Use of Electronic Anatomy Practical Examinations for Remediating “At Risk” Students

Frank J. Daly*
Department of Biological Sciences, University of New England, Biddeford, Maine

Restrictive laboratory scheduling, an increasing number of human cadaver-based anatomy courses and a reduction in the curricular time allotted to anatomy courses have created problems with cadaver laboratory access at the University of New England. This article describes a combination of anatomy testing and grading strategies to allow “at risk” (borderline failing) students an opportunity to remediate their lowest set of examination scores and pass their anatomy course. An alternative electronic practical examination for these students provided flexibility in laboratory scheduling, thereby increasing laboratory access for other students taking concurrent courses. Specifically, the electronic examinations allowed for a reduction in the amount of time the cadaver laboratory is locked down for examination purposes. Masters-level occupational therapy (MOT) students, physician assistant students (MPA), and doctoral level physical therapy (DPT) students participated in a prosection-based human cadaver laboratory and take cadaver-based practical examinations as part of their anatomy course. Students who were not performing at a passing level for their curriculum (69.5% for MOT and MPA, 79.5% for DPT) were given an opportunity to remediate their lowest set of multiple choice and practical examinations using the previous year’s multiple choice examination and a new electronic practical examination. When the original cadaver-based practical and multiple choice examination scores were replaced with the remedial electronic practical examination and remedial multiple choice examination scores, 75% (24/32) of these students were able to successfully remediate their academic deficiencies and pass their anatomy course. Anat Sci Educ 3:46–49, 2010. © 2009 American Association of Anatomists.

Key words: gross anatomy; computer-assisted examination; physical/occupational therapy; physician assistant; remediation; laboratory assessment

INTRODUCTION

An opportunity to study biological variation underscores an important concept in medicine (Ellis, 2001; Cahill et al., 2002; Older, 2004). At the University of New England, a prosection method of cadaver-based instruction was used for human gross anatomy courses for masters-level occupational therapy (MOT), masters-level physician assistant (MPA), and doctoral-level physical therapy (DPT) students. Prosection-based courses allowed the students to spend their laboratory time studying the structures and seeing as many different examples as possible. The prosections for the cadaver-based laboratories were performed during the summer by medical students who had completed their first year anatomy course and were under the direction of an anatomy faculty member. The summer MPA prosection-based anatomy courses did not coincide with another gross anatomy course. The reduction in MOT and DPT student laboratory time devoted to the prosection-based course allowed for additional cadaver-based courses to be run concurrently in the laboratory.

Three simultaneous human gross anatomy courses ran at the University of New England during the fall semesters of 2004 through 2008: medical gross anatomy, MOT gross anatomy, and DPT gross anatomy. The concurrent courses allowed students participating in prosection-based courses to see more than 30 different medical gross anatomy cadaveric dissections, all without having to dissect on their own. Medical students had dissection-based laboratories that alternated with the MOT and DPT prosection-based laboratories, so
that when the medical students were in lecture, the DPT or MOT students were in the cadaver laboratory (and vice versa). All of the MOT, MPA, or DPT students were required to attend the scheduled prosection-based laboratory sessions. Even with the prosection-based laboratories, there were still students who did not pass gross anatomy. These “at risk” students (borderline failing) were poorly performing students who were just under the pass-fail cutoff. The university strongly encouraged student retention and remediation examinations often needed to be offered to keep these students in their programs.

Concurrent cadaver-based courses lead to tight scheduling in the anatomy laboratory. Regular course examinations create additional laboratory access issues due to set up time. Students who need to take examinations outside of scheduled laboratory time create even more laboratory access problems. There was limited time and space in the laboratory to accommodate for make-up or remedial practical examinations. This article discusses an alternative electronic examination for these remedial students to avoid laboratory time conflicts.

DESCRIPTION

Prosection Anatomy

The DPT, MOT, and MPA laboratory sessions were based on a human anatomy prosection guide (Daly, 2008). Small student groups (6–13) were led by anatomy faculty and medical student instructors. During the laboratory, prosections, medical student dissections, and plastic models were freely available to the students. Outside of scheduled laboratory time and barring conflicts with other scheduled cadaver laboratory time, students had access to the cadaver laboratory through a swipe card security system. The laboratory was regularly open to all students from 5:00 PM to midnight daily.

The students taking the prosection-based courses took a total of four equally weighted multiple choice and practical examinations based on upper extremity, lower extremity and back, head and neck, and thorax, abdomen, and pelvis, respectively. The cadaver-based practical examinations only consisted of identification-type questions in which the students could rotate freely in an untimed format. More advanced anatomical knowledge was examined in the multiple choice examinations outside of laboratory practical examinations.

At Risk Students

Students who were not performing at a passing level for their curriculum by the end of the anatomy course (<69.5% for MOT and MPA, <79.5% for DPT) were given an opportunity to remediate their lowest set of examination grades (multiple choice and practical). The remediation examination scores replaced the student’s original examination scores and a new course grade was determined. The intention of this process was to attempt to keep competent, but marginal, students enrolled in their respective programs, while identifying poorly performing students to repeat the curriculum. Students who were significantly below the pass-fail cutoff (with no chance to successfully remediate even with a 100% on examinations) were not included in the remediation process.

Remediation Computer Practical Examination

High-resolution images from the Color Atlas of Anatomy (Rohen et al., 2006) were scanned and used to create the electronic practical examination. Images were cropped to remove all text labels, but the leader lines were retained. Images were imported into PowerPoint and simple labels to identify the structure or space, similar to the cadaver-based practical examinations, were added. The corresponding original (nonsequential) leader line number was indicated in the title of the slide to further direct the students.

At risk students were instructed that their remediation electronic practical examination would be based entirely on the Color Atlas of Anatomy (Rohen et al., 2006). The examination was restricted to topics covered in the prosection laboratory manual (Daly, 2008). Students were given the semester break (1–4 weeks) to restudy the course material. The upper extremity examination (covering the least amount of material) had a potential of at least 142 images and 1,590 labeled structures. The head and neck examination (covering the most amount of material) had a potential of at least 389 images and 4,642 labeled structures. Like the cadaver-based practical, students were responsible only for identification of structures in the untimed electronic practical examination.

Like Carmichael and Pawlina (2000), the electronic practical examination was transported on a flash drive, but presented on individual computers. This allowed the students to take the examination at their own pace. Because each student had an independent examination, they were able to move indicator arrows that obscured numbers or other structures and change the zoom ratio on the images without affecting other students. At all times, an examination proctor was present to monitor the students.

Remediation Results

Sixteen DPT, fifteen MOT, and two MPA students over 5 years (2004–2008) were given the opportunity to take the remediation examinations. An additional 21 students (DPT, MOT, and MPA) did not pass the anatomy course with sufficiently high enough grades to warrant remediation. A total of 515 students took these courses between 2004 and 2008 and the remedial (32) and failing (21) students represent 10.3% of the DPT/MOT/MPA population.

Two groups of data presented are based on the passing grade required by the masters and the doctorate curricula (<69.5% for MOT and MPA, <79.5% for DPT). The at risk MOT and at risk MPA students’ original cadaver-based practical examination scores averaged 49.9 ± 11.1 SD (standard deviation; range 31–74 of 100) and their original multiple choice examinations averaged 55.4 ± 10.1 SD (range 40–68). The remediation examinations resulted in the at risk MOT and at risk MPA student averages increasing to 69.9 ± 12.2 SD (range 44–87) on the electronic practical examination and 62.1 ± 10.8 SD (range 42–80) on the remediated multiple choice examination. The average change in examination scores was 20.0 points on the electronic practical and 6.7 points on the multiple choice examination.

The at risk DPT students’ original cadaver-based practical examination scores averaged 60.5 ± 13.6 SD (range 37–84) and their original multiple choice examinations averaged 68.3 ± 9.4 SD (range 54–86). The remediation examinations resulted in the at risk DPT student averages increasing to 81.2 ± 10.1 SD (range 52–91) on the electronic practical ex-
amination and 81.3 ± 10.5 SD (range 54–96) on the reme-
dial multiple choice examination. The average change in ex-
amination scores was 20.7 points on the electronic practical and 13.0 points on the multiple choice examination.

When the original cadaver-based practical and multiple choice examination scores were replaced with the electronic practical and remedial multiple choice examination scores, 75% (24/32) of the students were able to successfully pass the course. The at risk MOT and MPA students went from a course average of 65.4 ± 4.7 SD (range 52.1–68.8) to 68.1 ± 4.0 SD (range 58.2–71.6). The at risk DPT students went from a course average of 75.4 ± 4.4 SD (range 63.9–79.2) to 79.6 ± 4.5 SD (range 64.9–83.3). Those students who still did not pass the course (8/32) either chose to withdraw from the program or chose to retake the course the following year.

DISCUSSION

When a student repeats an examination, it is expected that they will do better the second time around. There was an increase in the students’ performance on the remediation examinations versus their original examinations. Scores on the electronic practical examinations increased 20.4% and scores on the multiple choice examinations increased 9.7%. This resulted in an average increase of the students’ course grade by 3.4%. This increase in scores could be due to a variety of factors that were different for the remediating students. Remediating students were given an extra one to four weeks of study time to prepare for the remediation examinations. The remediation examinations also took place when the students were not taking other courses nor preparing for other examinations.

The nature of the electronic practical examinations might also have given the students an advantage. Remediating students knew exactly which set of images would be used on the examination. The same types of questions were asked on the remedial examinations (identification only), but it is unlikely that students would have been able to memorize the 140–389 images with 1,600–4,600 identified structures. It may have been that the electronic practical examinations were significantly easier than the original cadaver-based practical examinations. Yet even with the relative ease of the electronic practical, not all at risk students successfully passed the course. Eight of the remedial students still had to retake the course or had to withdraw from their program.

There are benefits and drawbacks in using electronic practical examinations in anatomy courses. Some of the benefits include the following: time savings because there is no need for set up or break down of computer-based practical examinations; the ability to easily change examinations from year to year; the ability to proctor multiple practical examinations (extremities, head and neck, thorax, abdomen, and pelvis) within a single examination session; increased examination security; and lack of laboratory access conflicts. Electronic practical examinations also remove the need to retain cadavers over extended periods of time or provide new dissections after the regular course has been completed to allow for student remediation. These electronic examinations may also be useful for high performing students who were absent on examination days.

A significant benefit of the electronic practical is that it did not require the cadaver laboratory to be locked down to ensure security of the examination process. Normally, it takes at least two hours to prepare a cadaver-based practical. Of-
were based on a published atlas, the students did not have the opportunity to dissect during the course. An ideal way to present the electronic practical in the future would be to photograph the student dissections and prosections and create an examination from those images.

Electronic examinations, as presented in this article, may also not work as well with large groups of students. For students to proceed at their own pace and retain the ability to move arrows or change zoom, students need to have their own computer for the examination. Obviously, students should not have access to the Internet or prior access to the computers to ensure examination security. Therefore, electronic examinations such as this require the use of multiple computers, which can be cost prohibitive. This article discussed examinations restricted to four students at a time. It was a simple task to proctor the remedial students and maintain the security of the examination in a controlled situation. With larger groups, significant time and effort must be spent distributing and securing the electronic examination. It makes less sense to deal with individual computers for a large number of students. With enough students taking the same examination, it is worthwhile to set up a cadaver-based practical examination.

In conclusion, this article shows that it is possible to examine students using electronic resources while still maintaining the integrity of a cadaver-based laboratory course. Although it may not be academically ideal to examine students using electronic resources, it is critical to be able to provide access to cadaveric laboratories that give the greatest benefit to the most students. Laboratory lockdown for individual students’ examinations can now be eliminated.

NOTES ON CONTRIBUTORS

FRANK DALY, Ph.D., is an associate professor in the Department of Biological Sciences and the Physician Assistant program at the University of New England, Biddeford, Maine. He teaches human gross anatomy and neuroscience to graduate students in physical therapy and physician assistant programs and undergraduate occupational therapy students.

LITERATURE CITED