = 457)	78.7%	78.3%
	A&P II (n = 242)	79.0%	77.1%
Low-stakes PE	A&P I (n = 490)	75.3%	76.7%
	A&P II (n = 312)	75.0%	75.1%

Table 2. *Test scores on final exam and overall exam score for students who took all four practice exams during the semester for Anatomy and Physiology I and II and no-stakes or low-stakes practice exams (PE)*

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Anatomy and Physiology I and Anatomy and Physiology II students taking no-stakes and low-stakes practice exams practice exams scored significantly higher on each exam (Table 3).

Both female and male students who took no-stakes or low-stakes practice exams scored significantly higher on the actual exams than students who did not take any practice exam during the semester (Table 4). There was no difference for the different student populations (freshman, sophomore, etc.) and whether low-stakes or no-stakes practice exams were offered.

		Exam I	Exam II	Exam III	Final Exam
No-stakes PE					
A&P I	Took PE	77.9%	77.1%	74.3%	77.2%
	Did not take PE	73.7%	71.3%	63.5%	65.9%
	p-value	< 0.001*	< 0.001*	< 0.001*	< 0.001*
A&P II	Took PE	73.3%	78.6%	72.3%	78.0%
	Did not take PE	69.3%	73.4%	69.2%	70.0%
	p-value	< 0.001*	< 0.001*	0.036*	< 0.001*
Low-stakes PE					
A&P I	Took PE	79.7%	75.7%	75.1%	72.0%
	Did not take PE	72.1%	67.3%	64.1%	58.2%
	p-value	0.003*	0.002*	0.011*	< 0.001*
A&P II	Took PE	76.2%	79.0%	72.8%	74.8%
	Did not take PE	72.1%	71.9%	65.2%	68.3%
	p-value	0.034*	0.032*	0.031*	0.009*

* denotes statistical significance

Table 3. *Exam score averages for all four exams for students who took the practice exam (PE) and those who did not. (A two-sample t-test was used in determining statistical significance.)*

	Male		Female	
	A&P I	**A&P II**	**A&P I**	**A&P II**
No-stakes PE				
Took PE	77.0%	77.5%	76.8%	75.7%
Did not take PE	70.2%	71.3%	61.0%	70.9%
p-value	< 0.001*	0.008*	< 0.001*	< 0.001*
Low-stakes PE				
Took PE	76.9%	78.9%	76.5%	74.0%
Did not take PE	51.0%	72.5%	59.9%	66.7%
p-value	0.003*	0.009*	< 0.001*	0.003*

* denotes statistical significance

Table 4*: Comparison of overall test score in exams based on gender based on whether students took the practice exams (PE) versus none.*

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Discussion

Based on the results of this study, practice exams have to be considered a valuable tool for student success in Anatomy and Physiology I and II classes. Students who took no-stakes or low-stakes practice exams did significantly better on the actual lecture exams, leading to better grades and higher passing rates for our courses. There was no difference in success based on gender and student population.

For the courses with no-stakes practice exams, the percentage of students taking the practice exams was highest before exam 1 for both Anatomy and Physiology I and II, declined slightly for exam 2 and 3, before dropping to its lowest percentage for the final exam. Although there may have been some testing fatigue at the end of each semester, the main reason for the drop for the final exam was that students either knew that they would not be able to earn a better grade or were not in danger of dropping down to a lower grade regardless of their performance on the exam. For example, a student with a pre-final exam overall score of 85% would only need to score 73% on the final exam to earn a B as a final grade; on the other hand, the same student would need to score above 90% to earn a B+. Even though I did not gather survey data on this question, there is anecdotal evidence to back up this hypothesis and the data support it as well. Eighty percent of students who earned an A as a final grade took practice exams one to three but only 73.6% took the practice exam before the final.

As expected, the percentage of students taking low-stakes practice exams remained more or less constant throughout the semester at close to 100%. Even students who had no chance of earning a passing grade took the practice exam before the final exam. The automatic pursuit of "easy" points appears deeply ingrained in many of these students.

At first glance, it is surprising that Anatomy and Physiology I and II students in classes with no-stakes practice exams had higher scores on the final exam and higher overall exam scores on the four lecture exams. After all, fewer Anatomy and Physiology I and Anatomy and Physiology II students took practice exams compared with the classes that took low-stakes practice exams. It was expected that having more students take the practice exams would lead to higher exam scores; this was the reason we made the switch to low-stakes practice exams. The answer to this riddle may lie in the students' motivation for taking practice exams.

For example, in the no-stakes practice exam classes, of 391 Anatomy and Physiology I students who withdrew from class during the semester, only 89 students (22.8%) took practice exam 1, 42 students took practice exam 1 and 2 (10.7%), and only five students took practice exams 1-3 (1.3%). In contrast to that, of the 110 students who earned a final grade of A, 88 students (80.0%) took practice exams 1-3 and 81 students (73.6%) took all four practice exams. The percentages for Anatomy and Physiology II were similar. A breakdown of when students took the practice exam for the first time reveals that less than a quarter (24.2% in Anatomy and Physiology I; 23.6% in A%P II) took the practice exam for the first time on the day before the actual exam and that 60.8% of Anatomy and Physiology I students and 57.9% of Anatomy and Physiology II students took each practice exam more than once.

Student behavior changed with the switch to low-stakes practice exams. Almost 40% of Anatomy and Physiology I students (39.2%) and more than one-third of Anatomy and Physiology II students (34.6%) took each practice exam for the first time on the last day it was available. More students took the practice exam one time only and up to two-thirds of these students completed the practice exams in less than half the allotted time. Most students scored fairly high on the practice exams; for example, the average score on practice exam 1 was 91.1% while the average score on exam 1 was 79.3%. This difference may be indicative of students using additional input to earn more points on the practice exams. Some students answered all practice-exam questions correctly within a few minutes, consistent with consultation of answer keys on test archive websites such as Quizlet.com or CourseHero.com.

Faculty often received emails from students who asked for permission to take the practice exam after it had been closed because they "*needed the points*". Anecdotal evidence from talking to students in class or during office hours also points to students regarding the practice exams mainly as a means to improve their overall grade by earning the points. Our message that retrieval practice improves performance in exams and that taking the practice exams repeatedly enhances long-term retention seemed to be overshadowed by the point value of these practice tests.

Students in Anatomy and Physiology classes usually need the best grades they can get to be admitted to restricted-access undergraduate programs, such as nursing, or graduate school (Occupational Therapy, Physical Therapy, and Physician Assistant) at our institution. Earning an A instead of a B can make all the difference for them. For example, our Exercise Science program requires students to earn a B in both Anatomy and Physiology I and II before they are accepted into upper level classes. Requirements like this cause some students to worry primarily about the grade and not the learning, despite faculty exhortations to the contrary.

After seeing that exam scores and final grades did not change when using low-stakes practice exams, we decided to go back to no-stakes practice exams. We felt that using low-stakes practice exams had caused more pre-exam stress for our students and for us, without improving outcomes. The percentage of students taking practice exams dropped to two-

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thirds to three-quarters as the semester progressed. However, when we were forced to switch our in-person classes to online instruction during the Spring 2020 coronavirus pandemic, close to 90% of students in Anatomy and Physiology I and II took the practice exams and almost two-thirds took them more than once. It will be interesting to see whether this experience will change student attitudes toward practice exams when we return to in-person classes.

Conclusion

Previous studies have shown that, when used as intended, i.e., as a retrieval practice, practice exams improve student performance in actual exams in science classes. The problem for instructors lies in convincing students that practice exams have value apart from any points that are awarded simply for taking them. Future studies should use surveys or interviews to explore student attitudes toward and opinions on the benefits of practice exams.

About the Author

Peter Reuter, MD, PhD, is an Associate Professor at Florida Gulf Coast University where he teaches undergraduate and graduate Anatomy and Physiology courses. He is a member of the Honors College Executive Board and an Honors College Faculty Fellow.

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